Preliminary Economic Assessment
Firebag River Sand Property

Submitted to:
Athabasca Minerals Incorporated

Project Number: 761-1

Report Date: Effective Date:
March 3, 2015 November 26, 2014

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CERTIFICATE OF QUALIFICATIONS

I, Theresa Lavender, P. Eng., do hereby certify that:

1. I am currently employed as Manager, Mining, Suite 2700, 411 – 1st Street SE. Calgary, Alberta, Canada T2G 4Y5.
2. I graduated with a Bachelor of Science degree in Mining Engineering from the University of Alberta in 2000.
3. I am a member of the Association of Professional Engineers and Geoscientists of Alberta, (Member #65015).
4. I have worked as a mining engineer for 15 years since my graduation from university. My work experience includes 5 years of employment at various surface mining operations in Western Canada. Since 2005 I have been employed as a consultant to the mining industry. This work has included various assignments to either existing or potential surface mining operations.
5. I have read the definition of "qualified person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfil the requirements to be a "qualified person" for the purposes of NI 43-101.
6. I am responsible for the preparation of parts of Section 1, and Section 15 through Section 28 of the report titled "Preliminary Economic Assessment Firebag River Sand Property" dated March 3, 2015, Effective Date November 26, 2014 (the "Preliminary Economic Assessment Report").
7. As at the effective date of the Preliminary Economic Assessment Report, to the best of my knowledge, information and belief, the sections of the Preliminary Economic Assessment Report that I am responsible for contain all the scientific and technical information that is required to be disclosed to make the Preliminary Economic Assessment report not misleading.
8. I personally visited the property Tuesday, October 7, 2014.
9. I am independent of the issuer applying all of the tests in Section 1.5 of National Instrument 43-101.
10. I have read NI 43-101 and Form 43-101F1, and the Preliminary Economic Assessment Report has been prepared in compliance with that instrument and form.

Dated this 3rd day of March, 2015.

"Original Signed and Sealed" by

____

Theresa Lavender, P. Eng.
Manager, Mining

CERTIFICATE OF QUALIFICATIONS

I, Ted Hannah, P.Geo., P. Geol. do hereby certify that:

1. I am currently employed as Vice President Geology, by Norwest Corporation, Suite 2700, 411 – 1st Street SE., Calgary, Alberta, Canada T2G 4Y5.
2. I graduated with a Bachelor of Science degree from the University of New Brunswick in 1973.
3. I am a member of the Association of Professional Engineers, Geologists and Geophysicists of Alberta, (Member #22009) and the Association of Professional Engineers and Geoscientists of British Columbia, (Member #27030).
4. I have worked as a geologist for a total of forty-one years since my graduation from university. My work experience includes thirty-nine years of exploration and mining support on a variety of coal properties around the world. I have conducted sampling and supervised drilling at various locations in this coal basin adjacent to this property. I performed numerous geological interpretations and analyses during that period.
5. I have read the definition of "qualified person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
6. I am responsible for the preparation of parts of Section 1, Sections 2 through 14, and Sections 24 through 28 of the report titled "Preliminary Economic Assessment Firebag River Sand Property" dated March 3, 2015, Effective Date November 26, 2014 (the "Preliminary Economic Assessment Report").
7. As at the effective date of the Preliminary Economic Assessment Report, to the best of my knowledge, information and belief, the sections of the Preliminary Economic Assessment Report that I am responsible for contain all the scientific and technical information that is required to be disclosed to make the Preliminary Economic Assessment report not misleading.
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Dated this 3rd day of March, 2015.

"Original Signed and Sealed" by

Ted Hannah, P.Geo., P. Geol.
Vice President, Geology

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1 SUMMARY

In June of 2014, Athabasca Minerals Incorporated (AMI) and Norwest Corporation (Norwest) met to discuss the Firebag River Sand Property (Firebag Property/Project). AMI advised Norwest that APEX Geoscience Ltd had been commissioned to prepare a NI 43-101 Technical Report for the Firebag Property and asked for advice with respect to appropriate engineering studies. Norwest advised AMI that a Preliminary Economic Assessment (PEA) would provide the required engineering and economic analysis for the project in a format suitable for public disclosure. It should be noted that the level of engineering required to support a PEA is not considered sufficient to define “reserves”. It should also be noted that the entire Firebag River Sand Property “resource” has been classified as inferred.

The resource estimate is prepared in accordance with the requirements of the Canadian public reporting system, National Instrument 43-101. The effective date for the PEA is November 26, 2014 which is the date on which the last technical information to be included in the report, the resource estimate and classification, was made. The principal source of data concerning geology, drilling, frac sand quality testing and many other technical aspects, were obtained from the recently completed exploration program, public data sources or were provided by AMI.

1.1 Project Description

The Firebag Project is composed of three components; the mine site where the raw silica sand is mined, the Lynton trans-loading area, and the yet to be defined site in the Edson/Hinton site, where the ROM silica sand will be processed to produce a marketable frac sand product.

For the purposes of this report, the Edson/Hinton area will be referred to as the Edson area due to the uncertainty of the location of the processing plant at the time this report was authored. Also, in the cost analysis, the travel time of the rail cars on the Canadian National Railway Company (CN) rail line is to the town of Edson, Alberta.

1.2 Property Location

Firebag Property consists of two Surface Materials Leases (SML). These two SMLs are contiguous to each other. They are located in N ½ Section 8-99-08-4 within the Regional Municipality of Wood Buffalo (RMWB) and the Waterways Forest Area. The leases are located approximately 95 km north of Fort McMurray and 130 km southwest of Fort Chipewyan, at latitude 57°34’36.0156” and longitude -111°16’44.1372”. The primary focus of this PEA is SML 130021

(32.36 ha), SML 120032 (174.59 ha), License of Occupation (DLO) 130748 and Miscellaneous Lease (DML) 130162.

1.3 Property Geology

The Western Canada Sedimentary Basin (WCSB) represents the majority of Alberta's geology; it comprises a Phanerozoic wedge of strata overlying the crystalline Precambrian basement. This wedge measures up to 7,000 m thick; it is adjacent to the foothills and diminishes to its zero edge along the Canadian Shield to the northeast (Mossop and Shetsen, 1994).

The Athabasca Region lies along the inactive, eastward thinning margin of the WCSB where sediments overlap the southwest-dipping Precambrian Shield. Quaternary surficial deposits that are dominated by glaciofluvial and glaciolacustrine sediments cover the sedimentary rocks of the WCSB. The sources of frac sand at the Firebag Property might originate from the following processes:

- reworked deposits resulting from glacial and eolian processes;
- within a Quaternary glacial outwash; and
- deposited on the Cretaceous unconformity.

These frac sands are made up of rounded and sorted quartz-rich grains with few impurities. The potential sand-producing formations include McMurray, Grand Rapids and Pelican.

Silica sand, frac sand or proppant (i.e., propping agents) is a durable, round-grained, crush-resistant material produced for oil and gas hydraulic fracturing, otherwise known as fracking. Fracking is used in the oil and gas industry to increase the flow of oil and/or gas from a well. Using hydraulic pressure, the producing formation is fractured open, and then proppants are pumped into the well with fracturing fluid to hold the fissures open so that the natural gas or crude oil can flow up the well. The proppant's size, shape and mechanical strength influence the integrity of the newly created fractures, and, therefore, the flow of oil and gas from the well.

1.4 Exploration

During 2010, AMI conducted a preliminary evaluation of potential Devonian aggregate exposures in the general region of the Firebag Property. Surface Quaternary sand samples were also collected by AMI for geochemical analysis: the results showed high silica content along with grain-size fractions potentially suitable for frac sand.

Subsequently, two 2011 auger drill hole and backhoe test pit programs were launched to define the extent and quality of a potential high grade silica sand deposit at the Firebag Property. The analytical portion of the program was revisited in 2014.

1.5 Sand Quality

In January 2011, AMI conducted a 19-hole auger drill survey to test the aggregate potential of the Quaternary sand at the Firebag Property. The results of this program showed that the Firebag Property is dominated by silica sand that has the following characteristics:

- laterally extensive and consistent to depths exceeding 24 m;
- high in silica content (mean of 92% silica; n=135 samples);
- favourable grain-size distributions where the average sieve analyses yielded: 4.3% in the +20 mesh; 19.4% in the 20/40 mesh; 44.2% in the 40/70 mesh; 15.2% in the 70/100 mesh; and 16.9% in the -100 mesh size fractions; and
- roundness and sphericity measurements of between 0.6 and 0.8, which satisfy the International Standards ISO 13503-2:2006/Amd.1:2009E recommendations for proppant (0.6 or greater) and high strength proppant (0.7 or greater).

In December 2011, a follow-up exploration program to investigate the depositional aspects of the Quaternary sand was conducted.

The resulting December 2011 backhoe test pit and auger drill programs consisted of 26 test pits and six auger holes. The resulting logging confirmed that the Quaternary sand had a uniform depositional composition at the transition point between the uppermost fine to medium-grained eolian silica sand and coarse glacial outwash sand; this occurs at a depth of approximately 15 m. This observation is important as the uppermost (i.e., at or near-surface) sand generally has the highest silica content, 20/40 mesh size fraction sand and positive proppant test work results.

1.6 Frac Sand Resources

Using no base cut-off for the silica sand, this Firebag Inferred Resource estimate predicts that 39.244 million tonnes of in-situ silica sand is present within the Firebag Property resource area (bounded by SML 130021 and SML 120032), which includes the following:

- 33.120 million tonnes in SML 120032; and
- 6.123 million tonnes in SML 130021.

1.7 Mineable Resource Estimates

Mining criteria and recovery of select material at the processing plant were used to estimate the Firebag Inferred resource, effective November 26, 2014. The resource estimate predicts that 24,642,450 ROM tonnes, or 22,727,650 clean metric tonnes, of silica sand are present within the Firebag Property resource area (bounded by SML 130021 and SML 120032), which includes the following:

- 19,257,610 million clean tonnes in SML 120032; and
- 3,470,040 million clean tonnes in SML 130021.

The PEA is a conceptual study of the potential viability of the Firebag Project. It does not demonstrate the economic or technical viability of the Firebag Project. The PEA includes inferred mineral resources that are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves, and there is no certainty that the PEA will be realized.

1.8 Surface Mining

The development planned for the surface mineable area of Firebag Property will use the truck/excavator mining method.

The following three clean frac sand products will be produced from the Firebag Property:

- 20/40 mesh;
- 40/70 mesh; and
- 70/140 mesh.

The waste and run of mine tonnes (ROMt) and clean metric tonnes (cmt) of frac sand contained within the base case pit shell are shown in Table 1.1.

Table 1.1
Base Case Ultimate Pit

Product (Mesh)	Waste (bcm)	Frac Sand (ROMt)	Frac Sand (cmt)	Rejects (tonnes)
20/40 Mesh			2,919,738	
40/70 Mesh			12,273,327	
70/140 Mesh			7,534,586	
Total	**1,025,730**	**24,642,450**	**22,727,650**	**1,914,800**

Note: The waste volume includes topsoil and subsoil. The average recovery of select material (i.e., 20/140 mesh) is 92%.

A production schedule has been developed to cover the 25-year life of mine for the Firebag Property. The plateau production rate for Firebag was set at a nominal rate of 990,000 ROMt per year. The sand is hauled and railed as it is produced, and there is limited provision for in-progress stockpiling at Firebag or the Lynton rail yard. The production schedule is shown in Table 1.2.

Table 1.2
Firebag Property Mine Production Schedule

Year	Waste (bcm)	Reclamation Material (bcm)	ROM Frac Sand (ROMt)	Rejects (tonnes)	Clean Frac Sand		
					20/40 Mesh (cmt)	40/70 Mesh (cmt)	70/140 Mesh (cmt)
-1	58	129,178	322,500	21,652	28,277	147,228	125,342
1	390	36,913	990,000	69,021	90,463	451,308	379,208
2	526	36,913	990,000	76,135	104,857	465,643	343,366
3	520	36,913	990,000	80,677	117,505	474,516	317,301
4	305	36,913	990,000	83,528	126,537	474,945	304,990
5	308	36,913	990,000	80,907	127,100	464,798	317,195
6	503	36,913	990,000	79,441	126,507	460,833	323,220
7	390	36,913	990,000	80,037	116,568	483,693	309,702
8	101	36,913	990,000	79,688	110,978	499,356	299,978
9	238	36,913	990,000	76,696	108,198	508,225	296,882
10	458	36,913	990,000	69,272	108,217	515,309	297,201
11	458	36,913	990,000	69,272	108,217	515,309	297,201
12	458	36,913	990,000	69,272	108,217	515,309	297,201
13	458	36,913	990,000	69,272	108,217	515,309	297,201
14	458	36,913	990,000	69,272	108,217	515,309	297,201
15	438	36,913	990,000	68,412	114,862	522,653	284,073
16	438	36,913	990,000	68,412	114,862	522,653	284,073
17	438	36,913	990,000	68,412	114,862	522,653	284,073
18	438	36,913	990,000	68,412	114,862	522,653	284,073
19	438	36,913	990,000	68,412	114,862	522,653	284,073
20	507	36,913	990,000	89,654	134,419	476,847	289,080
21	507	36,913	990,000	89,654	134,419	476,847	289,080
22	507	36,913	990,000	89,654	134,419	476,847	289,080
23	507	36,913	990,000	89,654	134,419	476,847	289,080
24	507	36,913	990,000	89,654	134,419	476,847	289,080
25	280	0	559,950	50,324	75,252	268,739	165,635
Total	**10,635**	**1,015,094**	**24,642,450**	**1,914,800**	**2,919,740**	**12,273,330**	**7,534,580**

1.9 Trans-Loading and Processing

AMI sand-sizing operation system will begin at the Lynton receiving area, and continue along the transportation route to the processing area at Edson; this system will also include a product distribution component.

Both the Lynton receiving area and the Edson processing area are in alignment with the overall system capacity.

In general, the Lynton site functions as a receiving and trans-loading area to move the ROM sand from the mine to the processing plant in Edson. Note: No processing or beneficiation occurs at the Lynton operation.

The Edson site provides a receiving and stacking system for the ROM feed; it also has a wet plant and a dry plant, a dryer and a product-dispatching system on site.

1.10 Offsite Infrastructure

Transport of the ROM product to the Edson area for cleaning will take advantage of existing infrastructure

The main infrastructure items include the following:

- the main CN rail line from Lynton to Edmonton;
- the main CN rail line from Edmonton to the Edson area;
- roads and highways;
- town sites; and
- utilities and other facilities and services.

1.11 Mine Operating and Capital Costs

Operating cost estimates were prepared for operations, development work and the reclamation activities that are associated with the Firebag Property, located 95 km north of Fort McMurray; the rail yard at Lynton, Alberta; and the processing plant at Edson, Alberta.

The operating cost estimate was developed from first principles. The operating cost estimate includes provisions for corporate administrative costs, Alberta mineral tax and corporate income tax. The operating cost estimate considers all aspects of the operation, including sand processing, sand and waste loading and haulage, topsoil salvage and replacement, road maintenance, water management, reclamation and site administration.

The capital cost of the equipment required at the Firebag Property, the rail yard and the processing plant site are based on Norwest's database of equipment costs.

A 20% contingency has been applied to primary/support equipment, auxiliary equipment and other capital to account for any unforeseen or otherwise unanticipated cost elements that could be associated with development and/or operation of the Project.

Table 1.3 details the operating cost by activity.

Table 1.3
Operating Cost

Area	Operating Cost (Cdn$/ROMt)
Firebag	10.63
Highway Haul	26.50
G&A	7.36
Rail Yard	3.89
CN Rail	44.00
Plant	12.36
Total	**104.73**

The capital schedule is shown on Table 21.14

1.12 Economic Analysis

A series of cash-flow forecasts has been developed for the life of the Project. This includes a single-year, pre-production phase. The production period is 25 years followed by closure which is scheduled to take place in Year 25. Norwest determined the NPV in Year -1, the only year of pre-production.

The economic analysis has adopted the following long-term selling prices for the project:

- 20/40 mesh = $195 per clean metric tonne;
- 40/70 mesh = $170 per clean metric tonne; and
- 70/140 mesh = $155 per clean metric tonne.

Note this pricing was received in Q3 2014.

1.13 Royalties

Under Alberta Energy's royalty scheme for silica sand, a charge of $0.37 per clean tonne has been applied.

Under the Municipal Government Act, a royalty has been applied at a rate of $0.25 per clean tonne.

1.14 Results

Norwest developed a cash-flow forecast. The results are shown in Table 1.4. The Project sales and financial performance are shown on a before-and-after tax basis in Table 1.5.

Table 1.4
Cash Flow Forecast

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
	units	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Revenue by Source ($)															
Total Sales	cleant	**300,848**	**920,979**	**913,865**	**909,323**	**906,472**	**909,093**	**910,559**	**909,963**	**910,312**	**913,304**	**920,728**	**920,728**	**920,728**	**920,728**
P1 (20 - 40 mesh)	cleant	28,277	90,463	104,857	117,505	126,537	127,100	126,507	116,568	110,978	108,198	108,217	108,217	108,217	108,217
P2 (40 - 70 mesh)	cleant	147,228	451,308	465,643	474,516	474,945	464,798	460,833	483,693	499,356	508,225	515,309	515,309	515,309	515,309
P3 (70 - 140 mesh)	cleant	125,343	379,208	343,366	317,301	304,990	317,195	323,220	309,702	299,978	296,882	297,201	297,201	297,201	297,201
Average Selling Price (CDN$)		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
P1 (20 - 40 mesh)	$/cleant	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00
P2 (40 - 70 mesh)	$/cleant	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00
P3 (70 - 140 mesh)	$/cleant	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00
Revenue		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
P1 (20 - 40 mesh)	$	$5,513,919	$17,640,277	$20,447,035	$22,913,548	$24,674,673	$24,784,561	$24,668,800	$22,730,833	$21,640,706	$21,098,589	$21,102,345	$21,102,345	$21,102,345	$21,102,345
P2 (40 - 70 mesh)	$	$25,028,839	$76,722,318	$79,159,257	$80,667,776	$80,740,687	$79,015,662	$78,341,637	$82,227,859	$84,890,528	$86,398,218	$87,602,578	$87,602,578	$87,602,578	$87,602,578
P3 (70 - 140 mesh)	$	$19,428,193	$58,777,259	$53,221,675	$49,181,664	$47,273,417	$49,165,234	$50,099,038	$48,003,763	$46,496,526	$46,016,647	$46,066,178	$46,066,178	$46,066,178	$46,066,178
Total Revenue	**$**	**$49,970,950**	**$153,139,854**	**$152,827,967**	**$152,762,989**	**$152,688,777**	**$152,965,458**	**$153,109,475**	**$152,962,455**	**$153,027,760**	**$153,513,454**	**$154,771,101**	**$154,771,101**	**$154,771,101**	**$154,771,101**
Cost by Category		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Capital	$	$73,176,552	$4,822,745	$3,000,245	$3,985,245	$3,417,975	$3,000,245	$3,535,245	$3,000,245	$4,927,975	$3,485,245	$3,000,245	$3,050,245	$3,984,665	$5,079,245
Operating Costs	$	$19,810,794	$60,165,743	$60,132,247	$60,062,267	$60,008,563	$59,939,085	$59,955,561	$60,006,322	$60,047,041	$60,081,837	$60,181,626	$60,181,626	$60,181,626	$60,181,626
Capital Contingency	$	$14,635,310	$964,549	$600,049	$797,049	$683,595	$600,049	$707,049	$600,049	$985,595	$697,049	$600,049	$610,049	$796,933	$1,015,849
Operating Contingency	$	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cost of Production	**$**	**$107,622,657**	**$65,953,037**	**$63,732,541**	**$64,844,561**	**$64,110,132**	**$63,539,378**	**$64,197,855**	**$63,606,616**	**$65,960,611**	**$64,264,131**	**$63,781,920**	**$63,841,920**	**$64,963,224**	**$66,276,720**
Unit Cost of Production	**$/cleant**	**$357.73**	**$71.61**	**$69.74**	**$71.31**	**$70.72**	**$69.89**	**$70.50**	**$69.90**	**$72.46**	**$70.36**	**$69.27**	**$69.34**	**$70.56**	**$71.98**
Rail	$	$13,237,318	$40,523,069	$40,210,057	$40,010,202	$39,884,759	$40,000,109	$40,064,615	$40,038,388	$40,053,711	$40,185,389	$40,512,014	$40,512,014	$40,512,014	$40,512,014
NET CASHFLOW BEFORE TAX		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
		-$70,889,026	$46,663,748	$48,885,369	$47,908,226	$48,693,886	$49,425,970	$48,847,006	$49,317,451	$47,013,438	$49,063,934	$50,477,168	$50,417,168	$49,295,864	$47,982,368
Alberta Mineral Tax (Royalty)	$	$111,314	$340,762	$338,130	$336,449	$335,395	$336,365	$336,907	$336,686	$336,815	$337,923	$340,669	$340,669	$340,669	$340,669
Municipal Royalty	$	$75,212	$230,245	$228,466	$227,331	$226,618	$227,273	$227,640	$227,491	$227,578	$228,326	$230,182	$230,182	$230,182	$230,182
Operating Cash Flow before Income Tax	$	$16,736,311	$51,880,035	$51,919,067	$52,126,740	$52,233,443	$52,462,626	$52,524,753	$52,353,567	$52,362,614	$52,679,979	$53,506,611	$53,506,611	$53,506,611	$53,506,611
Income Tax (Federal and Provincial)	$	$0	$0	$8,243,065	$11,788,863	$12,015,593	$12,099,898	$12,098,089	$12,042,903	$11,981,887	$11,993,806	$12,223,678	$12,256,256	$12,242,427	$12,157,758
Operating Cash Flow after Income Tax	$	$16,736,311	$51,880,035	$43,676,002	$40,337,877	$40,217,850	$40,362,728	$40,426,663	$40,310,665	$40,380,727	$40,686,173	$41,282,933	$41,250,354	$41,264,184	$41,348,853
Net Cash Flow After Income Tax	$	**-$71,075,552**	**$46,092,741**	**$40,075,708**	**$35,555,583**	**$36,116,280**	**$36,762,434**	**$36,184,370**	**$36,710,371**	**$34,467,157**	**$36,503,879**	**$37,682,639**	**$37,590,060**	**$36,482,586**	**$35,253,759**

Table 1.4 (cont'd)

Cash Flow Forecast

		2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	
	units	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Total
Revenue by Source ($)														
Total Sales	**cleant**	**920,728**	**921,588**	**921,588**	**921,588**	**921,588**	**921,588**	**900,346**	**900,346**	**900,346**	**900,346**	**900,346**	**509,628**	**22,727,651**
P1 (20 - 40 mesh)	cleant	108,217	114,862	114,862	114,862	114,862	114,862	134,419	134,419	134,419	134,419	134,419	75,257	2,919,738
P2 (40 - 70 mesh)	cleant	515,309	522,653	522,653	522,653	522,653	522,653	476,847	476,847	476,847	476,847	476,847	268,736	12,273,327
P3 (70 - 140 mesh)	cleant	297,201	284,073	284,073	284,073	284,073	284,073	289,080	289,080	289,080	289,080	289,080	165,635	7,534,586
Average Selling Price (CDN$)		Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Total
P1 (20 - 40 mesh)	$/cleant	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	**$0.00**
P2 (40 - 70 mesh)	$/cleant	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	**$0.00**
P3 (70 - 140 mesh)	$/cleant	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	**$0.00**
Revenue		Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Total
P1 (20 - 40 mesh)	$	$21,102,345	$22,398,168	$22,398,168	$22,398,168	$22,398,168	$22,398,168	$26,211,659	$26,211,659	$26,211,659	$26,211,659	$26,211,659	$14,675,080	$569,348,879
P2 (40 - 70 mesh)	$	$87,602,578	$88,850,944	$88,850,944	$88,850,944	$88,850,944	$88,850,944	$81,064,033	$81,064,033	$81,064,033	$81,064,033	$81,064,033	$45,685,107	$2,086,465,661
P3 (70 - 140 mesh)	$	$46,066,178	$44,031,271	$44,031,271	$44,031,271	$44,031,271	$44,031,271	$44,807,337	$44,807,337	$44,807,337	$44,807,337	$44,807,337	$25,673,419	$1,167,860,765
Total Revenue	**$**	**$154,771,101**	**$155,280,382**	**$155,280,382**	**$155,280,382**	**$155,280,382**	**$155,280,382**	**$152,083,028**	**$152,083,028**	**$152,083,028**	**$152,083,028**	**$152,083,028**	**$86,033,606**	**$3,823,675,305**
Cost by Category		Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Total
Capital	$	$3,000,245	$3,485,245	$6,417,975	$4,440,245	$3,485,245	$3,000,245	$3,417,975	$3,048,000	$2,513,000	$2,513,000	$2,513,000	$14,834,227	$174,134,518
Operating Costs	$	$60,181,626	$60,252,473	$60,252,473	$60,252,473	$60,252,473	$60,252,473	$60,025,249	$60,025,249	$60,025,249	$60,025,249	$60,025,249	$34,087,591	$1,496,593,790
Capital Contingency	$	$600,049	$697,049	$1,283,595	$888,049	$697,049	$600,049	$683,595	$609,600	$502,600	$502,600	$502,600	$2,966,845	$34,826,904
Operating Contingency	$	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cost of Production	**$**	**$63,781,920**	**$64,434,767**	**$67,954,043**	**$65,580,767**	**$64,434,767**	**$63,852,767**	**$64,126,819**	**$63,682,849**	**$63,040,849**	**$63,040,849**	**$63,040,849**	**$51,888,663**	**$1,705,555,212**
Unit Cost of Production	**$/cleant**	**$69.27**	**$69.92**	**$73.74**	**$71.16**	**$69.92**	**$69.29**	**$71.22**	**$70.73**	**$70.02**	**$70.02**	**$70.02**	**$101.82**	**$75.04**
Rail	$	$40,512,014	$40,549,860	$40,549,860	$40,549,860	$40,549,860	$40,549,860	$39,615,207	$39,615,207	$39,615,207	$39,615,207	$39,615,207	$22,423,619	$1,000,016,637
NET CASHFLOW BEFORE TAX		Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Total
		$50,477,168	$50,295,756	$46,776,480	$49,149,756	$50,295,756	$50,877,756	$48,341,002	$48,784,972	$49,426,972	$49,426,972	$49,426,972	$11,721,324	$ 1,118,103,456
Alberta Mineral Tax (Royalty)	$	$340,669	$340,987	$340,987	$340,987	$340,987	$340,987	$333,128	$333,128	$333,128	$333,128	$333,128	$188,562	$8,409,231
Municipal Royalty	$	$230,182	$230,397	$230,397	$230,397	$230,397	$230,397	$225,086	$225,086	$225,086	$225,086	$225,086	$127,407	$5,681,913
Operating Cash Flow before Income Tax	$	$53,506,611	$53,906,665	$53,906,665	$53,906,665	$53,906,665	$53,906,665	$51,884,358	$51,884,358	$51,884,358	$51,884,358	$51,884,358	$29,206,427	$1,312,973,734
Income Tax (Federal and Provincial)	$	$12,130,239	$12,268,187	$12,170,367	$12,060,328	$12,086,626	$12,162,279	$11,715,127	$11,777,340	$11,842,823	$11,909,891	$11,959,264	$5,325,061	$278,551,756
Operating Cash Flow after Income Tax	$	$41,376,372	$41,638,478	$41,736,298	$41,846,337	$41,820,039	$41,744,386	$40,169,231	$40,107,018	$40,041,535	$39,974,467	$39,925,094	$23,881,366	$1,034,421,978
Net Cash Flow After Income Tax	$	**$37,776,078**	**$37,456,184**	**$34,034,728**	**$36,518,043**	**$37,637,745**	**$38,144,092**	**$36,067,661**	**$36,449,418**	**$37,025,935**	**$36,958,867**	**$36,909,494**	**$6,080,294**	**$825,460,557**

Table 1.5
Project Sales/Financial Performance

Total Sales (cmt)	Pre-Tax IRR	Pre-Tax NPV10	After-Tax IRR	After-Tax NPV10
22,727,650	68%	$368,306,000	57%	$268,342,000

1.15 Conclusions

The PEA completed by Norwest shows that the Firebag River Sand Property has considerable potential for development as a frac sand resource. This is based on the following observations:

1.15.1 Tenure

The "footprint "of the current mine plan, is fully within the property boundary.

Alberta Environment and Sustainable Resource Development (AESRD) has approved AMI's request to work in and remove sand from SML 130021 for a term of 10 years beginning on August 25, 2014.

SML 120032 is currently under application with the AESRD.

AMI currently has access to the rail yard in Lynton. They are in negotiations with a third party regarding a plant site in the Edson area alongside the CN rail line.

1.15.2 Quantity of the Firebag Property Deposit

The conceptual plan includes 24.6 M ROMt of frac sand. The processing plant is expected to salvage approximately 92% of the frac sand process, of which 12% is of the 20/40 mesh, 50% is 40/70 mesh, and 30% is 70/140 mesh. The remainder of the product is an oversize or undersize sand, i.e. +20 mesh or -140 mesh. The Firebag Property is developed over 25 years of mine life at an average rate of rate of 990,000 ROMt per year.

1.15.3 Access to Rail Infrastructure

The Firebag Property is located approximately 95 km north to the existing CN rail line in Lynton, Alberta. Its location would allow CN to rail Firebag Property frac sand to the Edson area via Edmonton.

The new trans-loading yard will be constructed adjacent to CN's existing line in Lynton.

1.15.4 Local Mining Support Industries

The RMWB is home to a number of supporting industries including mining equipment distributors, mining contractors, and other mining related service industries.

Mining equipment distributors will be able to support the operation with maintenance services, reduce the amount of warehouse inventory that is required, and providing equipment component rebuilds. Other mining related service industries such as construction contractors, mining equipment tire suppliers, and other speciality contractor's operate in the area.

1.15.5 Markets

Norwest has reviewed various publicly available sources of information with respect to the expected demand for frac sand in North America and, more specifically, Western Canada. The majority of these sources indicate that the demand is expected to increase. Forecasted annual rates of increase vary between 5% and 25%.

AMI has selected the Edson/Hinton area of west-central Alberta as its point of sale for frac sand. This area coincides with current vigorous activity in the production of tight oil and gas from a number of geological formations; the majority of these operations require frac sand.

1.15.6 Economics

The project provides after tax NPV values of $268 M, when discounted at 10%.

1.16 Recommendations

Norwest recommends that AMI consider the bridging or supplemental studies for the development of future projects at the three sites (Firebag, Edson and Lynton). These are detailed in Section 26 of this report.

2 INTRODUCTION

In June of 2014, Athabasca Minerals Incorporated (AMI) and Norwest Corporation (Norwest) met to discuss the Firebag River Sand Property (Firebag Property/Project). AMI advised Norwest that APEX Geoscience Ltd had been commissioned to prepare a NI 43-101 Technical Report for the Firebag Property and asked for advice with respect to appropriate engineering studies. Norwest advised AMI that a Preliminary Economic Assessment (PEA) would provide the required engineering and economic analysis for the project in a format suitable for public disclosure. It should be noted that the level of engineering required to support a PEA is not considered sufficient to define “reserves”. It should also be noted that the entire Firebag River Sand Property “resource” has been classified as inferred.

The Firebag Project is composed of three components; the mine site where the raw silica sand is mined, the Lynton trans-loading area, and the yet to be defined site in the Edson/Hinton site, where the ROM silica sand will be processed to produce a marketable frac sand product.

For the purposes of this report, the Edson/Hinton area will be referred to as the Edson area due to the uncertainty of the location of the processing plant at the time this report was authored. Also, in the cost analysis, the travel time of the rail cars on the Canadian National Railway Company (CN) rail line is to the town of Edson, Alberta.

For the geological section of this report, Norwest reviewed the “National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)” produced by APEX Geoscience Ltd. The report was deemed representative of the current status of the Project with respect to the known geology, exploration work done to date, and interpretation of the results with an accepted level of confidence for the resource calculations. Other than some additional commentary on sampling methodology and requirements for future work, no changes have been made to the geological interpretation.

On Tuesday, October 7, 2014, Ted Hannah, Norwest VP Geology, and Theresa Lavender, Norwest Manager Mining, conducted a one-day site visit to the Firebag Property in the company of Heather Budney, Chief Geologist, and Tim Sieben, Regional Operation Manager. The intent of this visit was to confirm the physical nature of the property and obtain access to it, confirm the locations of the reported exploration activities, observe the nature of any physical impediments to future development, understand the general layout of the rail loading facilities, and discuss any other aspects of the project that might be pertinent to this report.

The accuracy of resource and reserve estimates is, in part, a function of the quality and quantity of available data and of engineering and geological interpretation and judgment. Given the data available at the time this report was prepared, the estimates presented herein are considered reasonable. However, they should be accepted with the understanding that additional data and analysis available subsequent to the date of the estimates may necessitate revision. These revisions may be material. There is no guarantee that all or any part of the estimated resources or reserves will be recoverable.

3 RELIANCE ON OTHER EXPERTS

The report titled "National Instrument 43-101 Technical Report Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)", produced by APEX Geoscience Ltd. has been reviewed by Norwest, and deemed to be representative of the current status of the Project with respect to the known geology, exploration work done to date, and interpretation of the results with an accepted level of confidence for the resource calculations. With the exception of some additional commentary on sampling methodology and requirements for future work, no changes have been made to the geological interpretation presented in the APEX Report.

4 PROPERTY DESCRIPTION AND LOCATION

The Firebag Property consists of two SML. These two SMLs are contiguous to each other. They are located in N ½ Section 8-99-08-4 within the Regional Municipality of Wood Buffalo (RMWB) and the Waterways Forest Area. The leases are located approximately 95 km north of Fort McMurray and 130 km southwest of Fort Chipewyan, at latitude 57°34’36.0156” and longitude -111°16’44.1372”, as shown in Figure 4-1. The primary focus of this PEA is SML 130021 (32.36 ha), SML 120032 (174.59 ha), License of Occupation (DLO) 130748 and Miscellaneous Lease (DML) 130162.

Alberta Environment and Sustainable Resource Development (AESRD) has approved AMI's request to work in and remove sand from SML 130021 for a term of 10 years beginning on August 25, 2014.

Alberta-Pacific Forest Industries Inc. (Al-Pac) holds the Forest Management Agreement (FMA) 9100029 which includes this area. Al-Pac has obtained the required consent to withdraw this area from the FMA. There is no merchantable timber on site and there has been no harvest activity in the vicinity of the SML.

The SML area is both partially and fully burnt as a result of the 2011 wildfires. It is unlikely that the area contains any surviving rare plant species, and it is not known if there were any present in the area before the fire.

The SML is not located within a caribou range, but there is a caribou range boundary a few miles to the east. The SML is not listed in the historic resource registry and no archeological investigation is required.

5 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

The Firebag Property is located within the RMWB. The SMLs are flat to gently sloped, with elevations ranging from approximately 304 m to 312 m above sea level (masl). In the western part of the SML, there is a mild ridge with a northern aspect.

The SML area is both partially and fully burnt as a result of the 2011 wildfires. The SML is covered by jack pine stands and it is in an "a1.1" ecosite of jack pine/bearberry and blueberry. Trees have an average height of 3.5 m and a bole diameter of 3 cm to 8 cm.

The Fort Chipewyan Winter Road intersects the Firebag Property southwest-northeast through AMI's Alberta Metallic and Industrial Minerals Leases 9411050591 and 9411050594. The 2011 exploration work completed by AMI was conducted at the Firebag Property in the vicinity of SML 130021 and SML 120032. The resource boundary and SML 130021 are directly adjacent to the Fort Chipewyan Winter Road shown on Figure 5-1. This road is only passable to vehicle traffic during the winter months, but the Property can be accessed year round by all-terrain vehicles (ATV). Fall and spring exploration programs could be possible (i.e., October to December and March to May), but they are not often ideal due to insufficient frozen ground access and thin snow cover.

AMI's SMLs can also be accessed from an 860-m access road (AMB Road) that is operated by AMI and intersects the winter road; both are shown on Figure 5-1.

AMI's Firebag Property can also be accessed by fixed-wing and helicopter aircrafts out of Fort McMurray, which is located approximately 95 km south of the Property. Fort McMurray is nearly 500 km north of Edmonton, Alberta and is accessible by road or by regular daily commercial flights from other communities and several international airports.

Rail shipping services to Fort McMurray are provided by the Canadian National Railway Company (CN). CN operates the line that runs from Edmonton, passing through the communities of Boyle, Lac La Biche, Conklin, Leismer, Chard, Cheecham and Anzac, to its terminus at Lynton, which is southeast of the Fort McMurray airport (approximately 12.5 km west of Highway 63 on Highway 69).

Refer to Section 5 in "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)" produced by APEX Geoscience Ltd. for additional information.

6 HISTORY

Norwest reviewed the "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)" produced by APEX Geoscience Ltd. The report was deemed representative of the current status of the Project with respect to the known geology, exploration work done to date, and interpretation of the results with an accepted level of confidence for the resource calculations.

The following subsections summarize information from the aforementioned APEX report.

Subsurface information from the oil and gas well exploration programs was used to map the unconformity and delineate the unconformable contact between the Cretaceous McMurray Formation and the overlying Quaternary sediment. This information was also used to design the shallow auger drill program that was conducted in January 2011.

The January 2011 auger program consisted of 19 dry auger holes drilled to an average depth of 14.5 m. Although these holes were located north of the resource area that is the focus of this PEA report, these results serve to demonstrate the potential consistency of the area that was further explored in late 2011. There were 135 samples collected from these holes; these samples were subjected to a variety of laboratory tests to determine the material's suitability for frac-sand applications. Details of this program can be found in Sections 9.1, 10.1 and 11 of the "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)" produced by APEX Geoscience Ltd.

In December 2011, an auger and test pitting program focused within the resource area; it consisted of six auger holes drilled to 24.4 m, and 26 test pits dug to 3 m to 5 m deep. This work and subsequent laboratory testing concluded that the area had a consistent depositional composition. Piezometers were installed at each drill hole to monitor the water table elevations. At the time of this report, only one set of piezometer readings was available. Seventy-six sand samples were sent to various labs for sieve analysis to obtain accurate grain-size readings. Details of this program can be found in Sections 9.2, 10.2 and 11 of the "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)" produced by APEX Geoscience Ltd.

Oil sands operations that are located directly south of the Firebag Property in the Athabasca oil sands region of northeastern Alberta are shown on Figure 6-1.

7 GEOLOGICAL SETTING AND MINERALIZATION

7.1 Regional Stratigraphy

The Western Canada Sedimentary Basin (WCSB) represents the majority of Alberta's geology; it comprises a Phanerozoic wedge of strata overlying the crystalline Precambrian basement. This wedge measures up to 7,000 m thick; it is adjacent to the foothills and diminishes to its zero edge along the Canadian Shield to the northeast (Mossop and Shetsen, 1994).

The Athabasca Region lies along the inactive, eastward thinning margin of the WCSB where sediments overlap the southwest-dipping Precambrian Shield. Quaternary surficial deposits that are dominated by glaciofluvial and glaciolacustrine sediments cover the sedimentary rocks of the WCSB (see Figure 7-1 and Figure 7-2). The sources of frac sand at the Firebag Property might originate from the following processes:

- reworked deposits resulting from glacial and eolian processes;
- within a Quaternary glacial outwash; and
- deposited on the Cretaceous unconformity.

These frac sands are made up of rounded and sorted quartz-rich grains with few impurities. The potential sand-producing formations include McMurray, Grand Rapids and Pelican.

Refer to Section 7 in "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)", produced by APEX Geoscience Ltd. for additional information.

7.2 Property Geology

A deep Quaternary channel, up to 40 m thick, exists on the Property. It trends southwest-northeast and parallels the winter road through the Firebag Property. The Quaternary sediments mostly overlie the Cretaceous McMurray Formation, but in some places on the Property, the sediments can be in direct contact with the Devonian Formation. The Devonian is made up of limestone and dolomite. The Quaternary consists mostly of the following:

- moderately clean fine to coarse-grained sand; and
- basal clay and sand till.

AMI conducted a geological review of the 2011 exploration program using auger information; results showed that the 2011 program intersected five distinct sand units over a depth of approximately 14.5 m, as interpreted by the sand colour and grain size (Cotterill, 2011).

The 2011 backhoe test pit program and the 2011 auger drilling program showed that the Quaternary sand thicknesses exceed the auger depth capacity of 24 m, and that the Quaternary sand extends laterally beyond the boundaries of the SMLs.

The 2011 backhoe test pit program indicated the following:

- Fine to medium-quartz sand that is clean and moderate to well-sorted exists in the 3 m to 5 m deep backhoe test pits.
- Visually, the sand is generally 40/70 mesh material.
- As the depth increases, there are subtle changes to the sand relative to its colour, level of impurity and grain size.
- The sand is dominated by well-sorted, fine to medium-grained quartz that is sub-rounded to rounded and spherical in shape.

The 2011 auger drilling program indicated the following:

- The depth of the upper layer of clean sand extends to approximately 10 m deep, although this varied depending on topography.
- The quartz sand becomes slightly darker in colour between 10 m to 15 m deep, but it is still consistently clean and well-sorted.
- Between 15 m and 24 m, the sand becomes slightly coarser. The sand near the bottom of a number of drill holes is argillaceous, dark brown and coarse-grained.
- At the bottom of the hole, the sand is interpreted as glacial outwash sediment.

Refer to Section 7 in "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)" produced by APEX Geoscience Ltd. for additional information.

7.3 Mineralization

The overall Quaternary sand deposit is characterized as follows:

- laterally extensive;
- generally consistent to depths exceeding 24 m;
- high in silica content; and
- indicative of frac sand quality as evidenced by grain size and roundness.

The test-pitting and auger-drilling programs have confirmed that the sand deposit is extensive and correlates closely with the area mapped as "outwash sand" and "eolian sand". The sands are typically very mature, as geological processes have rounded the sand grains and sorted out most impurities.

Refer to Section 7.3 in "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)", produced by APEX Geoscience Ltd. for additional information.

8 DEPOSIT TYPES

The Firebag Property's main deposit type is silica sand, or frac sand.

Refer to Section 8 in "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)", produced by APEX Geoscience Ltd. for additional information.

8.1 Frac Sand

Silica sand, frac sand or *proppant* (i.e., propping agents) is a durable, round-grained, crush-resistant material produced for oil and gas hydraulic fracturing, otherwise known as *fracking*. Fracking is used in the oil and gas industry to increase the flow of oil and/or gas from a well. Using hydraulic pressure, the producing formation is fractured open, and then proppants are pumped into the well with fracturing fluid to hold the fissures open so that the natural gas or crude oil can flow up the well. The proppant's size, shape and mechanical strength influence the integrity of the newly created fractures, and, therefore, the flow of oil and gas from the well. Billions of frac sand grains are carried deep into the fracture, and it can take up to four million pounds of sand to frack a single well.

The size range of the frac sand is very important. Typical sand sizes are generally between 8 and 140 mesh; some examples include 16/30 mesh, 20/40 mesh, 30/50 mesh, 40/70 mesh or 70/140 mesh. A controlled range of sizes and favoured spherical shapes will lead to greater conductivity. The roundness is visually analyzed and is also based on the chart on Figure 8-1.

The demand and price for frac sand have both risen in the last few years. In recent years, billions of pounds of sand have been poured down wells to help coax more fuel out of the ground. In older oil and natural gas fields, fracturing allows for extended production and the recovery of oil and natural gas from formations that geologists once believed was impossible to produce, such as from tight shale formations.

Demand for fracking in Canada is expected to grow an estimated 16% in 2014. Trican Well Service Ltd. (Trican) and Calfrac Well Services Ltd. are two of Canada's largest fracking contractors. In Alberta, horizontal drilling and fracking technology is being used in an increasing number of oil plays, such as the Cardium in west-central Alberta, the Beaverhill Lake carbonates near Swan Hills, the Viking in east-central Alberta, the Redwater north of Edmonton, the Pemiscot at Princess in southern Alberta and at Judy Creek in northwestern Alberta.

Other emerging tight oil and gas plays in Canada include the Bakken in Saskatchewan and Manitoba; the Duvernay and Montney in Alberta; the Montney, Horn River Basin, Cordova Embayment and Liard Basin in British Columbia and Northwest Territories; and, the Doig phosphate shale in British Columbia and Alberta.

9 EXPLORATION

Norwest reviewed "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)" produced by APEX Geoscience Ltd. The report was deemed representative of the current status of the Firebag Property with respect to the known geology, exploration work done to date, and interpretation of the results with an accepted level of confidence for the resource calculations.

The following subsections summarize information from the aforementioned APEX report.

During 2010, AMI conducted a preliminary evaluation of potential Devonian aggregate exposures in the general region of the Firebag Property. Surface Quaternary sand samples were also collected by AMI for geochemical analysis: the results showed high silica content along with grain-size fractions potentially suitable for frac sand.

Subsequently, two 2011 auger drill hole and backhoe test pit programs were launched to define the extent and quality of a potential high grade silica sand deposit at the Firebag Property. The analytical portion of the program was revisited in 2014 and is also summarized in "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)" produced by APEX Geoscience Ltd.

9.1 Auger Drill Hole Program (January 2011)

Subsurface information from the oil and gas well exploration programs was used to map the Cretaceous unconformity and delineate the unconformable contact between the Cretaceous McMurray Formation and the overlying Quaternary sediment. This information was also used to design the shallow auger drill program that was conducted in January 2011.

A total of 19 dry auger vertical holes were drilled to a depth of 14.5 m, for a total of 275.5 m (see Figure 9-1). With the exception of auger hole F01, all of the January 2011 auger holes were collared north of the resource area that is the focus of this PEA Report.

Six 1 kg to 1.5 kg samples were collected from each hole at consistent top to bottom depth intervals and a seventh sample was collected while recovering the auger stem after terminating each hole at 14.5 m. A total of 135 samples were collected. The consistency of drill returns decreased at depths greater than 10 m.

All 135 samples were submitted to Loring Laboratories Ltd. (Loring Laboratories) in raw (bulk) form for geochemical and grain-size analysis; the samples weren't washed and did not receive any other treatment. The bulk samples were wet-sieved into fractions based on set mesh ranges used in the frac sand industry (i.e., +20 mesh, 20/40 mesh, 40/70 mesh and 70/100 mesh Standard API).

Refer to Section 9.1 in "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014")", produced by APEX Geoscience Ltd. for additional information.

9.2 Backhoe Test Pit and Auger Drill Hole Program (December 2011)

The second 2011 exploration program was conducted within a confined target area adjacent to the January 2011 program for the following reasons:

- to move the program to an area accessible by road; and
- to support theories that the Quaternary sand is more consistent and located deeper south of the F-series holes (January 2011 program).

The resulting December 2011 backhoe test pit and auger drill programs consisted of 26 test pits and six auger holes (Figure 9-2). The test pit depths ranged from 3 m to 5 m and exposed the upper depositional sequence for detailed logging.

The test pit indicated the 2,000 m x 1,600 m area was consistent in depositional composition. The test pit materials consisted of fine to medium-quartz sand, that is clean and moderately to well-sorted. Visually, the sand is generally 40/70 mesh material with little to no 20/40 mesh sand in the top 5 m. Subtle lithological changes are documented in the backhoe test pits which include occasional variations in colour, impurities and grain size; however, these changes were not significant enough to affect the general continuity of the upper sand interval.

Norwest believes that incremental samples should be collected by depth as each trench is being dug to get a more accurate picture and to allow for future compositing if confirmed by incremental sample observations. As they exist, the current samples seem to represent the bottom of the test pit because they were collected at the end of the trench instead of during excavation.

Six auger test holes were drilled to 24.4 m to determine the depth and continuity of the sand deposit. The holes were drilled to cover the perimeter of the backhoe trench test grid to ensure the deposit had sufficient depth throughout the area (see Figure 9-2). The piezometers that were installed at each drill hole showed the water table elevation to be at approximately 17 m. At the time of this report, there was no indication that any subsequent water level readings had been recorded.

The materials were similar in the auger holes and backhoe test pits. The sand was dominated by quartz that exhibited the following qualities:

- well-sorted;
- fine to medium grained;
- sub-rounded to rounded; and
- spherical in shape.

At a depth of approximately 10 m, the quartz sand becomes slightly darker, but it is still relatively clean and well-sorted. At a depth of about 15 m, the sand is slightly coarser and remains this way until a total depth of 24 m. Visually, the sand did not appear to meet the 20/40 mesh size; however, the 30/50 mesh size is visually apparent.

It is important to note that the transition between the fine to medium-grained sand and the coarse sand provides a contact between the upper dune deposit and the lower glacial outwash at a depth of approximately 15 m.

A select number of samples were sent to Loring Laboratories, Stim-Lab Inc., and DK Engineering Services Ltd. (DK Engineering) for sieve analysis.

Refer to Section 9.2 in "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)" produced by APEX Geoscience Ltd. for additional information.

9.3 Analytical Test Work (2014)

In 2014, AMI reviewed the January 2011 and December 2011 backhoe test pit and auger drill hole samples in an effort to composite the samples for Inferred resource estimation work. The auger stem lengths are in 1.524 m (5-ft) intervals, so it was decided that the following five composite sample groups should be created for the auger drill holes (TH01, TH05, TH11, TH14, TH16 and TH17):

- Group 1 (0 m to 3.05 m);
- Group 2 (3.05 m to 6.1 m);
- Group 3 (6.1 m to 9.15 m);
- Group 4 (9.15 m to 12.2 m); and
- Group 5 (12.2 m to 15.25 m).

The individual samples were sent to Stim-Lab and PropTester Inc. (PropTester) where the samples were subject to the following test work:

- measure the pre- and post-wash weights and sieve results;
- combine the samples into their respective depth-based groupings (Groups 1 to 5 at 3.05 m, or 10 ft depth increments);
- re-sieve composite samples;
- subject composite samples to the following series of proppant test work, including:
  - roundness and sphericity (Krumbein shape factor);
  - mean particle diameter;
  - crush resistance;
  - acid solubility; and
  - turbidity and settling rate.

    Note: The majority of the samples that were sent to PropTester Inc. (PropTester) did not have the test work conducted on individual samples.
- conduct x-ray diffraction (XRD) and energy dispersive x-ray (EDX) analysis on the composite samples to determine the silica content and degree and type of impurities; and
- record bulk density and apparent density measurements.

Sieve analysis, proppant test work and XRD results can be found in Section 9.3 of "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)" produced by APEX Geoscience Ltd.

10 DRILLING

Norwest reviewed the "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)" produced by APEX Geoscience Ltd. The report was deemed representative of the current status of the Firebag Property with respect to the known geology, exploration work done to date, and interpretation of the results with an accepted level of confidence for the resource calculations.

The following subsections summarize information from the aforementioned APEX report.

10.1 Auger Drill Hole Program (January 2011)

AMI drilled 19 silica sand auger holes (holes F1 to F19) and two auger holes (holes F20 and F21) to locate and test the top of the Winnipegosis Formation within the Firebag River valley (see Table 10.1). In January 2011, the auger rig was mounted on a tracked Argo and produced dry cuttings from vertical holes. The auger stems were in 5 ft increments, and, therefore, all holes were drilled and recorded in feet and then later converted to metres.

With the exception of auger hole F1, all of the January 2011 auger holes are directly north and outside of the resource area that is the focus of this PEA report. Fourteen auger holes (holes F01 to F14) were drilled at 1 km intervals on the north-south township line. The remaining auger holes (holes F15 to F19) were drilled at 2 km intervals along the southwest-trending winter road. Auger holes F20 and F21 were drilled within the Firebag River valley floodplain.

Table 10.1
Coordinates for the January 2011 F-Series Vertical Auger Hole Program*

January 2011 Auger	UTM, Z12, NAD83		
	Easting (m)	Northing (m)	Elevation (m)
F01	480904	6380689	303.6
F02	480913	6381717	304.0
F03	480927	6382913	302.0
F04	480933	6383796	300.9
F05	480932	6384806	300.0
F06	480944	6385880	298.0
F07	480946	6386839	297.0
F08	480940	6387882	296.0
F09	480942	6388834	295.0
F10	480960	6389839	294.0
F11	480963	6390921	288.0
F12	480962	6391802	281.0
F13	480961	6392783	276.0
F14	480978	6393584	274.3
F15	481245	6380858	304.0
F16	482605	6382045	307.0
F17	484222	6383587	300.0
F18	485496	6384893	293.0
F19	487217	6386434	289.0
F20	488147	6388891	250.0
F21	488085	6389270	249.2

* These auger holes are situated within the Firebag Property, but are located directly north of the resource area that is the focus of this PEA report. Only one auger hole, F16 (subsequently renamed to TH01) is included in the current resource.

10.2 Backhoe Test Pit and Auger Drill Hole Program (December 2011)

AMI tested the area in December 2011. Testing was conducted using a tracked hoe and an auger drill to determine the depth and quality of the sand. Sand was encountered in all 32 test sites (i.e., six auger holes and all 26 pits dug by a backhoe from 3 m to 5 m). The bottom of the sand deposit was not reached. Test results showed that the sand is of consistent quality and depth across the area.

The six auger holes were drilled to a maximum depth of 24.4 m and the backhoe test pits were dug to a maximum depth of approximately 5 m. These pit/hole names were originally prefixed with MZ; however, the pits/holes were relabeled and are hereafter referred to as the TH-series (see Table 10.2). The auger holes were evenly spaced over the resource area. In the context of this silica sand deposit's type, style and formation, the data spacing is deemed sufficient for resource volume estimation.

The testing showed that the approximately 2,000 m x 1,600 m area was consistent in depositional composition. The uppermost 10 m comprise the following:

- fine to medium-grained sand;
- clean sand; and
- moderately to well-sorted sand.

The quartz sand is slightly darker, but it is still relatively clean and well-sorted at approximately 10 m to 15 m. The sand is coarser between 15 m to 24 m.

In December 2011, the auger rig was mounted on a tracked Argo and produced dry cuttings from vertical holes. The auger stems were in 5 ft increments, and, therefore, all holes were drilled and recorded in feet and then later converted to metres.

Table 10.2
Location of the December 2011 Backhoe Test Pits and Auger Holes

TH-Series Hole ID	UTM, Z12, NAD83		Easting (m)	Northing (m)
	Original Hole ID	Test Type		
TH01	F16	auger hole	482,605	6,382,045
TH02	MZ4	backhoe test pit	482,556	6,381,992
TH03	MZ3-AP	backhoe test pit	482,555	6,381,720
TH04	MZ2	backhoe test pit	482,554	6,381,320
TH05	MZ1-A	auger hole	482,550	6,380,920
TH06	MZ9	backhoe test pit	482,950	6,380,920
TH07	MZ8	backhoe test pit	482,950	6,381,320
TH08	MZ7	backhoe test pit	482,950	6,381,720
TH09	MZ6	backhoe test pit	482,950	6,382,120
TH10	MZ14	backhoe test pit	483,000	6,382,449
TH11	MZ14A	auger hole	483,209	6,382,440
TH12	MZ15-AP	backhoe test pit	483,350	6,382,439
TH13	MZ13	backhoe test pit	483,350	6,382,120
TH14	MZ12-AP	auger hole	483,350	6,381,720
TH15	MZ11	backhoe test pit	483,350	6,381,320
TH16	MZ10-AP	backhoe test pit	483,349	6,380,919
TH17	MZ10-AP-2	auger hole	483,570	6,380,924
TH18	MZ20	backhoe test pit	483,751	6,380,919
TH19	MZ19-CA	backhoe test pit	483,750	6,381,319
TH20	MZ18-AP	backhoe test pit	483,750	6,381,720
TH21	MZ17-A	backhoe test pit	483,750	6,382,120
TH22	MZ16	backhoe test pit	483,750	6,382,439
TH23	MZ25	backhoe test pit	484,150	6,382,439
TH24	MZ24	backhoe test pit	484,150	6,382,120
TH25	MZ23	backhoe test pit	484,150	6,381,720
TH26	MZ22-A	backhoe test pit	484,150	6,381,319
TH27	MZ21	backhoe test pit	484,151	6,380,919
TH28	MZ30-AP	auger hole	484,550	6,380,920
TH29	MZ29	backhoe test pit	484,550	6,381,319
TH30	MZ28	backhoe test pit	484,550	6,381,720
TH31	MZ27	backhoe test pit	484,550	6,382,120
TH32	MZ26AP	auger hole	484,550	6,382,369
TH33	MZ26AP	backhoe test pit	484,550	6,382,439

11 SAMPLE PREPARATION, ANALYSES AND SECURITY

11.1 Sampling Method and Approach

Grab samples were collected from six auger holes and 26 backhoe trenches on the 80 acre parcel. Initial testing was completed in 2011 by Stim-Lab. Additional tests conducted in 2014 by Stim-Lab and PropTester confirmed that the Firebag Property silica sand is suitable to be used as frac sand.

In December 2011, the backhoe test pit and auger drill hole programs and sampling were conducted. These samples are most relevant to the resource estimation being presented in this PEA report. During the backhoe test pit program, the sand was piled adjacent to its representative pit. To obtain a sample, shovel samples were taken from top to bottom of the pile and placed into a sample bag. As per the APEX report, “National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)”, the top 5 m are comprised lithologically of uniform sand (as documented in both 2011 exploration programs), this method provided a representative sample of the test pit material and uppermost Group 1 and Group 2 (1 m to 6.1 m) sand.

Norwest believes that incremental samples should be collected by depth as each trench is being dug to get a more accurate picture and to allow for future compositing if confirmed by incremental sample observations. As they exist, current samples seem to represent the bottom of the test pit because they were collected at the end of the trench instead of during the excavation.

The drilling operation used a truck-mounted dry auger. Auger stems were 1.5 m (5 ft) in length, and the auger would penetrate the ground for 1.5 m and then be lifted up to the surface so that the material could be physically separated on the surface, and visually inspected and sampled. At this point, an experienced driller helped to determine whether the sample was a representative sample, and not colluvium that had slid back down into the auger hole.

The samples were then taken off the auger at standard depth intervals and placed in plastic sample bags. The samples were labeled and recorded. All samples were taken by pick-up truck to the AMI office in Edmonton, Alberta at the end of the Project. All samples arrived in their original condition (i.e., at the time they were bagged) and the bags were placed in a locked storage bin accessible by AMI staff only. This methodology was adopted for both the January 2011 and the December 2011 auger exploration programs.

11.2 Sample Preparation, Analyses and Security

Whole rock geochemical evaluation was conducted at Loring Laboratories in Calgary, Alberta using Inductively Coupled Plasma (ICP) analysis to evaluate the geochemical oxide properties of each sample.

Sieve fraction analysis was conducted at various laboratories, including the following:

- Loring Laboratories Ltd. (Calgary, Alberta);
- DK Engineering Services Ltd. (Edmonton, Alberta); and
- Stim-Lab Inc. (Duncan, Oklahoma).

Proppant test work was conducted at:

- Tetra Tech EBA (Edmonton, Alberta); and
- Stim-Lab Inc. (Duncan, Oklahoma) and PropTester (Cypress, Texas).

Refer to Section 11 in "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)" produced by APEX Geoscience Ltd. for additional information.

Loring Laboratories, Tetra Tech EBA, Stim-Lab, PropTester, and DK Engineering are independent laboratories that are qualified to run analyses for sand properties (see Table 11.1).

Loring Laboratories is an ISO 9001:2008 accredited laboratory for analyzing mining and mineral exploration samples (CERT-0063770).

Stim-Lab and PropTester are independent laboratories that conduct proppant analytical work, including the following:

- sphericity and roundness (Krumbein shape factor);
- acid solubility;
- turbidity;
- bulk density;
- apparent density; and
- crush K-Value results.

DK Engineering is a separate company based at the AMI office that provides in-house sieve analyses.

Table 11.1
Summary of Lab Results

Lab	Combined	Group	Sample ID	Tested Size Cut	Crush Resistance (K-Value)	Acid Solubility	Sphericity	Roundness	ISO Mean Particle Diameter (mm)	Turbidity (FTU)	Clusters (%)	Bulk Desnity (g/cm^3)	Bulk Density (lb/ft^3)	Specific Gravity (g/cm^3)
Prop Tester	NA	NA	F16	40/70	7	3.8	0.7	0.8	0.305	28	0	1.48	92.16	2.65
Prop Tester	NA	NA	MZ14A	40/70	7	4.5	0.76	0.9	0.303	12	0	1.47	91.98	2.63
Prop Tester	NA	NA	MZ12	40/70	5	1.6	0.7	0.8	0.291	26	0	1.45	90.22	2.65
Stim-Lab	NA	NA	MZ11	NA	NA	NA	NA	NA	0.267	NA	NA	NA	NA	NA
Prop Tester	NA	NA	MZ10AP	40/70	7	4	0.7	0.8	0.301	31	0	1.48	92.05	2.65
Prop Tester	NA	NA	MZ1	40/70	7	3.6	0.8	0.8	0.301	12	0	1.48	92.05	2.61
Prop Tester	Combined	Group 1	MZ1,10,12,14,F16	20/40	5	4.3	0.8	0.9	0.534	16	0	1.5	93.39	2.61
Stim-Lab	Combined	Group 1	MZ1,10AP,12,14A,F16	20/40	4	3	0.7	0.6	0.537	12	0	1.5	93.6	2.63
Stim-Lab	Combined	Group 1	MZ01,10AP,12A,14A,F16	40/70	7	2.7	0.7	0.6	0.295	12	0	1.47	91.7	2.64
Stim-Lab	Combined	Group 2	MZ1A,10AP,12A,14A	20/40	4	2.7	0.7	0.7	0.537	10	0	1.51	94.2	2.64
Stim-Lab	Combined	Group 2	MZ1A,10AP,12A,14A	40/70	7	2.2	0.6	0.6	0.296	10	0	1.51	94.2	2.64
Stim-Lab	Combined	Group 3	MZ1A,10AP-2,14A	40/70	6	3	0.7	0.6	0.291	6	0	1.44	89.9	2.63
Stim-Lab		Group 3	MZ1A,10AP-2,14A											
Stim-Lab	Combined	Group 4	MZ1A,10AP-2,12A,14A	20/40	3	3.3	0.7	0.6	0.538	10	0	1.47	91.7	2.61
Stim-Lab		Group 5	MZ1A,10AP-2,12A,14A											
Stim-Lab	Combined	Group 4	MZ1A,10AP-2,12A,14A	40/70	6	3.7	0.6	0.6	0.289	7	0	1.43	89.2	2.63
Stim-Lab	Combined	Group 5	MZ1A,10AP-2,12A,14A	40/70	5	3.9	0.7	0.6	0.287	9	0	1.41	88	2.63
Stim-Lab	Combined	CMB01	MZ1,10,12,14,F16	20/40	5	3.2	0.8	0.7	0.295	5	NIFC	1.561	94.2	2.63
				30/50	6	2.9	0.7	0.6	0.295	5	NIFC	1.5	93.6	2.64
				40/70	7	2.8	0.7	0.6	0.295	6	~1/100	1.48	92.4	2.64
				70/140	9	3.8	0.7	0.5	0.295	11	NIFC	1.43	89.2	2.64

11.3 Fracturing Proppant Specifications

The following fracturing proppant specifications are based on API RP56 (from Trican):

- Sphericity and Roundness (S&R): must have an average value > 0.6 based on 20 grains;
- Acid Solubility: 12% HCl and 3% HF; 5 grams are placed at 65.6°C for 30 minutes:
  - Specs: 6/12-30/50 mesh: 2% max; 40/70-70/140 mesh: 3% max.
- Turbidity: < 250 FTU;
- Crush Resistance: (see Table 11.2) suggested max fines for 20/40 mesh frac sand per API RP-56 = 14% at 4,000 psi. Crush resistance is the highest stress level at which proppant generates no more than 10% crushed material, rounded down to the nearest 1,000 psi=K-Value;
- Densities: used to determine the mass of untapped or unsettled proppant that will occupy a specific known volume; Density Specifications: ~1.6 g/cm^3 bulk density and ~2.65 g/cm^3 specific density; and
- Sieve Specification: > 90% between designated sieves, < 0.1% remaining on first sieve, and 1% max in pan.

Table 11.2
Applied Stress and Maximum Fines

Mesh Size	Load on Cell (lb force)	Stress on Sand (psi)	Suggested Maximum Fines (% by weight)
6/12	6,283	2,000	20
8/16	6,283	2,000	18
12/20	9,425	3,000	16
16/30	9,425	3,000	14
20/40	12,566	4,000	14
30/50	12,566	4,000	10
40/70	15,708	5,000	8
70/140	15,708	5,000	6

12 DATA VERIFICATION AND COMPUTER MODELING

The sampling and test work processes used during the 2011 auger drill sampling programs meet industry standards for accuracy and reliability, but Norwest recommends that additional drilling is required. The trench sampling also requires an alternative gathering method that is different from the backhoe test pits.

Norwest recommends that incremental samples should be collected by depth as each trench is being dug to get a more accurate picture and to allow for future compositing if confirmed by incremental sample observations. As they exist, the current samples seem to represent the bottom of the test pit because they were collected at the end of the trench instead of during excavation.

Many industrial mineral deposits are subject to a nugget effect. This is particularly true when dealing with Quaternary surficial deposits that are subject to various distribution mechanisms associated with glacial, water and wind-blown depositional environments. However, within the context of the Firebag silica sand deposit, the following is true:

- a sufficient and appropriate number of samples were analyzed to ensure that meaningful, average sample results were obtained; and
- the silica sand analytical results have demonstrated physical and chemical homogeneity.

As an example, Figure 12-1 and Figure 12-2 show that the sieve size fractions are generally consistent between laboratories and that the grain-size distributions are laterally consistent across the Firebag Property.

With respect to analytical precision, the physical test work techniques and composite sampling methodologies that are used to characterize the quality of the proppant make it difficult to quantify precision when compared to standard chemical analyses. However, the review and verification of the laboratory results has shown that the silica sand preparation and the analytical processes and test work were conducted using methodologies consistent with International Standards, and that the replication of similar analytical values from program-to-program and lab-to-lab has produced valid results.

12.1 Drill Hole Source and Collar Data

Drill hole source type and collar locations were supplied by AMI. Norwest received collar information for six auger holes and 26 test pits. Each drill hole collar elevation was compared to the publicly sourced topographic elevation at the collar location. Due to the discrepancies, shown in Table 12.1, Norwest chose to use the topographic elevation instead of the supplied collar elevation.

Table 12.1
Collar Elevations vs. Topographic Elevations

Hole No.	Collar Elevation	Topographic Elevation	Delta
TH04	306.98	306.96	0.02
TH05	306.00	306.03	-0.03
TH11	308.00	306.75	1.25
TH14	335.00	308.00	27.00

12.2 Sample Data

12.2.1 PSD Samples

AMI provided Norwest with particle size distribution (PSD) data consisting of 67 samples from five auger holes and 17 test pits. These consisted of single-sample intervals from test pits, multiple-sample intervals from auger holes and composited-sample intervals from multiple auger holes.

Composite samples across multiple auger holes were excluded from the model because the data could not be separated into discrete drill holes. Some samples were assayed several times by several different labs; in this case, the most recent lab results were used and all others were excluded from the model. When two or more labs conducted their tests at the same time, the results from the lab that provided the most sample results during that time period were used (i.e., Loring Laboratories (Alberta) Ltd.). In total, 36 of the 67 samples were included in the model (see Table 12.2).

Table 12.2
PSD Sample Selection for Model Use

Hole ID	Sample ID	Model Use	Comment
TH02	A-MZ4	No	Newer results used
TH03	A-MZ3	Yes	-
TH04	A-MZ2	No	Newer results used
TH06	A-MZ9	No	Newer results used
TH07	A-MZ8	No	Newer results used
TH08	A-MZ7	No	Newer results used
TH09	A-MZ6	No	Newer results used
TH10	MZ14	No	Newer results used
TH12	A-MZ15AP	No	Newer results used
TH13	A-MZ13	No	Newer results used
TH15	A-MZ11	No	Newer results used
TH16	MZ10AP	No	Newer results used
TH18	A-MZ20	No	Newer results used
TH19	A-MZ19CA	No	Newer results used
TH20	A-MZ18AP	No	Newer results used
TH21	A-MZ17A	No	Newer results used
TH22	A-MZ16	No	Newer results used
TH02	MZ4	Yes	-
TH04	MZ2	Yes	-
TH06	MZ9	Yes	-
TH07	MZ8-CA	Yes	-
TH08	MZ7	Yes	-
TH09	MZ6-CA	Yes	-
TH10	MZ14	No	Newer results used
TH12	MZ15-AP	Yes	-
TH13	MZ13	Yes	-
TH14	MZ12-A	No	Newer results used
TH15	MZ11	Yes	-
TH16	MZ10-AP	No	Newer results used
TH18	MZ20	Yes	-
TH19	MZ19-CA	Yes	-
TH20	MZ18-AP	Yes	-
TH21	MZ17-A	Yes	-
TH22	MZ16	Yes	-
TH15	MZ11	No	Results from preferred lab used

Table 12.2 (cont'd)
PSD Sample Selection for Model Use

Hole ID	Sample ID	Model Use	Comment
Combined	F16+MZ1+MZ14+MZ12+MZ10	No	Composite sample
TH01	F16 (0-3m or 9.72')	Yes	-
TH01	F16 (4-6m or 9.72'-16.4')	Yes	-
TH05	MZ1 (0-18')	Yes	-
TH05	MZ1A (15'-21')	Yes	-
TH05	MZ1A (21'-30')	Yes	-
TH05	MZ1A (31'-40')	Yes	-
TH05	MZ1A (40'-45')	Yes	-
TH10	MZ14 (0-13.5')	Yes	-
TH11	MZ14A (15'-20')	Yes	-
TH11	MZ14A (21'-30')	Yes	-
TH11	MZ14A (30'-40')	Yes	-
TH11	MZ14A (40'-45')	Yes	-
TH14	MZ12 (0-18')	Yes	-
TH14	MZ12A (15'-21')	Yes	-
TH14	MZ12A (30'-40')	Yes	-
TH14	MZ12A (40'-45')	Yes	-
TH16	MZ10AP (0-18')	Yes	-
TH17	MZ10AP-2 (15'-21')	Yes	-
TH17	MZ10AP-2 (20'-30')	Yes	-
TH17	MZ10AP-2 (32'-42')	Yes	-
TH17	MZ10AP-2 (42'-47')	Yes	-
Combined	F16+MZ1A+MZ14A+MZ12A+MZ10AP-2	No	Composite sample
Combined	F16+MZ1A+MZ14A+MZ12A+MZ10AP-2	No	Composite sample
Combined	MZ1A+MZ14A+MZ12A+MZ10AP-2	No	Composite sample
Combined	MZ1A+MZ14A+MZ12A+MZ10AP-2	No	Composite sample
Combined	MZ1A+MZ14A+MZ12A+MZ10AP-2	No	Composite sample
TH01	F16 (0-3 m or 9.72')	No	Results from preferred lab used
TH05	MZ1 (0-18')	No	Results from preferred lab used
TH10	MZ14 (0-13.5')	No	Results from preferred lab used
TH14	MZ12 (0-18')	No	Results from preferred lab used
TH16	MZ10AP (0-18')	No	Results from preferred lab used

12.2.2 Sand Quality Data

Frac sand quality data was supplied to Norwest in the following two size ranges:

- U.S. Mesh 20 to U.S. Mesh 40; and
- U.S. Mesh 40 to U.S. Mesh 70.

AMI provided 26 samples for each mesh size range. Not all sand quality items were used in the model. A list of items that were used to populate the model blocks and the reasoning behind the exclusion of some items is provided in Table 12.3.

Table 12.3
Sand Quality Items Used in the Model

Sand Quality Item	Model Use	Comment
In Size	No	Not relevant to model.
K-Value	Yes	Derived from crush resistance tests.
Crush Resistance (3,000 psi)	No	Used K-Value.
Crush Resistance (4,000 psi)	No	Used K-Value.
Crush Resistance (5,000 psi)	No	Used K-Value.
Crush Resistance (6,000 psi)	No	Used K-Value.
Crush Resistance (7,000 psi)	No	Used K-Value.
Crush Resistance (8,000 psi)	No	Used K-Value.
Crush Resistance (9,000 psi)	No	Used K-Value.
Turbidity	Yes	-
Roundness	Yes	-
Sphericity	Yes	-
Clusters	No	All data points. No clusters occurred
Bulk Density (g/cc)	Yes	-
Bulk Density (lb/ft^3)	No	Metric measurement used instead.
Specific Gravity	No	Not relevant to model.
Mean Particle Diameter (mm)	Yes	-
Median Particle Diameter (mm)	No	Mean particle diameter used instead.
Solubility (% Weight Loss)	Yes	-

12.3 Software

Norwest used Mintec's MineSight® software to develop and validate the 3D geological model to identify potential frac sand on the Firebag Property. MineSight® is widely used throughout the mining industry for digital resource model development. Mintec's suite of interpretive and modeling tools is well-suited to meet the modeling requirements of this Project.

12.4 Model Definition

All data point location information was provided in the UTM NAD 83 coordinate system. The extents of the deterministic 3D block model developed for the Project are provided in Table 12.4.

Table 12.4
Model Boundaries

Extent	Minimum (m)	Maximum (m)
Easting	482,500	484,090
Northing	6,380,750	6,382,740
Elevation	292	310

12.5 Topographic and Lease Data

Topographic data was downloaded from the GeoBase public database in the form of a 12.5 m x 23.2 m grid. Lease boundaries were supplied by AMI.

12.6 Geological Model Construction

After reviewing the PSD sample intervals, Norwest chose to create horizontal block model zones to constrain the population of model blocks (see Table 12.5).

Table 12.5
3D Block Model Zones and Definitions

Zone	Definition
1	Interval between topographic surface and the bottom of the topsoil plus subsoil layers (0.5 m).
2	Interval between bottom of Zone 1 and the bottom of test pits.
3	Interval between bottom of Zone 2 and a surface 30 ft (9.144 m) below the topographic surface.
4	Interval between bottom of Zone 3 and a surface 40 ft (12.192 m) below the topographic surface.
5	Interval between bottom of Zone 4 and the bottom of the auger holes.

Note: The zones were sampled in 10 ft resolution.

Zones were used to constrain the population of product and sand quality item percentages in the model blocks. The average percentage for each of the following products was calculated for each zone:

- Product 1 (P1), U.S. 20 mesh to U.S. 40 mesh;
- Product 2 (P2), U.S. 40 mesh to U.S. 70 mesh; and
- Product 3 (P3), U.S. 70 mesh to U.S. 140 mesh.

Most of the sand quality samples were composites based on data from multiple drill holes. Only P2 had multiple quality data points, and only in Zone 2. Surfaces for each sand quality item were created and the model was populated using those surfaces. All zones for P1 and the remaining zones for P2 were assigned single values for sand quality items (see Table 12.6).

Table 12.6
Sand Quality Values by Product and Zone

Zone	Product	K-Value (KV)	Turbidity (TU)	Roundness (RO)	Sphericity (SP)	Bulk Density (g/cc) (BD)	Mean Particle Diameter (mm)(PD)	Solubility (% Weight Loss) (SO)
2	P1	5,000	16	0.9	0.8	1.5	0.534	4.3
3	P1	3,000	10	0.6	0.7	1.47	0.538	3.3
4	P1	3,000	10	0.6	0.7	1.47	0.538	3.3
5	P1	3,000	10	0.6	0.7	1.47	0.538	3.3
3	P2	6,000	6	0.6	0.7	1.44	0.291	3
4	P2	6,000	7	0.6	0.6	1.43	0.289	3.7
5	P2	5,000	9	0.6	0.7	1.41	0.287	3.9

13 MINERAL PROCESSING AND METALLURGICAL TESTING

Other than the proppant test work conducted to determine the overall quality of the Firebag Property silica sand, AMI has not conducted any prototype metallurgical work specifically orientated towards extraction, separation, marketing and production of its silica sand/frac sand deposit.

With respect to the proppant test work, published specifications and standards for industrial minerals should be used primarily as a screening mechanism to establish the marketability of an industrial mineral. The suitability of an industrial mineral for use in specific applications can only be determined through detailed market investigations and discussions with potential consumers. Having said that, the proppant results show that the Firebag silica sand meets the recommendations set forth in International Standards ISO 13503-2:2006/Amd.1:2009E for sieve size fractions, sphericity, roundness, turbidity and crush classification. The majority of the Firebag Property clean frac sand is in the size ranges of 40/70 mesh and 70/140 mesh (87%). As such the maximum allowed acid solubility is 3%. Measured solubility's in the 40/70 mesh size fractions vary from 3.0% to 3.9% weight loss.

Therefore, with respect to reporting a resource estimate and abiding by the General Guidelines, it should be emphasized that the proppant test work results suggest that the silica sand from the Firebag Property has reasonable prospects of economic viability for an industrial mineral deposit.

Refer to Section 13 in "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)", produced by APEX Geoscience Ltd. for additional information.

13.1 Silica Quality

In January 2011, AMI conducted a 19-hole auger drill survey to test the aggregate potential of the Quaternary sand at the Firebag Property. The results of this program showed that the Firebag Property is dominated by silica sand that has the following characteristics:

- laterally extensive and consistent to depths exceeding 24 m;
- high in silica content (mean of 92% silica; n=135 samples);
- favourable grain-size distributions where the average sieve analyses yielded: 4.3% in the +20 mesh; 19.4% in the 20/40 mesh; 44.2% in the 40/70 mesh; 15.2% in the 70/100 mesh; and 16.9% in the -100 mesh size fractions; and

- roundness and sphericity measurements of between 0.6 and 0.8, which satisfy the International Standards ISO 13503-2:2006/Amd.1:2009E recommendations for proppant (0.6 or greater) and high strength proppant (0.7 or greater).

In December 2011, a follow-up exploration program to investigate the depositional aspects of the Quaternary sand was conducted.

The resulting December 2011 backhoe test pit and auger drill programs consisted of 26 test pits and six auger holes. The resulting auger-return logging confirmed that the Quaternary sand had a uniform depositional composition at the transition point between the uppermost fine to medium-grained eolian silica sand and coarse glacial outwash sand; this occurs at a depth of approximately 15 m. This observation is important as the uppermost (i.e., at or near-surface) sand generally has the highest silica content, 20/40 mesh size fraction sand and positive proppant test work results.

Refer to Section 9 in "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)", produced by APEX Geoscience Ltd. for additional information.

14 MINERAL RESOURCE ESTIMATES

14.1 Approach

In accordance with NI 43-101, Norwest used the Canadian Institute of Mining, Metallurgy and Petroleum's “Definition Standards for Mineral Resources and Mineral Reserves” and referenced the Geological Survey of Canada Paper 88-21 (GSC Paper 88-21), which is "a standardized coal resource/reserve reporting system for Canada," (which is often used as a guideline for other stratigraphic mineral deposits) during the classification, estimation and reporting of reserves for the Firebag River Sand Project.

To facilitate the estimation of resources and reserves in the Firebag River Sand Property, (Firebag Property) Norwest developed a geological model for the area using Mintec's MineSight® software. Key horizons or *surfaces* were modeled to provide the required inputs for volume estimation. Volumes were converted to tonnage by the application of density values representative of the mined frac sand. The computer model is described in detail in Section 12.

Mineral resources, which are not mineral reserves, do not have demonstrated economic viability. There is no certainty that all or any part of the mineral resources will be converted into mineral reserves. Mineral reserves are derived from mineral resources in the measured and indicated categories. This project has resources in the inferred category only, and, therefore, it cannot support the estimation of mineral reserves.

14.2 Silica Resource Estimation

Using no base cut-off for the silica sand, this Firebag Inferred Resource estimate predicts that 39.244 million tonnes of in-situ silica sand is present within the Firebag Property resource area (bounded by SML 130021 and SML 120032), which includes the following:

- 33.120 million tonnes in SML 120032; and
- 6.123 million tonnes in SML 130021.

The Firebag Inferred Resource is also reported by sieve size fraction, and the estimated tonnages of the individual fractions include the following:

- +20 mesh fraction: oversize;
- 20/40 mesh fraction: 4,340,530 tonnes (11.1%);
- 40/70 mesh fraction: 18,547,530 tonnes (47.3%);
- 70/140 mesh fraction: 12,894,430 tonnes (32.9%); and
- -140 mesh fraction: undersize.

The geological model created by Norwest did not separate the oversize and undersize material, +20 mesh and -140 mesh respectively. These two combined made up 3,461,510 tonnes of material or 8.8% of the total product.

The bulk of the total silica sand resource resides in the 40/70 mesh fraction (47%; 18.548 million tonnes), followed by the 70/140 mesh fraction (33%; 12.894 million tonnes) and then the 20/40 mesh fraction (11%; 4.341 million tonnes).

The accuracy of resource and reserve estimates is, in part, a function of the quality and quantity of available data and of engineering and geological interpretation and judgment. Given the data available at the time this report was prepared, the estimates presented herein are considered reasonable. However, they should be accepted with the understanding that additional data and analysis available subsequent to the date of the estimates may necessitate revision. These revisions may be material. There is no guarantee that all or any part of the estimated resources or reserves will be recoverable.

15 MINERAL RESERVE ESTIMATES

This section of the report includes estimates of recoverable sand resource tonnage for the Firebag River Sand Property based on preliminary mine plans, production schedules and processing plant and materials handling. These resource estimates are only intended for the purpose of completion of the cash flow forecasts presented in Section 22. These recoverable resource estimates are not, and should not be construed to be, estimates of reserves for the Firebag River Sand Property. They do not comply with the Classification of Reserves as required under NI 43-101 and the C.I.M. Guidelines for the classification of reserves. These estimates are inferred resources and are considered to be too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as reserves. The economic analysis has been prepared in compliance with Article 2.3 (3) of NI 43-101. It should be noted that there is no certainty that the preliminary economic assessment will be realized.

15.1 Approach

In accordance with NI 43-101, Norwest used the Canadian Institute of Mining, Metallurgy and Petroleum's "Definition Standards for Mineral Resources and Mineral Reserves" and referenced the Geological Survey of Canada Paper 88-21 (GSC Paper 88-21), which is "a standardized coal resource/reserve reporting system for Canada, (which is often used as a guideline for other stratigraphic mineral deposits), " during the classification, estimation and reporting of reserves for the Firebag River Sand Project.

To facilitate the estimation of resources and reserves in the Firebag River Sand Property, Norwest developed a geological model for the area using Mintec's MineSight® software. Key horizons or surfaces were modeled to provide the required inputs for volume estimation. Volumes were converted to tonnage by the application of density values representative of the mined frac sand. The computer model is described in detail in Section 12.

Mineral resources, which are not mineral reserves, do not have demonstrated economic viability. There is no certainty that all or any part of the mineral resources will be converted into mineral reserves. Mineral reserves are derived from mineral resources in the measured and indicated categories. This project has resources in the inferred category only, and, therefore, it cannot support the estimation of mineral reserves.

15.2 Silica Mineable Resource Estimation

Mining criteria and recovery of select material at the processing plant were used to estimate the Firebag Inferred resource, effective November 26, 2014. The resource estimate predicts that a 24,642,450 ROM tonnes, or 22,727,650 clean metric tonnes, of silica sand are present within the

Firebag Property resource area (bounded by SML 130021 and SML 120032), which includes the following:

- 19,257,610 million clean tonnes in SML 120032; and
- 3,470,040 million clean tonnes in SML 130021.

The Firebag Inferred Resource is also reported by sieve size fraction, and the estimated tonnages of the individual fractions include the following:

- +20 mesh fraction: oversize material;
- 20/40 mesh fraction: 2,919,730 clean metric tonnes (11.8%);
- 40/70 mesh fraction: 12,273,330 clean metric tonnes (49.8%);
- 70/140 mesh fraction: 7,534,590 clean metric tonnes (30.6%); and
- -140 mesh fraction: undersize.

The geological model created by Norwest did not separate the oversize and undersize material, +20 mesh and -140 mesh respectively. These two combined made up 1,914,800 tonnes of material or 7.8% of the total product.

The accuracy of resource and reserve estimates is, in part, a function of the quality and quantity of available data and of engineering and geological interpretation and judgment. Given the data available at the time this report was prepared, the estimates presented herein are considered reasonable. However, they should be accepted with the understanding that additional data and analysis available subsequent to the date of the estimates may necessitate revision. These revisions may be material. There is no guarantee that all or any part of the estimated resources or reserves will be recoverable.

16 MINING METHODS

The development planned for the surface mineable area of Firebag Property will use the truck/excavator mining method.

The topography at the Firebag Property is gently sloped, with a maximum elevation of 312 m, and a low of 304 m. The high is a sand ridge in the northwestern portion of the mining area. There are no major or minor bodies of water mapped on site. Water was encountered at a depth of 17 m below topography in one test hole, however, no other test holes showed water; therefore, because the property will only be developed to a depth of 16 m, surface and groundwater is not considered an issue.

Table 16.1 shows the Project development schedule for the Firebag Property. The Project development schedule includes first commercial production in Q3-2016.

16.1 Design Basis

No site-specific material performance data is available for the Firebag Property. As a result, no project-specific slope stability analyses were conducted. Norwest has used its experience with similar projects and the AESRD “Best Management Practices User Manual for Aggregate Operators on Public Land” to develop preliminary design criteria for the Project, as shown in Table 16.2.

Table 16.1

Firebag River Sand Property Development Schedule

Activity		Year -3 2014				Year -2 2015				Year -1 2016				Year 1 2017			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Project Development Requirements	Scoping Study																
	Environmental Assessment - Baseline Studies																
	Resource Definition																
	Detailed Engineering																
	Pre-Feasibility/Feasibility Study (Optional)																
	Submit Permit Applications																
	Regulatory Approval Process																
	Owner Approval (Sanction)																
Firebag River Sand Property	Highway 63 Upgrade																
	Access Road & Site Preparation																
	Site Infrastructure																
	Production																

Table 16.2
Design Criteria

Attribute	Criteria	Description
SML Offset	3 m	Undisturbed Buffer
Wall Angle	3:1	Overall
Reclamation Slope	3:1	Overall
Product Average Bulk Density (g/cc)	1.49	20/40 Mesh
	1.45	40/70 Mesh
	1.44	70/140 Mesh

16.2 Product Frac Sand

The following three clean frac sand products will be produced from the Firebag Property:

- 20/40 mesh;
- 40/70 mesh; and
- 70/140 mesh.

For the purposes of this PEA, all the run-of-mine (ROM) frac sand, that will ultimately constitute these three products, has been treated in exactly the same manner.

16.3 Waste and Rejects

Due to the nature of the deposit, and the geological modeling process, waste blocks are defined as either material that does not meet the product criteria mesh size on a whole-block basis (i.e., oversize or undersize material), or material that does not meet economic criteria.

Reject material is oversize or undersize sand (i.e., < 20 mesh or > 140 mesh, respectively) that is removed from the clean frac sand product during processing. The reject material will be transported with the ROM sand and handled at the processing plant site in the Edson area.

16.4 Mining Model

Two rounds of ore/waste discrimination were run on the model. The following initial ore/waste discrimination criteria used were:

- 0.5 m equipment selectivity;
- value of block based on the base selling price of the three products;
- combined costs of mining, transportation and processing for ore blocks; and

- cost of mining for waste blocks.

The ore blocks defined in the initial discrimination were then subject to a secondary ore/waste discrimination based on the full range of the selling prices for each product.

16.5 Base Case Pit Design

The mine design process must begin with the assignment of a number of parameters that are essential to the design.

Mintec's MineSight® Lerchs-Grossman (LG) software was used to develop the pit design for Firebag. Due to the different selling prices for the three products, it was not practical to use the standard Breakeven Strip Ratio approach for pit design. Instead, a dollar-based approach was used; the LG algorithm required the following four inputs:

- the pit slope and offset criteria as described previously;
- the unit selling price for each product type;
- the dollars available for stripping on a product-specific basis; and
- the unit cost of waste production.

Norwest engaged in confidential discussions with Alberta-based well services companies. They indicated pricing in the range of $155 to $200 per clean metric tonne would be realistic given AMI's three products and its point-of-sale location. Note this pricing was received in Q3 2014.

Upon reviewing the distribution of the products, a price of $155/cmt was used for the 70/140 mesh sand, $170/cmt for the 40/70 mesh, and $195/cmt was used for the 20/40 mesh sand.

Norwest chose to use the lower end of the range provided by the well services company. This is due to the higher range of reported acid solubility in the 20/40 and the 40/70 mesh sand. Norwest's understanding is that the International Standards accepted acid solubility for frac sand is lower than the Firebag Property's acid solubility for frac sand. Section 9.3 has further details on the ISO Standards for acid solubility and the actual acid solubility test results.

Initial product-specific values for the net selling price which determine the dollars available for stripping, and the unit cost of waste production are shown in Table 16.3. Note: During this stage of the design process, Norwest assumed a trucking cost of $26.50/ROMt from the Firebag Property to Lynton, and a rail cost of $44.10/ROMt from Lynton to the Edson processing site.

Table 16.3
Initial Pit Design Break Even In-Put

Category	20/40 Mesh	40/70 Mesh	70/140 Mesh
Selling Price ($/cmt)	$195	$170	$155
Estimated Recovery of Select Material	100%	100%	100%
Trucking Cost ($/cmt)	$33.13	$33.13	$33.13
Rail Cost ($/cmt)	$55.13	$55.13	$55.13
Clean Product Costs ($/cmt)	$31.34	$31.34	$31.34
Capital Cost Provision ($/cmt)	$8.53	$8.53	$8.53
Available for Stripping ($/cmt)	$66.88	$41.88	$26.88
Waste Production Cost ($/bcm)	$6.92	$6.92	$6.92

Notes:

- Frac Sand Product Pricing from Q3 2014
- 100% recovery of clean product expected at the plant, 92% recovery of ROMt, (i.e. 8% of ROMt are rejects)
- Clean product costs include ROM frac recovery at Firebag Property, materials handling at Lynton, processing plant and rejects handling at Edson, and general site and administration costs.

The LG algorithm searches the model to locate all blocks that occur within the cone described by the pit slope angle that can be uncovered at a net block value that is greater than or equal to zero. Through multiple passes, the LG algorithm locates the ultimate pit wall and floor at the point where net value equals zero. The waste and ROMt of frac sand contained within the base case pit shell are shown in Table 16.4. The ultimate pit designs are shown on Figure 16-1.

Note: The PEA includes a highway truck load-out system at the Edson facility, and, as such, the selling prices used in the PEA are assumed to be FOB Edson. It is conceivable that AMI could market the frac sand product to areas beyond what is considered a practical distance for highway transportation. In this case, the product could be shipped via rail. Norwest has made no provision for this possibility in the project economic analysis. However, this alternative would involve additional transportation costs and/or revised product pricing.

Table 16.4
Base Case Ultimate Pit

Product (Mesh)	Waste (bcm)	Frac Sand (ROMt)	Frac Sand (cmt)	Rejects (tonnes)
20/40 Mesh			2,919,730	
40/70 Mesh			12,273,330	
70/140 Mesh			7,534,590	
Total	**964,300**	**24,642,450**	**22,727,650**	**1,914,800**

Note: The waste volume includes topsoil and subsoil. The average recovery of select material (i.e., 20/140 mesh) is 92%.

Note: For the Base Pit design process, the saleable product was originally defined between 20/100 mesh. The pit was defined and mineable resources were determined. Upon reporting these mineable resources, AMI requested the resource base be updated to include the frac sand product to the 140 mesh size. The model was updated to report the 100/140, expanding the 70/100 classification to 70/140 mesh. Mineable resources were calculated within the defined pit, this added approximately 12% to the clean saleable tonnes.

16.6 Mine Development - Earthworks

The following three significant earthworks projects must be completed during the pre-production period:

- up-grade approximately 7 km of Highway 963 of the "Winter Road" to the SML (Highway 963 will be upgraded to Alberta Transportation standards for trucking);
- construct 860 m of the Primary Access Road on DLO 130748 (The Primary Access Road will be constructed to carry the highway trucks contracted to transport the frac sand from Firebag Property to Lynton); and
- site-preparation and soil salvage of the DML 130162 and the Year 1 footprint will be completed in the mine development period.

16.7 Production Schedule

A production schedule has been developed to cover the 25-year life of mine for the Firebag Property. The plateau production rate for Firebag was set at a nominal rate of 990,000 ROMt per year. The sand is hauled and railed as it is produced, and there is limited provision for in-progress stockpiling at Firebag or the Lynton rail yard.

A preset development sequence was developed to guide the production scheduling process. SML 130021 was developed from the western to the eastern limit. Mining continues south onto SML 120032 where the western half is stripped and mined first. The eastern portion is mined in a retreating manner so the frac sand product can be hauled to the stockpile area. This sequence also allows for progressive reclamation of the disturbed areas.

Minimal unsaleable sand is encountered over the life of mine. During the initial mining periods, the unsaleable sand will be placed in a temporary external waste dump. Once sufficient working space is available on the pit floor, all sand material that is not suitable for sale will be direct placed on the pit floor and contoured.

The production schedule is shown in Table 16.5.

Table 16.5
Firebag Property Mine Production Schedule

Year	Waste (bcm)	Reclamation Material (bcm)	ROM Frac Sand (ROMt)	Rejects (tonnes)	Clean Frac Sand		
					20/40 Mesh (cmt)	40/70 Mesh (cmt)	70/140 Mesh (cmt)
-1	58	129,178	322,500	21,652	28,277	147,228	125,343
1	390	36,913	990,000	69,021	90,463	451,308	379,208
2	526	36,913	990,000	76,135	104,857	465,643	343,366
3	520	36,913	990,000	80,677	117,505	474,516	317,301
4	305	36,913	990,000	83,528	126,537	474,945	304,990
5	308	36,913	990,000	80,907	127,100	464,798	317,195
6	503	36,913	990,000	79,441	126,507	460,833	323,220
7	390	36,913	990,000	80,037	116,568	483,693	309,702
8	101	36,913	990,000	79,688	110,978	499,356	299,978
9	238	36,913	990,000	76,696	108,198	508,225	296,882
10	458	36,913	990,000	69,272	108,217	515,309	297,201
11	458	36,913	990,000	69,272	108,217	515,309	297,201
12	458	36,913	990,000	69,272	108,217	515,309	297,201
13	458	36,913	990,000	69,272	108,217	515,309	297,201
14	458	36,913	990,000	69,272	108,217	515,309	297,201
15	438	36,913	990,000	68,412	114,862	522,653	284,073
16	438	36,913	990,000	68,412	114,862	522,653	284,073
17	438	36,913	990,000	68,412	114,862	522,653	284,073
18	438	36,913	990,000	68,412	114,862	522,653	284,073
19	438	36,913	990,000	68,412	114,862	522,653	284,073
20	507	36,913	990,000	89,654	134,419	476,847	289,080
21	507	36,913	990,000	89,654	134,419	476,847	289,080
22	507	36,913	990,000	89,654	134,419	476,847	289,080
23	507	36,913	990,000	89,654	134,419	476,847	289,080
24	507	36,913	990,000	89,654	134,419	476,847	289,080
25	280	0	559,953	50,326	75,257	268,736	165,635
Total	**10,635**	**1,015,094**	**24,642,453**	**1,914,802**	**2,919,738**	**12,273,327**	**7,534,586**

AMI is in negotiations with CN to form a commercial agreement that allows for Firebag frac sand throughput from CN's Fort McMurray loading facilities in Q3-2016. Throughput through AMI's Lynton rail yard facility is planned in Q4-2016.

The production schedule shows 322,500 ROMt of frac sand is produced during 2016 (Year -1): 75,000 ROMt in Q3 and 247,500 ROMt, full production, in Q4.

16.8 Mine Advance Drawings

A series of drawings were developed to show the advance of the mine as milestones are reached in the production schedule. Period-ending drawings showing the pit and dump advance were prepared for the following periods: 2016, 2020, 2025, 2030, 2035, and end of life, when mining is complete in 2041. The waste sand material is placed in-pit as backfill. The mine advance drawings are shown on Figure 16-2 through Figure 16-7.

16.8.1 Mine Advance – 2016 (Year -1)

The Year -1 drawing shows the status of the mine two-quarters into the start of commercial operations. Highway 963 has been upgraded, and the DLO, which allows highway trucks to access the mining operation, has been constructed. All topsoil and subsoil has been stripped and windrowed from the Year -1 and Year 1 mining area and the DML. A ROM stockpile area and all site-required infrastructure is in place. A temporary external waste sand dump is located close to mine operations.

During Q3 of Year -1, 75,000 ROMt of sand will be trucked to the CN rail yard to be transported to the processing plant in the Edson area. By Q4, the site is at full capacity, (i.e., 247,500 ROMt) will be trucked to AMI's Lynton rail yard from the Firebag Property.

Refer to Figure 16-2.

16.8.2 Mine Advance – 2020 (Year 4)

The Year 4 drawing shows the mine advance to the end of 2020. SML 130021 has been mined completely, and mining has begun in SML 120032.

By Year 4, all waste is direct placed in pit. Progressive reclamation is ongoing.

Refer to Figure 16-3.

16.8.3 Mine Advance – 2025 (Year 9)

Mining continues to the south of the west portion of SML 120032.

All waste is direct placed in pit. Progressive reclamation is ongoing.

Refer to Figure 16-4.

16.8.4 Mine Advance – 2030 (Year 14)

On the west portion of SML 120032, mining has reached the southerly limit. Mining continues to the east.

All waste is direct placed in pit. Progressive reclamation is ongoing.

Refer to Figure 16-5.

16.8.5 Mine Advance – 2035 (Year 19)

The south portion of SML 120032 has been mined to the eastern limit. Mining continues to the north.

All waste is direct placed in pit. Progressive reclamation is ongoing.

Refer to Figure 16-6.

16.8.6 Mine Advance – 2041 (Year 25) End of Life

Mining of the Firebag Property is complete.

All waste is direct placed in pit. Progressive reclamation is ongoing.

Refer to Figure 16-7.

16.9 Waste Dump Arrangement

A permanent external waste dump was not required for the Firebag Property. All waste material is placed in-pit.

A temporary external waste sand dump will been located close to mine operations. The temporary waste dump will be rehandled once sufficient working space has opened up in the pit floor. The temporary external dump is shown on Figure 16-2.

16.10 Mine Reclamation and Closure

AMI submitted the "Conservation and Reclamation Business Plan of SML 130021 in N ½ Section 8-99-08-4 (32.36 ha)" to the AESRD in April 2014. This plan was approved by AESRD in August 2014.

An allowance has been made in the cost model to provide for mine reclamation activities. Figure 16-8 shows the Firebag River Sand Property Conceptual Closure Plan.

16.11 Firebag Property Water Management

Water management at the mine site area will likely consist of perimeter ditches, sumps and a settlement pond releasing to the environment. It is assumed that no excavated materials will come in contact with the hydrocarbon-bearing McMurray Formation materials, and, therefore, surface water is expected to meet regulatory specifications for release to the environment after sediment is removed in a settlement pond. A regular regimen of environmental water sampling should be conducted in the settlement ponds in keeping with AESRD standards.

Norwest recommends that AMI consider the implementation of a method to secure the release system in the event of a toxic spill within the excavation. In the event of a breach, contaminated water would have to be trucked off site to an approved location, and AESRD approval would be required to resume water release to the environment.

16.12 Primary Equipment

The quantitative requirements of the production schedule were reviewed together with the expected conditions of the mine as seen through the advance drawings. In developing the equipment fleets for the Project, Norwest referenced certain makes and models of equipment. These references should in no way be construed as an endorsement of any piece of equipment over another. Based on the review, Table 16.6 shows the primary mining equipment requirements for the Firebag Property.

Table 16.6
Primary Mining Equipment

Equipment Type	Bucket Size (m^3)	NOH/Year	Productivity (bcm/NOH)	Production (bcm/yr)
CAT 349	3.2	3,255	213	817,355
CAT 930K	2.3	5,953	103	813,210
CAT 725	N/A	2,937	70	N/A

Note: Production (bcm/yr) is annual shovel capacity.

16.13 Truck Productivity

The mine advance drawings were used to develop haulage lengths for the ROM sand at each production interval. The haulage routes were then transferred to RungePincockMinarco’s TALPAC software to calculate haul and return times. Table 16.7 shows the rolling-resistance values and speed limits used in the assessment.

Table 16.7
Haul Simulation Design Criteria

Activity	Conditions	Rolling Resistance (%)	Max Speed (km/hr)	Minimum Distance (m)
Loading	Pit Area-	12	10	150
Hauling	Ramp*	6	25	200
Hauling	Haul Road	8	25	600
Stockpile Area	Stockpile Area	8	10	50

*Rig mats assumed to be utilized on the ramps in order to achieve a rolling resistance of 6%

The minimum haul length over the life of mine was limited to 1,000 m. Truck capacity was calculated at 15 bcm, or 23 tonnes for the CAT 725 trucks. The waste haul distance was assumed to be the same as the ROM sand haul over the life of the project as the waste consists of less than 1% of the total material moved. Haul-cycle fixed time criteria are shown in Table 16.8.

Table 16.8
Haul-Cycle Fixed Time Criteria

Item	Time (minute)
Loading – CAT 349	2.85
Wait at Excavator	0.5
Spot at Stockpile Area	0.33
Dump	0.5

The average productivity over the Project's life of mine is 70 bcm/NOH.

17 RECOVERY METHODS

17.1 Process Design

AMI sand-sizing operation system will begin at the Lynton receiving area, and continue along the transportation route to the processing area at Edson; this system will also include a product distribution component.

The following subsections describe the process development, the general system outline and key equipment and process components. Table 17.1 shows the project development schedule for the Lynton rail yard and the processing plant at Edson.

17.2 System Design

17.2.1 Design Criteria

The system's general design criteria were developed by Norwest to support a year-round transportation and production system. Previous work completed by Norwest and other project development efforts have identified the following potential product sizes:

- 20/40 mesh;
- 40/70 mesh; and
- 70/140 mesh.

These previous sample collection and quality information efforts are described in greater detail in Section 11.

The average expected run-of-mine particle size distribution is shown in Table 17.2. The conceptual process design was based on the hypothetical feed stock that was derived using the homogenized sample population from the geology component.

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Table 17.1
Project Development Schedule

Activity		Year -3 2014				Year -2 2015				Year -1 2016				Year 1 2017			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Project	Scoping Study		■	■													
	Environmental Assessment - Baseline Studies				■	■	■	■									
	Resource Definition					■	■										
	Detailed Engineering				■	■	■	■	■								
	Pre-Feasibility/Feasibility Study (Optional)						■	■	■								
	Submit Permit Applications				■	■	■	■	■								
	Regulatory Approval Process					■	■	■	■	■	■	■	■	■	■	■	■
	Owner Approval (Sanction)				■	■	■										
Lynton	Earthworks								■	■	■						
	Rail Siding									■	■	■					
	Stockpile area											■					
	Rail Loading											■					
	Utilities								■	■	■	■					
Edson	Earthworks							■	■	■							
	Rail Siding									■	■						
	Rail Unload										■	■					
	Stockpile Area										■	■					
	Wet Plant								■	■	■	■					
	Dry Plant									■	■	■					
	Product Loading										■	■					
	Utilities									■	■	■					

Table 17.2
Expected Run-of-Mine Particle Size Distribution

Top Size Mesh	Incremental Weight (% retained)	Cumulative Weight (% retained)
20M	1.2	0.5
25M	2.1	0.9
30M	4.0	1.9
35M	7.6	3.6
40M	12.4	4.8
45M	22.9	10.5
50M	34.5	11.6
60M	50.8	16.3
70M	61.6	10.8
80M	74.2	12.6
100M	83.3	9.0
120M	90.5	7.3
140M	95.1	4.5
170M	97.7	2.6
200M	99.0	1.4
Pan	100.0	0.9

The operating hours, system capacity and general assumptions are shown in Table 17.3.

Table 17.3
System Design Criteria

Criterion	Value
Annual Scheduled Hours	5,500
Plant Availability	90%
Annual Operating Hours	5,000
Mine Production (ROM tonnes per year)	990,000

17.3 Plant Description

Both the Lynton receiving area and the Edson processing area are in alignment with the overall system capacity.

In general, the Lynton site functions as a receiving and trans-loading area to move the ROM sand from the mine to the processing plant in Edson. Note: No processing or beneficiation occurs at the Lynton operation.

The Edson site provides a receiving and stacking system for the ROM feed; it also has a wet plant and a dry plant, a dryer and a product-dispatching system on site.

For the following discussions, refer to the simplified flowsheets on Figure 17-1 through Figure 17-3. General site plans are shown on Figure 17-4 and Figure 17-5 for Lynton and Edson, respectively.

17.3.1 Lynton

Using side dump trucks, the excavated sand will be hauled from the mine to the rail loading site, and unloaded near the train loading hopper. This unwashed and unsized sand will be loaded onto trains in the Lynton rail yard. For the following discussion, refer to Figure 17-1 and Figure 17-4.

The rail loading system comprises a 75-tonne hopper (BN-100) that is loaded with material from the ROM sand stockpile with a front-end loader (FEL). The train loading conveyor (CV-105) transfers the sand from the hopper to bifurcated chute work that is configured to load cars on either spur. For the purposes of this PEA, the capacity of the conveyance system is 200 t/hr. A car indexer positions the rail cars for loading, and a hydraulic ram pulls the full string of 100 cars along the spur, one car length at a time. A main-line switch, a yard switch and approximately 6,000 m of track are required to complete the rail car loading system at Lynton.

From Lynton CN will deliver and drop off a set of 100 loaded cars into the empty spur and return to Edson with a set of 100 empty cars that are standing by on the other spur. From preliminary discussions with CN, the transit cycle time is expected to be 66 hours from Lynton to Edson and 96 hours return from Edson to Lynton. Based on this preliminary information, the expected delay between the outbound loaded train at Lynton and the inbound empty train from Edson will require the system to have three independent sets of rail cars. This timing allows the system to load a returned set of empty cars during the transit cycle time between Lynton and Edson. Note: Loading operations at Lynton will occur year round on a 24-hour-a-day, 7-day-a-week schedule.

17.3.2 Edson

The Edson site will receive rail shipments, and transfer the load to a stockpile for temporary storage, and then feed the wet plant and dry plant before feeding the multi-lane product storage and dispatch bins. A general process description follows.

For the following discussion, refer to Figure 17-1 through Figure 17-3, and Figure 17-5.

Rail Off-Loading and Stockpiling

The loaded train is switched onto the rail siding (RS-140) that is located alongside the main-line track. RS-140 has sufficient track length to allow a complete string of 100 cars and three locomotives to be staged and positioned entirely off the main-line track, which allows other train traffic to pass while the train is being unloaded.

After the train is positioned on the siding, it is trammed over the unloading belly dump discharge hopper (BN-145) and sand is quickly and continuously discharged into the hopper. Beneath the hopper is a series of three parallel drawdown feeders that draw the sand out of the hopper and onto the transfer conveyor (CV-150) at 2,500 tonnes per hour. The transfer conveyor will feed a radial stacker (CV-160) which will build a stockpile of ROM material. Only the belt feeders, transfer conveyor and radial stacker are designed with increased capacity to quickly unload the train. All subsequent units have a reduced capacity. The system is currently designed to unload a train in less than 4 hours. Note: This does not include positioning time.

Another FEL will load sand from the ROM, unwashed sand stockpile and into the plant feed hopper (BN-165), and a vibratory pan feeder will discharge the sand onto the plant feed conveyor at the desired feed rate of 175 tonnes per hour. The plant feed conveyor (CV-170) will feed the wet plant system shown on Figure 17-3.

A release agent, added at the Lynton loading point, will allow the run of mine material to release from the rail cars upon arrival at Edson.

Wet Plant

Figure 17-3 shows a simplified flowsheet of the proposed wet plant process at Edson. Based on the preliminary sizing information and the homogenized feed stream shown in Table 17.2, Norwest has developed a conventionally sized classification process that uses screen classification and upward current separators (hydrosizers) followed by a final cyclone ultra-fines system. The wet plant includes a conventional, module-based system that has the capacity to process 175 tonnes per hour nominally, but is also capable of processing a 5% finer feed stream at up to 200 tonnes per hour. This design does not include an attriting or scrubbing process because clay-bound fines are not expected to be present in the mined seams.

The plant feed conveyor (CV-170) will feed an 8 x 20 single-deck wet screen (SC-200) which begins the wet-washing process. Any oversize from the screen (i.e., +20 mesh) will be rejected as waste. The slurried underflow will be collected in the primary sump (SP-210). A combination of a hydrocyclone (CY-215) and a hydrosizer (HY-S220) will provide the initial classification. The cyclone is used ahead of the hydrosizer to reduce the fines load within the hydrosizer; this provides a sharper separation. The hydrosizer is particularly effective at removing the ultra-fines and works by providing a countercurrent flow of water through the injection or teeter water, which flows upward and through the downward-trending solids. This creates a bed of suspended solids and allows the liberation of ultra-fines from the coarse material. The only goal of the hydrosizer operation is to remove the ultra-fines; this can be controlled via the rate of teetered water flow relative to the solid feed. An underflow valve discharges the collected solids from the lower zone and the ultra-fine clays collect from the overflow weir at the top of the unit and are combined with the hydrocyclone (CY-215) overflow for processing in the ultra-fines circuit. A high-frequency dewatering screen (SC-225) will dewater the hydrosizer product and discharge to the plant product conveyor (CV-230).

The ultra-fines process consists of a set of cyclones positioned on top of and ahead of a second high-frequency screen (SC-245). Cyclone underflow consists of the collected solids for dewatering; cyclone overflow consists of any segregated ultra-fines for the thickener feed. Dewatered cyclone product on the second high-frequency screen (SC-245) will discharge to the plant product conveyor (CV-230), and the underpan will collect the bypassed fines and circulate them for reprocessing and recapture.

The ultra-fines from the cyclone (CY-240) will gravity flow to the thickener feed well (TA-250). A 15.2 m diameter thickener has been sized for this project. Thickener underflow will be collected and pumped to a plate and frame press to dewater the fines. This is installed in lieu of any major settling pond; the slime fines will be collected and stored in an on-site reject area. Preliminary sizing indicates that the slime and off-spec coarse will be in the range of 20 to 25 tonnes per hour; it is recommended that future studies further characterize this stream.

As discussed above, the washed and sized sand is carried out of the wet plant on the plant product conveyor (CV-230). The product conveyor discharges onto the product radial stacker which is created by dumping material onto the ground into a product stockpile. This material is allowed to free drain in the stockpile before proceeding to the dry plant.

The wet plant is enclosed in a prefabricated building located on a floating-mat foundation. Norwest has included foundation support work as an allowance. It is recommended that future studies characterize the soil and depth to bedrock.

Dry Plant

The dry plant ultimately provides the final specification for the product streams. To complete this task, a thermal drying step is included. Due to its relatively efficient operation, Norwest selected the Ventilex Fluid Bed Dryer for this purpose. A Rotex® Minerals Separator™ sizing system was selected for the three-product separation. For additional information, refer to Figure 17-2 and Figure 17-5.

An FEL loads the stockpiled sand from the product drying stockpile into the product feed hopper; from here, the sand is metered onto the dryer feed conveyor with a vibratory pan feeder. A conveyor (CV-310) feeds the two Ventilex thermal dryers from a pant-leg chute. Ventilex dryers use a control and feedback loop to modulate the dryer temperature and, therefore, the fuel usage; this ensures that the product is not over dried and meets the conditions. Two collection conveyors transfer the dryer product from a pair of bucket feed elevators to the polishing screens.

The screen feed bucket conveyor feeds a set of splitters and flow-dividers into a series of four Rotex® Minerals Separators™ that separate the sand into the three product sizes (20/40 mesh, 40/70 mesh and 70/140 mesh). Each of these products is collected and conveyed into a bucket elevator and then dumped into their respective product bins. A dual product system for each of the bins provides a reasonable buffer to the loading and dispatching process. The section from the thermal dryer to the polishing screens is enclosed, and each product has a separate building. The dry plant and the product storage and dispatching systems each have separate dust collection and ventilation systems. However, it is still suggested that workers be required to wear a dust mask to comply with health and safety codes.

Highway haul trucks are weighed before and after they are loaded to verify the delivered volume. Truck scales (TS-345 A and TS-345 B) provide a batching and dispatching system for the loaded trucks. A unique ticket is created for each truck that provides its tare weight and allowable gross vehicle weight.

Infrastructure

Infrastructure components were estimated as an allowance. Because the Edson site is not specifically located within the area, an allowance for site access and ties to utilities were included in the capital cost schedule. Norwest assumed that the operation would be located adjacent to the local highway and rail lines; therefore, the overall site development costs were low.

Workshop and building allowances were based on budgetary pricing and recent project experience. The project support infrastructure construction was intended to be minimal, and only a few site facilities were developed.

At Lynton, two office trailers to support the receiving yard and rail transfer are planned. It is anticipated that a working manager will travel between the Lynton rail yard and mine site, and that all maintenance will be contractor-operated. A permanent maintenance area and warehouse at Lynton has not been developed.

At Edson, a dedicated maintenance workshop and administrative complex is planned. This will be the site complex used to house staff and office employees, load dispatching and maintenance personnel for the operation. One laboratory trailer is provided for quality assurance and sampling work. Two office trailers will support the needs of the superintendents and work crews.

A natural gas tie-in was provided as an allowance; it is recommended that future studies define the gas needs as well as the defined tie-point.

17.4 Lynton Trans-Loading Facility Water Management

Water management at the Lynton trans-loading area will likely consist of perimeter ditches, sumps and a settlement pond releasing to the environment. It is assumed that no excavated materials will come in contact with the hydrocarbon-bearing McMurray Formation materials, and, therefore, surface water is expected to meet regulatory specifications for release to the environment after sediment is removed in a settlement pond. A regular regimen of environmental water sampling should be conducted in the settlement ponds in keeping with AESRD standards.

Norwest recommends that AMI consider the implementation of a method to secure the release system in the event of a toxic spill within the excavation. In the event of a breach, contaminated water would have to be trucked off site to an approved location, and AESRD approval would be required to resume water release to the environment.

17.5 Processing Plant Water Management

The proposed Edson silica sand processing facility is assumed to require up to 2,500 GPM water use for approximately 5,500 hours per year. A water recycling system would be implemented to reduce the amount water withdrawn from the environment. The process water use equates to 0.825 billion gallons or 3.12 million cubic metres annually. It is estimated that only 220 GPM of make-up water will be required in addition to one week of available online storage.

17.5.1 Edson Groundwater Resources

The hydrogeology of the Edson area has been thoroughly studied. In 1960, the town began an extensive drilling program to delineate and characterize its aquifers. In the early 1960s, the Alberta Geological Survey (AGS) continued this work with aquifer pump tests and well installations (Lennox, 1966). The results identified several very productive aquifers for commercial use, particularly in the area between Edson and the McLeod River.

The most productive aquifer is a pre-glacial buried valley that trends northeast-southwest past the southern edge of Edson, and follows a thalweg for 20 km. It is currently referred to as the "Edson Valley Aquifer." This aquifer reaches a maximum thickness of 6 m, and consists mainly of unconsolidated gravels originating from the Rocky Mountain uplift, with lesser amounts of clay, silt and sand on its edges. Because it is the original water supply for Edson, the AGS conducted extensive testing on this aquifer, and concluded that it exhibited the following properties:

- Classification, "leaky confined";
- Transmissivity, 150-1,200m^2/d;
- Storativity, 10^{-3} to 10^{-2};
- 20-year safe yield, 8-38 L/s; and
- Depth, 30-40 m below surface (Vogwill, 1983).

Wells were generally completed with 8-in. screens, with 0.08 in. to 0.1-in. slots (Menely, 1961). Under pumping conditions, the aquifer benefits from recharge by the McLeod River. However, because the town currently draws only 10% of its water from this aquifer (Lovatt, 2007), conditions in Edson might have changed with regard to water availability or water quality.

The most important bedrock aquifer beneath Edson is the Paskapoo Formation, a Tertiary unit consisting primarily of sandstone and minor amounts of siltstone, shale and coal. Its importance has increased in recent years because, in 2007, the town drew 90%

of its municipal water supply from this aquifer (Lovatt, 2007). Productivity is mainly driven by fracture porosity, and the Paskapoo Formation is most fractured in areas with drift features such as buried valleys and channels due to weathering and water infiltration. Therefore, the most productive Paskapoo aquifer wells are drilled beneath the aforementioned Edson Valley Aquifer, or on its fringes. In the area, aquifer properties of Paskapoo are as follows:

- transmissivity: 1.5 m^2/d to 100 m^2/d, rarely as high as 1,000 m^2/d;
- storativity: $5x10^{-5}$ to 10^{-4};
- 20-year safe yield 2 L/s to 38 L/s; and
- depth: 20 m to 150 m depth below surface, with fractures extending to approximately 100 m depth (Vogwill, 1983).

17.5.2 Edson Surface Water Resources

Some reports indicate Edson's groundwater resources are not as sustainable as originally modeled (Menely, 1961); a recent municipal development plan reached this conclusion after researching new water options. In 2007, the town of Edson considered withdrawing surface water from the McLeod River to solve its long-term water needs (Lovatt, 2007). In 2012, hydrometric data from the Government of Canada (Figure 17-6) indicated a maximum flow of 550 m^3/s and a minimum flow of < 10 m^3/s at the Rosevar Station which is approximately 20 km downstream of Edson (Wateroffice, 2014). However, winter low-flow periods could pose a challenge to water diversion needs for silica sand processing.

17.5.3 Hinton Groundwater Resources

Hydrogeologic data for Hinton is scarcer than for Edson, but, as part of the same study in the 1960s, the Alberta Research Council mapped and described the aquifers in the Foothills region, with a greater reliance on interpretation.

Surficial drift aquifers are limited in the area due to the high relief, and they are mainly confined to the Athabasca River Valley. The most important of these is the glacial outwash gravel that lies between Brule and Gregg Lakes; this aquifer is proven to have a safe yield of 2 L/s to 38 L/s. Other glaciofluvial and more recent fluvial sand and gravel deposits occur along the Athabasca River and those in hydraulic connection with the river are expected to yield approximately 10 L/s. The most productive scenario for groundwater development is located where recent alluvium, glaciofluvial and buried valleys occur in vertical succession, such as southwest of Brule Lake, where the 2 L/s to 38 L/s safe yield has been assigned.

Bedrock aquifers are significantly less productive in the Foothills than in Edson. Although the Paskapoo is still an extensive aquifer, it only yields 0.4 L/s to 2 L/s with a transmissivity of 1.5 m^2/d to 15 m^2/d. The Brazeau Formation (fractures, sands and shales) forms the most common aquifer in the Foothills, with a 20-year safe yield of 0.1 L/s to 0.4 L/s and transmissivity of 0.8 m^2/d to 3.7 m^2/d.

The best bedrock aquifers in the Foothills are located in the Luscar Formation in fractured sandstones commonly associated with surface coal mining. Coal mines in the area generally require groundwater control schemes to prevent inflow from this aquifer. The Luscar aquifer's extent between Luscar and Folding Mountain has a 20-year safe yield of 2L/s to 8 L/s and transmissivity of 1.5 m^2/d to 150 m^2/d (Vogwill, 1983).

17.5.4 Hinton Surface Water Resources

A silica sand processing plant constructed near Hinton might be able to access the Athabasca River as a water source. Throughout the province, water from the Athabasca River is used for a wide variety of industrial activities from pulp mills at Whitecourt to oil sands processing in the Athabasca Valley. In 2011 (Figure 17-7), its maximum daily discharge at Hinton was 900 m^3/s with a minimum daily discharge of 40 m^3/s (Wateroffice, 2014). Given the seasonal variations, it is considered a more robust surface water source than the McLeod River.

17.5.5 Water Source Comparisons

Advantages to using groundwater for silica sand processing include the following:

- no need for an intake structure/pipeline from the McLeod or Athabasca River;
- no treatment required to remove turbidity or bacteria; and
- temperature and water quality are very consistent.

Disadvantages to using groundwater for silica sand processing include the following:

- upstream water storage required, because wells cannot not supply 2,500 GPM on demand;
- potentially difficult to obtain permitting if the aquifers are already at their maximum withdrawal rates;
- drilling and installation of one or more on-site water source wells required; and
- sparse publicly available data regarding present day well yields.

Advantages to using surface water for silica sand processing include the following:

- instant availability of 2,500 GPM assuming levels falls within regulations; and
- reduced demand on the town's aquifers.

Disadvantages to using surface water for silica sand processing include the following:

- permitting and construction of an intake structure and pipeline required;
- seasonal variations in water availability, quality, and temperature; and
- storage required during low-flow periods or if maximum allowed diversion is below target.

17.6 Process Water Management

Washwater used for processing frac sand to market specifications will contain a mixture of fine and coarse silica particles removed from the product. Methods for removing the sediment and recycling water for process will depend on the cost benefit analyses, and might include mechanical water/fines separation methods. It is assumed that no large-scale settling pond structure will be required, and that the plant will create a low-liquid waste sludge that will be stored on-site. Water recycle efficiency will be roughly 90% and, therefore, only 220 GPM make-up water will be required.

17.7 Water Balance

The water balance is strictly a function of the input and output streams of the plant. Any internal recirculating water flows within the plant are inconsequential. The water balance accounts for the surface (i.e., free) moisture of the feedstock as well as any surface moisture on the streams exiting the plant. Most wetted processes typically have output streams with higher levels of free moisture than its feedstock. Therefore, these plants have a water deficit which requires a make-up water stream to maintain operations.

The feedstock surface moisture content will likely be variable, depending on weather conditions, stockpiling methods, etc. However, surface moisture in the output streams will be fairly constant and predictable.

Norwest was unable to obtain actual moisture data regarding the feedstock, but it is expected that the moisture level will be between 2% and 6% depending on conditions in the ROM stockpiles. To determine the amount of make-up water needed to process the ROM sand into product, Norwest assumed the free moisture to be in this same range.

The principle outflows consist of the product sand and rejects filter cake. The product sand moisture, after screening, is reduced to an estimated 16% by weight.

A plate and frame filter press is used to dewater rejects. The filter cake discharged from the filter press will contain 30% moisture. The wet screen, that is the first element in the separation process, will discharge the oversize and undersize at 10% surface moisture.

Table 17.4 shows the input and output streams used to determine the water deficit, and, therefore, the required make-up water. This example considers a low 2% moisture feedstock.

Table 17.5 shows the same plant material but with feedstock surface moisture of 6%. Note: The 6% example requires less make-up water. Based on the assumptions discussed, the sand washing system will, therefore, require between 40 and 50 cubic metres of make-up water per hour.

Table 17.4
Make-Up Water Required with Feed Stock at 2% Surface Moisture

Plant Material	Solids t/h (ar)	Solids t/h (ad)	Water m^3/h	Moisture % (free)
Plant Feed	175	171.5	+3.5	2%
Product Sand	-	146	-23	16%
Filter Cake	-	26	-30	30%
Oversize Trash	-	1	-0 *	10%
Net Make-Up Water			**50**	

* Negligible.

Table 17.5
Make-Up Water Required with Feed Stock at 6% Surface Moisture

Plant Material	Solids t/h (ar)	Solids t/h (ad)	Water m^3/h	Moisture % (free)
Plant Feed	175	165	+11	6%
Product Sand	-	146	-23	16%
Filter Cake	-	26	-30	30%
Oversize Trash	-	1	-0	10%
Net Make-Up Water			**42**	

Using the plate and frame filter press shown on Figure 17-3, the water discharged from the wet plant to a settling pond will be minimal. The project site at Edson still requires a settling pond that is capable of handling plant upset conditions. The settling pond will be sized so that plant operations will be able to drain the thickener and the other process equipment.

Future studies should include a water retention analysis, and, at that time, the surface moisture of the sand delivered to Lynton should be determined.

18 PROJECT INFRASTRUCTURE

This section of the report addresses existing regional infrastructure that will be used as part of the project development and ongoing operations. It does not include any new project infrastructure; these additions are addressed in Sections 16 and 17 of the report. Therefore, the infrastructure issues addressed here include Highway 63, Highway 16 and the rail line beyond the load-out facility at Lynton.

The main infrastructure items include the following:

- the main CN rail line from Lynton to Edmonton;
- the main CN rail line from Edmonton to the Edson area;
- roads and highways;
- town sites; and
- utilities and other facilities and services.

The main regional road access to the Lynton site and the Firebag River site is via Highways 63 and 963. Fort McMurray is a supply centre for oil sands mining operations and it houses most of the mining labour force in the area. The communities in the RMWB already have all of the required facilities and services in place to help develop the mine at the Firebag Property. These communities are serviced by electric power, natural gas and water utilities. AMI expects to supply camp accommodations for the labour force at Firebag Property and Lynton sites. There is a commercial airport in the area; the majority of the workforce is expected to come from the Edmonton and Calgary areas.

The rail connection from the load-out at Lynton is the Lac la Biche Line from Lynton to the junction at Edmonton, Alberta, and the Edson Line from Edmonton to the Edson area processing facility. These lines currently transport various types of freight. Both are operated by CN and, although some bottlenecks exist, they both have the capacity to carry the frac sand production volume.

The main regional road access to the Edson site is via Highway 16, the Yellowhead Highway. Edson is a supply centre for coal mining, forestry and oil and gas operations, and it houses most of the labour force in the area. The processing plant personnel are also housed at Hinton and other communities located along Highway 16. These communities already have all of the required facilities and services in place to help develop the processing plant in the Edson area. These communities are serviced by electric power, natural gas and water utilities. There is no commercial airport in the area, but the closest airport is in Edmonton, Alberta about 230 km from Edson. The main commercial air access to the Project is through the Edmonton International Airport.

19 MARKETS AND CONTRACTS

19.1 Markets

Norwest has reviewed various publicly available sources of information with respect to the expected demand for frac sand in North America and, more specifically, Western Canada. The majority of these sources indicate that the demand is expected to increase. Forecasted annual rates of increase vary between 5% and 25%.

AMI has selected the Edson/Hinton area of west-central Alberta as its point of sale for frac sand. This area coincides with current vigorous activity in the production of tight oil and gas from a number of geological formations; the majority of these operations require frac sand.

Publicly available information regarding frac sand pricing is scarce. This scarcity of data is further compounded by the fact that pricing is heavily dependent on both transportation costs and the specific quality of the product. On the condition of confidentiality, Norwest engaged in confidential discussions with Alberta-based well services companies. They indicated pricing in the range of $155 to $200 per clean metric tonne would be realistic given AMI's three products and its point-of-sale location.

For the purposes of the PEA, Norwest chose to apply pricing and distribution levels as shown in Table 19.1.

Table 19.1
Frac Sand Selling Price and Distribution

Frac Sand (Mesh)	Selling Price* (Cdn$/cmt)	Product Distribution (%)
20/40 Mesh	$195	13
40/70 Mesh	$170	54
70/140 Mesh	$155	33

Note*: Frac Sand Product Pricing from Q3 2014

19.2 Contracts

At this time, AMI has no contracts in place for the production and/or sale of frac sand.

20 ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

AMI must complete the overall permitting and approval process in order to construct, operate and close Firebag Property and the associated trans-loading facility and processing site facilities.

AMI proposes to transport the silica sand by rail from the Lynton Trans-loading Facility located in Lynton to a processing plant located in the Edson region.

This permitting and approval process includes the acquisition of all necessary permits and approvals from various federal, provincial and local government agencies, and the completion of a baseline study program to assess the potential impacts to the human and natural environment that could result from the implementation of Project activities. This section is based on all the available information at the time of this report.

20.1 Environmental Studies

A multi-resource baseline study program will be implemented to collect the data required to support the completion of government permitting and the anticipation of the required environmental documentation process. The baseline study program might include, but will not be limited to, the following resource studies:

- general vegetation;
- general wildlife;
- invasive, non-native plant species including noxious weeds;
- soils;
- water quality and quantity, including surface and groundwater hydrology;
- air quality and emissions;
- waste management;
- social and economic impacts;
- aesthetics, including noise and visual assessments;
- surface water; and
- river flows: current and historic.

This baseline study program would be developed in consultation with the appropriate government regulatory agencies to ensure that the information is collected using approved procedures for quality assurance and data adequacy standards.

The estimated costs to complete the baseline study program could range from $100,000 to $200,000 depending on the number of resources that will need to be studied, and the amount of data that will need to be collected to assess the particular resource.

20.2 Waste and Rejects Disposal, Site Monitoring and Water Management

Disposed silica sand that does not meet specification requirements and water that is used in the extraction process will probably be captured in on-site settling ponds. These settling ponds will be constructed as a means to manage and recycle process-affected water because it is assumed that the excavation process will not affect the hydrocarbon-bearing McMurray Formation. AMI will arrange for a local, certified waste management company to regularly dispose of waste on site in bear-proof bins and to provide the required services, such as portable toilets with holding tanks. Water management at Firebag Property might consist of perimeter ditches, storage tanks and settling ponds.

The Lynton facility is the proposed site for loading and transporting the silica sand to the proposed processing plant near Edson region. AMI will be responsible for the site monitoring and water management activities.

The proposed processing facility in the Edson region will implement a water recycling system to reduce the amount of water withdrawn from the environment. AMI will need to submit an application to the AESRD under the Water Act to withdraw water from the river for use in the processing plant and associated settling ponds should AMI withdraw water from the river rather than use well water.

20.3 Permitting

AMI submitted its Conservation and Reclamation Business Plan to AESRD for the N ½ Section 8-99-08-4 (32.36 hectares). AMI received approval from AESRD to work and remove sand from SML 130021 for a term of 10 years beginning on August 25, 2014. On September 7, 2014, AESRD processed the applications for the DML 130162 and the DLO 130748. On September 18, 2014, the DML 130162 and the DLO 130748 were amended and are still in application status. The purpose of the DML is to provide an on-site hardened area for laydown areas, a repair shop, an office, security, stockpiles, loading facilities and a scale. The purpose of the DLO is to provide an access road to the site. Table 20.1 shows the status of all applications related to the two SMLs.

Table 20.1
Surface Disposition Status

Application	Application Date	Amendment Date	Process Date	Effective Date	Status
SML 130021	March 28, 2014	August 21, 2014	October 3, 2014	August 25, 2014	Active
SML 120032	April 30, 2012	January 21, 2014	October 3, 2014	N/A	Land Amendment Application
DML 130162	August 9, 2013	September 18, 2014	October 3, 2014	N/A	Land Amendment Application
DLO 130748	March 28, 2013	September 18. 2014	October 3, 2014	N/A	Land Amendment Application

A Temporary Diversion Licence (TDL) is required if there are plans to divert surface water or groundwater for use at Firebag Property. Two small watercourses, Moose Creek and McClelland Creek, are 5.5 km and 7 km, respectively, from the SML, and these could be potential water sources for Firebag Property.

If the processing facility is located in the green area (forested portion of Alberta designated by AESRD), permits will include dispositions under the Public Lands Act (PLA); construction of settling ponds might also be included in the licence issued by AESRD. If the processing facility is located in the white area (settled portion of Alberta designated by AESRD) on private land, a disposition will not be required under the PLA.

If AMI requires permanent access to the water on the bed and bank to process silica sand, applications for a DLO will be required under the PLA and Water Act. Permitting might also be required from the Department of Fisheries and Oceans (DFO): a review of DFO Projects Near Water (Dfo-mpo.gc.ca, 2014) will address this topic once the design of the water intake has been finalized.

Table 20.2 through Table 20.4 provide lists of provincial and federal regulations that might apply to Firebag Property and its associated construction and facilities; these tables are, in part, adapted from AESRD *Best Management Practice User Manual for Aggregate Operations on Public Land.*

Table 20.2

Provincial Acts that Could Apply to Firebag and Associated Facilities

Act	Responsible Ministry	Description
Water Act	AESRD	Regulates the allocation, protection and conservation of water within Alberta.
Environmental Protection and Enhancement Act	AESRD	Requires a review of proposed projects that might cause an adverse effect on the environment, and the reclamation and conservation of land.
Forests Act	AESRD	Requires approval for any forest management activity (e.g., timber harvest) which occurs on private land.
Historical Resources Act	Alberta Culture	Preserves, protects and presents historical and archeological resources of provincial, national and international significance.
Mines and Minerals Act	AESRD	Governs the management and disposition of rights on Crown-owned mines and minerals, including the levying and collecting of bonuses, rentals and royalties.
Public Lands Act	AESRD	Requires approvals for activities taking place on public land, as well as the bed and shores of all naturally occurring rivers, streams, watercourses and lakes under the Minister of AESRD. The Disposition and Fees Regulation grants approval to extract aggregate on public land.
Weed Control Act	Alberta Agriculture and Rural Development	Governs the legislation of restricted, noxious and nuisance invasive plant species or weeds.
Wildlife Act	AESRD	Prohibits the disturbance of wildlife habitation. The Wildlife Regulation identifies the wildlife, areas and time of the year to which the Act applies.

Table 20.3

Federal Regulatory Requirements that Could Apply to Public Land

Act	Responsible Ministry	Description
Fisheries Act	Department of Fisheries and Oceans	Protects fish and their habitat across Canada.
Migratory Birds Convention Act	Environment Canada	Ensures the protection of migratory birds, their eggs and their nests.
Navigation Protection Act	Transport Canada	Protects the public’s right to navigation in all navigable waters.
Species at Risk Act	Environment Canada	Provides protection for the recovery of threatened and endangered species and encourages the management of all other species to prevent them from becoming at risk.

Table 20.4
Provincial Acts and Associated Dispositions

Acts	Dispositions
Public Lands Act	Surface Material Exploration (SME) Surface Materials Lease (SML) Department Licence of Occupation (DLO) Department Miscellaneous Lease (DML) Temporary Field Authorization (TFA)
Water Act	Temporary Diversion Licence (TDL) Licence of Occupation (LOC)

20.4 Social or Community Requirements

The construction and operation of Firebag Property should not impact social or community infrastructure. There are no associated conflicts based on the current land status and activity reports. Ensuring protective measures for other stakeholders, AMI notified the Fort McKay First Nation, the Athabasca Chipewyan First Nation and the Mikisew Cree First Nation. The Trapping Area (TPA) lease use agreement holder was notified, and will be compensated as required. Al-Pac was notified and it allowed AMI to withdraw the following lands from the FMA 9100029 for the surface dispositions: SML 130021 and DLO 130748. RMWB is the registered holder of the Fort Chipewyan Winter Road and an agreement will be required to upgrade the road to meet AMI's construction requirements.

Firebag Property and its associated facilities have the potential to create additional local positions for both short- and long-term employment. Construction-site activities at Firebag and the proposed processing plant will introduce short-term jobs to the regional labour pool, while the processing site operations could potentially offer longer terms of employment. Positive impacts are expected in relation to direct, indirect and induced economic benefits to the local and regional communities.

20.5 Mine Closure

Reclamation and closure of Firebag Property will be completed in accordance with the approved Conservation and Reclamation Business Plan and other approved closure plans prepared by AMI. In consultation with AESRD, all plans will be updated on a regular basis to ensure that the most up-to-date reclamation and closure techniques are applied to the Project. This will also ensure that the posted reclamation bond remains sufficient to reclaim and close the surface mine.

The SML and DLO will be cleared of trees. About 50% of the treed vegetation will be salvaged and used as coarse woody debris to assist in the reclamation of backslopes. Reclamation will be a progressive and adaptive process to establish sustainable forest growth to an "a1" jack pine/lichen ecosite that will prevent wind and water erosion and be characteristic of the pre-disturbance forest (AMI, 2014). The closure condition will consist of a depression with 3:1 backslopes and an undulating pit floor.

AMI has taken steps to ensure that Firebag reclamation will be completed using the most up-to-date knowledge and research regarding disturbed area reclamation. AMI has met with the representatives of Alberta Innovates to learn about potential soil and vegetation strategies, and it has also joined the Cumulative Environmental Management Association (CEMA) to benefit from its extensive research regarding the management of sand landform reclamation.

21 CAPITAL AND OPERATING COSTS

21.1 Overview

Operating cost estimates were prepared for operations, development work and the reclamation activities that are associated with the Firebag Property, located 95 km north of Fort McMurray; the rail yard at Lynton, Alberta; and the processing plant at Edson, Alberta.

Note: Unit costs are expressed as dollars per bcm and/or dollars per ROMt, unless specified otherwise.

The cost estimates and resulting cash flow analysis were prepared in constant 2014 Canadian dollars (Cdn$), and the following factors were used:

- primary and support equipment capital and hourly equipment costs were estimated using Norwest's database;
- supplementary expenses (office furniture, computers, engineering consulting, etc.) were estimated using Norwest's database;
- labour rates were developed by Norwest based on knowledge of current labour agreements in the Fort McMurray region;
- management and staff salaries were estimated based on Norwest's knowledge of current mining salaries in Western Canada;
- diesel fuel was priced at $1.05 per litre; and
- exchange rate of Cdn$1:US$1 was assumed.

The average unit operating cost is $104.73 per ROMt over the 25-year life of the Project. The average unit capital cost, excluding contingency, is $7.07 per ROMt over the life of mine. The average unit product cost, including both capital and operating costs, but excluding capital contingency costs, is $111.80 per ROMt over the 25-year life of the Project.

Contingency has been applied to capital expenditures as follows:

- primary/support equipment, 20%;
- auxiliary equipment, 20%; and
- other capital, 20%.

Contingency was *not* applied to operating expenditures.

Including contingency, the average unit operating cost remains the same at $104.73 per ROMt; the average unit capital cost is $8.48 per ROMt; and, the average unit production cost is $113.21 per ROMt.

To establish the Project, the plan requires a capital investment in infrastructure, mine equipment and mine developments. The initial capital cost, cumulative through Year-1 including contingency, is estimated to be $87.8M.

21.2 Project Operating Cost Estimate

The mine operating cost estimate was developed from first principles. The operating cost estimate includes provisions for corporate administrative costs, Alberta mineral tax and corporate income tax. The operating cost estimate considers all aspects of the mining operation, including sand processing, sand and waste loading and haulage, topsoil salvage and replacement, road maintenance, water management, reclamation and site administration.

Table 21.1 details the operating cost by activity.

Table 21.1
Operating Cost

Area	Operating Cost (Cdn$/ROMt)
Firebag	10.63
Highway Haul	26.50
G&A	7.36
Rail Yard	3.89
CN Rail	44.00
Plant	12.36
Total	**104.73**

21.2.1 Equipment Requirements

Equipment fleets were specified to meet the work requirements of the production schedule. Caterpillar equipment was used to develop the operating cost estimate for the Project. No analysis has been performed to compare the technical and/or commercial merits of Caterpillar equipment versus other manufacturers. The use of Caterpillar equipment does not imply an endorsement by Norwest.

Excavators

The number and size of the primary loading backhoes were selected to satisfy the annual production requirement of the Project: approximately 1M bcm per year. Of the Project's three sites, only Firebag requires an excavator. The Caterpillar 349 was the selected model with an annual capacity of approximately 817K bcm per year or 1.3M tonnes per year. It is assumed that the excavator will work day shift only.

Haul Truck Fleet

The selected haul trucks for use at Firebag are Caterpillar 725 articulated haul trucks. The trucks have a capacity of 23 tonnes. The productivity of the haul trucks is determined by haul distance. The truck fleet will haul both waste and ROM sand from the pit. The ROM sand will be hauled to a stockpile and loaded onto highway haul trucks; the waste will be placed in a temporary ex-pit storage area in Years -1 and 1. Waste in Year 2 through to Year 25 will be back-hauled and placed in-pit. It is assumed that the truck fleet will work day shift only.

A haul truck will be required at the processing plant to haul plant rejects.

Highway Haul Truck Fleet

The ROM sand will be hauled from Firebag to the rail yard using 36-tonne highway haul trucks. It is assumed that the highway truck fleet will be contracted and the cost was estimated to be $26.50 per ROMt.

Loader Fleet

Loaders are required at the three Project sites: the Firebag Property, the Lynton rail-yard, and the Edson processing plant. The primary activity at each site is to load the ROM sand from a stockpile into the following:

- highway haul truck for movement from Firebag Property to the rail yard;
- a hopper for loading into railcars at the Lynton rail yard; and
- a plant feed hopper for discharge into the Edson processing plant.

Details of the rail yard and processing plant front-end loader activities can be found in Section 17.

At all locations, the volume of ROM sand handled by the individual loaders will be the same.

The loader-size selected for the Project is a 2.3-cubic metre (3-cubic yard), Caterpillar 930K. The capacity of the loader is 813K bcm per year or 1.2M tonnes per year.

Depending on actual loader performance and availability, the selected loader should be able to perform a limited number of alternate activities at each of the three sites. It is assumed that the loaders at all three locations will work both day and night shifts.

If the loader fleet experiences unexpected downtime, it is assumed that a temporary replacement loader can be found on short notice in the Fort McMurray and Edson areas.

Dozer Fleet

A Caterpillar D9 dozer will be used at Firebag for pit and stockpile cleanup. It is assumed that the dozer at Firebag will work both day and night shifts. On day shift, the dozer will work with the excavator, and, on night shift, the dozer will perform tasks to support the mine operation (for example, reclamation material salvage).

A Caterpillar D9 dozer will be used at Edson for rejects and dewatering.

Grader Fleet

A Caterpillar 14M grader will be used at Firebag for pit cleanup and road maintenance.

A Caterpillar 14M grader will be used at Edson for road maintenance and rejects support.

Other Support Equipment

A Caterpillar 740 truck converted to dispense water will be used at Firebag Property for dust control and road maintenance.

The limited rejects and, therefore, haul requirements at the processing plant allows for only one person to operate the dozer, haul truck and grader.

The maximum annual NOH and cumulative NOH replacement thresholds for each type of equipment specified are shown in Table 21.2.

Table 21.2
Equipment Replacement and Operation Hours

Equipment	Expected Life (NOH)	Maximum NOH/year
CAT 349	30,000	3,255
CAT 725	45,000	2,937
CAT 740 Water Truck	50,000	2,750
CAT D9	30,000	5,550
CAT 14M	50,000	2,750
CAT 930K	50,000	5,953

21.2.2 Equipment Operating Costs

It is assumed that all equipment will be purchased new, except for the CAT 740 water truck. The hourly operating rates used in this evaluation assume that the equipment will be maintained in accordance with original equipment manufacturers' (OEM) recommendations and will be replaced at the NOH replacement intervals identified in Table 21.2. The equipment hourly operating rates, exclusive of depreciation, are shown in Table 21.3.

Table 21.3
Equipment Hourly Operating Rates

Equipment	Unit Rate ($/NOH)
CAT 349	254
CAT 725	185
CAT 740 Water Truck	305
CAT D9	224
CAT 14G	245
CAT 930K	192

21.2.3 Hourly Manpower

The requirement for and the cost of hourly labour, for both operations and maintenance, is included in the mobile equipment and processing plant operating rates. These operating rates were used to develop the unit functional costs.

21.2.4 Salaried Manpower Requirement

Salaried manpower estimates were developed with reference to industry standards for an operation of this size. Staffing costs for the Project were included as "administration" in the operating costs. The salary allotment was based on a staff of 22, at an average of $140K per year per employee, plus burden costs of 30%.

A list of anticipated positions is shown in Table 21.4.

Table 21.4
Salaried Positions

Position	# People
Firebag Site Management	0.5
Firebag Operations	1
Firebag Maintenance	1
Lynton Loading Facilities	4.5
Edson Frac Sand Processing	8
Firebag Technical Services	2
Firebag & Rail Yard Human Resources	1
Processing Plant Safety/Training	4

21.2.5 Lynton Rail Loading

Operational staff at the train-loading facility at Lynton was assumed to be a two-person crew, both day and night shifts using four rotating shifts. The estimated operating expenditure for the rail yard does not include management or front-line personnel.

Power demand for the conveyors and railcar indexer is estimated to be approximately 375 kW per hour. The assumed unit cost for power is $0.08 per kW h. The variable cost estimate for consumables is $0.20 per ROMt and maintenance is $0.15 per ROMt. The annual operating cost at Lynton is projected to be $3,893M per year or $3.89 per ROMt. The operating expenditures for the rail yard are shown in Table 21.5.

Table 21.5
Operational Costs at Lynton

Category	Annual Cost (Cdn$)	$/ROMt	$/cmt
Manpower	1,583,840	1.58	1.98
Power	1,962,240	1.96	2.45
Consumables	198,000	0.20	0.25
Maintenance	148,500	0.15	0.19
Total	**3,892,580**	**3.89**	**4.87**

21.2.6 Administration Costs

Allowances were made to cover the cost of the general and administrative (G&A) costs that are required to operate the three sites. These items include salaries, burden, travel, office supplies, taxes, insurance, light vehicles, energy, head office, and buildings and grounds. Note: The insurance cost estimate does not include a provision for business interruption or delay of construction. The total G&A cost was estimated to be $6.53 per ROMt.

21.2.7 Plant Operating Costs

Operational staff at the processing plant facility at Edson was assumed to be an eleven person crew, both day and night shifts using four rotating shifts. This crew will run the train unloading equipment, wet plant, dry screening and product storage stockpile. Three additional maintenance personnel will be required to ensure equipment availability is upheld. The estimated operating expenditure for the processing plant does not include management or front-line personnel.

Electrical power has been projected to cost $0.08 per kW-h with connected loads at 745 kW. This does not include the heating costs of the thermal dryer. Natural gas costs are assumed to be $0.60 per million Btu (MBtu); heating power demand was provided by an equipment vendor. The estimate for consumables at the processing plant is assumed to be $1.25 per ROMt. Maintenance costs are estimated at $0.50 per ROMt. Total annual operating costs for Edson are projected to be about $12.36M per year or $12.36 per ROMt. The operating expenditures for the processing plant are shown in Table 21.6.

Table 21.6
Operational Costs at Edson

Category	Annual Cost (Cdn$)	$/ROMt	$/cmt
Manpower	4,207,075	4.21	5.26
Power	3,924,480	3.92	4.91
Consumables	1,237,500	1.24	1.55
Natural Gas	2,500,000	2.50	3.13
Maintenance	495,000	0.50	0.62
Total	**12,364,055**	**12.36**	**15.46**

21.2.8 Reclamation, Marketing and Corporate Costs

Reclamation material will be salvaged as the pit advances. Salvage will be achieved using a dozer. Progressive pit reclamation will take place annually, where appropriate, beginning in Year 2. Waste from Years -1 and one will be placed back in-pit in Year 2.

21.3 Capital Cost Estimate

The capital cost estimate is divided into three separate categories:

- mobile equipment at Firebag;
- mobile equipment and infrastructure at both the rail yard and the processing plant; and
- supplementary infrastructure.

The methods and procedures that were used to develop the capital cost estimate are described in the following subsections.

The capital cost with contingency for the project is shown in Table 21.7.

Table 21.7
Capital Cost by Area

Area	Capital Cost (Cdn$)
Firebag	14,593,000
Rail yard	10,025,288
Plant	52,065,880
Railcar Leasing	65,338,000
Supplementary	32,112,351
Total	**174,134,518**

21.3.1 Project Primary/Support Mobile Equipment

The capital cost of the mobile equipment required for the Project was based on Norwest's database of equipment costs. The purchase price of mine mobile equipment is shown in Table 21.8.

Table 21.8
Primary/Support Equipment Purchase Price

Equipment	(Cdn$)
CAT 349	1,164,000
CAT 725	720,000
CAT 740 Water Truck	630,000
CAT D9	1,510,000
CAT 14M	735,000
CAT 930K	305,000

Over the life of the project the total Primary/Support mobile equipment purchase price is $18.8M, as detailed in Table 21.12, Table 21.13 and Table 21.14.

21.3.2 Equipment at Rail Yard

The capital cost of the equipment required at the Rail Yard site was based on Norwest's database of equipment costs. The purchase price of the Lynton rail-yard equipment is shown in Table 21.9.

Table 21.9
Rail Yard Equipment

Equipment	(Cdn$)
Hopper	75,000
Stacker	265,000
Rail Load-out	350,000
Siding 1	900,000
Siding 2	900,000
Rail Earthworks	250,000
Rail Culverts	200,000
Turnouts	120,000
Mainline Switch	150,000
Signal	150,000
Car Indexer	350,000
Office Trailers	80,000
Site Earthworks	150,000
Power	200,000
Engineering	320,000

Over the life of the project the total Rail Yard Primary/Support Mobile Equipment and the Auxiliary Equipment and Infrastructure purchase price is $610,000 and $9.4M, respectively, as detailed in Table 21.13 and Table 21.15.

21.3.3 Equipment at Processing Plant

The capital cost of the equipment required at the processing plant site was based on Norwest's database of equipment costs. The purchase price of processing plant equipment is shown in Table 21.10.

Over the life of the project the total Primary/Support Mobile Equipment and the Auxiliary Equipment/Infrastructure purchase price for the processing plant is $3.6M and $48.5M, respectively, as detailed in Table 21.14 and Table 21.16.

Table 21.10
Processing Plant Equipment

Equipment	(Cdn$)
Mainline Switches	500,000
Rail Siding	1,800,000
Rail Unloading	2,700,000
Transfer Conveyor	250,000
Conveyor Tunnel	450,000
Stacking System	390,000
Plant Feed Hopper	75,000
Plant Feed Conveyor	165,000
Building Shell	2,000,000
Wet Plant	3,550,000
Oversize Conveyor	75,000
Product Radial Stacker	275,000
Product Feed Hopper	75,000
Dryer Feed Conveyor	250,000
Thermal FB Dryer	3,250,000
Screen Feed Conveyor	225,000
Final Size Separation Plant	7,200,000
Product Conveyors	450,000
Concrete – Wet Plant	850,000
Concrete – Thermal Dryer	400,000
Product Bins	1,500,000
Bucket Elevators to Product Bins	660,000
Truck Scales	520,000
Maintenance Shop	2,200,000
Administration Facility	1,200,000
Lab Trailer	40,000
Office Trailers	80,000
Earthworks – Rail	2,000,000
Earthworks – Site	2,000,000

Table 21.10 (cont'd)
Processing Plant Equipment

Equipment	(Cdn$)
Mainline Power Tie	250,000
Gas Tie-in	250,000
Site Security	75,000
Road Accesses	125,000
Controls	1,790,000
Piping	1,650,000
Power	2,800,000
Engineering	3,000,000
Future Engineering Studies	750,000
Geotechnical Studies	75,000

21.3.4 Supplementary Infrastructure

Key capital items not captured in the previous subsections are discussed in the following subsections.

Railcar

It is assumed that railcars will be leased under a full-service lease agreement that will include maintenance. Details of the annual railcar lease costs are shown in Table 21.11.

Table 21.11
Railcar Lease

Category	Rate/Cost
Lease Factor*	0.70%
Railcar Cost (new)	$90,000
Monthly Charge per Railcar	$630
Maintenance Fee	$50
Total Monthly Rate	$680
Unit Trains	3
Cars per Unit Train	100
Primary Cars (No.)	300
Car Standby Rate	2.5%
Standby Cars (No.)	7.5
Total Cars (No.)	308
Lease Cost per Month	$209,440
Lease Cost per Year	**$2,513,280**

*Lease factor determined by bank.

Highway Upgrade

It has been assumed that a 7 km stretch of highway will need to be upgraded for the Project. The estimated cost of the upgrade is $5.4M.

Mine Access Road

A mine access road, approximately 860 m in length, will be required. The estimated cost of the access road is $425,000.

Clearing and Grubbing

A total of 217 ha of land will need to be cleared before project development. The total cost for clearing and grubbing is estimated to be $1.9M.

Reclamation Material Salvage

A total of 217 ha of land will need to be developed and stripped of topsoil. For this PEA, it is assumed that the topsoil depth is 0.15 m and the subsoil depth is 0.35 m for a total of 0.5 m. The total cost of topsoil salvage is estimated to be $12.2M. Topsoil and subsoil salvage will be completed as follows: 20% in pre-production and then 4% annually until Year 20.

Closure

A provision of $12.2M ($0.50 per ROMt) was made in Year 25, the final year of the Project, to cover the costs of closure. The costs of closure are assumed to include all three Project sites.

21.3.5 Contingency and Salvage

A 20% contingency has been applied to primary/support equipment, auxiliary equipment and other capital to account for any unforeseen or otherwise unanticipated cost elements that could be associated with development and/or operation of the Project.

No salvage value was included in the cost summary.

The capital schedules without contingency are shown in Table 21.12 through to Table 21.17. Table 21.18 and Figure 21-1 both show a summary of capital, including contingency and salvage expenditures.

Table 21.12

Primary/Support Mobile Equipment – Firebag

Primary/Support Mobile Equipment - Firebag	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Excavators	$1,164,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,164,000
FEL - Site	$305,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$305,000
Haul Trucks - Firebag	$1,440,000	$1,440,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Graders - Firebag	$735,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Dozers - Firebag	$1,510,000	$0	$0	$0	$0	$0	$0	$0	$1,510,000	$0	$0	$0	$0	$0
Water Truck	$630,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
SubTotal Primary/Support Mobile Equipment - Firebag	**$5,784,000**	**$1,440,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$1,510,000**	**$0**	**$0**	**$0**	**$0**	**$1,469,000**

Primary/Support Mobile Equipment - Firebag (cont'd)	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Total
Dozers - Plant	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,328,000
Water Truck	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$610,000
Primary/Support Mobile Equipment (cont'd)	$0	$0	$1,440,000	$1,440,000	$0	$0	$0	$0	$0	$0	$0	$0	$5,760,000
FEL - Site	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$735,000
FEL - Plant	$0	$0	$1,510,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,530,000
Haul Trucks - Plant	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$630,000
SubTotal Primary/Support Mobile Equipment - Firebag	**$0**	**$0**	**$2,950,000**	**$1,440,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$14,593,000**

Table 21.13

Primary/Support Mobile Equipment – Rail Yard

Primary/Support Mobile Equipment - Railyard	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
FEL - Railyard	$305,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$305,000
SubTotal Primary/Support Mobile Equipment - Railyard	**$305,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$305,000**

Primary/Support Mobile Equipment - Railyard (cont'd)	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Total
Graders - Firebag	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$610,000
SubTotal Primary/Support Mobile Equipment - Railyard	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$610,000**

Table 21.14

Primary/Support Mobile Equipment – Processing Plant

Primary/Support Mobile Equipment - Plant	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
FEL - Plant	$305,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$305,000
Haul Trucks - Plant	$720,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Graders - Plant	$735,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Dozers - Plant	$1,510,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
SubTotal Primary/Support Mobile Equipment - Plant	**$3,270,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$305,000**

Primary/Support Mobile Equipment - Plant (cont'd)	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Total
FEL - Plant	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$610,000
Haul Trucks - Plant	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$720,000
Graders - Plant	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$735,000
Dozers - Plant	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,510,000
SubTotal Primary/Support Mobile Equipment - Plant	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$3,575,000**

Table 21.15

Auxiliary Equipment/Infrastructure - Rail Yard

Mobile Equipment / Infrastructure - Railyard	**Year -1**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**
Fuel / Lube Truck	$88,935	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Mechanic / Welding Truck	$120,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Fuel Stations (2)	$150,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Management L.V.	$50,000	$0	$0	$50,000	$0	$0	$50,000	$0	$0	$50,000	$0	$0	$50,000	$0
Operations L.V.	$200,000	$0	$0	$200,000	$0	$0	$200,000	$0	$0	$200,000	$0	$0	$200,000	$0
Crew Van	$50,000	$0	$0	$0	$50,000	$0	$0	$0	$50,000	$0	$0	$0	$50,000	$0
Flatbed Truck w/ crane	$119,090	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Quonset (Maintenance)	$473,383	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Welder	$15,000	$0	$0	$15,000	$0	$0	$15,000	$0	$0	$15,000	$0	$0	$15,000	$0
Compressor	$57,750	$0	$0	$0	$57,750	$0	$0	$0	$57,750	$0	$0	$0	$57,750	$0
Generator	$76,230	$0	$0	$0	$76,230	$0	$0	$0	$76,230	$0	$0	$0	$76,230	$0
Light Towers	$105,000	$0	$0	$0	$105,000	$0	$0	$0	$105,000	$0	$0	$0	$105,000	$0
Portable Trailers	$150,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Lynton Infrastructure	$4,140,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Lynton Engineering	$320,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
SubTotal Mobile Equipment / Infrastructure - Railyard	**$6,115,388**	**$0**	**$0**	**$265,000**	**$288,980**	**$0**	**$265,000**	**$0**	**$288,980**	**$265,000**	**$0**	**$0**	**$553,980**	**$0**

Mobile Equipment / Infrastructure - Railyard (cont'd)	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**	**Year 21**	**Year 22**	**Year 23**	**Year 24**	**Year 25**	**Total**
Fuel / Lube Truck	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$88,935
Mechanic / Welding Truck	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$120,000
Fuel Stations (2)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$150,000
Management L.V.	$0	$50,000	$0	$0	$50,000	$0	$0	$50,000	$0	$0	$0	$0	$400,000
Operations L.V.	$0	$200,000	$0	$0	$200,000	$0	$0	$200,000	$0	$0	$0	$0	$1,600,000
Crew Van	$0	$0	$50,000	$0	$0	$0	$50,000	$0	$0	$0	$0	$0	$300,000
Flatbed Truck w/ crane	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$119,090
Quonset (Maintenance)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$473,383
Welder	$0	$15,000	$0	$0	$15,000	$0	$0	$15,000	$0	$0	$0	$0	$120,000
Compressor	$0	$0	$57,750	$0	$0	$0	$57,750	$0	$0	$0	$0	$0	$346,500
Generator	$0	$0	$76,230	$0	$0	$0	$76,230	$0	$0	$0	$0	$0	$457,380
Light Towers	$0	$0	$105,000	$0	$0	$0	$105,000	$0	$0	$0	$0	$0	$630,000
Portable Trailers	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$150,000
Lynton Infrastructure	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,140,000
Lynton Engineering	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$320,000
SubTotal Mobile Equipment / Infrastructure - Railyard	**$0**	**$265,000**	**$288,980**	**$0**	**$265,000**	**$0**	**$288,980**	**$265,000**	**$0**	**$0**	**$0**	**$0**	**$9,415,288**

Table 21.16

Auxiliary Equipment/Infrastructure - Processing Plant

Mobile Equipment / Infrastructure - Process Plant	**Year -1**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**
Fuel / Lube Station	$100,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Management L.V.	$50,000	$0	$0	$50,000	$0	$0	$50,000	$0	$0	$50,000	$0	$0	$50,000	$0
Operations L.V.	$120,000	$0	$0	$120,000	$0	$0	$120,000	$0	$0	$120,000	$0	$0	$120,000	$0
Small Forklift	$81,690	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$81,690	$0
Welder	$25,000	$0	$0	$25,000	$0	$0	$25,000	$0	$0	$25,000	$0	$0	$25,000	$0
Compressor	$57,750	$0	$0	$0	$57,750	$0	$0	$0	$57,750	$0	$0	$0	$57,750	$0
Light Towers	$21,000	$0	$0	$0	$21,000	$0	$0	$0	$21,000	$0	$0	$0	$21,000	$0
Crew Van	$50,000	$0	$0	$0	$50,000	$0	$0	$0	$50,000	$0	$0	$0	$50,000	$0
Edson Infrastructure (rail / stacker / all plant / roads / bldgs)	$42,070,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Edson Engineering & Geotech	$3,442,500	$382,500	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
SubTotal Mobile Equipment / Infrastructure - Process Plant	**$46,017,940**	**$382,500**	**$0**	**$195,000**	**$128,750**	**$0**	**$195,000**	**$0**	**$128,750**	**$195,000**	**$0**	**$0**	**$405,440**	**$0**

Mobile Equipment / Infrastructure - Process Plant (cont'd)	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**	**Year 21**	**Year 22**	**Year 23**	**Year 24**	**Year 25**	**Total**
Fuel / Lube Station	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$100,000
Management L.V.	$0	$50,000	$0	$0	$50,000	$0	$0	$50,000	$0	$0	$0	$0	$400,000
Operations L.V.	$0	$120,000	$0	$0	$120,000	$0	$0	$120,000	$0	$0	$0	$0	$960,000
Small Forklift	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$163,380
Welder	$0	$25,000	$0	$0	$25,000	$0	$0	$25,000	$0	$0	$0	$0	$200,000
Compressor	$0	$0	$57,750	$0	$0	$0	$57,750	$0	$0	$0	$0	$0	$346,500
Light Towers	$0	$0	$21,000	$0	$0	$0	$21,000	$0	$0	$0	$0	$0	$126,000
Crew Van	$0	$0	$50,000	$0	$0	$0	$50,000	$0	$0	$0	$0	$0	$300,000
Edson Infrastructure (rail / stacker / all plant / roads / bldgs)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$42,070,000
Edson Engineering & Geotech	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,825,000
SubTotal Mobile Equipment / Infrastructure - Process Plant	**$3,000,245**	**$3,025,245**	**$3,050,245**	**$3,000,245**	**$3,025,245**	**$3,000,245**	**$3,000,245**	**$2,588,000**	**$2,513,000**	**$2,513,000**	**$2,513,000**	**$14,834,227**	**$48,490,880**

Table 21.17

Supplementary Capital

Supplementary Capital	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Railcar Leasing (annual cost)	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000
Water Truck Fill Station	$20,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Water Management	$125,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Mine Radios & Communication Network	$40,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Office Furniture	$50,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Computers / Survey Equipment	$50,000	$0	$0	$0	$0	$0	$50,000	$0	$0	$0	$0	$50,000	$0	$0
Exploration Program	$100,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sampling Program	$25,000	$0	$0	$25,000	$0	$0	$25,000	$0	$0	$25,000	$0	$0	$25,000	$0
Feasibility Study (Permitting)	$500,000	$0	$0	$500,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Highway Upgrade	$5,400,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Mine Access Road	$425,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Reclamation Material Salvage (Load/Haul/Place)	$2,436,225	$487,245	$487,245	$487,245	$487,245	$487,245	$487,245	$487,245	$487,245	$487,245	$487,245	$487,245	$487,245	$487,245
Mine Closure	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
SubTotal Supplementary Capital	**$11,684,225**	**$3,000,245**	**$3,000,245**	**$3,525,245**	**$3,000,245**	**$3,000,245**	**$3,075,245**	**$3,000,245**	**$3,000,245**	**$3,025,245**	**$3,000,245**	**$3,050,245**	**$3,025,245**	**$3,000,245**

Supplementary Capital (cont'd)	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Total
Railcar Leasing (annual cost)	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$2,513,000	$65,338,000
Water Truck Fill Station	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,000
Water Management	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$125,000
Mine Radios & Communication Network	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$40,000
Office Furniture	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$50,000
Computers / Survey Equipment	$0	$0	$50,000	$0	$0	$0	$0	$50,000	$0	$0	$0	$0	$250,000
Exploration Program	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$100,000
Sampling Program	$0	$25,000	$0	$0	$25,000	$0	$0	$25,000	$0	$0	$0	$0	$200,000
Feasibility Study (Permitting)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,000,000
Highway Upgrade	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,400,000
Mine Access Road	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$425,000
Reclamation Material Salvage (Load/Haul/Place)	$487,245	$487,245	$487,245	$487,245	$487,245	$487,245	$487,245	$0	$0	$0	$0	$0	$12,181,124
Mine Closure	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$12,321,227	$12,321,227
SubTotal Supplementary Capital	**$3,000,245**	**$3,025,245**	**$3,050,245**	**$3,000,245**	**$3,025,245**	**$3,000,245**	**$3,000,245**	**$2,588,000**	**$2,513,000**	**$2,513,000**	**$2,513,000**	**$14,834,227**	**$97,450,351**

Table 21.18

Capital Expenditure Summary

CAPITAL GROUP	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Primary/Support Mobile Equipment - Firebag	$5,784,000	$1,440,000	$0	$0	$0	$0	$0	$0	$1,510,000	$0	$0	$0	$0	$1,469,000
Primary/Support Mobile Equipment - Railyard	$305,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$305,000
Primary/Support Mobile Equipment - Plant	$3,270,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$305,000
Auxiliary Equipment / Infrastructure - Railyard	$6,115,388	$0	$0	$265,000	$288,980	$0	$265,000	$0	$288,980	$265,000	$0	$0	$553,980	$0
Auxiliary Equipment / Infrastructure - Process Plant	$46,017,940	$382,500	$0	$195,000	$128,750	$0	$195,000	$0	$128,750	$195,000	$0	$0	$405,440	$0
Supplementary Capital	$11,684,225	$3,000,245	$3,000,245	$3,525,245	$3,000,245	$3,000,245	$3,075,245	$3,000,245	$3,000,245	$3,025,245	$3,000,245	$3,050,245	$3,025,245	$3,000,245
SubTotal Capital	**$73,176,552**	**$4,822,745**	**$3,000,245**	**$3,985,245**	**$3,417,975**	**$3,000,245**	**$3,535,245**	**$3,000,245**	**$4,927,975**	**$3,485,245**	**$3,000,245**	**$3,050,245**	**$3,984,665**	**$5,079,245**
Salvage Value	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Contingency	$14,635,310	$964,549	$600,049	$797,049	$683,595	$600,049	$707,049	$600,049	$985,595	$697,049	$600,049	$610,049	$796,933	$1,015,849
Total Capital	**$87,811,863**	**$5,787,294**	**$3,600,294**	**$4,782,294**	**$4,101,570**	**$3,600,294**	**$4,242,294**	**$3,600,294**	**$5,913,570**	**$4,182,294**	**$3,600,294**	**$3,660,294**	**$4,781,598**	**$6,095,094**

CAPITAL GROUP (cont'd)	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	TOTAL
Primary/Support Mobile Equipment - Firebag	$0	$0	$2,950,000	$1,440,000	$0	$0	$0	$0	$0	$0	$0	$0	$14,593,000
Primary/Support Mobile Equipment - Railyard	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$610,000
Primary/Support Mobile Equipment - Plant	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,575,000
Auxiliary Equipment / Infrastructure - Railyard	$0	$265,000	$288,980	$0	$265,000	$0	$288,980	$265,000	$0	$0	$0	$0	$9,415,288
Auxiliary Equipment / Infrastructure - Process Plant	$0	$195,000	$128,750	$0	$195,000	$0	$128,750	$195,000	$0	$0	$0	$0	$48,490,880
Supplementary Capital	$3,000,245	$3,025,245	$3,050,245	$3,000,245	$3,025,245	$3,000,245	$3,000,245	$2,588,000	$2,513,000	$2,513,000	$2,513,000	$14,834,227	$97,450,351
SubTotal Capital	**$3,000,245**	**$3,485,245**	**$6,417,975**	**$4,440,245**	**$3,485,245**	**$3,000,245**	**$3,417,975**	**$3,048,000**	**$2,513,000**	**$2,513,000**	**$2,513,000**	**$14,834,227**	**$174,134,518**
Salvage Value	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Contingency	$600,049	$697,049	$1,283,595	$888,049	$697,049	$600,049	$683,595	$609,600	$502,600	$502,600	$502,600	$2,966,845	$34,826,904
Total Capital	**$3,600,294**	**$4,182,294**	**$7,701,570**	**$5,328,294**	**$4,182,294**	**$3,600,294**	**$4,101,570**	**$3,657,600**	**$3,015,600**	**$3,015,600**	**$3,015,600**	**$17,801,072**	**$208,961,422**

22 ECONOMIC ANALYSIS

The economic analysis includes the calculation of Net Present Value (NPV) on an after-tax (mineral and income) basis. The estimates assume that production, cost targets, pricing and sales goals are achieved. Any deviation from those values affects the determination of NPV.

A series of cash-flow forecasts has been developed for the life of the Project. This includes a single-year, pre-production phase. The production period is 25 years followed by closure which is scheduled to take place in Year 25. Norwest determined the NPV in Year -1, the only year of pre-production.

22.1 Assumptions

22.1.1 Sand Price and Exchange Rate

The unit product selling price was determined during confidential discussions with a well services company. The range provided for the three products was between $155 and $200 per cmt. Note these pricing was received in Q3 2014.

Upon reviewing the distribution of the products, a price of $155/cmt was used for the 70/140 mesh sand, $170/cmt for the 40/70 mesh, and $195/cmt was used for the 20/40 mesh sand.

Norwest chose to use the lower end of the range provided by the well services company. This is due to the higher range of reported acid solubility in the 20/40 and the 40/70 mesh sand. Norwest's understanding is that the International Standards accepted acid solubility for frac sand is lower than the Firebag Property's acid solubility for frac sand. Section 9.3 has further details on the ISO Standards for acid solubility and the actual acid solubility test results.

The economic analysis has adopted the following long-term selling prices for the project:

- 20/40 mesh = $195 per clean metric tonne;
- 40/70 mesh = $170 per clean metric tonne; and
- 70/140 mesh = $155 per clean metric tonne.

22.1.2 Rail Cost

The rail cost as provided by AMI was $44.00 per ROMt.

22.1.3 Royalties

Under Alberta Energy's royalty scheme for silica sand, a charge of $0.37 per clean tonne has been applied.

Under the Municipal Government Act, a royalty has been applied at a rate of $0.25 per clean tonne.

22.1.4 Income Tax

Federal Canadian and Alberta income taxes were calculated on a project basis in accordance with the 2014 tax laws. Federal government tax changes brought forward in the 2013 Federal Budget were incorporated into the calculation.

The calculation assumes the following:

- Pre-production capital in Year -1 is considered to be class 41A. The capital cost allowance rate is 100% against operating cash flow. Capital from Year 1 onward is considered to be class 41B, and the capital allowance rate is 25%.
- Operating costs in Year -1 are classified as a Canadian Exploration Expense (CEE). This is allowed because achievement of "nameplate" production is not achieved until Year 1. CEE can be written off at a rate of 100% against operating cash flow from the mine.
- Federal income tax rate is 15% (reached in 2012, per Federal Budget).
- Alberta income tax rate is 10% (reached in 2009, per Provincial Budget).
- Large corporation tax rate is zero for both jurisdictions.
- No surtaxes are payable.

22.2 Results

Norwest developed a cash-flow forecast. The results are shown in Table 22.1. The Project sales and financial performance are shown on a before-and-after tax basis in Table 22.2.

Table 22.1
Cash Flow Forecast

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
	units	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Revenue by Source ($)															
Total Sales	cleant	**300,848**	**920,979**	**913,865**	**909,323**	**906,472**	**909,093**	**910,559**	**909,963**	**910,312**	**913,304**	**920,728**	**920,728**	**920,728**	**920,728**
P1 (20 - 40 mesh)	cleant	28,277	90,463	104,857	117,505	126,537	127,100	126,507	116,568	110,978	108,198	108,217	108,217	108,217	108,217
P2 (40 - 70 mesh)	cleant	147,228	451,308	465,643	474,516	474,945	464,798	460,833	483,693	499,356	508,225	515,309	515,309	515,309	515,309
P3 (70 - 140 mesh)	cleant	125,343	379,208	343,366	317,301	304,990	317,195	323,220	309,702	299,978	296,882	297,201	297,201	297,201	297,201
Average Selling Price (CDN$)		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
P1 (20 - 40 mesh)	$/cleant	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00
P2 (40 - 70 mesh)	$/cleant	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00
P3 (70 - 140 mesh)	$/cleant	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00
Revenue		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
P1 (20 - 40 mesh)	$	$5,513,919	$17,640,277	$20,447,035	$22,913,548	$24,674,673	$24,784,561	$24,668,800	$22,730,833	$21,640,706	$21,098,589	$21,102,345	$21,102,345	$21,102,345	$21,102,345
P2 (40 - 70 mesh)	$	$25,028,839	$76,722,318	$79,159,257	$80,667,776	$80,740,687	$79,015,662	$78,341,637	$82,227,859	$84,890,528	$86,398,218	$87,602,578	$87,602,578	$87,602,578	$87,602,578
P3 (70 - 140 mesh)	$	$19,428,193	$58,777,259	$53,221,675	$49,181,664	$47,273,417	$49,165,234	$50,099,038	$48,003,763	$46,496,526	$46,016,647	$46,066,178	$46,066,178	$46,066,178	$46,066,178
Total Revenue	**$**	**$49,970,950**	**$153,139,854**	**$152,827,967**	**$152,762,989**	**$152,688,777**	**$152,965,458**	**$153,109,475**	**$152,962,455**	**$153,027,760**	**$153,513,454**	**$154,771,101**	**$154,771,101**	**$154,771,101**	**$154,771,101**
Cost by Category		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Capital	$	$73,176,552	$4,822,745	$3,000,245	$3,985,245	$3,417,975	$3,000,245	$3,535,245	$3,000,245	$4,927,975	$3,485,245	$3,000,245	$3,050,245	$3,984,665	$5,079,245
Operating Costs	$	$19,810,794	$60,165,743	$60,132,247	$60,062,267	$60,008,563	$59,939,085	$59,955,561	$60,006,322	$60,047,041	$60,081,837	$60,181,626	$60,181,626	$60,181,626	$60,181,626
Capital Contingency	$	$14,635,310	$964,549	$600,049	$797,049	$683,595	$600,049	$707,049	$600,049	$985,595	$697,049	$600,049	$610,049	$796,933	$1,015,849
Operating Contingency	$	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cost of Production	**$**	**$107,622,657**	**$65,953,037**	**$63,732,541**	**$64,844,561**	**$64,110,132**	**$63,539,378**	**$64,197,855**	**$63,606,616**	**$65,960,611**	**$64,264,131**	**$63,781,920**	**$63,841,920**	**$64,963,224**	**$66,276,720**
Unit Cost of Production	**$/cleant**	**$357.73**	**$71.61**	**$69.74**	**$71.31**	**$70.72**	**$69.89**	**$70.50**	**$69.90**	**$72.46**	**$70.36**	**$69.27**	**$69.34**	**$70.56**	**$71.98**
Rail	$	$13,237,318	$40,523,069	$40,210,057	$40,010,202	$39,884,759	$40,000,109	$40,064,615	$40,038,388	$40,053,711	$40,185,389	$40,512,014	$40,512,014	$40,512,014	$40,512,014
NET CASHFLOW BEFORE TAX		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
		-$70,889,026	$46,663,748	$48,885,369	$47,908,226	$48,693,886	$49,425,970	$48,847,006	$49,317,451	$47,013,438	$49,063,934	$50,477,168	$50,417,168	$49,295,864	$47,982,368
Alberta Mineral Tax (Royalty)	$	$111,314	$340,762	$338,130	$336,449	$335,395	$336,365	$336,907	$336,686	$336,815	$337,923	$340,669	$340,669	$340,669	$340,669
Municipal Royalty	$	$75,212	$230,245	$228,466	$227,331	$226,618	$227,273	$227,640	$227,491	$227,578	$228,326	$230,182	$230,182	$230,182	$230,182
Operating Cash Flow before Income Tax	$	$16,736,311	$51,880,035	$51,919,067	$52,126,740	$52,233,443	$52,462,626	$52,524,753	$52,353,567	$52,362,614	$52,679,979	$53,506,611	$53,506,611	$53,506,611	$53,506,611
Income Tax (Federal and Provincial)	$	$0	$0	$8,243,065	$11,788,863	$12,015,593	$12,099,898	$12,098,089	$12,042,903	$11,981,887	$11,993,806	$12,223,678	$12,256,256	$12,242,427	$12,157,758
Operating Cash Flow after Income Tax	$	$16,736,311	$51,880,035	$43,676,002	$40,337,877	$40,217,850	$40,362,728	$40,426,663	$40,310,665	$40,380,727	$40,686,173	$41,282,933	$41,250,354	$41,264,184	$41,348,853
Net Cash Flow After Income Tax	$	**-$71,075,552**	**$46,092,741**	**$40,075,708**	**$35,555,583**	**$36,116,280**	**$36,762,434**	**$36,184,370**	**$36,710,371**	**$34,467,157**	**$36,503,879**	**$37,682,639**	**$37,590,060**	**$36,482,586**	**$35,253,759**

NORWEST CORPORATION

Table 22.1 (cont'd)

Cash Flow Forecast

		2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	
	units	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Total
Revenue by Source ($)														
Total Sales	**cleant**	**920,728**	**921,588**	**921,588**	**921,588**	**921,588**	**921,588**	**900,346**	**900,346**	**900,346**	**900,346**	**900,346**	**509,628**	**22,727,651**
P1 (20 - 40 mesh)	cleant	108,217	114,862	114,862	114,862	114,862	114,862	134,419	134,419	134,419	134,419	134,419	75,257	2,919,738
P2 (40 - 70 mesh)	cleant	515,309	522,653	522,653	522,653	522,653	522,653	476,847	476,847	476,847	476,847	476,847	268,736	12,273,327
P3 (70 - 140 mesh)	cleant	297,201	284,073	284,073	284,073	284,073	284,073	289,080	289,080	289,080	289,080	289,080	165,635	7,534,586
Average Selling Price (CDN$)		Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Total
P1 (20 - 40 mesh)	$/cleant	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	$195.00	**$0.00**
P2 (40 - 70 mesh)	$/cleant	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	$170.00	**$0.00**
P3 (70 - 140 mesh)	$/cleant	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	$155.00	**$0.00**
Revenue		Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Total
P1 (20 - 40 mesh)	$	$21,102,345	$22,398,168	$22,398,168	$22,398,168	$22,398,168	$22,398,168	$26,211,659	$26,211,659	$26,211,659	$26,211,659	$26,211,659	$14,675,080	$569,348,879
P2 (40 - 70 mesh)	$	$87,602,578	$88,850,944	$88,850,944	$88,850,944	$88,850,944	$88,850,944	$81,064,033	$81,064,033	$81,064,033	$81,064,033	$81,064,033	$45,685,107	$2,086,465,661
P3 (70 - 140 mesh)	$	$46,066,178	$44,031,271	$44,031,271	$44,031,271	$44,031,271	$44,031,271	$44,807,337	$44,807,337	$44,807,337	$44,807,337	$44,807,337	$25,673,419	$1,167,860,765
Total Revenue	**$**	**$154,771,101**	**$155,280,382**	**$155,280,382**	**$155,280,382**	**$155,280,382**	**$155,280,382**	**$152,083,028**	**$152,083,028**	**$152,083,028**	**$152,083,028**	**$152,083,028**	**$86,033,606**	**$3,823,675,305**
Cost by Category		Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Total
Capital	$	$3,000,245	$3,485,245	$6,417,975	$4,440,245	$3,485,245	$3,000,245	$3,417,975	$3,048,000	$2,513,000	$2,513,000	$2,513,000	$14,834,227	$174,134,518
Operating Costs	$	$60,181,626	$60,252,473	$60,252,473	$60,252,473	$60,252,473	$60,252,473	$60,025,249	$60,025,249	$60,025,249	$60,025,249	$60,025,249	$34,087,591	$1,496,593,790
Capital Contingency	$	$600,049	$697,049	$1,283,595	$888,049	$697,049	$600,049	$683,595	$609,600	$502,600	$502,600	$502,600	$2,966,845	$34,826,904
Operating Contingency	$	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cost of Production	**$**	**$63,781,920**	**$64,434,767**	**$67,954,043**	**$65,580,767**	**$64,434,767**	**$63,852,767**	**$64,126,819**	**$63,682,849**	**$63,040,849**	**$63,040,849**	**$63,040,849**	**$51,888,663**	**$1,705,555,212**
Unit Cost of Production	**$/cleant**	**$69.27**	**$69.92**	**$73.74**	**$71.16**	**$69.92**	**$69.29**	**$71.22**	**$70.73**	**$70.02**	**$70.02**	**$70.02**	**$101.82**	**$75.04**
Rail	$	$40,512,014	$40,549,860	$40,549,860	$40,549,860	$40,549,860	$40,549,860	$39,615,207	$39,615,207	$39,615,207	$39,615,207	$39,615,207	$22,423,619	$1,000,016,637
NET CASHFLOW BEFORE TAX		Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Total
		$50,477,168	$50,295,756	$46,776,480	$49,149,756	$50,295,756	$50,877,756	$48,341,002	$48,784,972	$49,426,972	$49,426,972	$49,426,972	$11,721,324	$ 1,118,103,456
Alberta Mineral Tax (Royalty)	$	$340,669	$340,987	$340,987	$340,987	$340,987	$340,987	$333,128	$333,128	$333,128	$333,128	$333,128	$188,562	$8,409,231
Municipal Royalty	$	$230,182	$230,397	$230,397	$230,397	$230,397	$230,397	$225,086	$225,086	$225,086	$225,086	$225,086	$127,407	$5,681,913
Operating Cash Flow before Income Tax	$	$53,506,611	$53,906,665	$53,906,665	$53,906,665	$53,906,665	$53,906,665	$51,884,358	$51,884,358	$51,884,358	$51,884,358	$51,884,358	$29,206,427	$1,312,973,734
Income Tax (Federal and Provincial)	$	$12,130,239	$12,268,187	$12,170,367	$12,060,328	$12,086,626	$12,162,279	$11,715,127	$11,777,340	$11,842,823	$11,909,891	$11,959,264	$5,325,061	$278,551,756
Operating Cash Flow after Income Tax	$	$41,376,372	$41,638,478	$41,736,298	$41,846,337	$41,820,039	$41,744,386	$40,169,231	$40,107,018	$40,041,535	$39,974,467	$39,925,094	$23,881,366	$1,034,421,978
Net Cash Flow After Income Tax	$	**$37,776,078**	**$37,456,184**	**$34,034,728**	**$36,518,043**	**$37,637,745**	**$38,144,092**	**$36,067,661**	**$36,449,418**	**$37,025,935**	**$36,958,867**	**$36,909,494**	**$6,080,294**	**$825,460,557**

Table 22.2
Project Sales/Financial Performance

Total Sales (cmt)	Pre-Tax IRR	Pre-Tax NPV10	After-Tax IRR	After-Tax NPV10
22,727,650	68%	$368,306,000	57%	$268,342,000

22.3 Sensitivity

Sensitivity analyses were carried out to determine how changes in certain key parameters would impact the economic performance of the Project. Sensitivity to the following key parameters and assumptions was examined:

- Product price at 10%, 20% and 30% below base case;
- Product price at 10%, 20%, and 30% above base case; and
- Leasing four 100-car unit trains vs. three 100-car unit trains.

The sensitivity results are shown on Figure 22-1 and Figure 22-2. Table 22.3 details the before and after tax NPVs and IRRs at the various product prices

22.3.1 Base Case

The Base Case is shown in Table 22.1 and Table 22.2.

22.3.2 Case 1

Case 1 is the Base Case with a 10% reduction in product pricing.

22.3.3 Case 2

Case 2 is the Base Case with a 20% reduction in product pricing.

22.3.4 Case 3

Case 3 is the Base Case with a 30% reduction in product pricing.

22.3.5 Case 4

Case 4 is the Base Case with a 10% increase in product pricing.

22.3.6 Case 5

Case 5 is the Base Case with a 20% increase in product pricing.

22.3.7 Case 6

Case 6 is the Base Case with a 30% increase in product pricing.

22.3.8 Case 7

Case 7 is the Base Case with four 100-car unit trains.

Table 22.3
NPV Sensitivity to Price

Category	Units	Product Price Variance						
		30%	20%	10%	Base Case	-10%	-20%	-30%
Before-Tax NPV10	Cdn$	799,400,000	655,702,000	512,004,000	368,306,000	224,608,000	80,910,000	-62,788,000
Before-Tax IRR	%	167	128	96	68	43	22	-4
After-Tax NPV10	Cdn$	592,395,000	484,498,000	376,602,000	268,342,000	159,939,000	50,218,000	-68,094,000
Before-Tax IRR	%	136	106	81	57	37	18	-7

23 ADJACENT PROPERTIES

This report does not use any data and/or interpretations from adjacent properties.

24 OTHER RELEVANT DATA AND INFORMATION

The author has referred to and used data from several historic reports regarding the geological exploration conducted on the Firebag River Sand Property. These reports include the following:

- APEX Geoscience Ltd. (2014): "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada.
- Athabasca Minerals Inc. (2014): Conservation and Reclamation Business Plan of SML 130021 in N ½ Section 8-99-08-4 (32.36 hectares).
- Athabasca Minerals Inc. (2011): 2009-2011 Exploration Firebag River Project, Northeast Alberta. Mineral Assessment Report Part B Technical Report.

25 INTERPRETATION AND CONCLUSIONS

For the geological section of this report, Norwest reviewed the "National Instrument 43-101 Technical Report, Inferred Frac Sand Resource Estimate for the Firebag Property, Northeastern Alberta, Canada (September 19, 2014)" produced by APEX Geoscience Ltd. The report was deemed representative of the current status of the Project with respect to the known geology, exploration work done to date, and interpretation of the results with an accepted level of confidence for the resource calculations. Other than some additional commentary on sampling methodology and requirements for future work, no changes have been made to the geological interpretation.

On Tuesday, October 7, 2014, Ted Hannah, Norwest VP Geology, and Theresa Lavender, Norwest Manager Mining, conducted a one-day site visit to the Firebag Property in the company of Heather Budney, Chief Geologist, and Tim Sieben, Regional Operation Manager. The intent of this visit was to confirm the physical nature of the property and obtain access to it, confirm the locations of the reported exploration activities, observe the nature of any physical impediments to future development, understand the general layout of the rail loading facilities, and discuss any other aspects of the project that might be pertinent to this report.

The effective date for the PEA is November 26, 2014, which is the date on which the last technical information to be included in the report, the frac sand resource estimate and classification, was made.

The PEA completed by Norwest shows that the Firebag River Sand Property has considerable potential for development as a frac sand resource. This is based on the following observations:

25.1 Tenure

The "footprint "of the current mine plan, is fully within the property boundary.

(AESRD has approved AMI's request to work in and remove sand from SML 130021 for a term of 10 years beginning on August 25, 2014.

SML 120032 is currently under application with the AESRD.

AMI currently has access to the rail yard in Lynton. They are in negotiations with a third party regarding a plant site in the Edson area alongside the CN rail line.

25.2 Quantity of the Firebag Property Deposit

The conceptual plan includes 24.6 M ROMt of frac sand. The processing plant is expected to salvage approximately 92% of the frac sand process, of which 12% is of the 20/40 mesh, 50% is 40/70 mesh, and 30% is 70/140 mesh. The remainder of the product is an oversize or undersize sand, i.e. +20 mesh or -140 mesh. The Firebag Property is developed over 25 years of mine life at an average rate of rate of 990,000 ROMt per year.

25.3 Access to Rail Infrastructure

The Firebag Property is located approximately 95 km north to the existing CN rail line in Lynton, Alberta. Its location would allow CN to rail Firebag Property frac sand to the Edson area via Edmonton.

The new trans-loading yard will be constructed adjacent to CN's existing line in Lynton.

25.4 Local Mining Support Industries

The Municipality of Wood Buffalo, Alberta, is home to a number of supporting industries including mining equipment distributors, mining contractors, and other mining related service industries.

Mining equipment distributors will be able to support the operation with maintenance services, reduce the amount of warehouse inventory that is required, and providing equipment component rebuilds. Other mining related service industries such as construction contractors, mining equipment tire suppliers, and other speciality contractor's operate in the area.

25.5 Markets

Norwest has reviewed various publicly available sources of information with respect to the expected demand for frac sand in North America and, more specifically, Western Canada. The majority of these sources indicate that the demand is expected to increase. Forecasted annual rates of increase vary between 5% and 25%.

AMI has selected the Edson/Hinton area of west-central Alberta as its point of sale for frac sand. This area coincides with current vigorous activity in the production of tight oil and gas from a number of geological formations; the majority of these operations require frac sand.

25.6 Economics

The project provides after tax NPV values of $268 M, when discounted at 10%.

26 RECOMMENDATIONS

Norwest recommends that AMI consider the following bridging or supplemental studies for the development of future projects at the three sites (Firebag, Edson and Lynton).

26.1 Materials Characterization Study

While geologic characterization has been compiled by APEX, some additional samples should be collected to confirm the lateral and vertical continuity of the deposit and the potential for the selective extraction of a variety of material size ranges that could optimize the project marketability and economics. This work could be accomplished by conducting additional auger drilling and backhoe trenching.

A review of a limited number of Attrition Scrubbing Analyses by Dawson Metallurgical Laboratories, and subsequent ISO Proppant analyses of the resulting samples by Stim-Lab, would seem to indicate that the addition of an attrition circuit into the processing design may have a beneficial effect on the products produced. Therefore, when additional samples are collected from the property, a representative number should be considered for this additional testing to allow formulation of conclusive statements that may affect the processing design and marketability.

Some additional process-related materials characterization work should be completed to confirm the applicability of the flowsheet as described in this Study; this could include something as simple as a trial wet-plant operation at Lynton.

26.2 Process Optimization Study

Attrition and scrubbing tests should be completed on additional samples across the operation to confirm that no further scrubbing is required.

In addition, a trade-off between the proposed Ventilex Fluidized Bed Dryer and an alternative rotary dryer should be considered; this would be dependent on the outcome of the materials characterization work and process optimization study described here.

26.3 Edson Geotechnical Study

The processing plant and rail area at Edson have been developed without a geotechnical site investigation. To further develop the foundation and project designs, a site-specific geotechnical study is required.

26.4 Edson/Hinton Water Sourcing Study

Due to the uncertainty of the processing plant location, a specific water source cannot be recommended at this time. A river water intake, however, would likely be the most economical solution given that there is a low probability that the processing plant site will be located above the most ideal aquifer conditions described in this report. In the absence of ideal conditions, multiple water-source wells would be needed to achieve the 220 gallons per minute (GPM) make-up water that is required. Water sourcing at Edson needs to be researched and developed. This PEA assumed that a water source is readily available.

26.5 Utilities Supply Study

Norwest assumed that all utilities, including natural gas and power supply, would be readily available for the purposes of this PEA. A required next step will be to engage the local utilities to confirm the nearest tie-in point and to confirm the system's capacity. Of particular importance is the system impact (SI) study for power supply; a minor allowance was made in this PEA for this study. It is likely that the timeline for the SI study will be on the critical path for project development.

26.6 Workforce Development Study

The costs for labour have been developed using historic and working projects in the vicinity of the Fort McMurray and Edson areas. Norwest recommends that AMI proceed with a labour sourcing and workforce development study in the future.

26.7 Edson Building Requirements Study

There is an opportunity to reduce costs by reducing the number of constructed buildings at the Edson site. To explore this potential, future studies should investigate the use of an administrative centre or existing office complex located in a nearby town, as well as a possible warehouse and storage centre.

26.8 Product Transportation Study

Future studies should investigate the need for and extent of ROM material release from the rail cars at Edson. This could include heated and covered sheds, car shakers or a combination of the two.

Future studies should investigate the need for a delumper or double-roll crusher to help handle the material between the wet plant and the final sizing stage. This might impact the ultimate size distribution. Alternatively, the stockpile could be kept very small and direct feed to the dry plant.

AMI should assess railcar lease strategies; Norwest has learned that orders placed now for railcars will be filled by 2017. Note: Railcar leasing companies do not have extra car capacity; railcars need to be built.

Norwest believes that is not necessary to assess railcar purchase strategies at this time: AMI is unlikely to purchase railcars due to maintenance facility logistics and the need for a maintenance crew.

A study should be completed to assess the implications of delays in rail travel time; the cost of an extra unit train; and, how an extra unit train(s), either leased or purchased, would impact production rates.

26.9 Infrastructure Location Study

Future studies should review processing plant location. Currently, the ROM material, including reject material (oversize and undersize) is hauled by truck and then by rail to the Edson processing plant facility. Note: The rejects constitute approximately 8% of total product handled.

26.10 Highway Upgrade Study

The 7 km long Highway 63 upgrade is critical to the Project. In the current study, Norwest developed a cost estimate for the road. In the future, AMI should consult with the Government of Alberta regarding the shared cost of this project.

26.11 Water Management Study

Norwest recommends a simple network of perimeter ditches and sumps to manage surface water at all three sites; collected water will be treated passively in a sedimentation pond before it is released into the environment. Although it is assumed that no excavated material will come in contact with bituminous or contaminated material, it is important to include a means to close the system in the event of equipment failure or a fuel spill.

The water levels in the existing piezometers should be read twice a year.

27 REFERENCES

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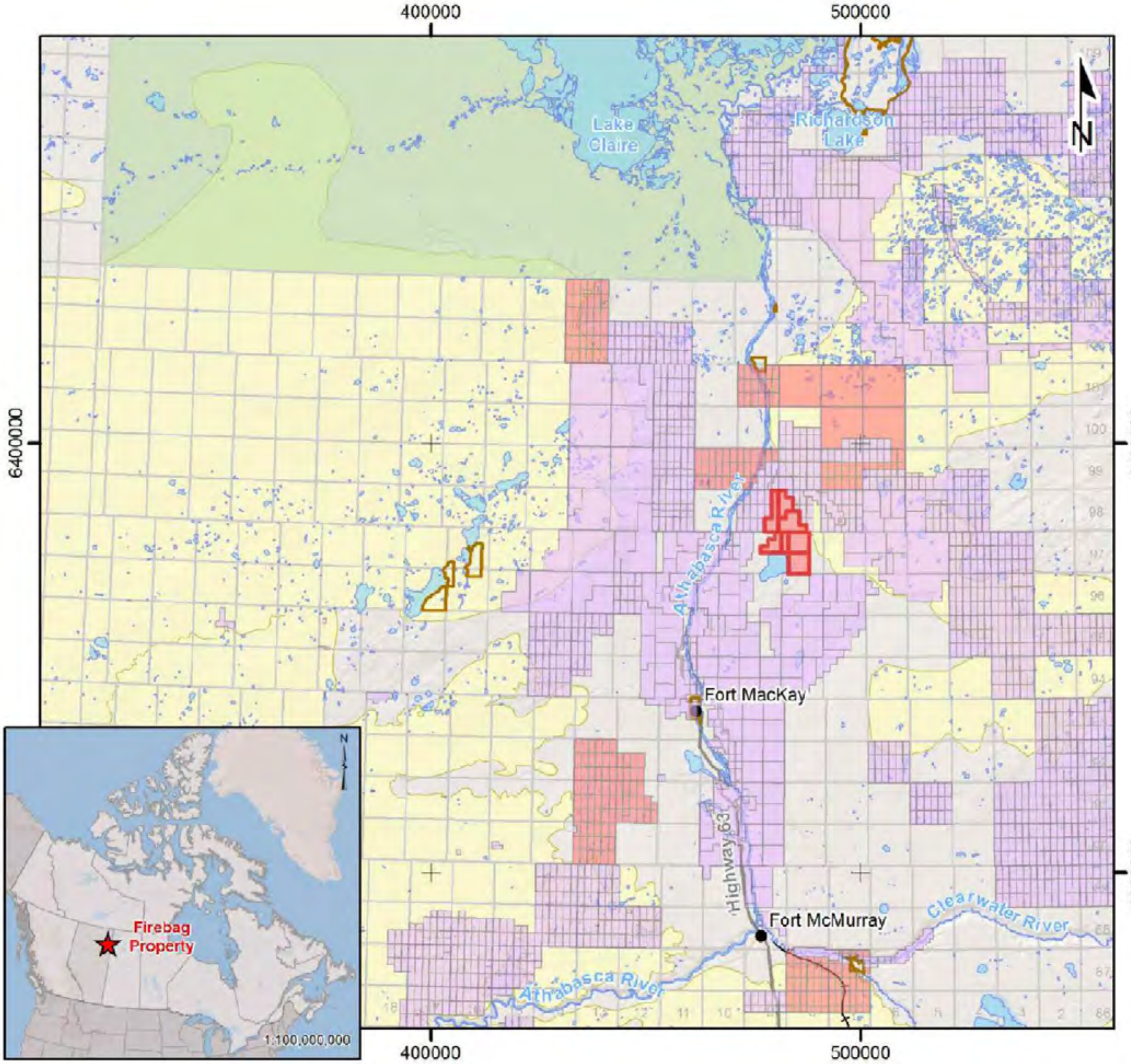
28 ILLUSTRATIONS



REFERENCE

1. ORIGINAL FIGURE FROM NATIONAL INSTRUMENT 43-101 TECHNICAL REPORT, INFERRED FRAC SAND RESOURCE ESTIMATE FOR THE FIREBAG PROPERTY, NORTHEASTERN ALBERTA, CANADA (SEPTEMBER 19, 2014) PRODUCED BY APEX GEOSCIENCE LTD.

LEGEND

- City
- Railway
- Major Road
- Township
- Reserves Outline
- Waterbody
- National and Provincial Park
- Caribou Range
- Alberta
- Canada Provinces
- United States

Landuse

- Firebag Property
- Athabasca Minerals Inc.
- Other Owners

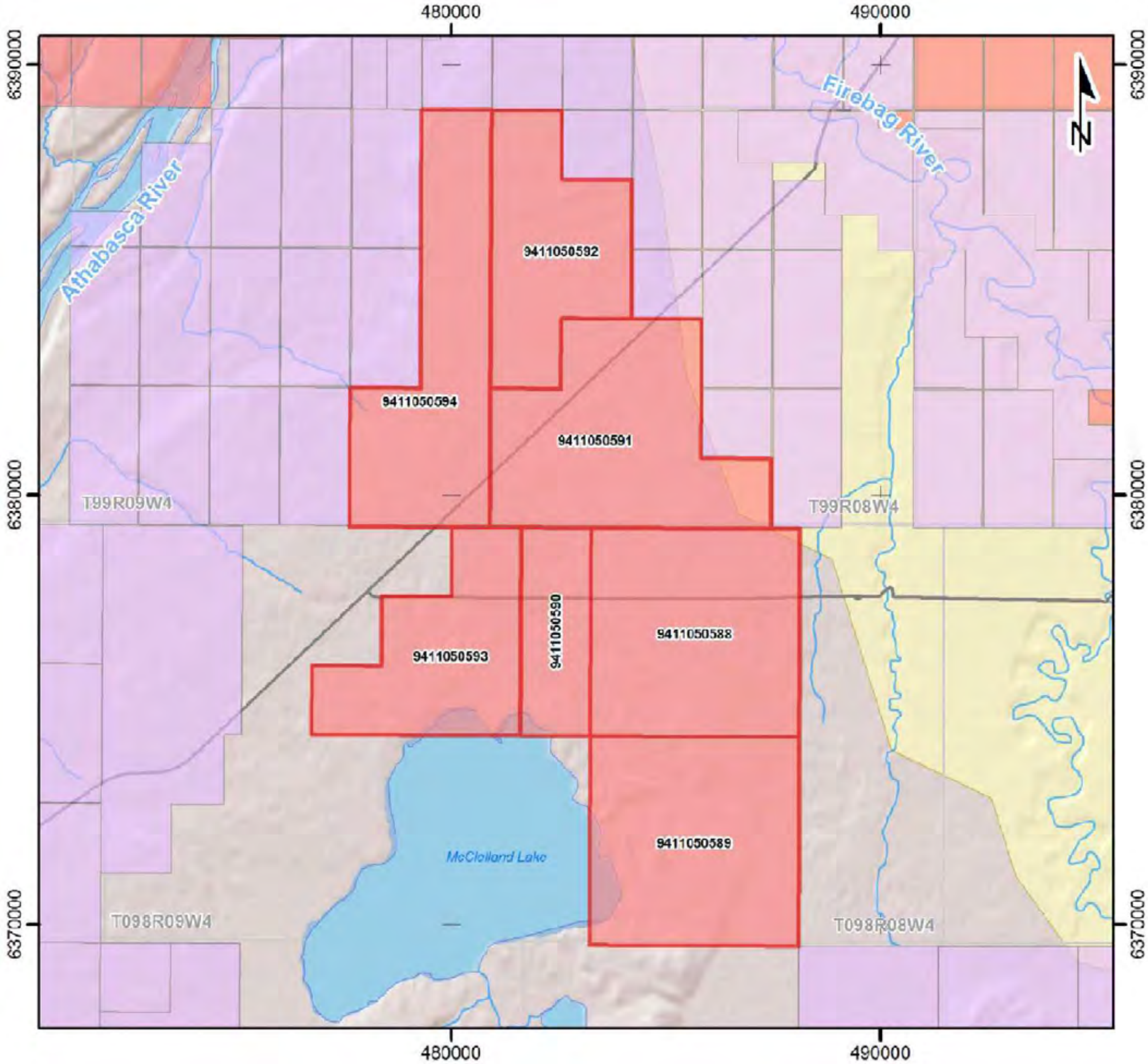
Athabasca MINERALS INC.

Firebag River Sand Pit

PROPERTY LOCATION

FIGURE 4-1

DRAWN BY: D.B.	FILE: Fig 4-1 Property Location.dwg	NORWEST
CHK'D BY: T.L.	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 11 28	\Disc\Mining\Drafting	P05015



NOTE

1. THE FORT CHIPEWYAN WINTER ROAD REPRESENTS A MAJOR WINTER ACCESS ROUTE TO THE PROPERTY AND NORTHEASTERN ALBERTA.

REFERENCE

1. ORIGINAL FIGURE FROM NATIONAL INSTRUMENT 43-101 TECHNICAL REPORT, INFERRED FRAC SAND RESOURCE ESTIMATE FOR THE FIREBAG PROPERTY, NORTHEASTERN ALBERTA, CANADA (SEPTEMBER 19, 2014) PRODUCED BY APEX GEOSCIENCE LTD.

0 1:150,000 5 km

NAD 1983 UTM Zone 12

LEGEND

- Township
- Access road
- Drainage
- Waterbody
- Caribou Range

Landuse

- Firebag Property
- Athabasca Minerals Inc.
- Other owners

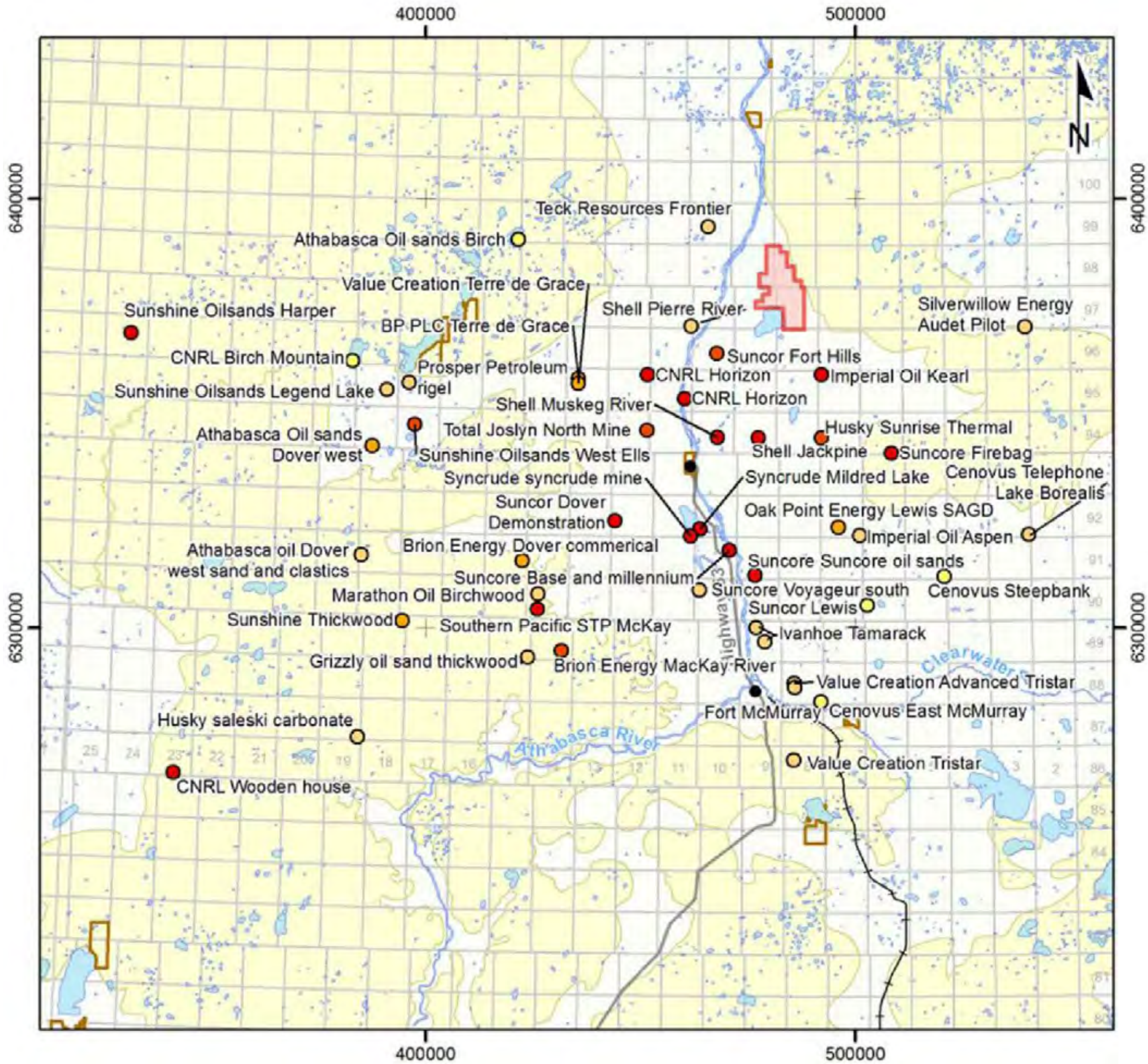
Athabasca MINERALS INC.

Firebag River Sand Pit

ROAD ACCESS TO FIREBAG PROPERTY

FIGURE 5-1

DRAWN BY: D.B.	FILE: Fig 5-1 Road Access to Firebag...	NORWEST
CHK'D BY: T.L.	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 11 28	\Disc\Mining\Drafting	P05015



NOTE

1. THESE OIL SANDS PROJECTS ARE LOCATED DIRECTLY SOUTH OF THE FIREBAG PROPERTY AREA.

REFERENCE

1. ORIGINAL FIGURE FROM NATIONAL INSTRUMENT 43-101 TECHNICAL REPORT, INFERRED FRAC SAND RESOURCE ESTIMATE FOR THE FIREBAG PROPERTY, NORTHEASTERN ALBERTA, CANADA (SEPTEMBER 19, 2014) PRODUCED BY APEX GEOSCIENCE LTD.

1:1,500,000

0 50 km

NAD 1983 UTM Zone 12

LEGEND

- City
- Railway
- Major Road
- Township
- Reserves Outline
- Waterbody
- Caribou Range

Landuse

- Firebag Property

Oilsands Projects Stage

- Announced
- Application
- Approved
- Construction
- Operating

Athabasca MINERALS INC.

Firebag River Sand Pit

OILSANDS PROJECTS

FIGURE 6-1

DRAWN BY: D.B.	FILE: Fig 6-1 Oilsands Projects	NORWEST
CHK'D BY: T.L.	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit P05015
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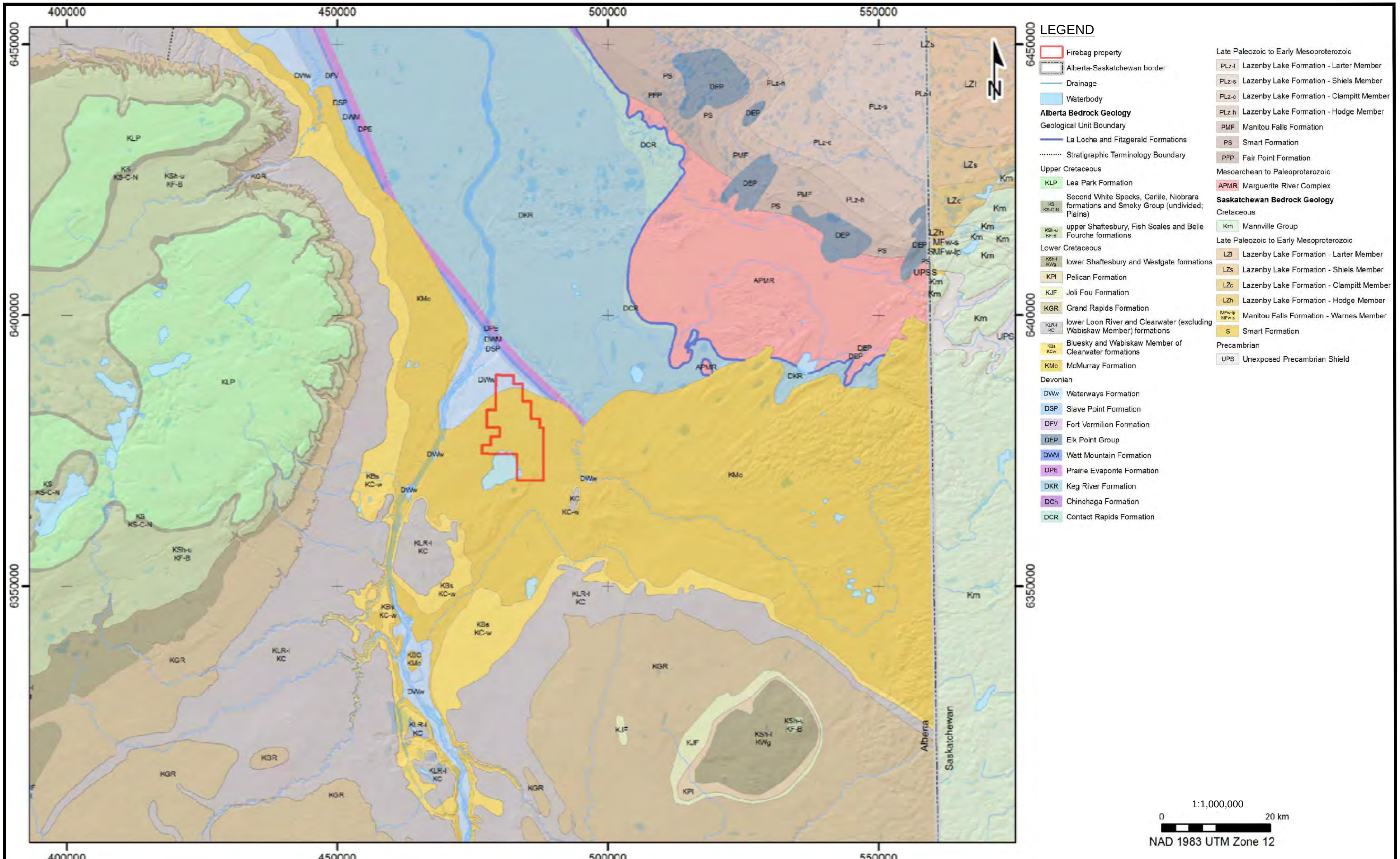


NOTE

1. LOCATED IN THE FIREBAG PROPERTY REGION IN NORTHEASTERN ALBERTA.

REFERENCE

1. ORIGINAL FIGURE FROM NATIONAL INSTRUMENT 43-101 TECHNICAL REPORT, INFERRED FRAC SAND RESOURCE ESTIMATE FOR THE FIREBAG PROPERTY, NORTHEASTERN ALBERTA, CANADA (SEPTEMBER 19, 2014) PRODUCED BY APEX GEOSCIENCE LTD.

Athabasca MINERALS INC.

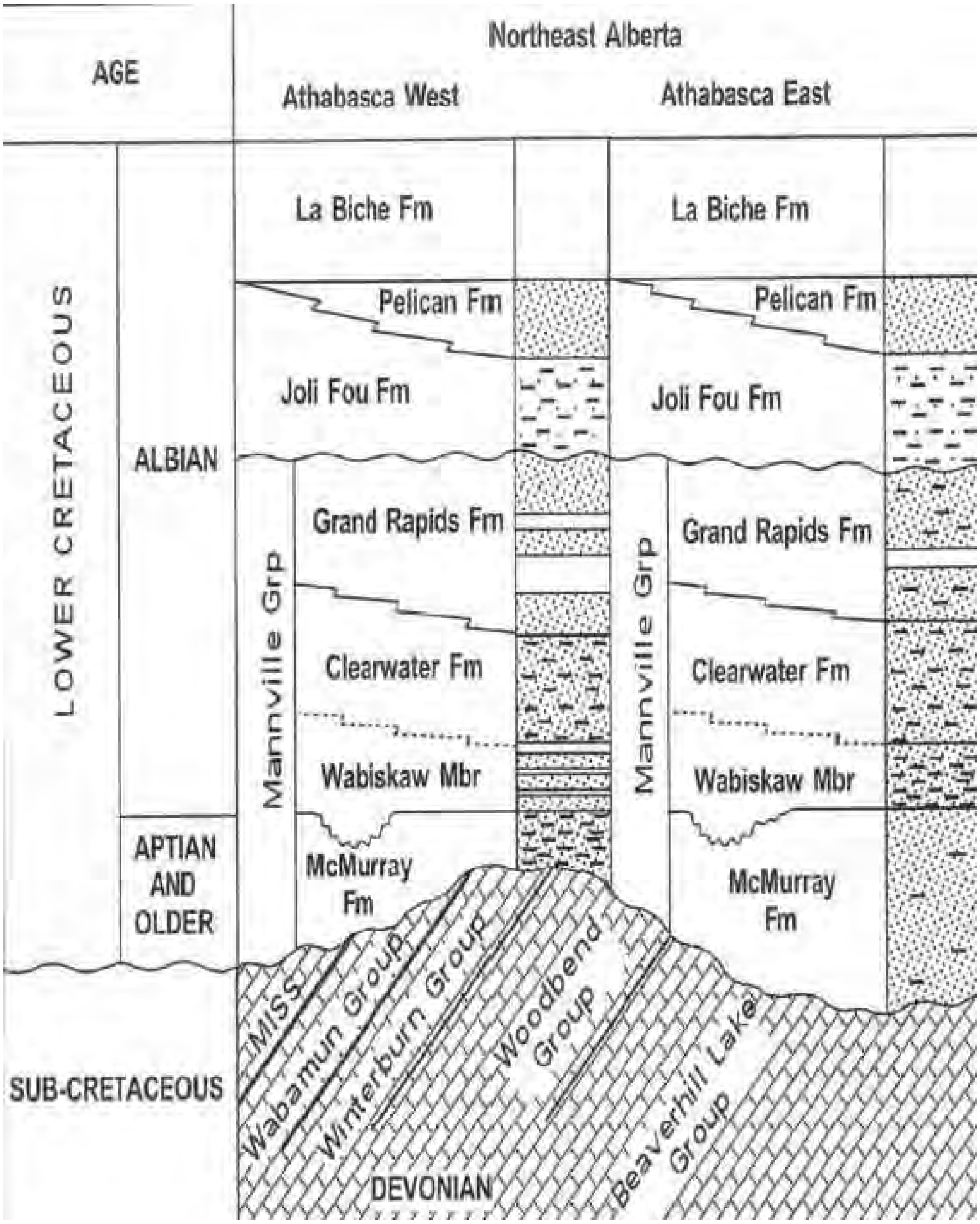
Firebag River Sand Pit

REGIONAL BEDROCK GEOLOGY

ALBERTA GEOLOGY AFTER PRIOR ET AL. (2013)
SASKATCHEWAN GEOLOGY AFTER SIMMON (2013)

FIGURE 7-1

DRAWN BY: D.B.	FILE: Fig 7-1 Regional Bedrock Geology.dwg	NORWEST
CHK'D BY: T.L.	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 11 28	Disc\Mining\Drafting	P05015



Athabasca MINERALS INC.

Firebag River Sand Pit

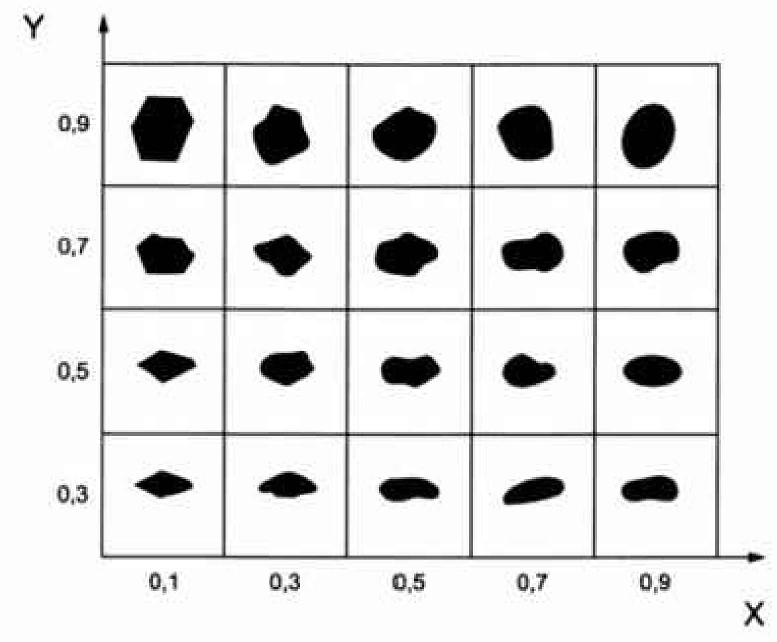
STRATIGRAPHIC TABLE OF FORMATIONS IN NORTHEASTERN ALBERTA

FIGURE 7-2

NOTE

1. THE SURFICIAL GEOLOGY AT THE FIREBAG PROPERTY AREA COULD BE SOURCED BY SAND-DOMINATED UNITS ASSOCIATED WITH THE McMURRAY, GRAND RAPIDS OR PELICAN FORMATIONS (COTTERILL, 1996).

DRAWN BY: D.B.	FILE: Fig 7-2 Stratigraphic Table of Format...	NORWEST
CHK'D BY: T.L.	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 11 28	\Disc\Mining\Drafting	P05015



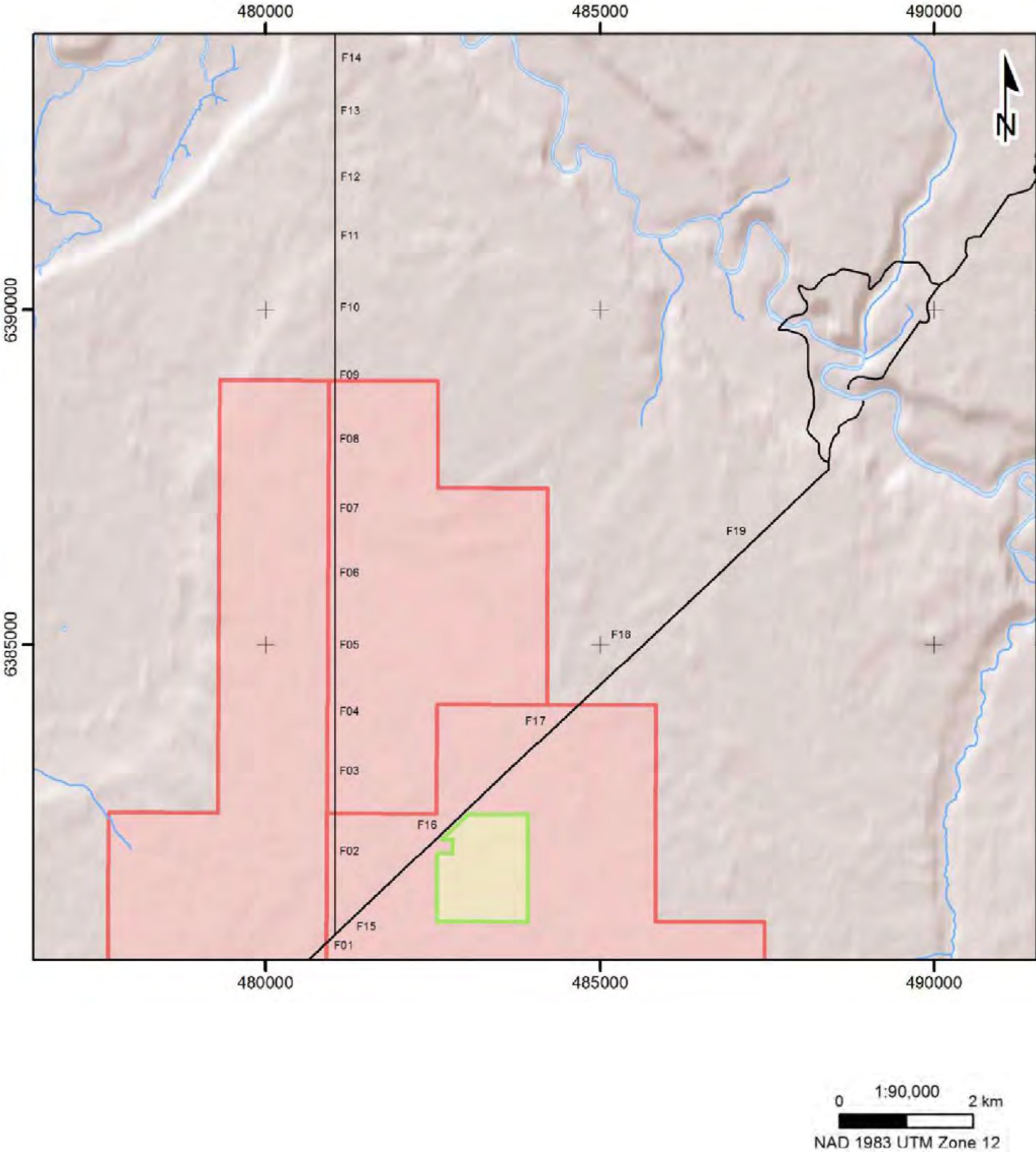
Athabasca MINERALS INC.

Firebag River Sand Pit

CHART FOR VISUAL ESTIMATION OF SPHERICITY (Y-AXIS) AND ROUNDNESS (X-AXIS)

FIGURE 8-1

DRAWN BY: D.B.	FILE: Fig 8-1 Chart for Visual Estimation.dwg	NORWEST
CHK'D BY: T.L.	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 11 28	Disc\Mining\Drafting	P05015



LEGEND

- ⊗ F-series auger holes
- Township
- Access road
- Drainage
- Waterbody

Landuse

- Resource boundary
- Industrial Minerals Leases

NOTE

1. AUGER HOLES (n=19) WERE DRILLED BY AMI AT THE FIREBAG PROPERTY. WITH THE EXCEPTION OF HOLE F16, THE AUGER HOLES ARE SITUATED OUTSIDE OF THE FIREBAG INFERRED FRAC SAND RESOURCE ESTIMATE AREA FOCUSED ON IN THIS PEA REPORT.

REFERENCE

1. ORIGINAL FIGURE FROM NATIONAL INSTRUMENT 43-101 TECHNICAL REPORT, INFERRED FRAC SAND RESOURCE ESTIMATE FOR THE FIREBAG PROPERTY, NORTHEASTERN ALBERTA, CANADA (SEPTEMBER 19, 2014) PRODUCED BY APEX GEOSCIENCE LTD.

Athabasca MINERALS INC.

Firebag River Sand Pit

LOCATION OF JANUARY 2011 F-SERIES AUGER HOLES

FIGURE 9-1

DRAWN BY: D.B.	FILE: Fig 9-1 Location of the January 2011...	NORWEST
CHK'D BY: T.L.	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit P05015
DATE: 14 11 28	\Disc\Mining\Drafting	

NOTE

1. BACKHOE TEST PITS (n=26) AND AUGER HOLES (n=6).

REFERENCE

1. ORIGINAL FIGURE FROM NATIONAL INSTRUMENT 43-101 TECHNICAL REPORT, INFERRED FRAC SAND RESOURCE ESTIMATE FOR THE FIREBAG PROPERTY, NORTHEASTERN ALBERTA, CANADA (SEPTEMBER 19, 2014) PRODUCED BY APEX GEOSCIENCE LTD.

0 1:15,000 390 m

NAD 1983 UTM Zone 12

LEGEND

- × Actual test pit location
- ⊗ Auger hole location
- Logged in Cotterill (2011)
- Logged in Zdunczyk (2012)
- Analytical test work conducted on 3.05 m intervals
- TH01 New hole ID number
- MZ11 Original hole ID number
- Road
- Resource boundary
- Surface Materials Leases (SML)
- Industrial Minerals Leases

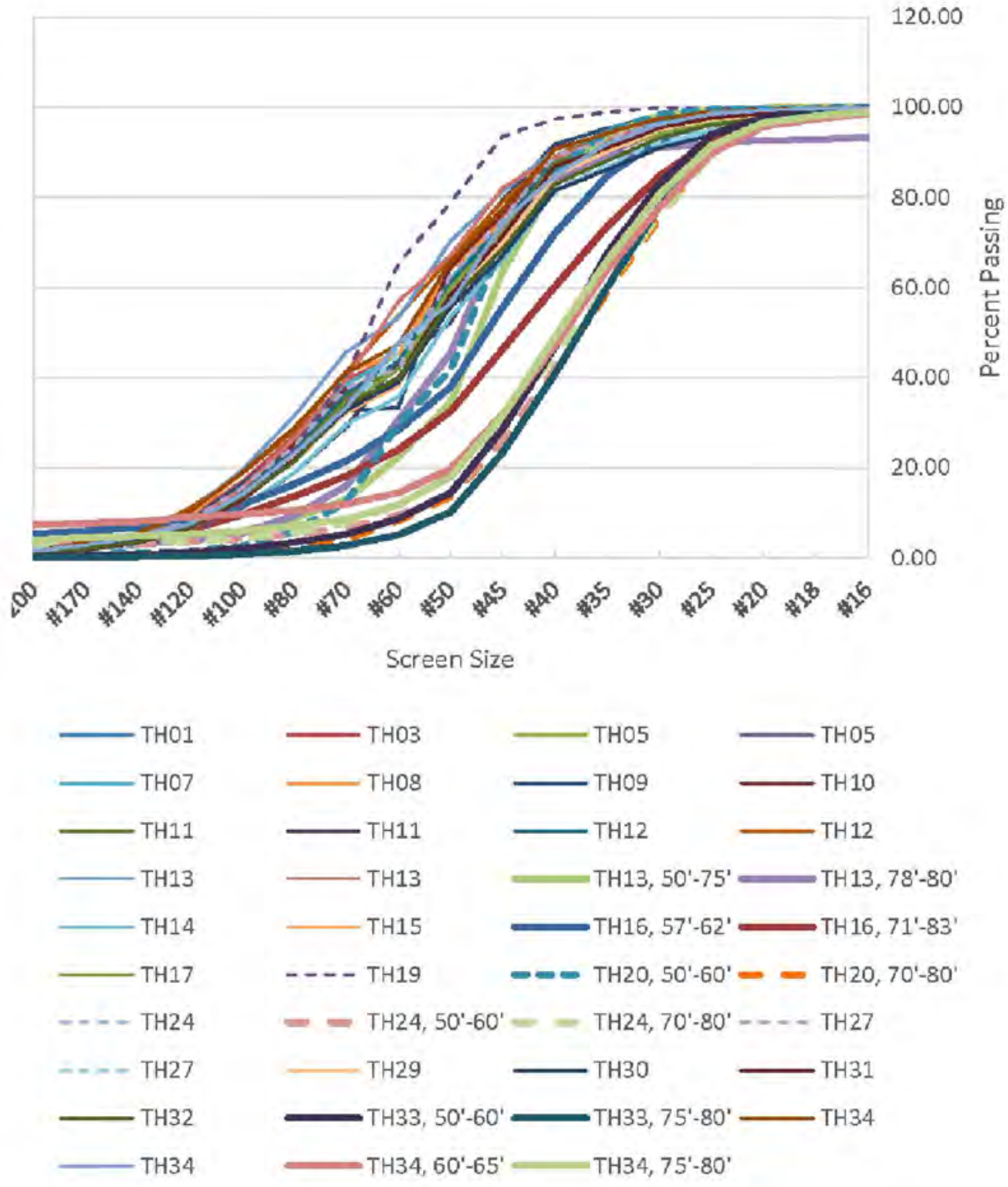
Athabasca MINERALS INC.

Firebag River Sand Pit

LOCATION OF THE DECEMBER 2011 BACKHOE TEST PITS AND AUGER HOLES

FIGURE 9-2

DRAWN BY: D.B.	FILE: Fig 9-2 Location of the December...	NORWEST
CHK'D BY: T.L.	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 11 28	\Disc\Mining\Drafting	P05015



NOT TO SCALE

Athabasca MINERALS INC.

Firebag River Sand Pit

SIEVE ANALYSES

FIGURE 12-1

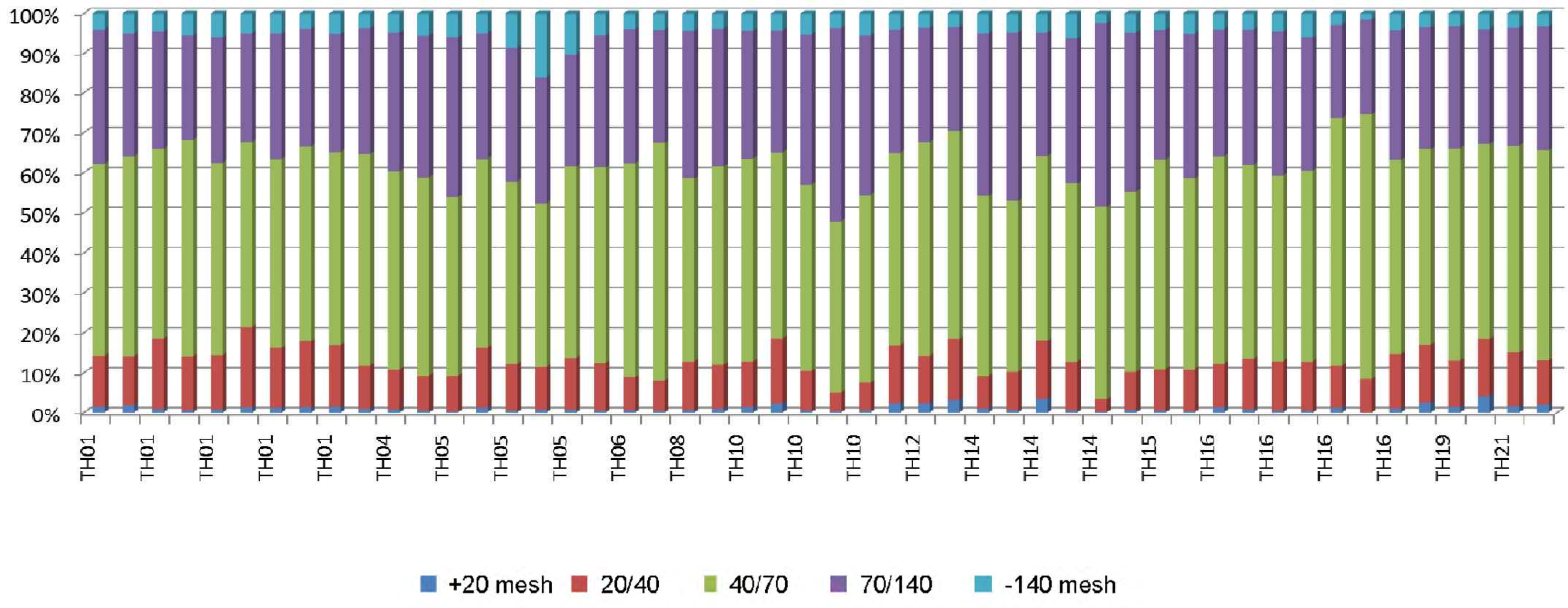
NOTE

1. INCLUDES INDIVIDUAL SAMPLE ANALYSES FROM LORING LABORATORIES, STIM-LAB AND DK ENGINEERING.

REFERENCE

1. ORIGINAL FIGURE FROM NATIONAL INSTRUMENT 43-101 TECHNICAL REPORT, INFERRED FRAC SAND RESOURCE ESTIMATE FOR THE FIREBAG PROPERTY, NORTHEASTERN ALBERTA, CANADA (SEPTEMBER 19, 2014) PRODUCED BY APEX GEOSCIENCE LTD.

DRAWN BY: D.B.	FILE: Fig 12-1 Sieve Analyses.dwg	NORWEST
CHK'D BY: T.L.	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit P05015
DATE: 14 11 28	\Disc\Mining\Drafting	



NOT TO SCALE

NOTE

1. DEMONSTRATION ACROSS THE FIREBAG INFERRED FRAC SAND RESOURCE ESTIMATE AREA. THE DATA (n=50) ARE FROM SAMPLES ASSOCIATED WITH THE DECEMBER 2011 BACKHOE TEST PIT AND AUGER PROGRAM, AND INCLUDES SIEVE ANALYSES FROM LORING LABORATORIES, AND STIM-LAB AND PROPTESTER LABORATORIES.

REFERENCE

1. ORIGINAL FIGURE FROM NATIONAL INSTRUMENT 43-101 TECHNICAL REPORT, INFERRED FRAC SAND RESOURCE ESTIMATE FOR THE FIREBAG PROPERTY, NORTHEASTERN ALBERTA, CANADA (SEPTEMBER 19, 2014) PRODUCED BY APEX GEOSCIENCE LTD.

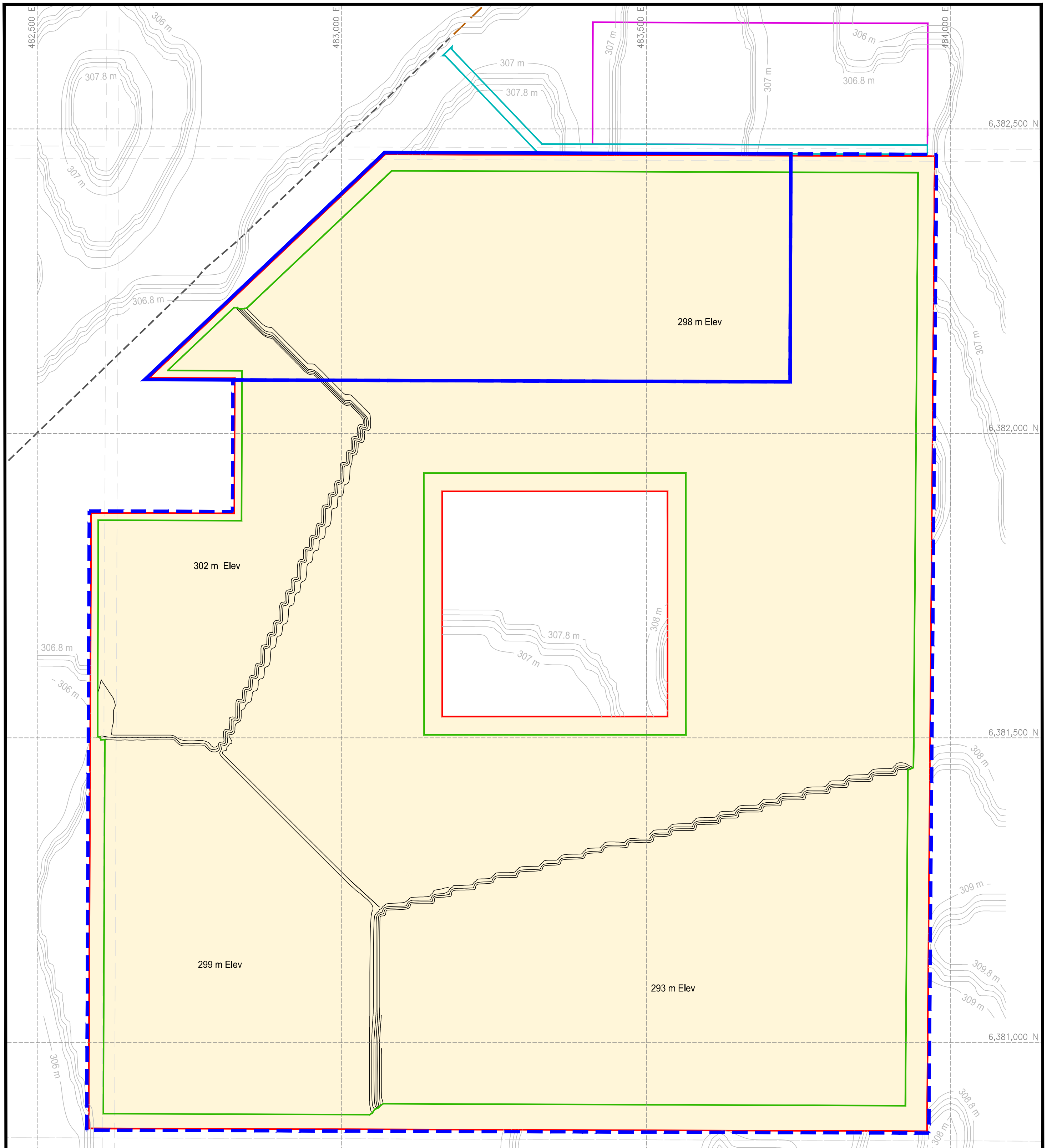
Athabasca MINERALS INC.

Firebag River Sand Pit

SILICA SAND GRAIN SIZE DISTRIBUTION

FIGURE 12-2

DRAWN BY: D.B.	FILE: Fig 12-2 Silica Sand Grain Size Distrib...	NORWEST
CHK'D BY: T.L.	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 11 28	Disc\Mining\Drafting	P05015



LEGEND

- PRE-STRIPPING
- OPEN PIT
- PROGRESSIVE RECLAMATION AREA
- RECLAMATION AREA
- SAND STOCKPILE AREA
- WASTE STOCKPILE AREA
- PIT CREST
- PIT TOE
- SML-APPROVED BOUNDARY
- SML-APPLICATION BOUNDARY
- WINTER ROAD
- UPGRADED HWY 963
- DML AREA
- DLO AREA
- 0.2 m TOPO CONTOUR
- 1.0 m PIT FLOOR CONTOUR

NOTE

1. ALL COORDINATES BASED ON UTM ZONE 12, NAD 83.
2. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. NOT ALL FEATURES OR STRUCTURES MAY BE SHOWN.

REFERENCE

1. TOPOGRAPHIC BASE INFORMATION PROVIDED BY ATHABASCA MINERALS INC., JUNE 19, 2014.

N

20 0 200
METRES

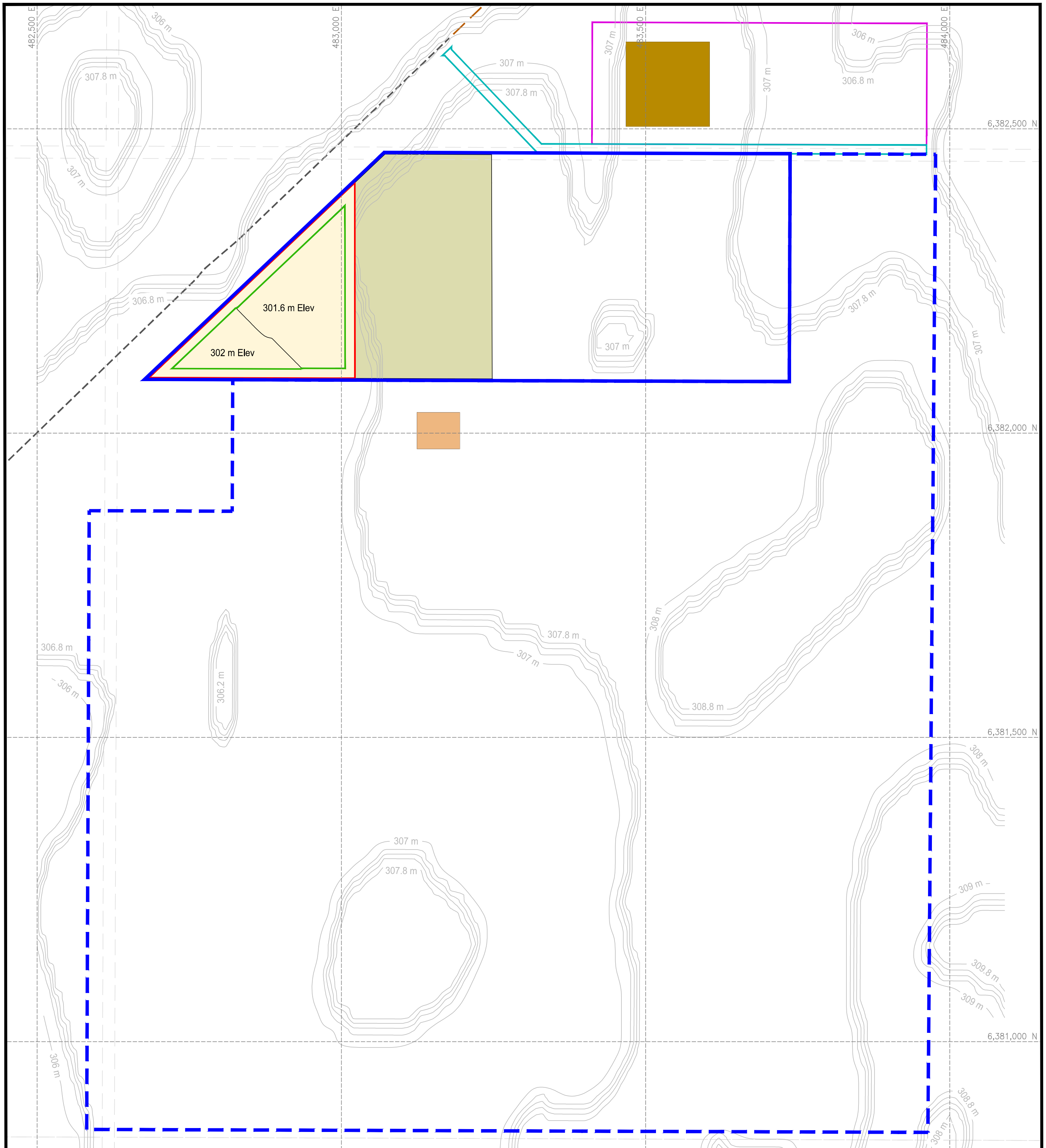
Athabasca MINERALS INC.

Firebag River Sand Pit

ULTIMATE PIT DESIGN

FIGURE 16-1

DRAWN BY: K.G.	FILE: Fig XX Intervals.dwg	NORWEST
CHK'D BY: T.L.	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 11 12	\Disc\Mining\Drafting	P05015



LEGEND

PRE-STRIPPING	PIT CREST	DML AREA
OPEN PIT	PIT TOE	DLO AREA
PROGRESSIVE RECLAMATION AREA	SML-APPROVED BOUNDARY	0.2 m TOPO CONTOUR
RECLAMATION AREA	SML-APPLICATION BOUNDARY	1.0 m PIT FLOOR CONTOUR
SAND STOCKPILE AREA	WINTER ROAD	
WASTE STOCKPILE AREA	UPGRADED HWY 963	

NOTE

1. ALL COORDINATES BASED ON UTM ZONE 12, NAD 83.
2. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. NOT ALL FEATURES OR STRUCTURES MAY BE SHOWN.

REFERENCE

1. TOPOGRAPHIC BASE INFORMATION PROVIDED BY ATHABASCA MINERALS INC., JUNE 19, 2014.

N

20 0 200
METRES

Athabasca MINERALS INC.

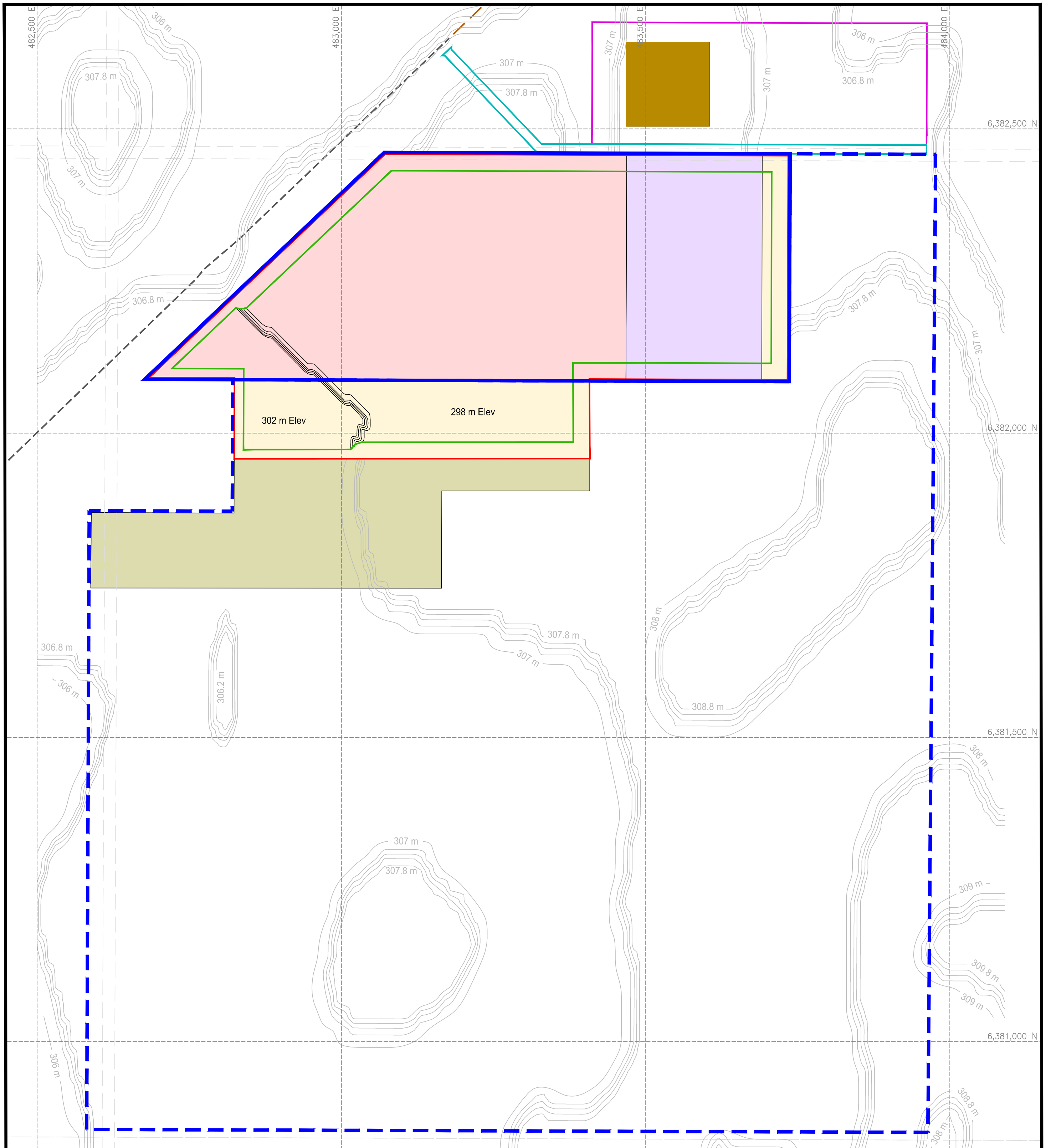
Firebag River Sand Pit

MINE ADVANCE

YEAR 2016

FIGURE 16-2

DRAWN BY: K.G.	FILE: Fig XX Intervals.dwg	NORWEST
CHK'D BY: T.L.	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 11 12	\Disc\Mining\Drafting	P05015



LEGEND

PRE-STRIPPING	PIT CREST	DML AREA
OPEN PIT	PIT TOE	DLO AREA
PROGRESSIVE RECLAMATION AREA	SML-APPROVED BOUNDARY	0.2 m TOPO CONTOUR
RECLAMATION AREA	SML-APPLICATION BOUNDARY	1.0 m PIT FLOOR CONTOUR
SAND STOCKPILE AREA	WINTER ROAD	
WASTE STOCKPILE AREA	UPGRADED HWY 963	

NOTE

1. ALL COORDINATES BASED ON UTM ZONE 12, NAD 83.
2. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. NOT ALL FEATURES OR STRUCTURES MAY BE SHOWN.

REFERENCE

1. TOPOGRAPHIC BASE INFORMATION PROVIDED BY ATHABASCA MINERALS INC., JUNE 19, 2014.

N

20 0 200
METRES

Athabasca MINERALS INC.

Firebag River Sand Pit

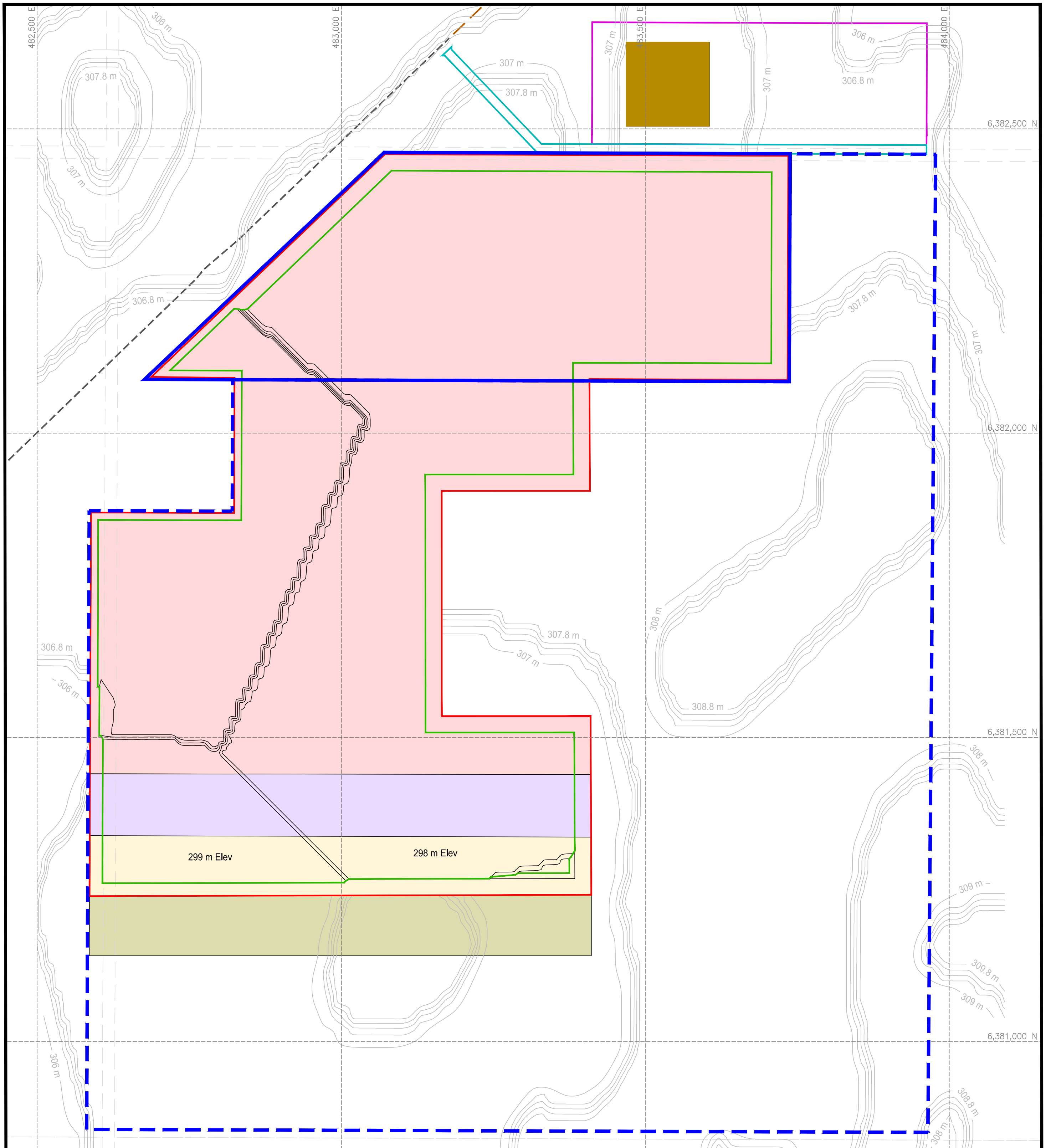
MINE ADVANCE
YEAR 2020

FIGURE 16-3

DRAWN BY: K.G.
CHK'D BY: T.L.
DATE: 14 11 12

FILE: Fig XX Intervals.dwg
G:\ProjectData\AMI_761\761-1_Firebag Frac S\Disc\Mining\Drafting

NORWEST
APEGA Permit P05015



LEGEND

PRE-STRIPPING	PIT CREST
OPEN PIT	PIT TOE
PROGRESSIVE RECLAMATION AREA	SML-APPROVED BOUNDARY
RECLAMATION AREA	SML-APPLICATION BOUNDARY
SAND STOCKPILE AREA	WINTER ROAD
WASTE STOCKPILE AREA	UPGRADED HWY 963
DML AREA	DLO AREA
0.2 m TOPO CONTOUR	1.0 m PIT FLOOR CONTOUR

NOTE

1. ALL COORDINATES BASED ON UTM ZONE 12, NAD 83.
2. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. NOT ALL FEATURES OR STRUCTURES MAY BE SHOWN.

REFERENCE

1. TOPOGRAPHIC BASE INFORMATION PROVIDED BY ATHABASCA MINERALS INC., JUNE 19, 2014.

N

20 0 200
METRES

Athabasca MINERALS INC.

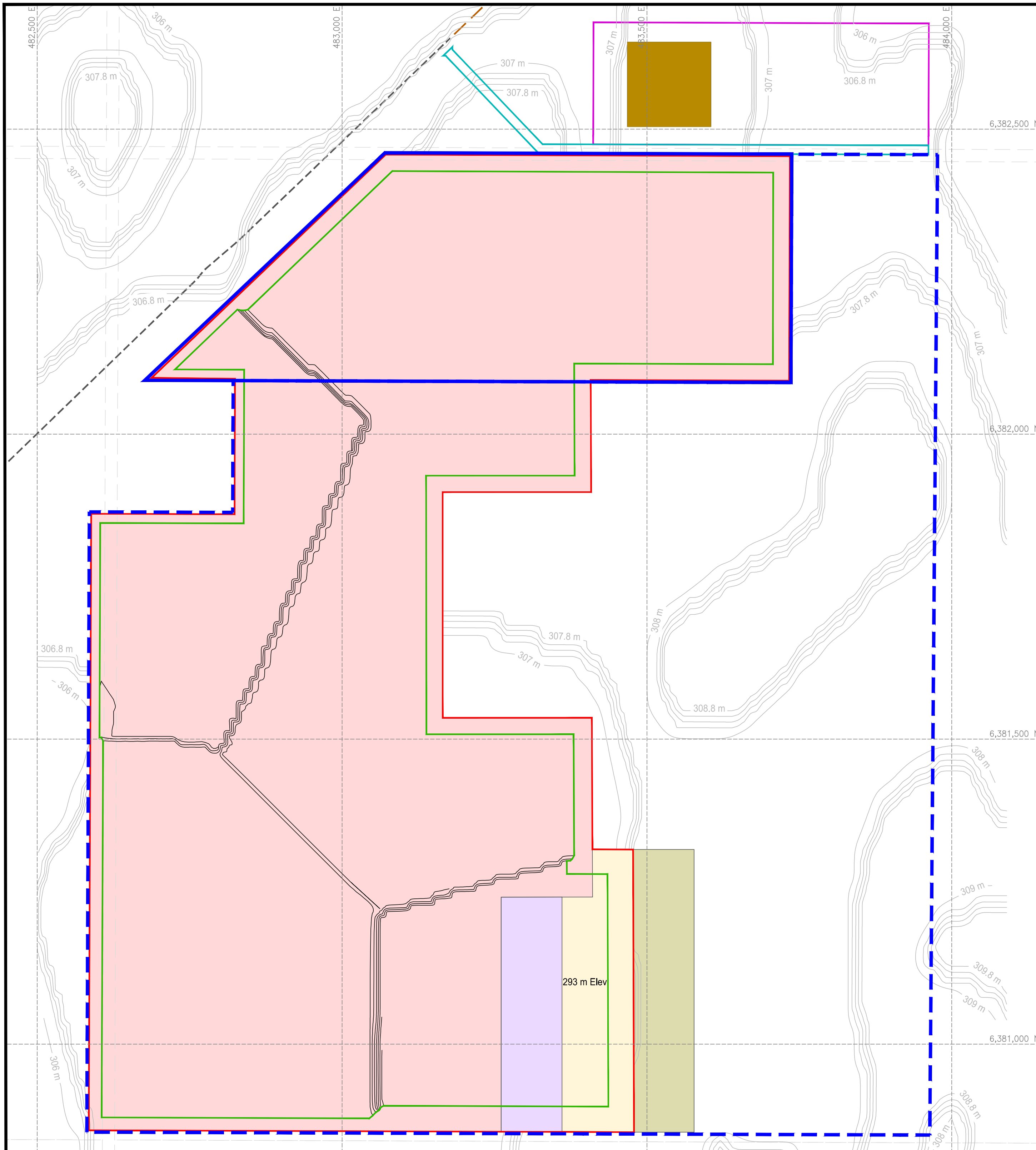
Firebag River Sand Pit

MINE ADVANCE

YEAR 2025

FIGURE 16-4

DRAWN BY: K.G.	FILE: Fig XX Intervals.dwg	NORWEST
CHK'D BY: T.L.	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 11 12	\Disc\Mining\Drafting	P05015



LEGEND

PRE-STRIPPING	PIT CREST	DML AREA
OPEN PIT	PIT TOE	DLO AREA
PROGRESSIVE RECLAMATION AREA	SML-APPROVED BOUNDARY	0.2 m TOPO CONTOUR
RECLAMATION AREA	SML-APPLICATION BOUNDARY	1.0 m PIT FLOOR CONTOUR
SAND STOCKPILE AREA	WINTER ROAD	
WASTE STOCKPILE AREA	UPGRADED HWY 963	

NOTE

1. ALL COORDINATES BASED ON UTM ZONE 12, NAD 83.
2. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. NOT ALL FEATURES OR STRUCTURES MAY BE SHOWN.

REFERENCE

1. TOPOGRAPHIC BASE INFORMATION PROVIDED BY ATHABASCA MINERALS INC., JUNE 19, 2014.

N

20 0 200
METRES

Athabasca MINERALS INC.

Firebag River Sand Pit

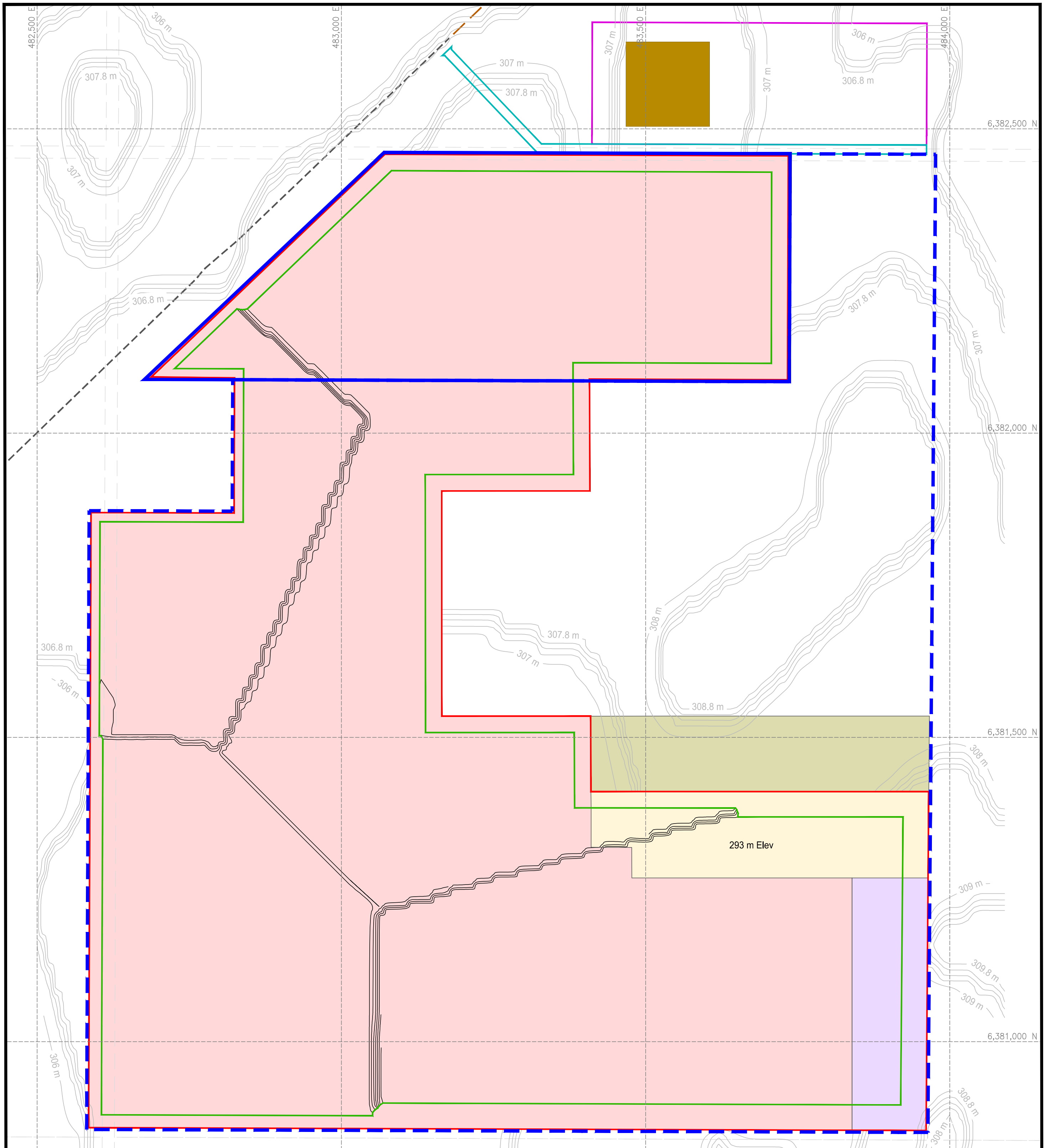
MINE ADVANCE
YEAR 2030

FIGURE 16-5

DRAWN BY: K.G.
CHK'D BY: T.L.
DATE: 14 11 12

FILE: Fig XX Intervals.dwg
G:\ProjectData\AMI_761\761-1_Firebag Frac S
\Disc\Mining\Drafting

NORWEST
APEGA Permit
P05015



LEGEND

- PRE-STRIPPING
- OPEN PIT
- PROGRESSIVE RECLAMATION AREA
- RECLAMATION AREA
- SAND STOCKPILE AREA
- WASTE STOCKPILE AREA
- PIT CREST
- PIT TOE
- SML-APPROVED BOUNDARY
- SML-APPLICATION BOUNDARY
- WINTER ROAD
- UPGRADED HWY 963
- DML AREA
- DLO AREA
- 0.2 m TOPO CONTOUR
- 1.0 m PIT FLOOR CONTOUR

NOTE

1. ALL COORDINATES BASED ON UTM ZONE 12, NAD 83.
2. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. NOT ALL FEATURES OR STRUCTURES MAY BE SHOWN.

REFERENCE

1. TOPOGRAPHIC BASE INFORMATION PROVIDED BY ATHABASCA MINERALS INC., JUNE 19, 2014.

N

20 0 200
METRES

Athabasca MINERALS INC.

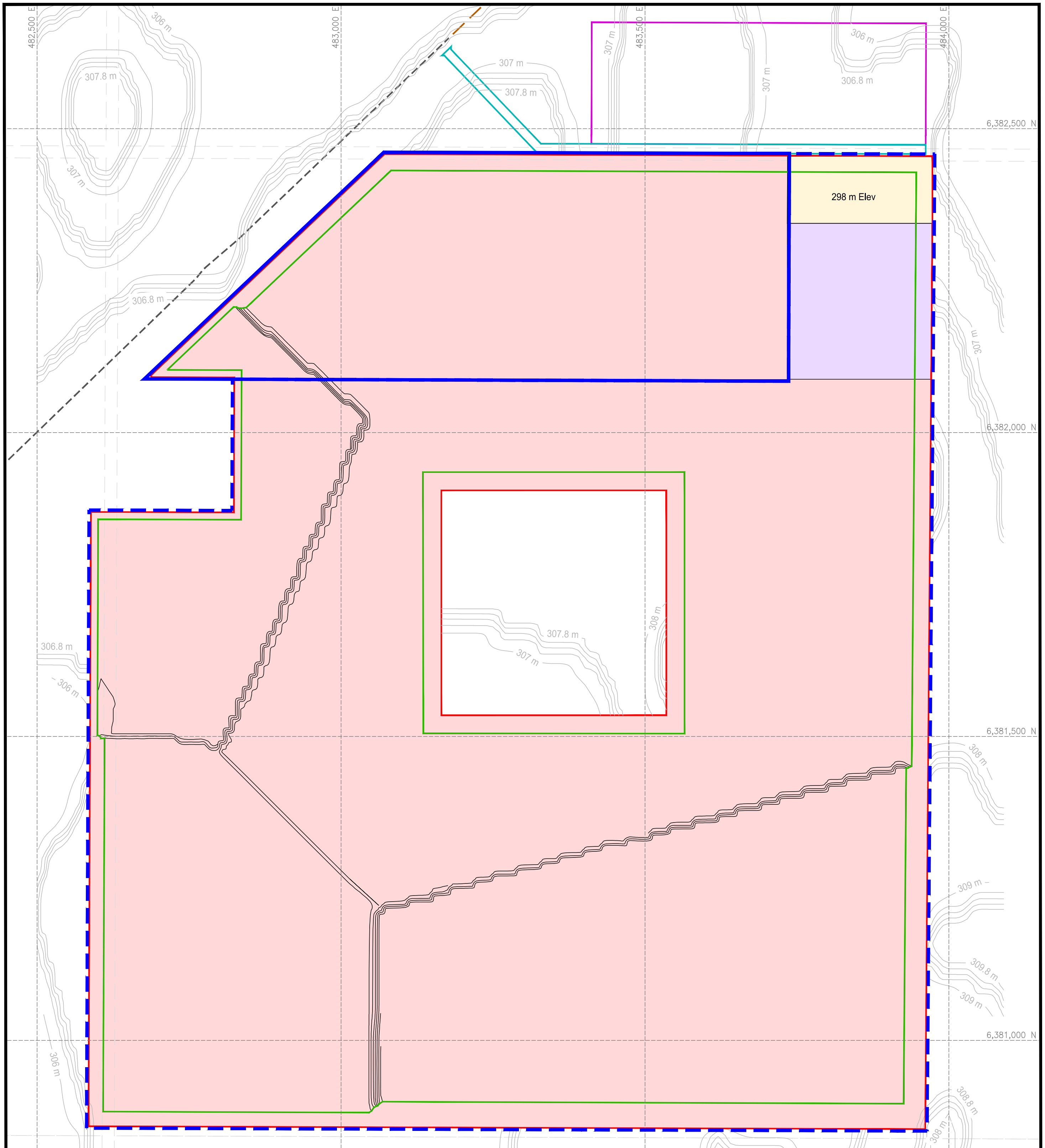
Firebag River Sand Pit

MINE ADVANCE

YEAR 2035

FIGURE 16-6

DRAWN BY: K.G.	FILE: Fig XX Intervals.dwg	NORWEST
CHK'D BY: T.L.	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 11 12	\Disc\Mining\Drafting	P05015



LEGEND

- PRE-STRIPPING
- OPEN PIT
- PROGRESSIVE RECLAMATION AREA
- RECLAMATION AREA
- SAND STOCKPILE AREA
- WASTE STOCKPILE AREA
- PIT CREST
- PIT TOE
- SML-APPROVED BOUNDARY
- SML-APPLICATION BOUNDARY
- WINTER ROAD
- UPGRADED HWY 963
- DML AREA
- DLO AREA
- 0.2 m TOPO CONTOUR
- 1.0 m PIT FLOOR CONTOUR

NOTE

1. ALL COORDINATES BASED ON UTM ZONE 12, NAD 83.
2. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. NOT ALL FEATURES OR STRUCTURES MAY BE SHOWN.

REFERENCE

1. TOPOGRAPHIC BASE INFORMATION PROVIDED BY ATHABASCA MINERALS INC., JUNE 19, 2014.

N

20 0 200
METRES

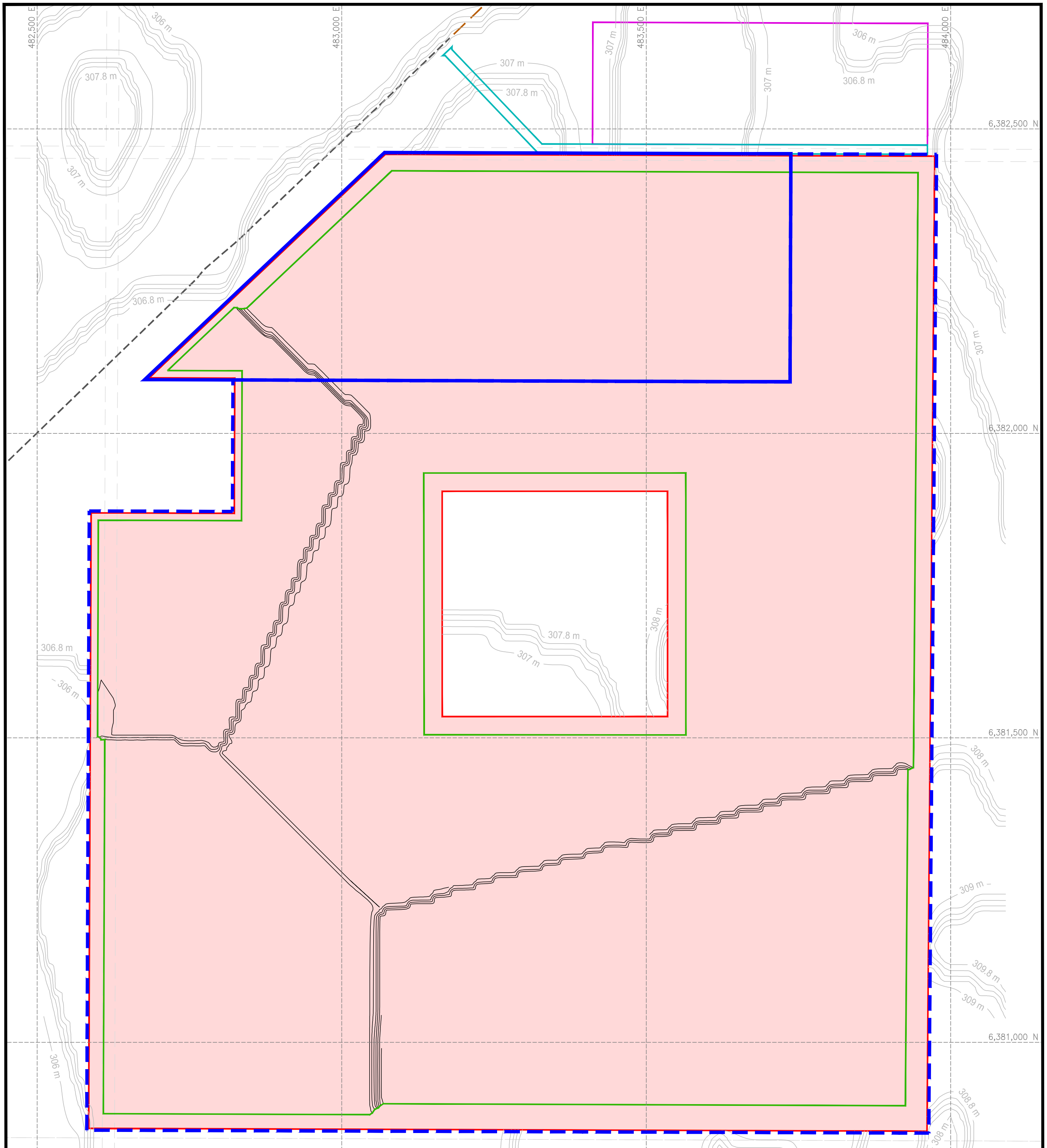
Athabasca MINERALS INC.

Firebag River Sand Pit

MINE ADVANCE
Year 2041

FIGURE 16-7

DRAWN BY: K.G.	FILE: Fig XX Intervals.dwg	NORWEST
CHK'D BY: T.L.	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 11 12	\Disc\Mining\Drafting	P05015



LEGEND

	PRE-STRIPPING		PIT CREST		DML AREA
	OPEN PIT		PIT TOE		DLO AREA
	PROGRESSIVE RECLAMATION AREA		SML-APPROVED BOUNDARY		0.2 m TOPO CONTOUR
	RECLAMATION AREA		SML-APPLICATION BOUNDARY		1.0 m PIT FLOOR CONTOUR
	SAND STOCKPILE AREA		WINTER ROAD		
	WASTE STOCKPILE AREA		UPGRADED HWY 963		

NOTE

1. ALL COORDINATES BASED ON UTM ZONE 12, NAD 83.
2. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. NOT ALL FEATURES OR STRUCTURES MAY BE SHOWN.

REFERENCE

1. TOPOGRAPHIC BASE INFORMATION PROVIDED BY ATHABASCA MINERALS INC., JUNE 19, 2014.

N

20 0 200
METRES

Athabasca MINERALS INC.

Firebag River Sand Pit

CONCEPTUAL CLOSURE PLAN

FIGURE 16-8

DRAWN BY: K.G.
CHK'D BY: T.L.
DATE: 14 11 12

FILE: Fig XX Intervals.dwg
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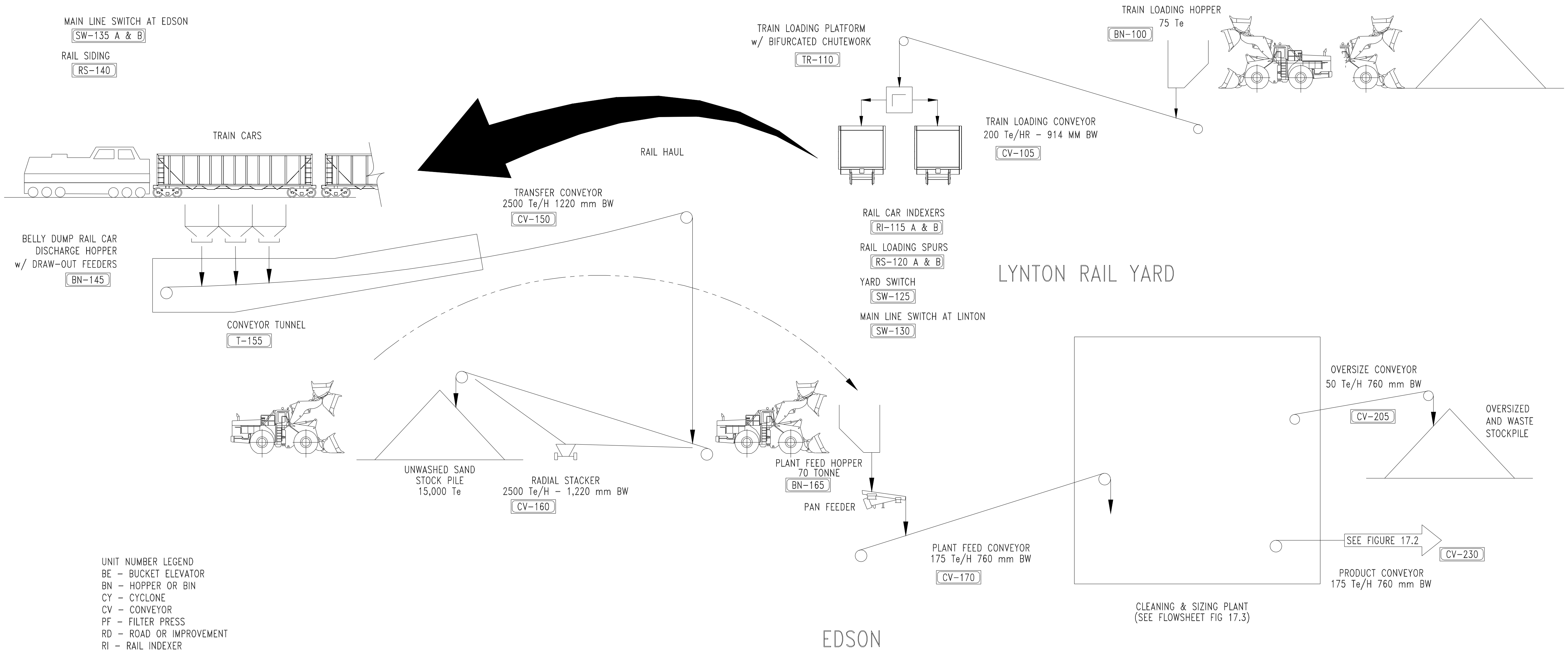
NORWEST
APEGA Permit P05015



UNIT NUMBER LEGEND
BE - BUCKET ELEVATOR
BN - HOPPER OR BIN
CY - CYCLONE
CV - CONVEYOR
PF - FILTER PRESS
RD - ROAD OR IMPROVEMENT
RI - RAIL INDEXER
RS - RAIL SPUR
SC - SCREEN
SW - RAIL SWITCH
TA - TANK
TR - TRANSFER PLATFORM
TS - TRUCK SCALE

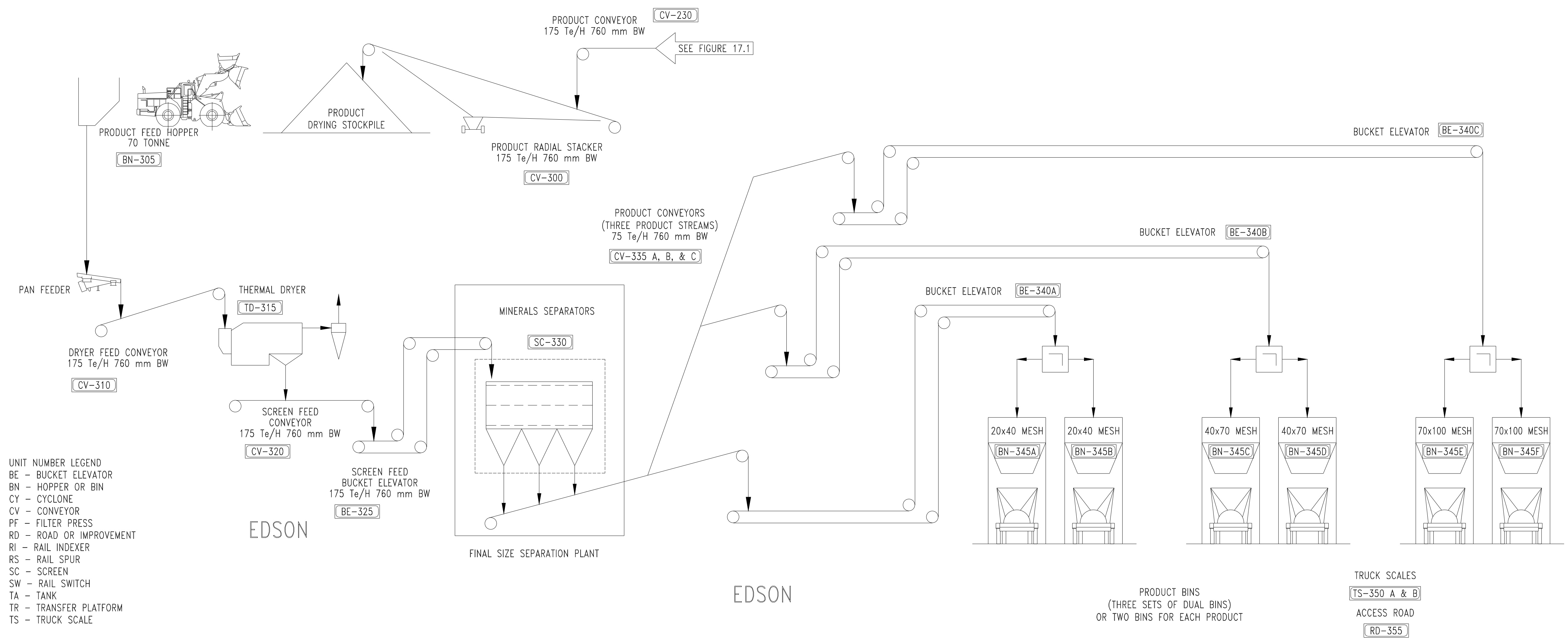
Athabasca MINERALS INC.

Firebag Sand CRB Plan

MATERIALS HANDLING FLOWSHEET

FIGURE 17.1

DRAWN BY: CJH	FILE: Fig 17.1,2 & 3 MH FLOWSHEETS	NORWEST
CHK'D BY: GMG	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 10 24	Disc\Facilities\Drafting	P05015



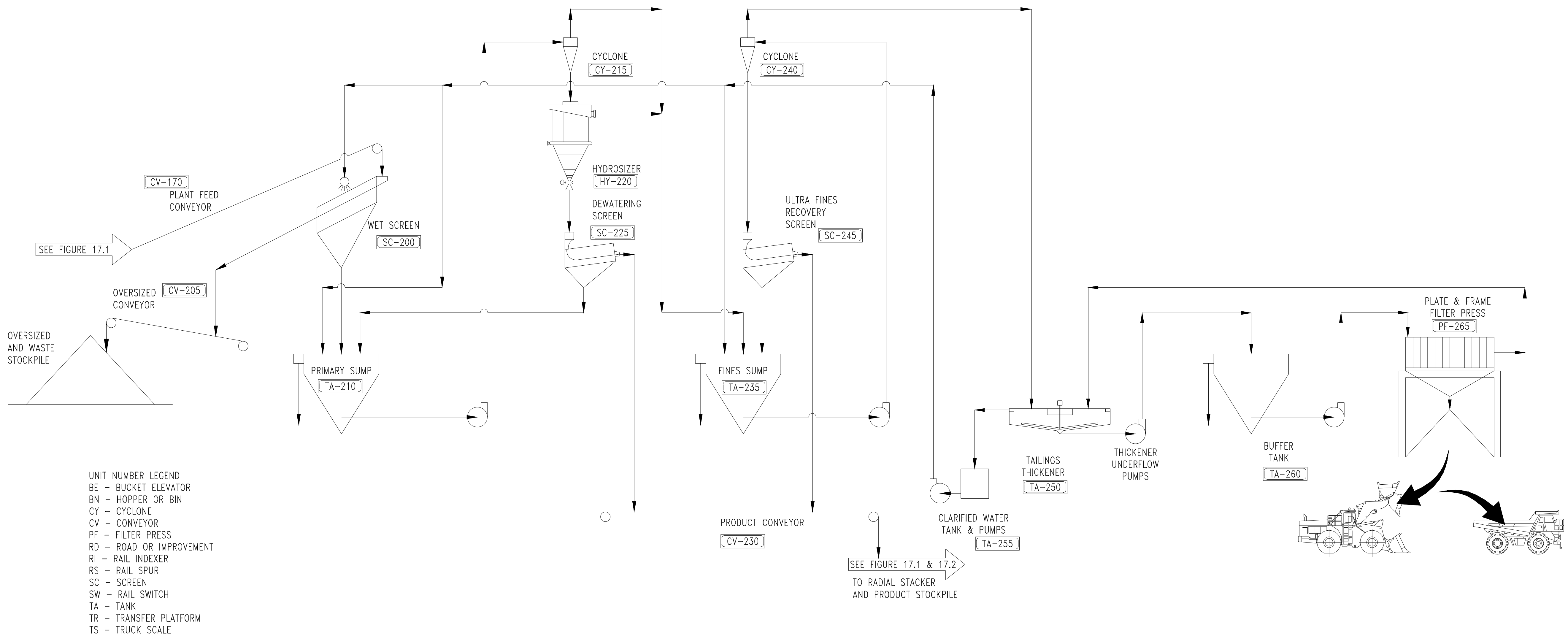
Athabasca MINERALS INC.

Firebag Sand CRB Plan

MATERIALS HANDLING FLOWSHEET - CONTINUATION

FIGURE 17.2

DRAWN BY: CJH	FILE: Fig 17.1,2 & 3 MH FLOWSHEETS	NORWEST
CHK'D BY: GMG	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 10 24	Disc\Facilities\Drafting	P05015



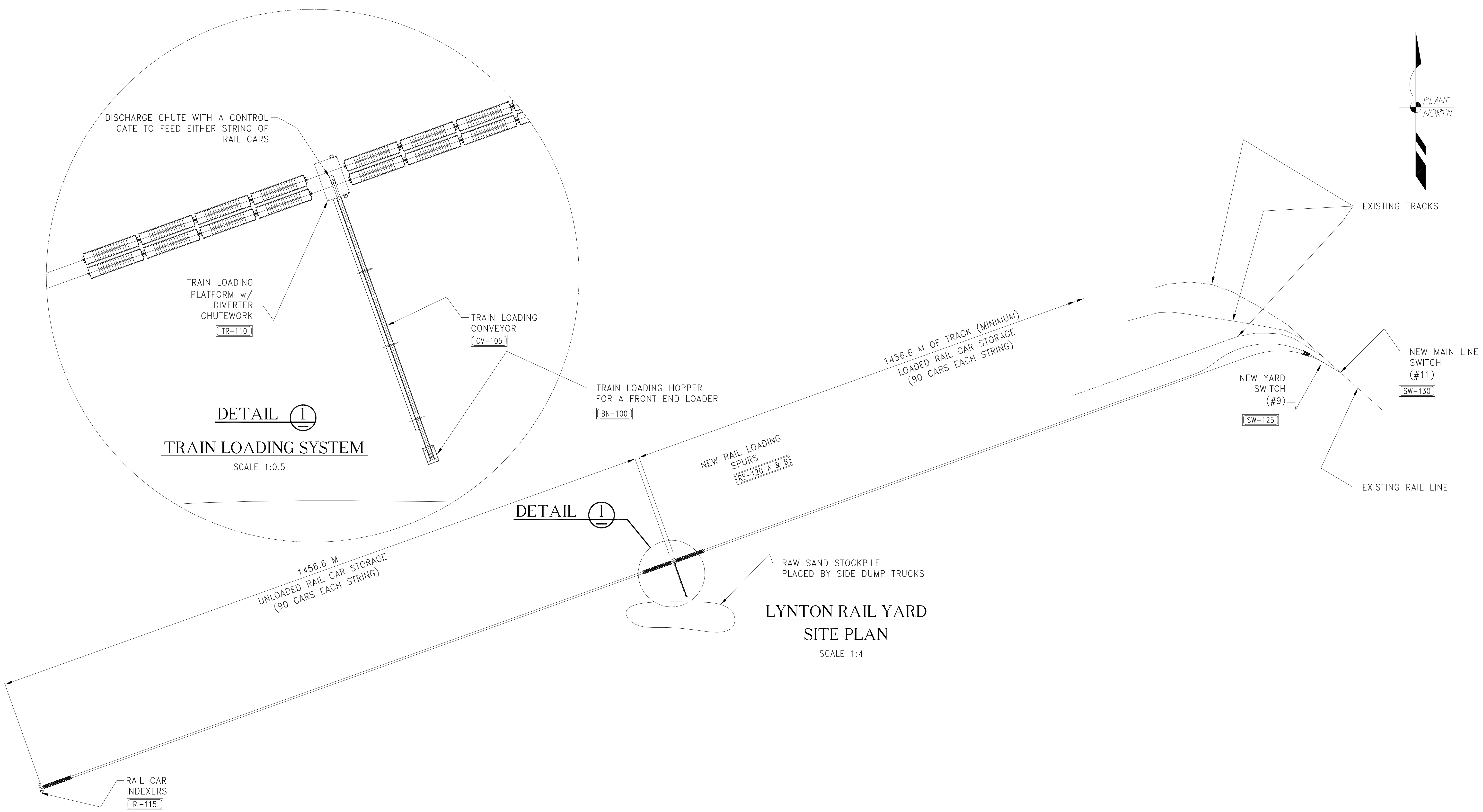
Athabasca MINERALS INC.

Firebag Sand CRB Plan

WET PLANT FLOWSHEET

FIGURE 17.3

DRAWN BY: CJH.	FILE: Fig 17.12 & 3 FLOWSHEETS	NORWEST
CHK'D BY: GMG	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 10 24	Disc\Facilities\Drafting	P05015



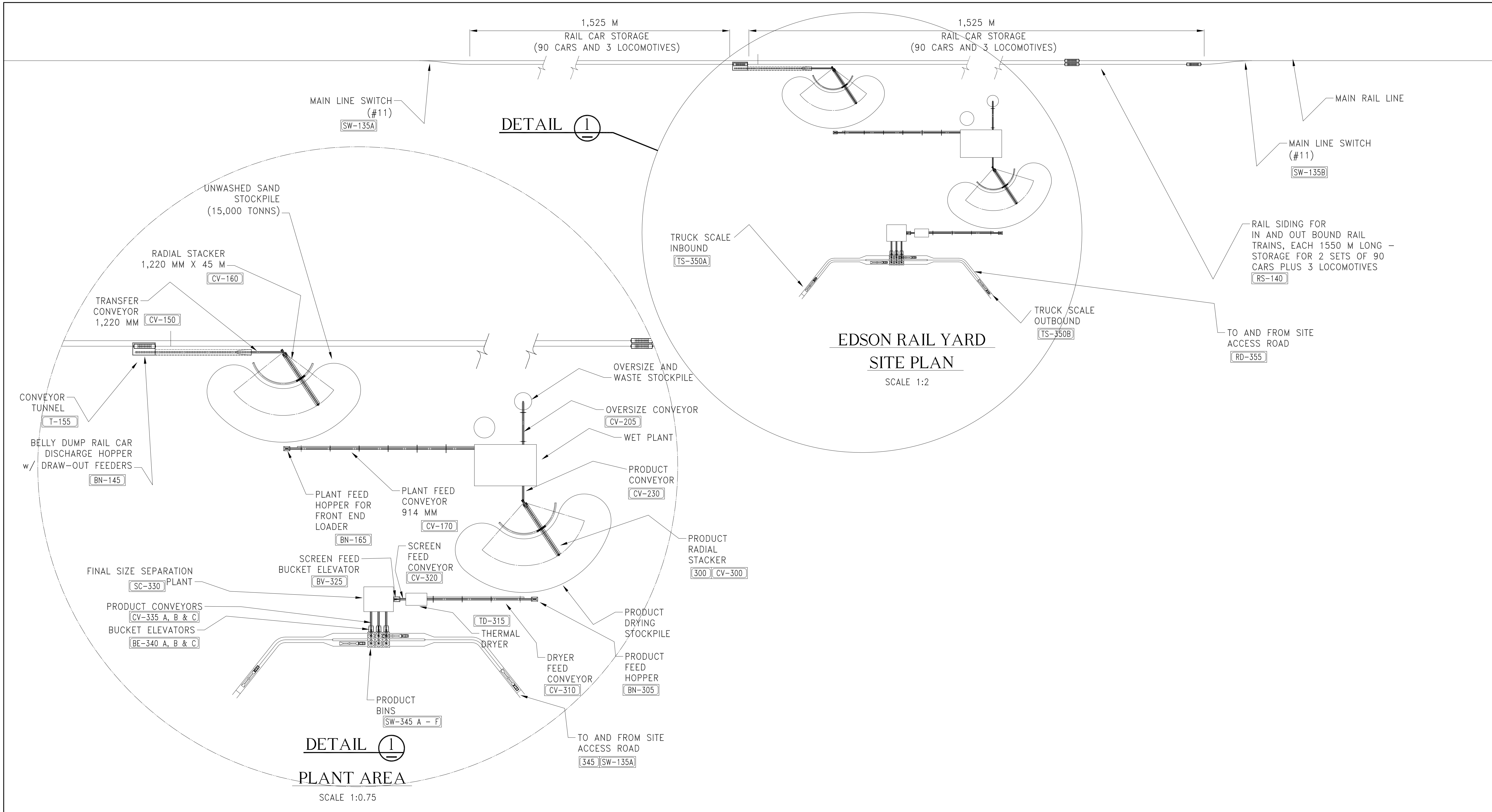
Athabasca MINERALS INC.

Firebag Sand CRB Plan

LYNTON RAIL AREA
SITE PLAN AND LOADOUT DETAIL

FIGURE 17.4

DRAWN BY: CJH.	FILE: Fig 17.4&5 SITE PLANS	NORWEST
CHK'D BY: GMG	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit
DATE: 14 10 27	Disc\Facilities\Drafting	P05015



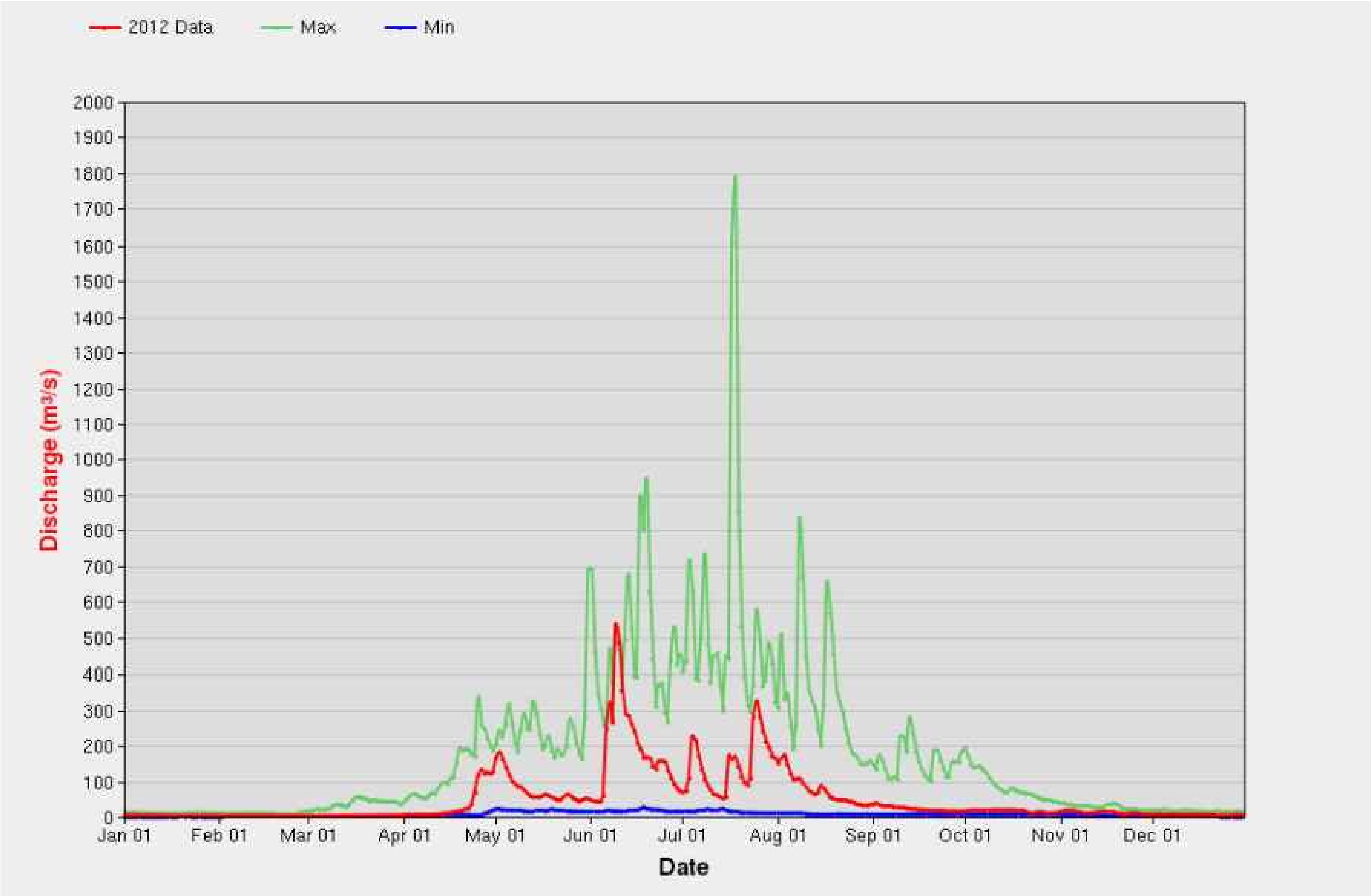
Athabasca MINERALS INC.

Firebag Sand CRB Plan

EDSON PROCESSING AREA
SITE PLAN FOR RAIL UNLOADING, PROCESS PLANT AND TRUCK LOADING FACILITIES

FIGURE 17.5

DRAWN BY: CJH.	FILE: Fig 17-5&6 SITE PLANS	NORWEST
CHK'D BY: GMG	G:\ProjectData\AMI_761\761-1_Firebag Frac S	APEGA Permit P05015
DATE: 14 10 27	Disc\Facilities\Drafting	



NOT TO SCALE

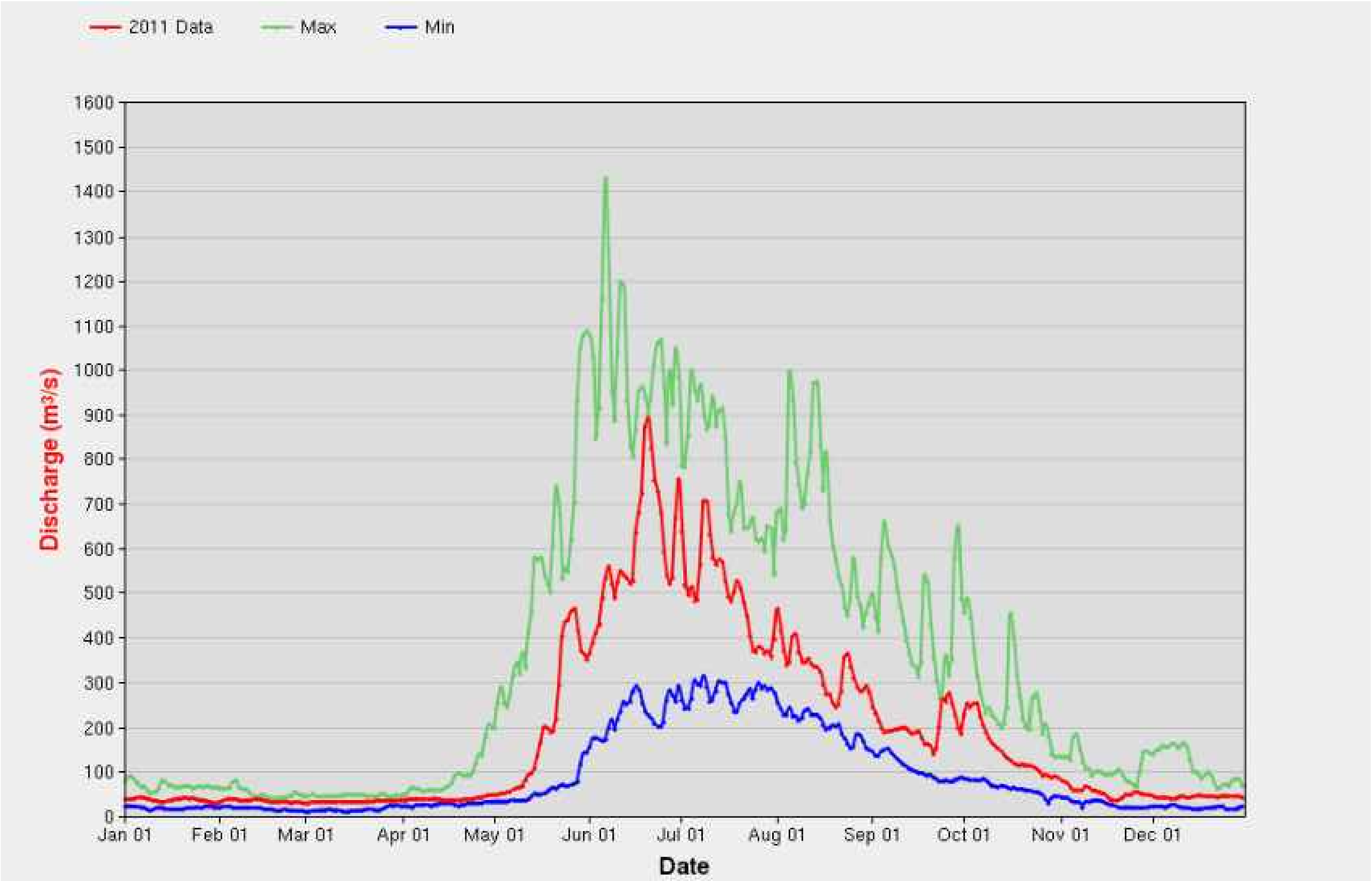
Athabasca MINERALS INC.

Firebag River Sand Pit

McLEOD RIVER DISCHARGE ROSEVAR (20 km DOWNSTREAM OF EDSON)

FIGURE 17-6

DRAWN BY: D.B. CHK'D BY: T.L. DATE: 14 11 28	FILE: Fig 17-6 McLeod River Discharge.dwg G:\ProjectData\AMI_761\761-1_Firebag Frac S Disc\Mining\Drafting	NORWEST APEGA Permit P05015



NOT TO SCALE

Athabasca MINERALS INC.

Firebag River Sand Pit

ATHABASCA RIVER DISCHARGE AT HINTON

FIGURE 17-7

DRAWN BY: D.B.
CHK'D BY: T.L.
DATE: 14 11 28

FILE: Fig 17-7 Athabasca River Discharge...
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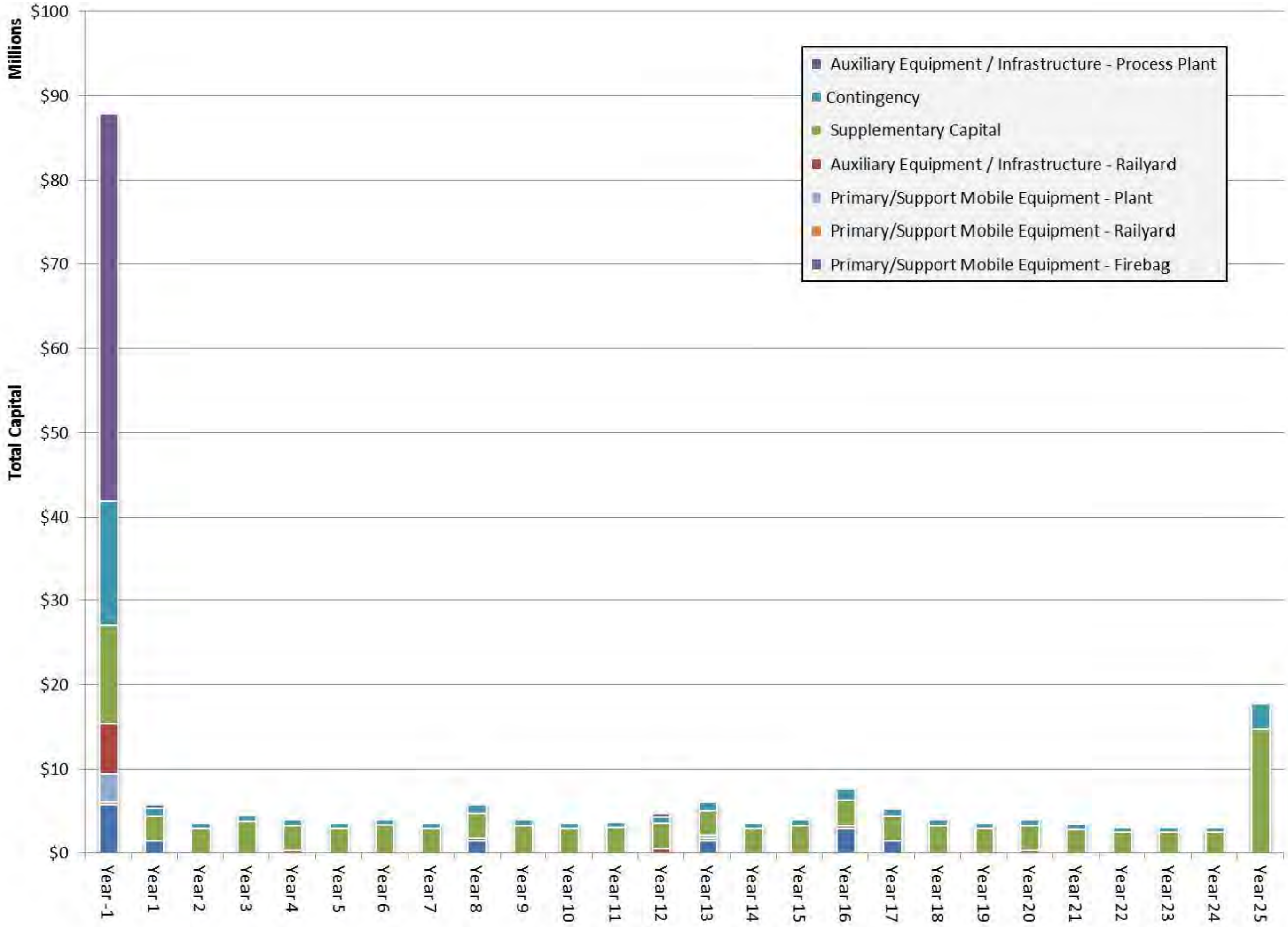
Disc\Mining\Drafting

NORWEST
APEGA Permit P05015



NOT TO SCALE

Athabasca MINERALS INC.

Firebag River Sand Pit

CAPITAL EXPENDITURE SUMMARY

FIGURE 21-1

DRAWN BY: D.B.
CHK'D BY: T.L.
DATE: 14 11 28

FILE: Fig 21-1 Capital Expenditure Summary
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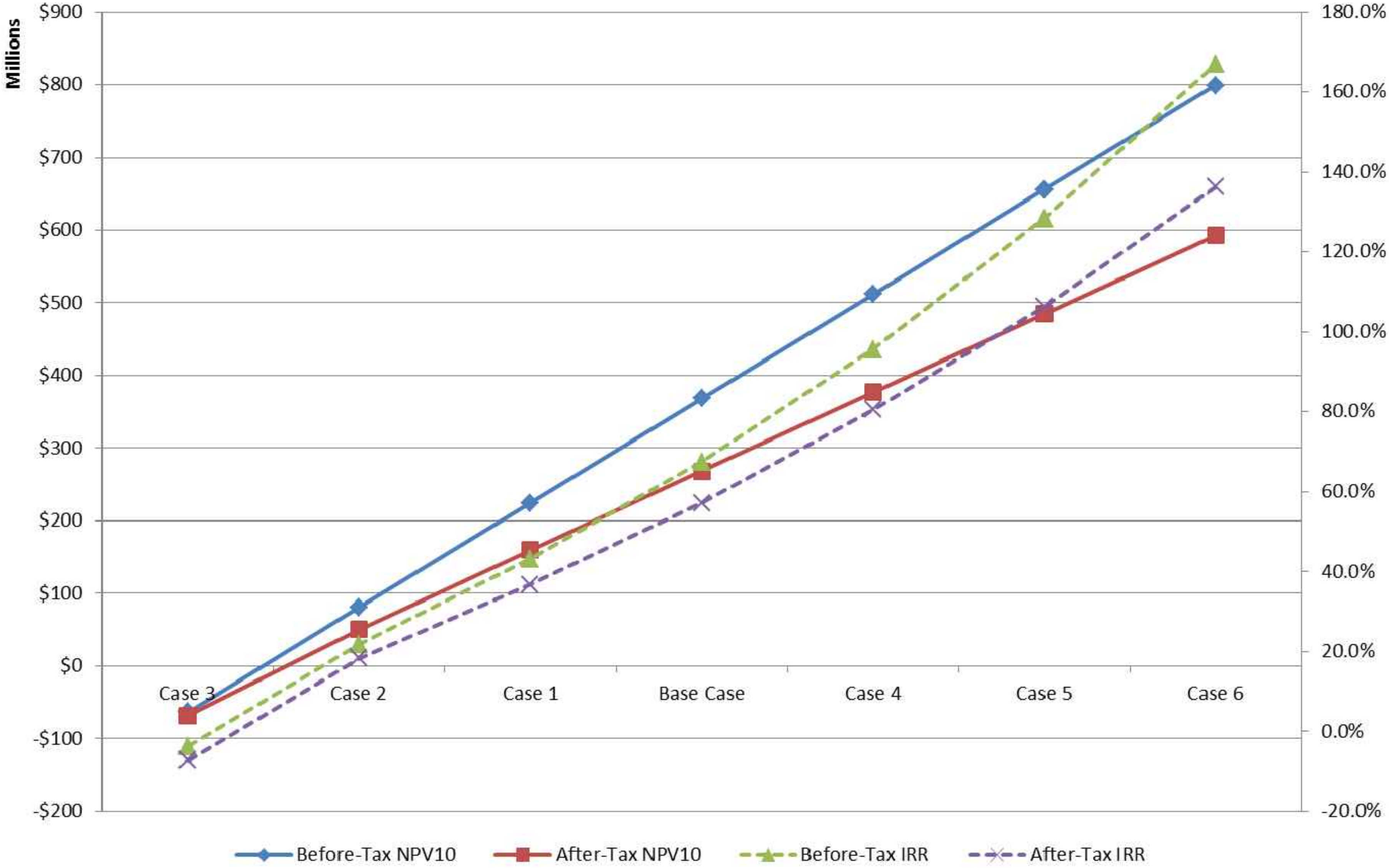


NOT TO SCALE

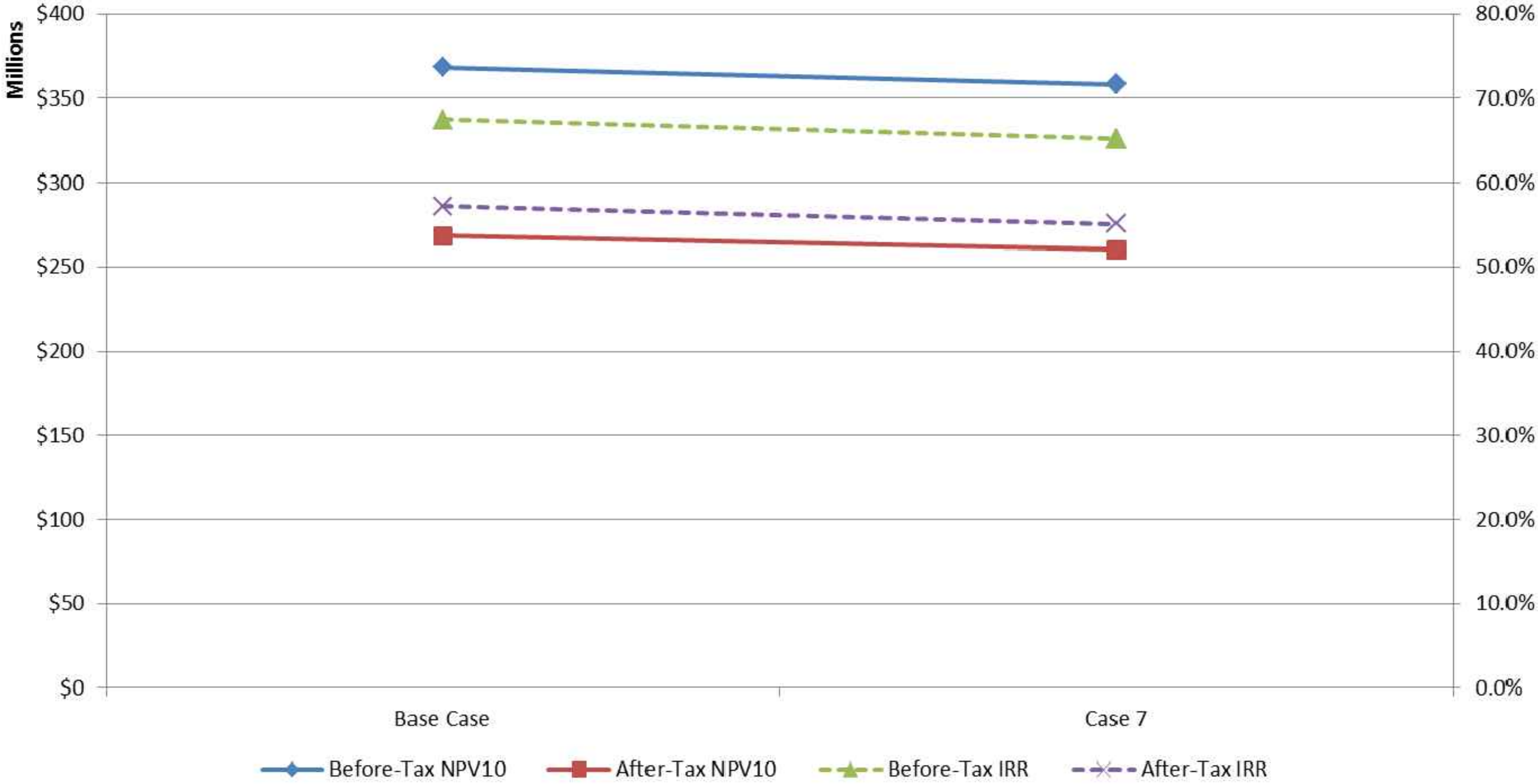
Athabasca MINERALS INC.

Firebag River Sand Pit

SENSITIVITY ANALYSIS: PRODUCT PRICE

FIGURE 22-1

DRAWN BY: D.B. CHK'D BY: T.L. DATE: 14 11 28	FILE: Fig 22-1 Sensitivity Analysis.dwg G:\ProjectData\AMI_761\761-1_Firebag Frac S Disc\Mining\Drafting	NORWEST APEGA Permit P05015



NOT TO SCALE

Athabasca MINERALS INC.

Firebag River Sand Pit

SENSITIVITY ANALYSIS: UNIT TRAINS (LEASE THREE vs. LEASE FOUR)

FIGURE 22-2

DRAWN BY: D.B. CHK'D BY: T.L. DATE: 14 11 28	FILE: Fig 22-2 Sensitivity Analysis.dwg G:\ProjectData\AMI_761\761-1_Firebag Frac S Disc\Mining\Drafting	NORWEST APEGA Permit P05015