Deloitte & Touche

Revised Oxide Fines Management Plan
Anvil Range Mine Site

Prepared for:

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Anvil Range Mine Site

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1 Introduction

The 2002/03 waste characterization program for the Anvil Range site indicated that the majority of the zinc loadings at Monitoring Station X23 originated from the oxide fines and low grade ore stockpiles. As a result, the oxide fines and low grade ore stockpiles were identified as priority remediation areas. This was recognized in the 2004 water licence, Licence Number QZ03-059. Condition 57 of the water licence states:

> *Plan for the Management of Oxide Fines*
>
> *57. A long term plan for the management of oxide fines shall be prepared and submitted to the Board by July 30, 2004 or no later than 90 days prior to the proposed implementation date, whichever comes first.*

To address this requirement, an initial evaluation of oxide fines management options was provided to the Water Board ("Anvil Range Mine Site Oxide Fines Management Plan", SRK Consulting Inc., July 2004).

For the Faro mine area, the initial evaluation narrowed the available options down to two, namely "Consolidate and Cover" and "Amend and Place below Water in Faro Pit". To select the preferred option, further field investigation and evaluations were recommended. This report presents results of the recommended work.

The 2004 report also discussed options for dealing with oxide fines in the Vangorda mine area. However, backfilling of the waste rock into the pit is being considered as a final closure option for the Vangorda mine area. If that option is selected, the oxide fines will be backfilled along with the waste rock, preferably to the base of the pit below the long-term water table. Furthermore, the oxide fines at the Vangorda site are not causing the same levels of contaminant release as those at the Faro site. These factors suggest that further evaluation of oxide fines management options for the Vangorda area should await decisions about the overall closure plan. Therefore, the Vangorda oxide fines are not discussed further herein.

2 Supplemental Information

2.1 Introduction

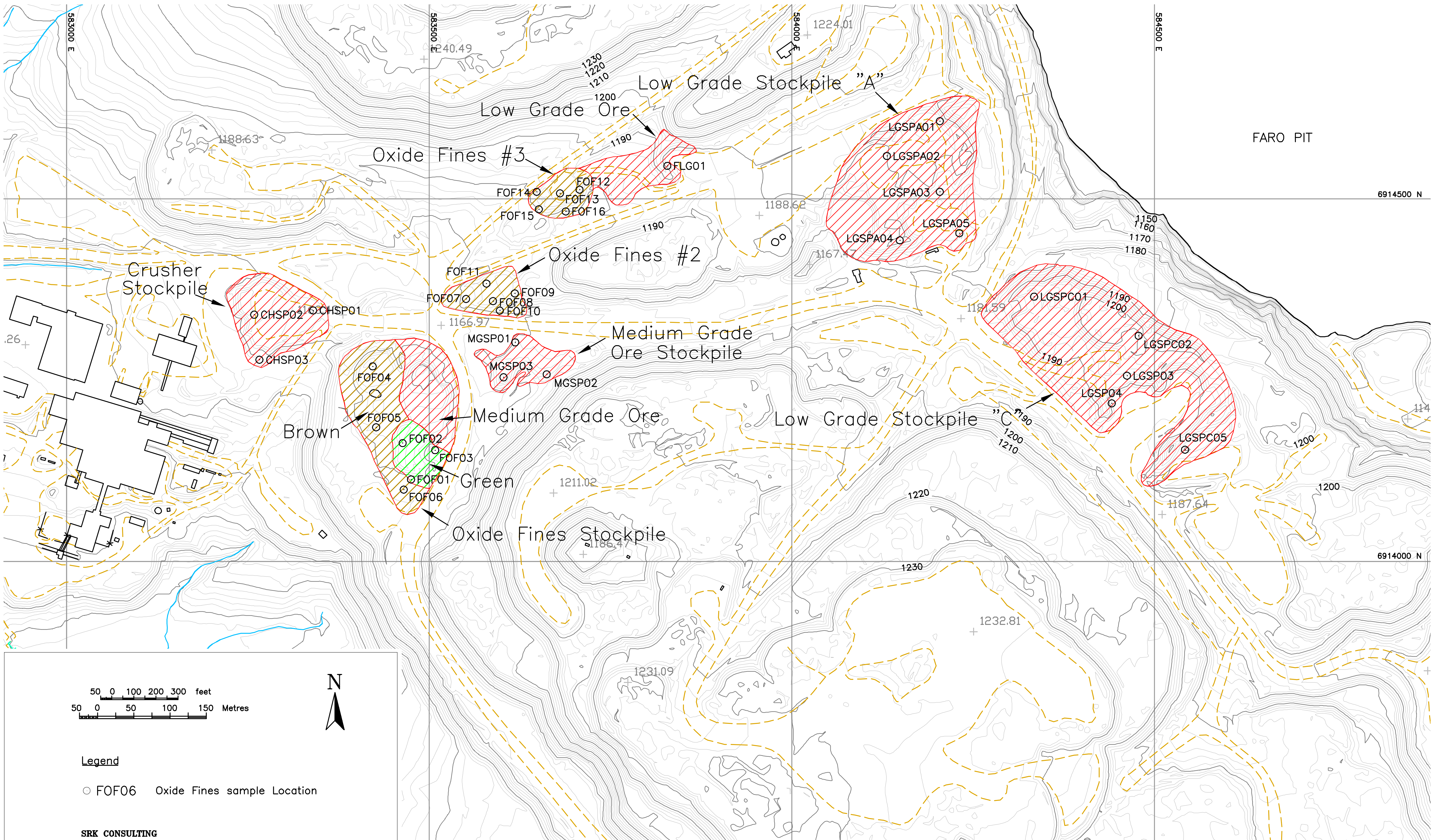
The field investigation of the oxide fines (and low grade ore) commenced in June 2004. The oxide fines and low grade ore stockpile areas identified during the field investigation are shown in Figure 2.1. The figure also shows sample locations. The results from the field investigation, comprising field paste parameters and lime demand testing, were reported in the 2004 report and are not repeated herein. However, the laboratory testing of selected samples was not complete at the time the 2004 report was issued. The following sections present and briefly discuss supplemental information from the laboratory investigation.

2.2 Acid Base Account

The acid base account results, provided in Table 2.1, confirm the net acid generating properties of the oxide fines and the low grade ore. In general the low grade ore has a higher potential for acid generation than the oxide fines, as indicated by the total sulphur. Furthermore, the oxide fines are already more oxidized than the low grade ore, as indicated by the sulphate content. The elevated sulphate and low paste pH values indicate that there is a significant potential for solute release from the oxide fines and the low gade ore.

2.3 Metals Content

Results of metals analyses of the oxide fines and low grade ore are provided in Appendix A and summarised in Table 2.2. In general, the oxide fines have a lower zinc content than the medium grade and low grade ore. However, there is significant variability in zinc content of samples from the Low Grade Stockpiles A and C. As expected, the Medium Grade Stockpile has a higher zinc content. The lead content of all samples were above 1 %.



50 0 100 200 300 feet

50 0 50 100 150 Metres

N

Legend

○ FOF06 Oxide Fines sample Location

SRK CONSULTING

Faro Mine, Yukon

Map Scale:1:5,000
Contour Interval: 2m
Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

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OXIDE FINES MANAGEMENT PLAN

Oxide Fines
Field Program Sample Locations

PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.044	Feb. 2005	JTC	2.1

File Ref: 2003 FARO SITE PLAN-Oxide Fines.dwg

Table 2.1 Acid Base Account

Sample		Paste pH	S(T) %	S(SO4) %	AP	NP	Net NP	NP/AP	TIC %	CO3 NP
FLG	01	2.3	35.80	2.25	1048.4	-21.3	-1069.8	<0.1	<0.01	0.8
LGSP C	01	-	13.10	0.58	391.3	-	-	-	-	-
LGSP C	02	2.4	15.30	1.48	431.9	-23.1	-454.9	<0.1	<0.01	< 0.8
LGSP C	03	-	44.50	0.68	1369.4	-	-	-	-	-
LGSP C	04	3.3	29.00	0.54	889.4	-6.1	-895.5	<0.1	<0.01	< 0.8
LGSP C	05	-	9.32	0.79	266.6	-	-	-	-	-
LGSP A	01	-	33.70	1.44	1008.1	-	-	-	-	-
LGSP A	02	2.3	32.90	1.06	995.0	-14.8	-1009.8	<0.1	0.07	5.8
LGSP A	03	-	29.80	1.50	884.4	-	-	-	-	-
LGSP A	04	2.6	32.00	0.57	982.2	-7.8	-990.0	<0.1	<0.01	< 0.8
LGSP A	05	-	11.40	1.39	312.8	-	-	-	-	-
CHSP	01	6.6	5.45	0.26	162.2	21.0	-141.2	<0.1	0.74	61.7
CHSP	02	-	8.21	0.19	250.6	-	-	-	-	-
CHSP	03	7.0	5.38	0.23	160.9	36.4	-124.5	0.2	0.89	74.2
FOF -	1	-	20.60	2.62	561.9	-	-	-	-	-
FOF -	2	2.4	22.00	2.56	607.5	2.2	-605.3	<0.1	<0.01	< 0.8
FOF -	3	-	20.60	2.18	575.6	-	-	-	-	-
FOF -	4	2.0	13.00	2.38	331.9	-37.8	-369.6	<0.1	<0.01	< 0.8
FOF -	5	-	17.40	2.35	470.3	-	-	-	-	-
FOF -	6	2.2	15.80	2.19	425.3	-25.1	-450.4	<0.1	<0.01	< 0.8
FOF -	7	-	8.28	2.35	185.3	-	-	-	-	-
FOF -	8	2.2	12.10	2.51	299.7	-25.1	-324.8	<0.1	<0.01	< 0.8
FOF -	9	-	18.00	2.27	491.6	-	-	-	-	-
FOF -	10	2.2	11.80	2.49	290.9	-20.6	-311.6	<0.1	<0.01	< 0.8
FOF -	11	-	13.50	2.27	350.9	-	-	-	-	-
FOF -	12	2.5	5.82	2.27	110.9	-15.3	-126.2	<0.1	<0.01	< 0.8
FOF -	13	-	13.00	1.92	346.3	-	-	-	-	-
FOF -	14	2.1	13.00	2.24	336.3	-19.9	-356.1	<0.1	<0.01	< 0.8
FOF -	15	-	14.80	2.33	389.7	-	-	-	-	-
FOF -	16	2.1	13.10	2.64	326.9	-22.0	-348.9	<0.1	<0.01	, 0.8
MGSP -	1	-	8.33	0.77	236.3	-	-	-	-	-
MGSP -	2	6.0	16.00	0.61	480.9	22.9	-458.1	<0.1	0.53	44.2
MGSP -	3	-	11.20	0.34	339.4	-	-	-	-	-

Note: AP, NP, NNP and CO_3NP in units of $CaCO_3$ eq/tonne

Table 2.2 Solids Analysis

Sample	As ppm	Cd ppm	Co ppm	Cu ppm	Fe %	Mn ppm	Mo ppm	Ni ppm	Pb ppm	Sb ppm	Zn ppm
FLG - 01	347	<1	159	1081	>15.00	36	<2	8	>10000	51	1575
LGSP C - 01	4063	<1	30	1019	13.71	154	9	20	>10000	86	>10000
LGSP C - 02	391	<1	102	922	>15.00	29	6	11	>10000	34	1276
LGSP C - 03	243	<1	73	671	>15.00	36	<2	9	>10000	27	5563
LGSP C - 04	525	<1	211	2666	>15.00	435	<2	15	>10000	31	>10000
LGSP C - 05	450	<1	94	1331	12.96	261	13	21	>10000	41	>10000
LGSP A - 01	501	<1	114	885	>15.00	78	<2	21	>10000	63	3191
LGSP A - 02	529	<1	125	1007	>15.00	35	<2	7	>10000	36	3440
LGSP A - 03	673	<1	152	1912	>15.00	548	<2	24	>10000	38	8218
LGSP A - 04	615	<1	250	1833	>15.00	252	<2	16	>10000	32	>10000
LGSP A - 05	253	<1	46	877	13.92	150	3	22	>10000	27	1911
CHSP - 01	1697	<1	40	480	7.75	702	8	140	>10000	56	>10000
CHSP - 02	1405	<1	34	591	9.83	941	9	64	>10000	72	>10000
CHSP - 03	912	<1	33	328	7.14	996	10	69	>10000	37	>10000
FOF - 1	1307	<1	70	9859	>15.00	152	4	10	>10000	126	3465
FOF - 2	1323	<1	69	9709	>15.00	375	3	10	>10000	96	5284
FOF - 3	1413	<1	68	5625	>15.00	405	3	14	>10000	85	7421
FOF - 4	239	<1	58	1503	>15.00	79	4	10	>10000	51	6368
FOF - 5	228	<1	80	1022	>15.00	76	3	13	>10000	39	4829
FOF - 6	233	<1	97	1229	>15.00	124	3	14	>10000	45	8539
FOF - 7	133	<1	32	650	11.69	200	<2	26	>10000	18	4135
FOF - 8	250	<1	48	1064	13.89	56	5	13	>10000	49	2918
FOF - 9	386	<1	75	1266	>15.00	81	3	14	>10000	48	4435
FOF - 10	295	<1	41	1131	13.46	68	6	8	>10000	52	2899
FOF - 11	306	<1	53	1296	14.67	66	6	10	>10000	47	3119
FOF - 12	208	<1	23	565	11.03	137	<2	19	>10000	30	1780
FOF - 13	253	<1	71	923	13.26	320	5	15	>10000	49	7113
FOF - 14	217	<1	48	1152	13.39	58	5	9	>10000	44	2706
FOF - 15	326	<1	54	1087	>15.00	77	6	12	>10000	60	3826
FOF - 16	275	<1	44	1229	13.79	62	6	9	>10000	54	2740
MGSP - 1	1532	<1	40	1924	9.58	397	11	29	>10000	72	>10000
MGSP - 2	1121	5	39	3200	13.22	2594	7	62	>10000	110	>10000
MGSP - 3	3900	<1	46	4077	8.64	95	17	23	>10000	194	>10000

2.4 Leach Extraction Tests

Leach extraction tests were completed to evaluate solute release from the oxide fines and the low grade ore, and to assess the effectiveness of alkalinity amendment to limit metals release. Composite samples were prepared to represent the Low Grade Ore Stockpile A and the oxide fines. The make-up of the composite samples is shown in Table 2.3. The leach extraction tests were completed according to a standard 24 hr protocol, using distilled water at solid to liquid ratio of 1:3.

Table 2.3 Leach Extraction Test Composite Sample Make-Up

Composite FOF1		Composite LGS1	
Sample	Lime Demand (gCaO/kg)	Sample	Lime Demand (gCaO/kg)
FOF01	13.0	LGSPA01	9.6
FOF02	17.4	LGSPA02	5.1
FOF03	15.1	LGSPA03	9.2
FOF04	19.8	LGSPA04	3.8
FOF05	24.9	LGSPA05	8.8
FOF06	17.6		
Average	18.0	Average	7.3

The results from the leach extraction are summarised in Table 2.4. Complete results are provided in Appendix B. The leach extraction tests completed on the 'As Is' samples indicate soluble zinc concentrations in excess of 660 mg/L for the oxide fines sample, and about 470 mg/L for the low grade ore samples. The extractable zinc equates to about 1.9 kg per tonne in the oxide fines, and about 1.4 kg/tonne of rock in the low grade ore. Other metals released at elevated concentrations include iron, aluminium, copper and manganese.

Table 2.4 Leach Extraction Test Results – Water Quality

Parameter			As Is		With Lime		With Limestone	
Sample ID			FOF1	LGS1	FOF1	LGS1	FOF1	LGS1
pH			2.21	2.18	8.31	4.54	7.37	6.88
Alkalinity			0.0	0.0	15.0	0.0	49	25
Acidity		(pH 4.5)	3125	1140	0.0	0.0	0.0	0.0
Acidity		(pH 8.3)	5945	2630	0.0	495	18	48
Sulphate		(mg/L)	6667	3327	1829	2058	1609	1956
Dissolved Metals (mg/L)								
Aluminum	Al	mg/L	168	44.5	0.40	<0.40	<0.20	<0.20
Arsenic	As	mg/L	2.9	0.73	<0.20	<0.40	<0.40	<0.20
Cadmium	Cd	mg/L	0.981	0.660	<0.010	0.477	0.030	0.085
Cobalt	Co	mg/L	1.17	0.550	<0.010	0.436	0.061	0.123
Copper	Cu	mg/L	45.4	27.5	0.012	0.114	<0.010	0.013
Iron	Fe	mg/L	1970	614	<0.030	20.1	0.054	<0.030
Lead	Pb	mg/L	<0.25	2.15	<0.050	2.35	<0.050	<0.050
Manganese	Mn	mg/L	31.3	20.9	<0.0050	19.7	7.23	11.6
Molybdenum	Mo	mg/L	<0.15	<0.090	<0.030	<0.060	<0.030	<0.030
Nickel	Ni	mg/L	0.39	0.63	<0.050	0.41	<0.050	0.071
Zinc	Zn	mg/L	664	468	0.010	297	5.20	24.8

Note: Alkalinity and acidity reported in units of mg $CaCO_3$/L

The alkalinity amendment tests were completed using both lime (as $Ca(OH)_2$) and limestone ($CaCO_3$), added at a rate equal to the average alkalinity demand indicated in Table 2.3. A pH of 8.3 was achieved for the oxide fines sample amended with lime, resulting in very low metal concentrations in the supernatant. In contrast the results for the low grade ore sample amended with lime indicated incomplete neutralization, and the zinc concentration remained elevated at about 300 mg/L. The limestone amended samples achieved a circumneutral pH, but did not attain a high enough pH to precipitate all of the soluble zinc.

The estimated lime and limestone utilizations are shown in Table 2.5. The results indicate comparatively low utilizations for both lime and limestone. In other words, much of the added alkalinity did not participate in the neutralization reactions.

Table 2.5 Leach Extraction Test Results – Alkalinity Utilization

Sample	pH		Alkalinity Added	Acidity neutralized	Utilization
	Initial	Final	gCaO eq/kg	gCaO eq/kg	(%)
With Lime					
FOF1	2.21	8.31	18	9.99	55.5
LGS1	2.18	4.54	7.3	3.59	48.9
With Limestone					
FOF1	2.21	7.37	42.84	17.8	41.5
LGS1	2.18	6.88	17.48	7.74	44.3

2.5 Column Test Results

Column tests were completed to assess the alkalinity amendment under saturated anoxic conditions. The column tests were set up to allow recycling of the porewater while excluding atmospheric oxygen. Porewater samples were obtained and analysed after 15 and 21 days of recycling. Complete results are provided in Appendix C and are summarised in Table 2.6.

The results indicate that only the lime amended oxide fines sample achieved an acceptable pH and low zinc concentrations. The remainder of the tests, although amended at the same rate as the leach extraction tests, did not achieve similar levels of neutralization or reduction in metal concentrations. This suggests that the lime and limestone amendments were 'blinded' in the remaining tests. It is apparent that the lime and limestone utilizations were significantly lower than those indicated by the leach extraction tests.

Table 2.6 Summary of Column Test Results

Sample:	UNITS	FOF 1 - Lime		FOF 1 - Limestone		LGS1 - Lime		LGS1- Limestone	
Time	**days**	**15**	**21**	**15**	**21**	**15**	**21**	**15**	**21**
Field pH		9.17	8.80	5.34	5.40	3.60	3.37	5.50	5.18
Lab pH		7.07	7.30	4.47	6.59	3.58	3.60	6.03	4.92
ALKALINITY		20.0	11.5	0.0	8.5	0.0	0.0	7.5	2.5
ACIDITY(pH 4.5)		0.0	0.0	0.5	0.0	31.0	25.0	0.0	0.0
ACIDITY(pH 8.3)		11.0	7.5	988.0	386.5	1479.5	900.0	669.5	360.5
SULPHATE	(mg/L)	1525	1450	2565	1840	2815	2050	2235	1925
Total Metals (mg/L)									
Aluminum	(mg/L)	<0.20	0.5	1.13	<0.40	4.41	2.80	<0.40	<0.20
Arsenic	(mg/L)	<0.20	<0.20	<0.60	<0.40	<0.80	<1.0	0.49	<0.30
Cadmium	(mg/L)	<0.010	<0.010	0.041	0.075	0.652	0.587	0.148	0.194
Chromium	(mg/L)	<0.010	<0.010	<0.030	<0.020	<0.040	<0.050	<0.020	<0.010
Cobalt	(mg/L)	<0.010	<0.010	1.69	0.92	1.34	0.89	0.925	0.490
Copper	(mg/L)	0.013	0.033	0.654	0.029	1.22	1.27	<0.020	0.012
Iron	(mg/L)	0.060	2.120	216	014	120	038	73.4	18.9
Lead	(mg/L)	<0.050	0.698	5.61	0.53	1.91	2.10	2.23	2.25
Manganese	(mg/L)	0.0112	0.1160	54.8	33.0	70.5	46.6	68.5	37.4
Nickel	(mg/L)	<0.050	<0.050	0.60	0.28	1.13	0.85	0.70	0.40
Zinc	(mg/L)	0.0247	0.3170	445	241	782	590	361	201

Notes: Alkalinity and acidity reported in units of mg $CaCO_3$/L

2.6 Summary

Field mapping and sampling undertaken in support of this assessment indicated the surface distribution of the oxide fines and low grade ore at the Faro site. The field investigation further showed significant variability in lime demand among the different material types, with the highest lime demand measured for the oxide fines. The rock contained in the crusher stockpile was shown to be the least oxidized. Because of these differences there would be significant savings in lime or limestone requirements if a variable dosing system is applied.

The results from the laboratory program verified that all of the rock contained in the oxide fines and low grade ore stockpile areas are significantly net acid generating. The results further indicated that the zinc content of oxide fines generally is lower than that of the low grade ore. This is likely due to the rapid oxidation and leaching of the oxide fines. The results further indicated that there are likely areas within Low Grade Ore Stockpile Area A that contain variable levels of mineralization. Nonetheless, these materials are very acid generating and should be treated as low grade ore.

Leach extraction tests showed that solute concentrations can be controlled effectively if appropriate alkalinity amendment rates are applied. The results further indicated lime and limestone utilizations ranging from 45 to 55 percent. Under anoxic conditions, as indicated by the column tests, alkalinity amendments at similar rates proved to be less effective at limiting solute release. However, the results do indicate that if a high pH (in excess of 9) can be achieved, solute concentrations can be limited to low levels.

3 Cover in Place / Consolidate and Cover

3.1 Description

The primary purpose of the oxide fines management strategy will be to affect an immediate and sustainable reduction in contaminant loadings. One way to achieve that would be to construct a low infiltration cover, either on the oxide fines and low grade ore in their current locations, or after consolidating part or all of the oxide fines and low grade ore to a central location. A number of steps were completed to assess these options. These are discussed in the following sections.

3.2 Cover Design Considerations

The cover design adopted for both the ‘cover in place’ option and the ‘consolidate and cover’ option comprises a 0.5 m compacted till layer overlain by a 1.5 m nominally compacted till layer. Cover design and assessment is the topic of another investigation and is not addressed in detail herein. However, motivation for the selection of this cover configuration is provided in Appendix D. The cover is expected to reduce infiltration to less than 5% of mean annual precipitation.

To facilitate compaction of the cover material, all slopes would the re-graded to a 3:1 (H:V) gradient in preparation for cover placement. The recommended maximum down-slope run is 50 m. Conservatively it was assumed that runoff length would be restricted to a maximum of 15 m to minimise soil loss.

3.3 Relocation Requirements

Revised estimates of the total volumes of material contained in the oxide fines and low grade ore stockpiles are shown in

Table 3.1. The volume estimates are shown to the base of the current dumps, distinguishable visually and to pre-mining topography. Without drilling the stockpile areas, it is impossible to verify the depth to which the oxide fines and low grade ore extends. Nonetheless, the estimates provide a reasonable range of the volumes that would require relocation.

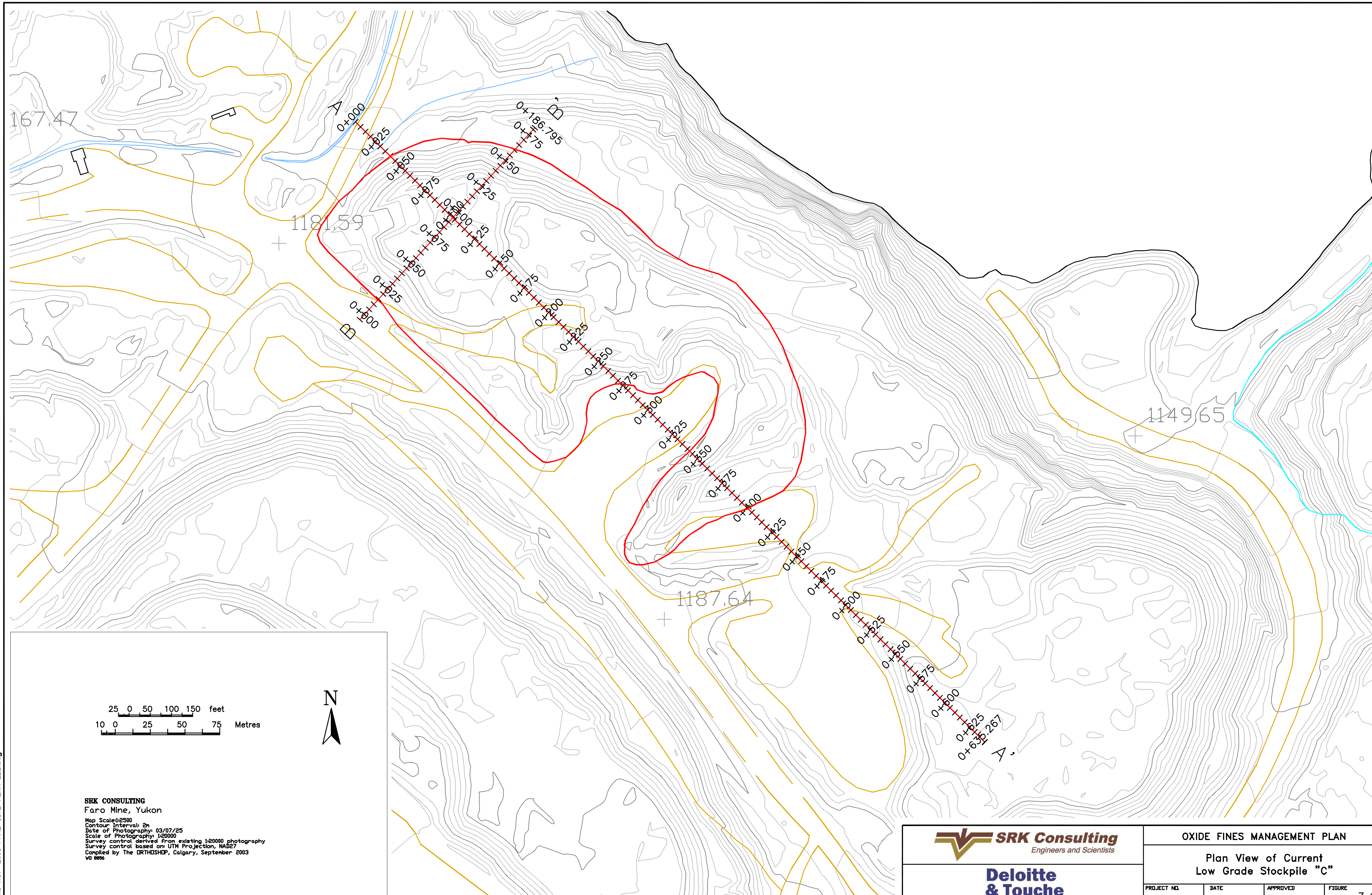
Table 3.1 Summary of Estimated Plan Areas and Volumes of Oxide Fines and Low Grade Ore Stockpiles

Stockpile	Area (m^2)	Volume (m^3) To current base of pile	Volume (m^3) To pre-mining topography
Oxide Fines- Green	5,000	20,000	-
Oxide Fines- Brown	14,000	39,000	-
Oxide Fines- Medium Grade	9,000	50,000	-
Crusher Stockpile	12,000	42,000	95,000
Medium Grade Stockpile	6,000	10,000	136,000
Oxide Fines #2	5,000	11,000	66,000
Oxide Fines #3	5,000	-	38,000
Low Grade Ore	7,000	-	45,000
Low Grade Stockpile A	36,000	71,000	555,000
Low Grade Stockpile C	51,000	333,000	723,000
Total	**150,000**	**576,000**	**1,658,000**

The proposed target relocation area, Low Grade Stockpile C, is shown in Figure 3.1. The volume that may need to be accommodated within the Stockpile C Area is estimated to be between about 326,000 m^3 and 1,000,000 m^3 (excluding the Low Grade Stockpile C).

To estimate the volume of fill that could be accommodated within the Stockpile C area, it was assumed that the no fill would be placed beyond the current footprint of the stockpile, with the exception of the plateau to the south-east of the main area. Longitudinal and cross sections were developed (as shown in Figure 3.2 and Figure 3.3) to assess re-sloping requirements and to estimate the volume available for oxide fines and low grade ore placement. It was estimated that about 28,000 m^3 material would need to be cut from the existing side-slopes to achieve a slope of 3:1 (H:V). Allowing for the resloping, approximately 424,000 m^3 of fill could be placed within the confines of the Stockpile C area. If the final elevation is raised by about 1.5 m above the current highest elevation of the stockpile, about 500,000 m^3 of fill could be placed.

All of the oxide fines and low grade ore could be accommodated in the Stockpile C area should the lower end of the volume estimate apply. However, in the event that the upper end of the range applies, the Low Grade Stockpile A could not be accommodated within this area. That stockpile would then need to be covered in place.



File Ref: 2003 FARO SITE PLAN-LDD.dwg

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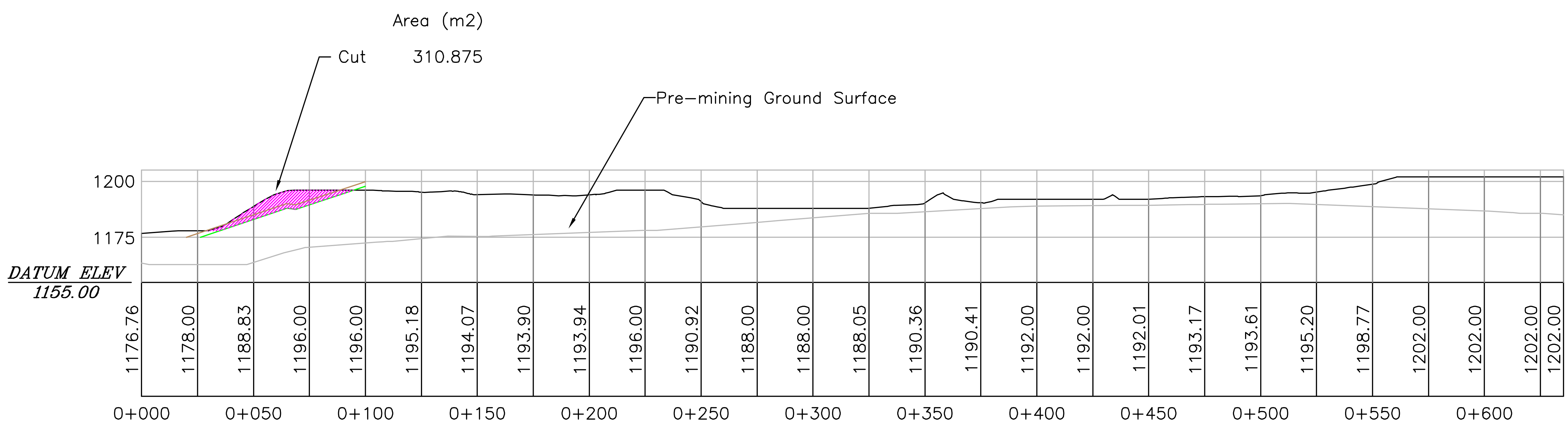
OXIDE FINES MANAGEMENT PLAN

Plan View of Current Low Grade Stockpile "C"

PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.044	Feb. 2005	JTC	3.1

Low Grade Stockpile Section A–A'



Location of Soil Cover

Location of Regraded 3H:1V Slope

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OXIDE FINES MANAGEMENT PLAN

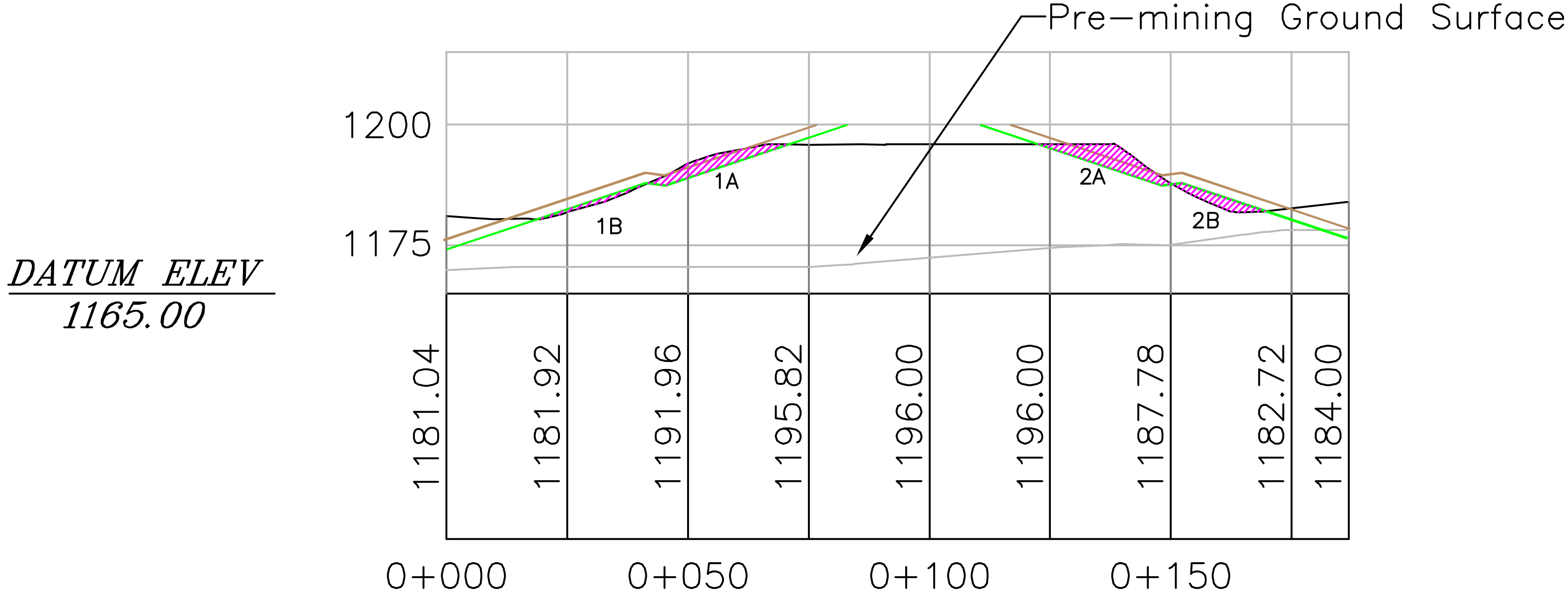
Longitudinal Section A–A' of Low Grade Stockpile "C"

PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.044	Feb. 2005	JTC	3.2

File Ref: 2003 FARD SITE PLAN–LDD.dwg

Low Grade Stockpile Section B–B'

	Area (m2)		Area (m2)
Cut 1A	59.005	2A	77.601
Fill 1B	12.324	2B	31.846



Location of Soil Cover

Location of Regraded 3H:1V Slope

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OXIDE FINES MANAGEMENT PLAN

Cross section B–B of Low Grade Stockpile "C"

PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.044	Feb. 2005	JTC	3.3

File Ref: 2003 FARO SITE PLAN-LDD

3.4 Effects on Contaminant Loadings

The dump water quality modelling completed in 2004 provided estimates of contaminant loadings from each of the oxide fines and low grade ore stockpiles. The estimated current average annual loadings are summarised in Table 3.2. Estimates of the contaminant loadings after covering in place, and after consolidating and covering in the Low Grade Ore Stockpile C area, have also been prepared and are included in the table.

Table 3.2 Summary of Estimated Contaminant Loadings for Cover in Place and Consolidate and Cover Options

Description	Acidity	SO4	Cu	Fe	Mn	Zn
Estimated Current Average Loadings (kg per year)						
Medium Grade Stockpile	71,391	90,612	772	8,604	909	42,621
Crusher Stockpile	59,688	70,569	380	11,438	1,601	17,571
Oxide Fines Stockpile	115,913	132,951	699	25,254	3,503	25,937
Low Grade Stockpile A	76,451	90,387	487	14,650	2,051	22,505
Low Grade Stockpile C	89,953	106,350	573	17,237	2,413	26,480
Total	**413,397**	**490,869**	**2,911**	**77,182**	**10,477**	**135,115**
Estimated Cover in Place Loadings (kg per year)						
Medium Grade Stockpile	7,932	10,068	86	956	101	4,736
Crusher Stockpile	6,632	7,841	42	1,271	178	1,952
Oxide Fines Stockpile	12,879	14,772	78	2,806	389	2,882
Low Grade Stockpile A	8,495	10,043	54	1,628	228	2,501
Low Grade Stockpile C	9,995	11,817	64	1,915	268	2,942
Totals	**45,933**	**54,541**	**323**	**8,576**	**1,164**	**15,013**
Estimated Consolidate and Cover Loadings (kg per year)						
Low Grade Stockpile C Area	**14,992**	**17,725**	**95**	**2,873**	**402**	**4,413**

The results indicate that:

- Covering the oxide fines and low grade ore in place could reduce contaminant loadings by about 89 %, i.e. the residual loadings will be about 11 percent of current loadings. For example, zinc loadings could decrease from about 135 tonnes per year to about 15 tonnes per year.
- Consolidating and covering the oxide fines and low grade ore would lead to a further reduction in estimated contaminant loadings, resulting in residual loadings of approximately 3 to 4 percent of estimated current loadings for these piles. Zinc loadings could be reduced from about 135 tonnes per year to less than 5 tonnes per year.

Although it is not shown in the table, the laboratory results presented in the preceding chapter suggest that alkalinity amendment of the oxide fines during relocation initially would limit contaminant release to a fraction of the "current average" shown in Table 3.2. Over time however, oxidation would consume the excess alkalinity and loadings would increase, potentially to the levels shown in the "consolidate and cover" estimate. The time required for the loadings to increase would depend on how effectively the cover would prevent oxygen from reaching the reactive material.

3.5 Design Concepts

Cover in Place

The cover in place option would entail that the slopes of the existing areas be regraded to a 3:1 (H:V) gradient. It is anticipated that this could be done within the constraints of the existing locations of the oxide fines and low grade ore stockpiles. To achieve the design slope, regrading of the combined medium grade ore – oxide fines area (see Figure 2.1) may encroach on the road, and may require that a portion of this material be relocated before cover construction could commence.

Covering all the oxide fines and low grade ore stockpiles in place will require approximately 500,000 m^3 of till. Surface water runoff and cover interflow would be managed in a manner similar to that described below.

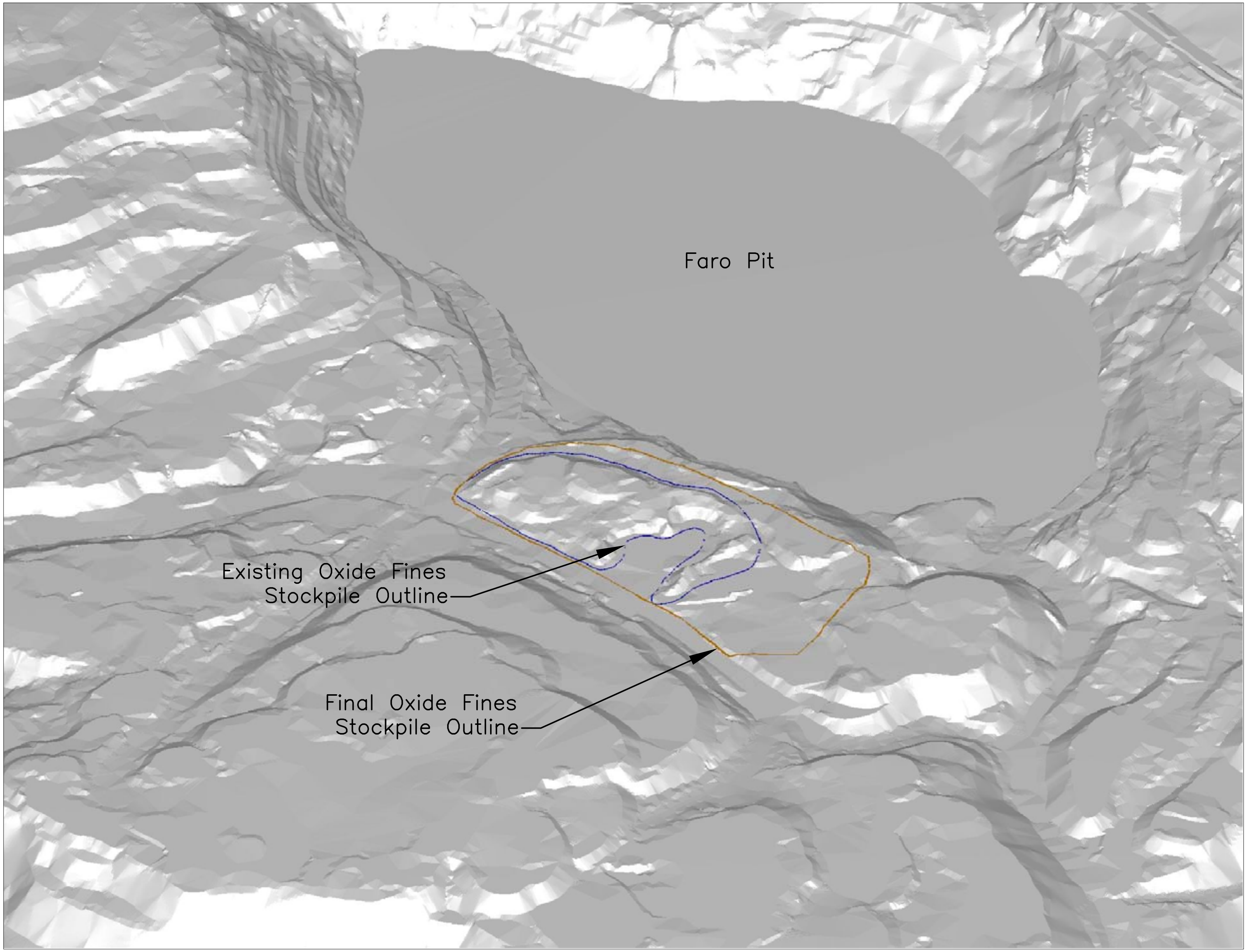
Consolidate and Cover

Figure 3.4 provides an outline of the current Low Grade Stockpile C area (red line) and the area that would be required to accommodate about 500,000 m^3 of fill. As shown, the resloped backfilled area would be contained within the existing roads. A view of the backfilled area complete with cover is shown in Figure 3.5. A section through the consolidated heap, showing the cover configuration, is provided in Figure 3.6. As shown, a toe drain would be installed to collect clean seepage from the cover. A toe ditch will also be installed to collect clean runoff for clean water release off-site if suitable.

The final landform would include a bench, sloped inward to control runoff. Erosion protection would be provided, and the collector bench would discharge to a rock face drain that would be located at the corners of the consolidated stockpile. As shown in Figure 3.7, the top surface of the consolidated heap would be sloped to direct runoff to these rock drains. The toe drain would discharge to the collection ditch at the toe of the heap. The toe drain and the toe collection ditch would be routed to a central sump from which the clean water could be discharged.

A similar cover construction - water management strategy would be applied in the event the Low Grade Ore Stockpile A could not be accommodated in the consolidated heap and would require a separate cover.

Approximately 210,000 m^3 of till would be required for the construction of the cover over the consolidated stockpile. An additional 95,000 m^3 of till would be required to cover the Low Grade Ore Stockpile A separately.



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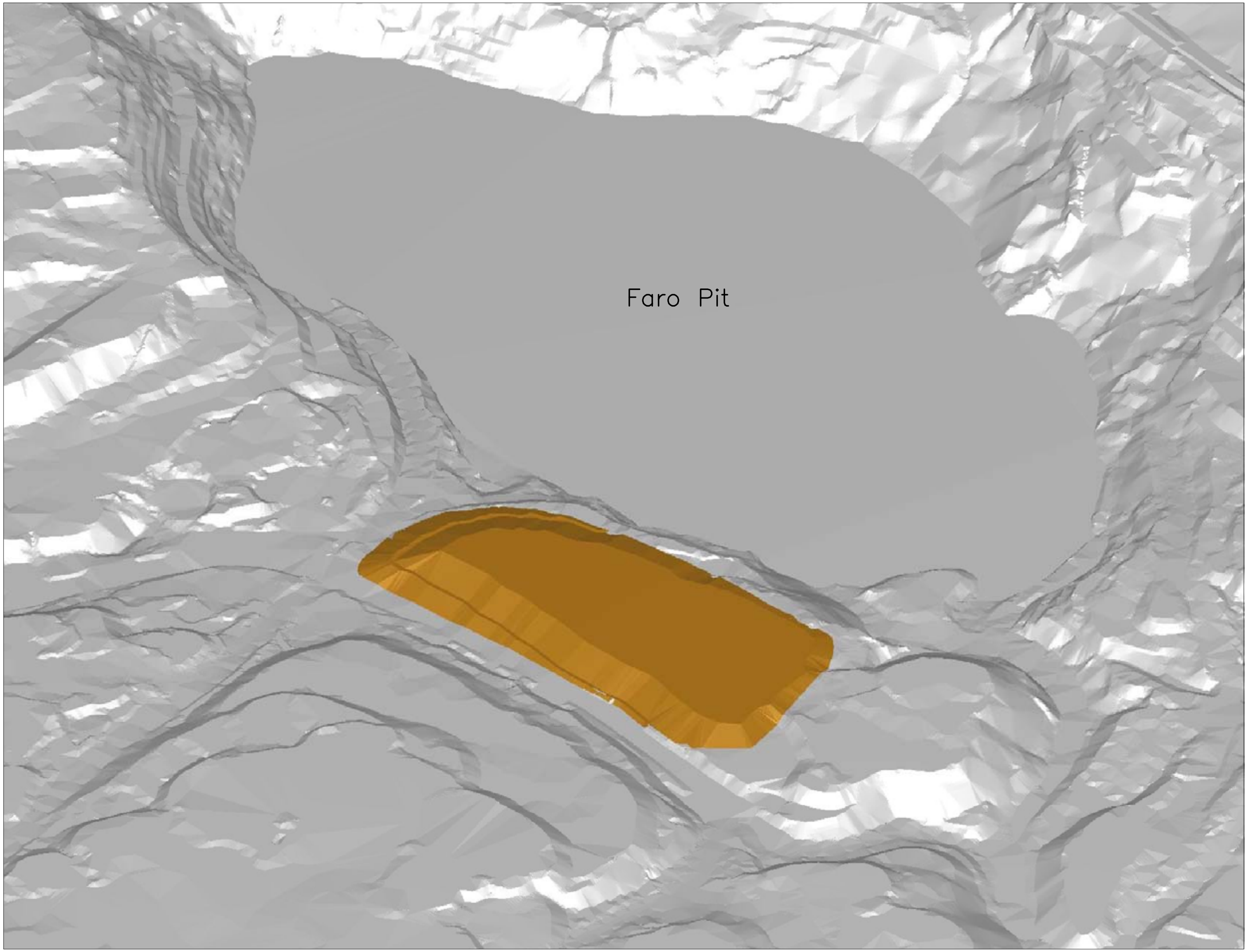
OXIDE FINES MANAGEMENT PLAN

Outlines of Existing Low Grade Stockpile "C" and Proposed Fill Area

PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.044	Feb. 2005		3.4

Dwg Ref: Acad-faro\Oxide-Fines\OxideFines_3dviews.dwg



Dwg Ref: Acad-faro\Oxide-Fines\OxideFines_3dviews.dwg

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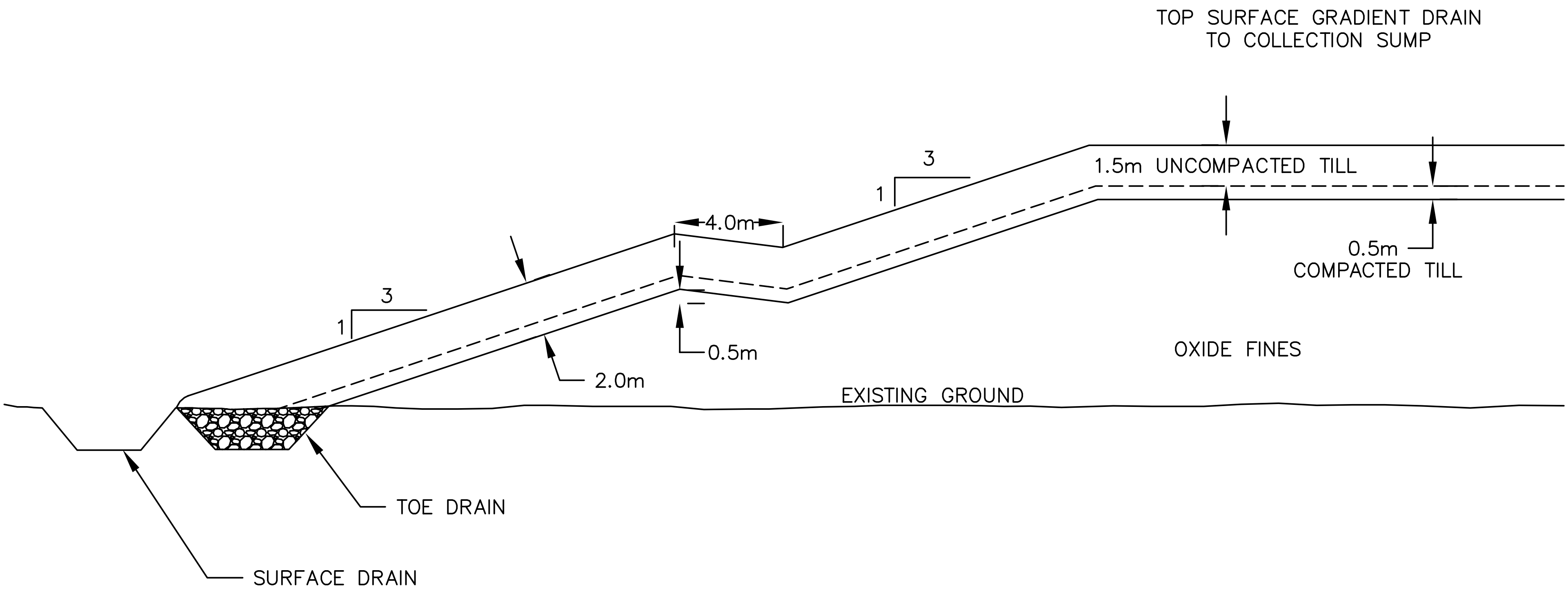
OXIDE FINES MANAGEMENT PLAN

View of Covered Fill Area

PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.044	Feb. 2005		3.5



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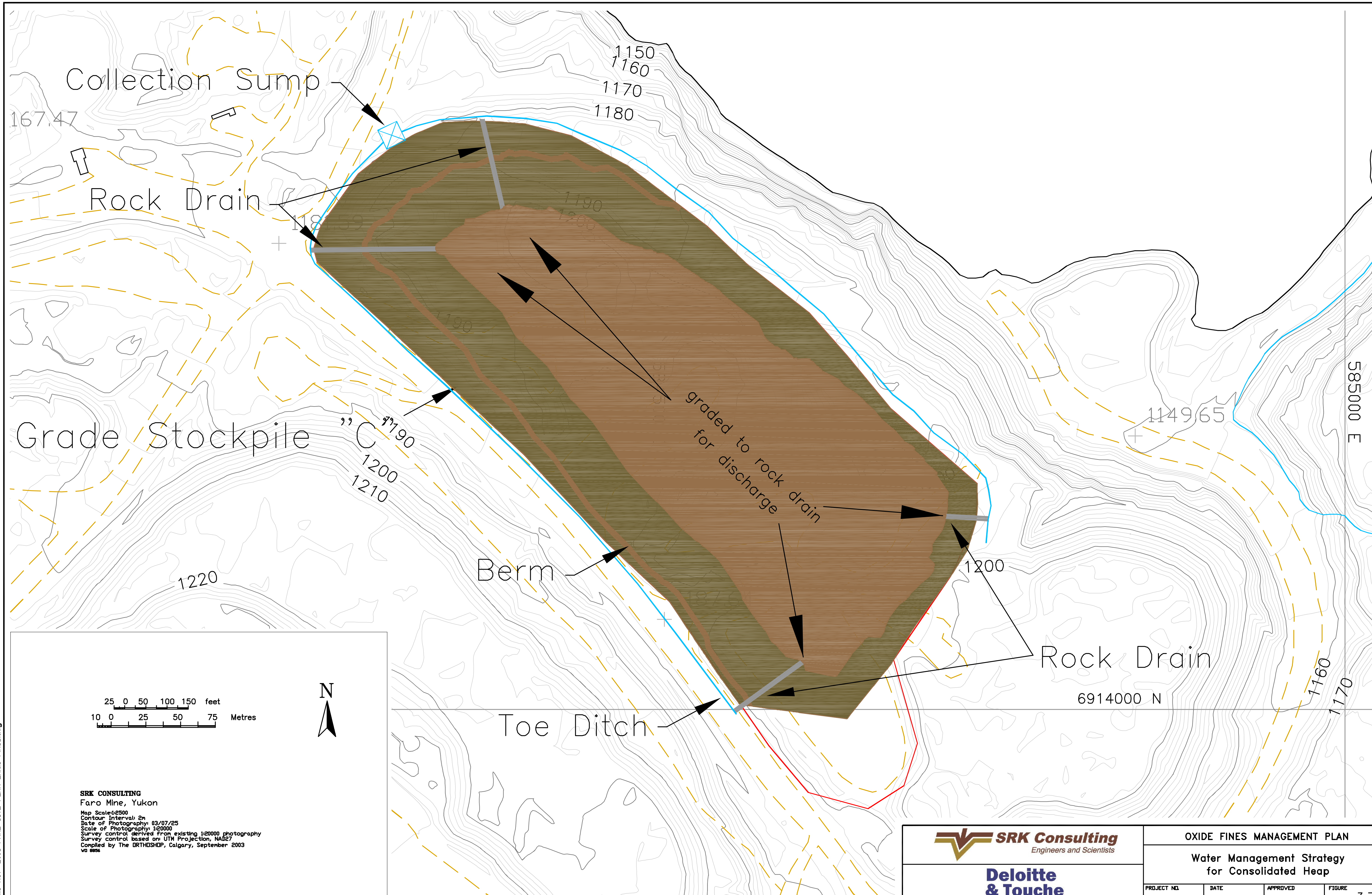
OXIDE FINES MANAGEMENT PLAN			
Section Through Consolidated Covered Heap Showing Cover Configuration			
PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.044	Feb. 2005		3.6

Dwg Ref: Acad-faro\Oxide-Fines\Typical Section.dwg



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OXIDE FINES MANAGEMENT PLAN

Water Management Strategy for Consolidated Heap

PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.044	Feb. 2005	JTC	3.7

File Ref: 2003 FARO SITE PLAN-Oxide Fines.dwg

3.6 Cost Estimates

Cost estimates were prepared were prepared to a level that can facilitate comparison of the major options. Yukon contractors use either Cat 777 (50.1 Lm^3) or Cat 773 (39.8 Lm^3) trucks for this type of work. Cost estimates were prepared for both these truck types. The detailed calculations are provided in Appendix E.

Cover in Place

The estimated costs for covering in place are presented in Table 3.3. The estimates presented in the table are intended only for comparison of options. For example, they do not include costs associated with construction of surface runoff and water collection structures. The estimates range from about $5.7 to $6.1 million.

Table 3.3 Summary of Estimated Costs to Cover in Place

Location	Cat 773 Trucks	Cat 777 Trucks
Oxide fines- green	$204,000.00	$191,000.00
Oxide fines- brown	$570,000.00	$535,000.00
Oxide fines- medium grade	$367,000.00	$344,000.00
Crusher stockpile	$489,000.00	$458,000.00
Medium grade stockpile	$244,000.00	$229,000.00
Oxide fines #2	$204,000.00	$191,000.00
Oxide fines #3	$204,000.00	$191,000.00
Low grade ore	$285,000.00	$267,000.00
Low grade stockpile A	$ 1,467,000.00	$1,375,000.00
Low grade stockpile C	$ 2,078,000.00	$1,948,000.00
Total	$ 6,112,000.00	$5,729,000.00

Consolidate and Cover

The cost estimates for consolidating and covering the oxide fines and low grade ore are summarised in Table 3.4. Estimates were again prepared for the two trucks sizes to a comparative level only. In each case costs were also derived for the lower and upper estimates of the volumes of material in the oxide fines and low grade ore stockpiles. In the case of the upper bound volume estimate, the Low Grade Ore Stockpile A was assumed to be covered in place. The costs provided in the table include relocation, resloping, and cover construction. Costs associated with the construction of the water management structures are not included. The cost estimates are from $4.5 million to $5.9 million for the lower volume estimates. For the upper estimates of volumes, the cost estimates are from $6.8 million to $9.7 million.

Table 3.4 Estimated Costs Associated with Consolidate and Cover

Description	Low Volume Estimate	High Volume Estimate
Oxide Relocation & Cover - Large Trucks (Cat 777 (50.1 Lm3))	$ 4,535,000	$ 6,837,000
Oxide Relocation & Cover - Smaller Trucks (Cat 773 (30.9 Lm3))	$ 5,940,000	$ 9,698,000

3.7 Comparison of Cover in Place vs. Consolidate and Cover

A direct comparison between cost estimates for the two options is provided in Table 3.5. The table shows a cost advantage for consolidating the sources if the low volume estimates are correct. If the upper volume estimates are assumed to apply, cover in place offers a cost advantage for the Crusher Stockpile, Medium Grade Stockpile and Oxide Fines #2. However, the load reduction that can be achieved through consolidating these sources counterbalances the additional costs. Consolidating all the sources to a single locations offer a number of other benefits, including lower monitoring and maintenance costs and fewer constraints on l future closure measures.

Table 3.5 Cost Comparison between Relocation and Cover and Place

Location	Cat 773 Trucks			Cat 777 Trucks		
	Cover in Place	Low Volume	High Volume	Cover in Place	Low Volume	High Volume
Oxide fines- green	$ 204,000	$185,000	$ 185,000	$ 191,000	$ 133,000	$133,000
Oxide fines- brown	$ 570,000	$335,000	$ 335,000	$ 535,000	$ 241,000	$241,000
Oxide fines- medium grade	$ 367,000	$441,000	$ 441,000	$ 344,000	$ 317,000	$317,000
Crusher stockpile	$ 489,000	$370,000	**$ 837,000**	$ 458,000	$ 266,000	**$603,000**
Medium grade stockpile	$ 244,000	$ 88,000	**$1,216,000**	$ 229,000	$63,000	**$875,000**
Oxide fines #2	$ 204,000	$ 88,000	**$ 591,000**	$ 191,000	$63,000	**$425,000**
Oxide fines #3	$ 204,000	$344,000	$ 344,000	$ 191,000	$ 247,000	$247,000
Low grade ore	$ 285,000	$388,000	$ 388,000	$ 267,000	$ 279,000	$279,000
Low grade stockpile A	$1,467,000	$481,000	$ -	$1,375,000	$ 346,000	$ -

3.8 Other Considerations

Alkalinity Amendment

Consideration may be given to amending the oxide fines and low grade ore during relocation. Lime amendment would achieve the maximum reduction in solute concentrations in percolate from the consolidated heap. Limestone would not achieve similar reductions in solute concentrations. However, it would sustain a reduction in solute concentrations over a longer period as it is less soluble than lime and, consequently, would not ‘wash out’. Table 3.6 summarises the estimated costs associated with supply of the lime amendment. The costs associated with spreading the lime are not included in the estimates.

Table 3.6 Summary of Estimated Lime Amendment Costs

Location	Lime Demand (kg/tonne)	Lime Cost ($/tonne)	Low Volume Estimate	High Volume Estimate
Oxide fines- green	17.99	5.76	$ 218,000	$ 218,000
Oxide fines- brown	17.99	5.76	$ 394,000	$ 394,000
Oxide fines- medium grade	2.28	0.73	$ 66,000	$ 66,000
Crusher stockpile	0.55	0.18	$ 14,000	$ 31,000
Medium grade stockpile	2.28	0.73	$ 13,000	$ 181,000
Oxide fines #2	12.55	4.02	$ 72,000	$ 485,000
Oxide fines #3	9.11	2.92	$ 205,000	$ 205,000
Low grade ore	6.65	2.13	$ 169,000	$ 169,000
Low grade stockpile A	7.34	2.35	$ 300,000	$ -
TOTAL			**$1,451,000**	**$1,748,000**

Opportunity for Cover Testing

A small ‘valley’ is present in Stockpile C area at the 0+300 to 0+325 m interval on the section line shown on Figure 3.1. The valley has a flat base and as such offers an ideal location for the installation of a large scale lysimeter. Installation of a lysimeter at this location would provide an excellent opportunity to assess the full scale performance of the cover system. It is anticipated that it would be possible to apply the performance data obtained from the facility directly to other areas at the site. Installation of a liner, complete with a bedding layer and an overlying drainage layer, would cost approximately $367,000.

4 Amendment and Relocation to Faro Pit

4.1 Description and Design Concepts

In this scenario, all of the oxide fines and low grade ore would be relocated to below the water level in the Faro Pit. Alkalinity amendment would be required to protect water quality in the pit lake, and to achieve the lowest possible solute concentrations. Based on the results presented in Chapter 2, lime would be the alkalinity of choice and it would be necessary to increase the pH of the oxide fines and low grade ore to at least 9.5.

The laboratory testing has shown that dry blending of lime was only marginally successful in achieving the target pH. Because of the stringent requirement to achieve complete neutralization, it would be necessary to implement a ‘wet’ neutralization process.

The steps would be as follows. First, the oxide fines and low grade ore would be picked up and moved to a location near the Faro pit where a neutralization system would be set-up. The rock would be dumped in a chute that would feed into the neutralization system. The wet neutralization ‘reactor system’ would comprise a large rotating drum or ‘mill-like’ mixer, similar to a concrete mixer. The rock would be loaded into the rotating drum and water would be added to generate a ‘dense’ slurry. Lime would then be added to the slurry until the desired pH is achieved. The drum would discharge to a large diameter pipe which would deposit the neutralized rock at depth in the pit lake.

Since the rock would be placed underwater, anoxic conditions would prevail. Therefore, as shown by the laboratory column tests, the lime demand would be in excess of that indicated by the field tests for oxidizing conditions. Based on acidity balance calculations for the column tests, it is anticipated that the lime demand would be about 20 % in excess of that indicated for oxidizing conditions. Once under water, oxygen would be excluded and further oxidation of the sulphides present in the rock would be limited.

4.2 Cost Estimates

The estimated costs for amending the oxide fines and low grade ore with lime and relocating them to below the water in the Faro Pit are shown in Table 4.1. The table does not include the capital or operating costs for the wet neutralization system. A unique system would need to be designed specifically for the Faro site, and it would require detailed design that is beyond the scope of this project.

Table 4.1 Summary of Estimated Costs for Relocation to Pit

Description	Low Volume Estimate	High Volume Estimate
Large Trucks (Cat 777 (50.1 Lm3))		
Alkalinity (lime) Amendment	$3,438,000	$ 8,571,000
Oxide Relocation	$4,174,000	$11,229,000
Subtotal	$7,612,000	$19,800,004
Smaller Trucks (Cat 773 (30.9 Lm3))		
Alkalinity (lime) Amendment	$3,438,000	$ 8,571,000
Oxide Relocation	$4,978,000	$15,601,000
Subtotal	$8,416,000	$24,172,000

4.3 Comparison to Consolidate and Cover

Estimated costs for the relocation to Faro Pit option are strongly dependent on the volumes of material, and therefore are strongly influenced by the uncertainty in those volumes. However, the estimated costs are clearly higher than those for the consolidate and cover option. If the low estimates of volumes are used, the relocation to Faro Pit option is about $4,000,000 more costly than the consolidate and cover option. If the higher volume estimates are used, the cost difference is about $14,000,000.

The relocation to Faro Pit option has the advantage that future oxidation of the material will be prevented. However, the consolidate and cover option also offers a restriction on future oxidation rates, albeit dependent on cover performance.

The relocation to Faro Pit option is dependent on the selection of broader site-wide closure alternatives. For example, if the lime amendment is not certain to be effective, moving the oxide fines and low grade ore into the pit could jeopardize closure alternatives that include a clean, flow-through pit lake. On the other hand, if a decision is made to relocate the tailings to the Faro Pit, relocation of the oxide fines and low grade ore would become a logical add on. These inter-relationships suggest that it would be difficult to make a decision to relocate the oxide fines and low grade ore to the pit before the broader closure plans are defined and approved.

In contrast, the consolidate and cover option is relatively independent of the selection of site-wide closure alternatives. This independence means that the consolidate and cover option could be implemented sooner than the relocation to Faro Pit option.

5 Conclusions

Based on the further evaluations completed in 2004, three options for the Faro oxide fines and low grade ore have been developed to a level that allows comparison:

- Cover in place;
- Consolidate and cover; and
- Amend with lime and relocate to Faro Pit.

Comparison of the “cover in place” and “consolidate and cover” options shows slight advantages for consolidating the oxide fines and low grade ore in one location prior to constructing a cover. The consolidate and cover option may be slightly more costly than the cover in place option, but any cost differences are offset by the benefits of lower contaminant releases and lower monitoring and maintenance requirements.

The option of relocating the oxide fines and low grade ore to below the water level in the Faro Pit poses technical and engineering design challenges that add an element of risk. The current uncertainty in the volume estimates for some of the low grade ore stockpiles translates into very significant uncertainty in the cost estimates for the relocation and lime amendment components of this option. The relocation to Faro Pit may constrain or be constrained by other uses of the pit lake that are being considered in the site-wide closure planning. Therefore this option would be difficult to implement before the site-wide plan is in place.

The consolidate and cover option offers significant advantages over the relocate to Faro Pit option. These include significantly lower costs and an independence from other closure decisions. The latter advantage means that the consolidate and cover option could be implemented prior to approval of the site-wide closure plan.

Appendix A

Metals Analyses

Appendix A
Metals Analyses

Parameter	Units	FLG - 01	LGSP C - 01	LGSP C - 02	LGSP C - 03	LGSP C - 04	LGSP C - 05	LGSP A - 01	LGSP A - 02	LGSP A - 03	LGSP A - 04	LGSP A - 05	CHSP - 01 01	CHSP - 02 02
Ag	ppm	37.8	32.4	23.7	17.5	17.3	19.5	31.6	27.8	24.8	16.3	24.8	28.4	28.4
Al	%	0.12	0.21	0.3	0.02	0.13	0.2	0.18	0.08	0.21	0.07	0.61	0.49	0.24
As	ppm	347	4063	391	243	525	450	501	529	673	615	253	1697	1405
Ba	ppm	18	<10	<10	16	<10	13	15	<10	12	<10	16	25	18
Be	ppm	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bi	ppm	32	16	19	31	29	13	30	27	36	31	10	<5	<5
Ca	%	0.01	0.16	0.01	0.01	0.04	0.14	0.07	0.03	0.06	0.01	0.42	0.78	0.82
Cd	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Co	ppm	159	30	102	73	211	94	114	125	152	250	46	40	34
Cr	ppm	149	181	241	180	134	146	184	93	92	99	51	248	125
Cu	ppm	1081	1019	922	671	2666	1331	885	1007	1912	1833	877	480	591
Fe	%	>15.00	13.71	>15.00	>15.00	>15.00	12.96	>15.00	>15.00	>15.00	>15.00	13.92	7.75	9.83
K	%	0.07	0.11	0.17	0.01	0.04	0.09	0.05	0.04	0.07	0.03	0.17	0.08	0.08
Mg	%	<0.01	0.04	0.02	<0.01	0.08	0.06	0.05	<0.01	0.09	0.01	0.28	0.89	0.71
Mn	ppm	36	154	29	36	435	261	78	35	548	252	150	702	941
Mo	ppm	<2	9	6	<2	<2	13	<2	<2	<2	<2	3	8	9
Na	%	0.01	0.02	0.02	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
Ni	ppm	8	20	11	9	15	21	21	7	24	16	22	140	64
P	ppm	327	228	216	224	388	596	431	318	439	319	695	596	606
Pb	ppm	>10000	>10000	>10000	>10000	>10000	>10000	>10000	>10000	>10000	>10000	>10000	>10000	>10000
Sb	ppm	51	86	34	27	31	41	63	36	38	32	27	56	72
Sc	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2	3	2
Sn	ppm	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Sr	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	23	16
Ti	%	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
V	ppm	25	19	22	20	28	28	26	21	34	27	37	34	20
W	ppm	14	326	17	72	351	265	38	40	114	161	22	537	523
Y	ppm	<1	2	<1	<1	1	2	<1	<1	2	<1	3	4	5
Zn	ppm	1575	>10000	1276	5563	>10000	>10000	3191	3440	8218	>10000	1911	>10000	>10000
Zr	ppm	16	12	12	14	17	12	16	15	18	17	13	11	15

Appendix A
Metals Analyses

Parameter	Units	CHSP - 03 03	FOF - 1	FOF - 2	FOF - 3	FOF - 4	FOF - 5	FOF - 6	FOF - 7	FOF - 8	FOF - 9	FOF - 10	FOF - 11	FOF - 12	FOF - 13	FOF - 14	FOF - 15
Ag	ppm	17.2	78.1	71.4	59.7	50.1	34.3	33.6	12.6	39.6	34.7	41.3	33.8	18.7	44.4	38.3	43.4
Al	%	0.31	0.28	0.37	0.39	0.15	0.25	0.22	1.12	0.32	0.29	0.29	0.29	1.18	0.4	0.2	0.32
As	ppm	912	1307	1323	1413	239	228	233	133	250	386	295	306	208	253	217	326
Ba	ppm	28	20	20	24	<10	<10	<10	21	<10	<10	<10	<10	26	<10	<10	<10
Be	ppm	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bi	ppm	<5	26	23	24	20	29	26	8	17	25	23	22	8	19	19	20
Ca	%	1.26	0.3	0.23	0.27	0.15	0.17	0.21	1.01	0.5	0.27	0.53	0.41	1.22	0.42	0.27	0.2
Cd	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Co	ppm	33	70	69	68	58	80	97	32	48	75	41	53	23	71	48	54
Cr	ppm	183	54	32	41	37	92	62	89	70	56	63	64	70	89	44	92
Cu	ppm	328	9859	9709	5625	1503	1022	1229	650	1064	1266	1131	1296	565	923	1152	1087
Fe	%	7.14	>15.00	>15.00	>15.00	>15.00	>15.00	>15.00	11.69	13.89	>15.00	13.46	14.67	11.03	13.26	13.39	>15.00
K	%	0.11	0.1	0.09	0.06	0.1	0.14	0.14	0.36	0.18	0.14	0.17	0.14	0.23	0.18	0.16	0.17
Mg	%	0.75	0.08	0.14	0.14	0.01	0.02	0.03	0.54	0.05	0.04	0.05	0.06	0.5	0.07	0.02	0.04
Mn	ppm	996	152	375	405	79	76	124	200	56	81	68	66	137	320	58	77
Mo	ppm	10	4	3	3	4	3	3	<2	5	3	6	6	<2	5	5	6
Na	%	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.05	0.03	0.02	0.02	0.02	0.1	0.03	0.02	0.02
Ni	ppm	69	10	10	14	10	13	14	26	13	14	8	10	19	15	9	12
P	ppm	920	454	510	439	426	425	479	732	434	640	444	574	686	618	347	521
Pb	ppm	>10000	>10000	>10000	>10000	>10000	>10000	>10000	>10000	>10000	>10000	>10000	>10000	>10000	>10000	>10000	>10000
Sb	ppm	37	126	96	85	51	39	45	18	49	48	52	47	30	49	44	60
Sc	ppm	2	<1	<1	1	<1	2	1	4	1	1	1	1	3	2	1	1
Sn	ppm	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Sr	ppm	22	<1	<1	<1	<1	<1	<1	11	<1	<1	<1	<1	52	<1	<1	<1
Ti	%	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	0.03	0.01	<0.01	<0.01
V	ppm	24	23	27	33	26	26	28	51	32	35	39	33	44	31	27	33
W	ppm	286	43	68	97	90	62	114	53	35	57	36	39	19	93	33	50
Y	ppm	5	<1	1	<1	<1	2	2	3	1	1	1	1	3	2	1	1
Zn	ppm	>10000	3465	5284	7421	6368	4829	8539	4135	2918	4435	2899	3119	1780	7113	2706	3826
Zr	ppm	13	14	14	13	11	12	12	10	12	14	12	12	12	11	12	13

Appendix A
Metals Analyses

Parameter	**Units**	FOF - 16	MGSP - 1	MGSP - 2	MGSP - 3
Ag	ppm	47.8	32.7	60.7	50.1
Al	%	0.27	0.7	0.8	0.18
As	ppm	275	1532	1121	3900
Ba	ppm	<10	11	19	<10
Be	ppm	<0.5	<0.5	<0.5	<0.5
Bi	ppm	20	8	12	9
Ca	%	0.19	0.42	0.87	0.02
Cd	ppm	<1	<1	5	<1
Co	ppm	44	40	39	46
Cr	ppm	71	140	133	162
Cu	ppm	1229	1924	3200	4077
Fe	%	13.79	9.58	13.22	8.64
K	%	0.17	0.12	0.08	0.07
Mg	%	0.01	0.31	0.59	0.03
Mn	ppm	62	397	2594	95
Mo	ppm	6	11	7	17
Na	%	0.02	0.02	0.01	0.01
Ni	ppm	9	29	62	23
P	ppm	441	479	489	208
Pb	ppm	>10000	>10000	>10000	>10000
Sb	ppm	54	72	110	194
Sc	ppm	<1	2	2	<1
Sn	ppm	<10	<10	<10	<10
Sr	ppm	<1	<1	<1	<1
Ti	%	<0.01	<0.01	<0.01	<0.01
V	ppm	33	24	32	12
W	ppm	34	286	715	555
Y	ppm	1	3	4	<1
Zn	ppm	2740	>10000	>10000	>10000
Zr	ppm	11	11	11	10

Appendix B

Leach Extraction Test Results

Appendix B
Leach Extraction Test Results

		As Received		Lime Amended		Limestone Amended	
Parameter	**Units**	**FOF1**	**LGS1**	**FOF1**	**LGS1**	**FOF1**	**LGS1**
WATER	(mL)	750	750	750	750	750	750
SAMPLE	(g)	250	250	250	250	250	250
pH		2.21	2.18	8.31	4.54	7.37	6.88
CONDUCTIVITY	(uS/cm)	4350	3820	1270	1280	1211	1198
ALKALINITY	(mg $CaCO_3$/L)	0.0	0.0	15.0	0.0	49.0	24.5
ACIDITY	(pH 4.5)	3125.0	1140.0	0.0	0.0	0.0	0.0
ACIDITY	(pH 8.3)	5945.0	2630.0	0.0	495.0	18.0	48.5
SULPHATE	(mg/L)	6667	3327	1829	2058	1609	1956
Dissolved Metals							
Aluminum	(mg/L)	168	44.5	0.40	<0.40	<0.20	<0.20
Antimony	(mg/L)	<1.0	<0.60	<0.20	<0.40	<0.20	<0.20
Arsenic	(mg/L)	2.9	0.73	<0.20	<0.40	<0.40	<0.20
Barium	(mg/L)	<0.050	<0.030	0.033	<0.020	0.011	0.021
Beryllium	(mg/L)	<0.025	0.019	<0.0050	<0.010	<0.015	<0.0050
Bismuth	(mg/L)	<1.0	<0.60	<0.20	<0.40	<0.20	<0.20
Boron	(mg/L)	<0.50	<0.30	<0.10	<0.20	<0.10	<0.10
Cadmium	(mg/L)	0.981	0.660	<0.010	0.477	0.030	0.085
Calcium	(mg/L)	371	179	685	583	606	648
Chromium	(mg/L)	0.444	0.162	<0.010	<0.020	<0.010	<0.010
Cobalt	(mg/L)	1.17	0.550	<0.010	0.436	0.061	0.123
Copper	(mg/L)	45.4	27.5	0.012	0.114		0.013
Iron	(mg/L)	1970	614	<0.030	20.1	0.054	<0.030
Lead	(mg/L)	<0.25	2.15	<0.050	2.35	<0.050	<0.050
Lithium	(mg/L)	0.139	0.036	<0.010	0.028	0.022	<0.010
Magnesium	(mg/L)	72.1	37.7	4.55	41.8	60.7	39.9
Manganese	(mg/L)	31.3	20.9	<0.0050	19.7	7.23	11.6
Molybdenum	(mg/L)	<0.15	<0.090	<0.030	<0.060	<0.030	<0.030
Nickel	(mg/L)	0.39	0.63	<0.050	0.41	<0.050	0.071
Phosphorus	(mg/L)	3.7	<0.90	<0.30	<0.60	<0.30	<0.30
Potassium	(mg/L)	<10	<6.0	7.6	<4.0	<2.0	<2.0
Selenium	(mg/L)	<1.0	<0.60	<0.20	<0.40	<0.20	<0.20
Silicon	(mg/L)	2.76	1.85	0.239	1.37	1.40	0.792
Silver	(mg/L)	<0.050	<0.030	<0.010	<0.020	<0.010	<0.010
Sodium	(mg/L)	<10	<6.0	<2.0	<4.0	<2.0	<2.0
Strontium	(mg/L)	0.138	0.091	1.89	1.42	0.130	0.315
Thallium	(mg/L)	<2.0	<0.60	<0.20	<0.40	<0.20	<0.20
Tin	(mg/L)	<0.15	<0.090	<0.030	<0.060	<0.030	<0.030
Titanium	(mg/L)	<0.050	<0.030	<0.010	<0.020	<0.010	<0.010
Vanadium	(mg/L)	0.26	<0.090	<0.030	<0.060	<0.030	<0.030
Zinc	(mg/L)	664	468	0.0100	297	5.20	24.8

Appendix C

Column Test Results

Appendix C
Column Test Reslts

Column #	Sample	Composite Weight (kg)	*Lime/ Limestone (grams)	Columns Wt (incl. reagents) (grams)	Pore Volume (ml)
1	VG1 with Lime	1.40	1.20	1021	300
2	VG1 with Limestone	1.48	2.29	990	310
3	VG 2 with Lime	1.39	4.64	964	310
4	VG 2 with Limestone	1.40	8.41	935	330
5	FOF 1 with Lime	1.39	33.10	965	315
6	FOF 1 with Limestone	1.40	59.98	910	330
7	LGS1 with Lime	1.40	13.59	1051	330
8	LGS with Limestone	1.40	24.40	1040	325

*Lime (CaO) was added as $Ca(OH)_2$. CaO required was converted to $Ca(OH)_2$, using stochiometric relationship.

Porewater at 14 Days

Parameter		FOF 1 - Lime	FOF 1 - Limestone	LGS1 - Lime	LGS1 - Limestone
Volume Collected	(mL)	315	310	295	295
Redox	(mV)	160	89	180	160
Immediate pH		9.17	5.34	3.60	5.50
CONDUCTIVITY	(uS/cm)	1342	1716	2570	1412
ALKALINITY	(mg $CaCO_3$/L)	20.0	0.0	0.0	7.5
ACIDITY	(pH 4.5)	0.0	0.5	31.0	0.0
ACIDITY	(pH 8.3)	11.0	988.0	1479.5	669.5
SULPHATE	(mg/L)	1525	2565	2815	2235
Total Metals (mg/L)					
Aluminum	(mg/L)	<0.20	1.13	4.41	<0.40
Antimony	(mg/L)	<0.20	<0.60	<0.80	<0.40
Arsenic	(mg/L)	<0.20	<0.60	<0.80	0.49
Barium	(mg/L)	0.026	0.413	<0.040	<0.020
Beryllium	(mg/L)	<0.0050	<0.015	<0.020	0.011
Bismuth	(mg/L)	<0.20	<0.60	<0.80	<0.40
Boron	(mg/L)	<0.10	<0.30	<0.40	<0.20
Cadmium	(mg/L)	<0.010	0.041	0.652	0.148
Calcium	(mg/L)	580	506	486	510
Chromium	(mg/L)	<0.010	<0.030	<0.040	<0.020
Cobalt	(mg/L)	<0.010	1.69	1.34	0.925
Copper	(mg/L)	0.013	0.654	1.22	<0.020
Iron	(mg/L)	0.060	216	120	73.4
Lead	(mg/L)	<0.050	5.61	1.91	2.23
Lithium	(mg/L)	<0.010	0.052	0.041	0.036
Magnesium	(mg/L)	3.81	189	156	206
Manganese	(mg/L)	0.0112	54.8	70.5	68.5
Molybdenum	(mg/L)	<0.030	<0.090	<0.12	<0.060
Nickel	(mg/L)	<0.050	0.60	1.13	0.70
Phosphorus	(mg/L)	<0.30	<0.90	<1.2	<0.60
Potassium	(mg/L)	27.2	7.7	<8.0	37.4
Selenium	(mg/L)	<0.20	<0.60	<0.80	<0.40
Silicon	(mg/L)	0.838	6.83	7.78	6.02
Silver	(mg/L)	<0.010	<0.030	<0.040	<0.020
Sodium	(mg/L)	2.6	<6.0	<8.0	6.4
Strontium	(mg/L)	2.08	0.283	0.390	0.191
Thallium	(mg/L)	<0.20	<0.60	<0.80	<0.40
Tin	(mg/L)	<0.030	<0.090	<0.12	<0.060
Titanium	(mg/L)	<0.010	<0.030	<0.040	<0.020
Vanadium	(mg/L)	<0.030	<0.090	<0.12	<0.060
Zinc	(mg/L)	0.0247	445	782	361

Appendix C
Column Test Reslts
Porewater at 21 Days

Parameter	Units	FOF 1 - Lime	FOF 1 - Limestone	LGS1 - Lime	LGS1 - Limestone
Volume Collected	(mL)	340	340	300	300
Redox	(mV)	235	255	343	308
Immediate pH		8.80	5.40	3.37	5.18
CONDUCTIVITY	(uS/cm)	1087	1031	2370	1386
ALKALINITY	(mg $CaCO_3$/L)	11.5	8.5	0.0	2.5
ACIDITY	(pH 4.5)	0.0	0.0	25.0	0.0
ACIDITY	(pH 8.3)	7.5	386.5	900.0	360.5
SULPHATE	(mg/L)	1450	1840	2050	1925
Total Metals (mg/L)					
Aluminum	(mg/L)	0.5	<0.40	2.80	<0.20
Antimony	(mg/L)	<0.20	<0.40	<1.0	<0.20
Arsenic	(mg/L)	<0.20	<0.40	<1.0	<0.30
Barium	(mg/L)	0.126	0.021	<0.050	<0.010
Beryllium	(mg/L)	<0.0050	<0.010	<0.025	0.007
Bismuth	(mg/L)	<0.20	<0.40	<1.0	<0.20
Boron	(mg/L)	<0.10	<0.20	<0.50	<0.10
Cadmium	(mg/L)	<0.010	0.075	0.587	0.194
Calcium	(mg/L)	529	522	542	516
Chromium	(mg/L)	<0.010	<0.020	<0.050	<0.010
Cobalt	(mg/L)	<0.010	0.92	0.89	0.490
Copper	(mg/L)	0.033	0.029	1.27	0.012
Iron	(mg/L)	2.120	014	038	18.9
Lead	(mg/L)	0.698	0.53	2.10	2.25
Lithium	(mg/L)	<0.010	0.026	<0.050	0.017
Magnesium	(mg/L)	5.11	117	103	107
Manganese	(mg/L)	0.1160	33.0	46.6	37.4
Molybdenum	(mg/L)	<0.030	<0.060	<0.15	<0.030
Nickel	(mg/L)	<0.050	0.28	0.85	0.40
Phosphorus	(mg/L)	<0.30	<0.60	<1.5	<0.30
Potassium	(mg/L)	22.0	7.0	<10	30.0
Selenium	(mg/L)	<0.20	<0.40	<1.0	<0.20
Silicon	(mg/L)	1.510	8.94	9.86	6.55
Silver	(mg/L)	<0.010	<0.020	<0.050	<0.020
Sodium	(mg/L)	<2.0	<4.0	<10	3.5
Strontium	(mg/L)	1.94	0.289	0.386	0.179
Thallium	(mg/L)	<0.20	<0.40	<1.0	<0.20
Tin	(mg/L)	<0.030	<0.060	<0.15	<0.030
Titanium	(mg/L)	0.029	<0.020	<0.050	<0.010
Vanadium	(mg/L)	<0.030	<0.060	<0.15	<0.030
Zinc	(mg/L)	0.3170	241	590	201

Appendix D

Motivation for Cover Design for the Low-Grade Ore and Oxide Fines Stockpiles

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DRAFT Technical Memorandum

To:	John Chapman	**Date:**	February 10, 2005
cc:	Project File	**From:**	Maritz Rykaart
Subject:	Motivation for Cover Design for the Low-Grade Ore and Oxide Fines Stockpiles	**Project #:**	1CD003.051

Cover trials are currently underway to evaluate the most effective soil cover designs to use at the Anvil Range Mining Complex (ARMC). These cover trials have been designed based on a scoping level cover assessment completed in 2003 (SRK, 2004). This report included a summary of basic cover concepts as it applies to the ARMC as well as a summary of all historic cover design research at the site. A complete field characterization program was undertaken at time, including test pitting, collection of samples for detailed geotechnical characterization, in-situ geotechnical testing, and finally installation of thermal instrumentation. The field characterization was primarily to evaluate the suitability of potential cover materials, as identified in the Phase 2 Borrow Source Survey (SRK, 2003). Cover constructability is discussed in SRK (2004) specifically within the context of re-shaping requirements for the dumps and material availability. Finally, SRK (2004) presents preliminary numerical surface flux boundary modeling results to illustrate the likely benefit that covers constructed from the available materials could offer. Although un-calibrated, the modeling results does appear to be reasonable , especially in the light of recent waste rock dump water balance calculations (Janowicz et al, 2005) which supports the modeling results.

Based on the numerical modeling carried out in SRK (2004), uncovered waste rock should allow between 24 and 34 % of mean annual precipitation (MAP) to infiltrate and report to the groundwater (whether that is a perched aquifer or not). Numerical modeling suggest that placing a till cover would reduce the infiltration to between 1% and 7% of MAP , and that in fact a cover as thin as 50 cm would achieve this target.

Anecdotal data, as well as in-situ testing of the 200 cm thick till cover constructed on the Vangorda waste rock pile in 1994, suggest that the modeling observations may be reasonable. Surface erosion due to runoff has resulted in the development of significant gullies, and since there is limited gravel and cobble sized material in the till, self armoring is not likely to occur. Without some form of erosion protection, it is thus conceivable that the cover could be complete eroded over a sufficiently long time.

The scoping level cover assessment (SRK, 2004) work has shown that an infiltration reducing cover at the ARMC could be a “barrier” or a “store-and-release” type cover. The bulk of the infiltration through the uncovered waste rock piles occur during the latter part of the freshet, when there is ample supply of water, and the ground is sufficiently thawed. At this time the evapotranspiration potential is still relatively low, and the stored moisture infiltrates. During the remainder of the year, the precipitation is more spread out, and although significant shallow infiltration occurs, the water is taken out via evapotranspiration during the drier periods. It would thus be possible to reduce the infiltration if the cover could prevent water from entering the profile in the first place by means of a physical barrier, i.e. a low permeability soil layer, or alternatively if a sufficiently thick soil layer could be placed such that all the infiltrated water is stored in the soil such that it could be released to the atmosphere at times when the evaporation driving forces are high.

The most abundant and potentially suitable cover material at the ARMC is till. This soil is predominantly silicateous having a specific gravity of 2.7. It is somewhat variable and can be classified as either sandy-clay (CL) or clayey-sand (SC) with a plasticity index between 2 and 10. Some tested till samples have no plasticity and classify as a silty-sand (SM). The till is generally well-graded with the gravel content less than 20%. Occasional well-rounded cobbles and boulders are found within the till matrix. Laboratory compaction testing confirms that the saturated hydraulic conductivity of this material at 95% of Standard Proctor Density is between 2.5×10^{-6} cm/sec and 1.1×10^{-7} cm/sec (788 to 35 mm/year). In-situ field permeability tests on surface exposed till measured saturated hydraulic conductivities between 2.5×10^{-4} and 1.9×10^{-5} cm/sec (79 to 6 m/yr). In-situ density tests at these locations confirmed densities between 80 and 82% of Standard Proctor Density, which would explain the higher hydraulic conductivity. This does however confirm that the till is likely to undergo significant physical change as it is subjected to the physical processes of freeze-thaw, wet-dry and erosion cycles.

The well-graded texture, together with the high fines content suggests that the material would be a good candidate to construct a “barrier” cover. The soil water characteristic curve (SWCC) testing confirms that the air entry value (AEV) for the till is between 1 and 20 kPa; however, there appears to be duel porosity in the material, with a secondary AEV of around 1,000 kPa. This means that although the till can experience rapid initial de-saturation, the fines will retain significant moisture, and could likely act as a saturated barrier, provided sufficient moisture is present.

The mean annual precipitation (MAP) at the ARMC varies substantially due to the elevation differences between Faro, Grum and Vangorda, with the highest MAP of 387 mm occurring at Vangorda. This equates to a hydraulic conductivity of 1.2×10^{-6} cm/sec, which implies that any cover soil that has a lower saturated hydraulic conductivity than this value would reduce the amount of infiltration that can take place, under the assumption that the precipitation occurs at a steady rate over the year, that there is no runoff and no evapotranspiration. Similarly, if the infiltration had to be reduced to say 5% of MAP, or 19 mm, the cover soil would require a saturated hydraulic conductivity of at least 6.0×10^{-8} cm/sec. Comparing these numbers to the measured saturated hydraulic conductivity of the till confirms that if appropriately compacted it is conceivable that the till could act as a “barrier” due to the low hydraulic conductivity. It is however evident that if the till is exposed to the atmospheres this “barrier” would no longer be effective due to desiccation processes.

Alternatively, we can use simple empirical calculations such as developed by Chen (1999) and Benson (2000) to determine the minimum store-and-release layer thickness. These calculations assume that 100% of the annual infiltration has to be stored in the soil profile, without accounting for runoff and evapotranspiration losses. These calculations are thus extremely conservative, and probably constitute the upper boundary with respect to cover thickness. Based on these calculations, using the measured till properties, the cover thickness should be between 40 and 130 cm, with a mean thickness of 70 cm.

The high silt content in some of the till samples does suggest that water erosion will be an issue that may result in a reduced cover thickness over time. It is possible to estimate what this erosion rate would be; however, these calculations have not been completed at this time. Anecdotally, assuming the erosion that has occurred on the Vangorda till cover placed in 1994 is representative, some general conclusions can be drawn. Erosion has occurred primarily through rill development, with the rill depth being approximately 10 – 30 cm in 2004. The upper 50 – 75 m of the slope has predominantly shallow rills (less than 15 cm deep); whilst further down the slope, the rilling becomes increasingly deeper. This slope is steep (1H:2.7V), long (more than 200 m), and has no vegetative cover. Assuming this erosion rate (rilling only) continues at a constant rate of 1.5 cm/yr, the upper portion of the cover will be rilled through to the underlying waste rock within 120 years (i.e. 130 year life). Similarly, the lower portions of the slope will be rilled though within 55 years (i.e. 65 year life).

Based on these analysis, an appropriate low infiltration cover design for the low-grade ore and oxide stockpile would be a lower 50 cm thick compacted till layer (98% Standard Proctor Density) overlain by a nominally compacted (equipment self-weight) 150 cm thick till layer. The upper till layer should be sufficiently thick to ensure the cover perform as a “store-and-release” cover; however, in the event that extremely large precipitation events (i.e. an extremely large snow-pack) occurs, the lower compacted layer will restrict infiltration to the target value (less than 5% of MAP). Furthermore, the cover should be vegetated, have maximum uninterrupted slopes of 1H:3V, of less than 50 m. Under these conditions the maximum rilling rate would be 1.5 cm/year, which means that the cover should perform as a complete store-and-release cover for at least 45 years (overall cover thickness reduced to 130 cm). It is recognized that 150 cm till may not be sufficient coverage to ensure that frost will not impact the integrity of the lower compacted till layer. It is however reasonable to assume that this degradation will take some time, possibly decades, and until evidence from the test cover program prove otherwise, this compacted zone is assumed to be a benefit.

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Appendix EI

Oxide Fines and Low Grade Ore Consolidation Cover

Appendix E

Part I Oxide Fines and Low Grade Ore Consolidation and Cover

1 HDPE Liner Cost Summary

Task	Activity	Quanity	Unit	Unit Price	Subtotal	Total
Place 150mm bedding layer at Low Grade Stockpile "C"	Process/screen bedding material	1,939	Lm3	$ 10.00	$ 19,388	$ 34,200
	Load, haul, place spread bedding	1,939	Lm3	$ 7.64	$ 14,812	
Place HDPE Liner		11,750	m2	$ 24.00	$ 282,000	$ 282,000
Place 225mm bedding layer at Low Grade Stockpile "C"	Process/screen bedding material	2,908	Lm3	$ 10.00	$ 29,081	$ 51,299
	Load, haul, place spread bedding	2,908	Lm3	$ 7.64	$ 22,218	
						$367,500

2 OXIDE RELOCATION CASE 1: 773 TRUCKS (30.9 Lm3 Cap.)

A. High Volume Estimate

Task	Activity	Quanity	Unit	Unit Price	Subtotal	Total
Load, Haul, Place and Compact Oxide Materials	Oxide fines - Green	27,300	Lm3	$ 6.78	$ 185,094	$ 4,336,488
	Oxide fines - Brown	49,400	Lm3	$ 6.78	$ 334,932	
	Oxide fines - Medium Grade	65,000	Lm3	$ 6.78	$ 440,700	
	Crusher stockpile	123,500	Lm3	$ 6.78	$ 837,330	
	Medium Grade Stockpile	179,400	Lm3	$ 6.78	$ 1,216,332	
	Oxide fines #2	87,100	Lm3	$ 6.78	$ 590,538	
	Oxide fines #3	50,700	Lm3	$ 6.78	$ 343,746	
	Low grade ore	57,200	Lm3	$ 6.78	$ 387,816	
Regrade Stockpiles "A" and "C" to 3:1 slope	D10	44,000	m	$ 0.34	$ 14,960	$ 14,960
Install Cover - Low Grade Stockpile "A"	Load, haul, place compacted till (0.5m)	23,400	Lm3	$ 18.37	$ 429,858	$ 1,652,040
	Load, haul, place loose till (1.5m)	70,200	Lm3	$ 17.41	$ 1,222,182	
Install Cover - Low Grade Stockpile "C"	Load, haul, place compacted till (0.5m)	52,325	Lm3	$ 18.37	$ 961,210	$ 3,694,145
	Load, haul, place loose till (1.5m)	156,975	Lm3	$ 17.41	$ 2,732,935	
						$ 9,697,700

A. Low Volume Estimate

Task	Activity	Quanity	Unit	Unit Price	Subtotal	Total
Load, Haul, Place and Compact Oxide Materials	Oxide fines - Green	27,300	Lm3	$ 6.78	$ 185,094	$ 2,238,756
	Oxide fines - Brown	49,400	Lm3	$ 6.78	$ 334,932	
	Oxide fines - Medium Grade	65,000	Lm3	$ 6.78	$ 440,700	
	Crusher stockpile	54,600	Lm3	$ 6.78	$ 370,188	
	Medium Grade Stockpile	13,000	Lm3	$ 6.78	$ 88,140	
	Oxide fines #2	13,000	Lm3	$ 6.78	$ 88,140	
	Oxide fines #3	50,700	Lm3	$ 6.78	$ 343,746	
	Low grade ore	57,200	Lm3	$ 6.78	$ 387,816	
	Low Grade Stockpile "A"	71,000	Lm3	$ 6.78	$ 481,380	
Regrade Stockpile "C" to 3:1 slope	D10	22,000	m	$ 0.34	$ 7,480	$ 7,480
Install Cover - Low Grade Stockpile "C"	Load, haul, place compacted till (0.5m)	52,325	Lm3	$ 18.37	$ 961,210	$ 3,694,145
	Load, haul, place loose till (1.5m)	156,975	Lm3	$ 17.41	$ 2,732,935	
						$ 5,940,400

3 OXIDE RELOCATION CASE 2: 777 TRUCKS (50.1 Lm3 Cap.)

A. High Volume Estimate

Task	Activity	Quanity	Unit	Unit Price	Subtotal	Total
Load, Haul, Place and Compact Oxide Materials	Oxide fines - Green	27,300	Lm3	$ 4.88	$ 133,224	$ 3,121,248
	Oxide fines - Brown	49,400	Lm3	$ 4.88	$ 241,072	
	Oxide fines - Medium Grade	65,000	Lm3	$ 4.88	$ 317,200	
	Crusher stockpile	123,500	Lm3	$ 4.88	$ 602,680	
	Medium Grade Stockpile	179,400	Lm3	$ 4.88	$ 875,472	
	Oxide fines #2	87,100	Lm3	$ 4.88	$ 425,048	
	Oxide fines #3	50,700	Lm3	$ 4.88	$ 247,416	
	Low grade ore	57,200	Lm3	$ 4.88	$ 279,136	
Regrade Stockpile "C" to 3:1 slope	D10	22,000	m	$ 0.34	$ 7,480	$ 7,480
Install Cover - Low Grade Stockpile "A"	Load, haul, place compacted till (0.5m)	23,400	Lm3	$ 12.61	$ 295,074	$ 1,145,898
	Load, haul, place loose till (1.5m)	70,200	Lm3	$ 12.12	$ 850,824	
Install Cover - Low Grade Stockpile "C"	Load, haul, place compacted till (0.5m)	52,325	Lm3	$ 12.61	$ 659,818	$ 2,562,355
	Load, haul, place loose till (1.5m)	156,975	Lm3	$ 12.12	$ 1,902,537	
						$ 6,837,000

B. Low Volume Estimate

Task	Activity	Quanity	Unit	Unit Price	Subtotal	Total
Load, Haul, Place and Compact Oxide Materials	Oxide fines - Green	27,300	Lm3	$ 4.88	$ 133,224	$ 1,957,856
	Oxide fines - Brown	49,400	Lm3	$ 4.88	$ 241,072	
	Oxide fines - Medium Grade	65,000	Lm3	$ 4.88	$ 317,200	
	Crusher stockpile	54,600	Lm3	$ 4.88	$ 266,448	
	Medium Grade Stockpile	13,000	Lm3	$ 4.88	$ 63,440	
	Oxide fines #2	13,000	Lm3	$ 4.88	$ 63,440	
	Oxide fines #3	50,700	Lm3	$ 4.88	$ 247,416	
	Low grade ore	57,200	Lm3	$ 4.88	$ 279,136	
	Low Grade Stockpile "A"	71,000	Lm3	$ 4.88	$ 346,480	
Regrade Stockpile "C" to 3:1 slope	D10	44,000	m	$ 0.34	$ 14,960	$ 14,960
Install Cover - Low Grade Stockpile "C"	Load, haul, place compacted till (0.5m)	52,325	Lm3	$ 12.61	$ 659,818	$ 2,562,355
	Load, haul, place loose till (1.5m)	156,975	Lm3	$ 12.12	$ 1,902,537	
						$ 4,535,200

Appendix E - Part I cont.

Areas/Volumes

	High Volume Estimate	Low Volume Estimate
Low grade stockpile "A" Area (m2):	36000	36000
Low grade stockpile "C" Cover Area (m2):	80500	80500
Liner Area (m2):	11750	11750
"Oxide fines - Green" Volume (m3):	21000	21000
"Oxide fines - Brown" Volume (m3):	38000	38000
"Oxide fines - Medium Grade" Volume (m3):	50000	50000
"Crusher stockpile" Volume (m3):	95000	42000
"Medium Grade Stockpile" Volume (m3):	138000	10000
"Oxide fines #2" Volume (m3):	67000	10000
"Oxide fines #3" Volume (m3):	39000	39000
"Low grade ore" Volume (m3):	44000	44000
"Low grade Stockpile A" Volume (m3):	n/a	71000
Regrade Volume (Low Grade Stockpiles) (m3):	22000	44000

Assumptions

Bedding material bulking factor	1.1
Till bulking factor	1.3
Oxide bulking factor	1.3

Unit Rates

Item	Unit Cost	Unit	Source
Process Screen Bedding Material	$ 10.00	Lm3	Giant Remediation Cost Estimate
Place HDPE Liner	$ 24.00	m2	Giant Remediation Cost Estimate
Regrade slopes w/ D10 to 3:1	$ 0.34	m3	based on Dozer rate $392.38/hr and 1180m3/hr production rate calculated in "Faro_Reslope_LowGradeStockpile.xls"

Hauling Unit Rates

Actions	Source	Truck Type	Unit Cost	Unit
Load, Haul, Dump, Spread bedding	North Fork	777	$ 5.15	Lm3
		773	$ 7.64	Lm3
Load, Haul, Dump, Spread, Compact Oxides	Various	777	$ 4.88	Lm3
		773	$ 6.78	Lm3
Load, Haul, Dump, Spread, Compact Till	Vangorda	777	$ 12.61	Lm3
		773	$ 18.37	Lm3
Load, Haul, Dump, Spread Till	Vangorda	777	$ 12.12	Lm3
		773	$ 17.41	Lm3

Appendix EII

Oxide Relocation to Faro Open Pit

Appendix E - Part II
Oxide Relocation to Faro Open Pit

1 OXIDE RELOCATION CASE 1: 773 TRUCKS (30.9 Lm3 Cap.)

A. High Volume Estimate

Task	Activity	Quanity	Unit	Unit Price	Subtotal	Total
Load, Haul, Dump	Oxide fines - Green	27,300	Lm3	$ 6.78	$ 185,094	$ 15,600,780
	Oxide fines - Brown	49,400	Lm3	$ 6.78	$ 334,932	
	Oxide fines - Medium Grade	65,000	Lm3	$ 6.78	$ 440,700	
	Crusher stockpile	123,500	Lm3	$ 6.78	$ 837,330	
	Medium Grade Stockpile	179,400	Lm3	$ 6.78	$ 1,216,332	
	Oxide fines #2	87,100	Lm3	$ 6.78	$ 590,538	
	Oxide fines #3	50,700	Lm3	$ 6.78	$ 343,746	
	Low grade ore	57,200	Lm3	$ 6.78	$ 387,816	
	Low Grade Stockpile "A"	721,500	Lm3	$ 6.78	$ 4,891,770	
	Low Grade Stockpile "C"	939,900	Lm3	$ 6.78	$ 6,372,522	

$ 15,600,800

A. Low Volume Estimate

Task	Activity	Quanity	Unit	Unit Price	Subtotal	Total
Load, Haul, Place and Compact Oxide Materials	Oxide fines - Green	27,300	Lm3	$ 6.78	$ 185,094	$ 4,977,876
	Oxide fines - Brown	49,400	Lm3	$ 6.78	$ 334,932	
	Oxide fines - Medium Grade	65,000	Lm3	$ 6.78	$ 440,700	
	Crusher stockpile	54,600	Lm3	$ 6.78	$ 370,188	
	Medium Grade Stockpile	13,000	Lm3	$ 6.78	$ 88,140	
	Oxide fines #2	13,000	Lm3	$ 6.78	$ 88,140	
	Oxide fines #3	50,700	Lm3	$ 6.78	$ 343,746	
	Low grade ore	57,200	Lm3	$ 6.78	$ 387,816	
	Low Grade Stockpile "A"	71,000	Lm3	$ 6.78	$ 481,380	
	Low Grade Stockpile "C"	333,000	Lm3	$ 6.78	$ 2,257,740	

$ 4,977,900

3 OXIDE RELOCATION CASE 2: 777 TRUCKS (50.1 Lm3 Cap.)

A. High Volume Estimate

Task	Activity	Quanity	Unit	Unit Price	Subtotal	Total
Load, Haul, Place and Compact Oxide Materials	Oxide fines - Green	27,300	Lm3	$ 4.88	$ 133,224	$ 11,228,880
	Oxide fines - Brown	49,400	Lm3	$ 4.88	$ 241,072	
	Oxide fines - Medium Grade	65,000	Lm3	$ 4.88	$ 317,200	
	Crusher stockpile	123,500	Lm3	$ 4.88	$ 602,680	
	Medium Grade Stockpile	179,400	Lm3	$ 4.88	$ 875,472	
	Oxide fines #2	87,100	Lm3	$ 4.88	$ 425,048	
	Oxide fines #3	50,700	Lm3	$ 4.88	$ 247,416	
	Low grade ore	57,200	Lm3	$ 4.88	$ 279,136	
	Low Grade Stockpile "A"	721,500	Lm3	$ 4.88	$ 3,520,920	
	Low Grade Stockpile "C"	939,900	Lm3	$ 4.88	$ 4,586,712	

$ 11,228,900

B. Low Volume Estimate

Task	Activity	Quanity	Unit	Unit Price	Subtotal	Total
Load, Haul, Place and Compact Oxide Materials	Oxide fines - Green	27,300	Lm3	$ 4.88	$ 133,224	$ 4,174,352
	Oxide fines - Brown	49,400	Lm3	$ 4.88	$ 241,072	
	Oxide fines - Medium Grade	65,000	Lm3	$ 4.88	$ 317,200	
	Crusher stockpile	54,600	Lm3	$ 4.88	$ 266,448	
	Medium Grade Stockpile	13,000	Lm3	$ 4.88	$ 63,440	
	Oxide fines #2	13,000	Lm3	$ 4.88	$ 63,440	
	Oxide fines #3	50,700	Lm3	$ 4.88	$ 247,416	
	Low grade ore	57,200	Lm3	$ 4.88	$ 279,136	
	Low Grade Stockpile "A"	92,300	Lm3	$ 4.88	$ 450,424	
	Low Grade Stockpile "C"	432,900	Lm3	$ 4.88	$ 2,112,552	

$ 4,174,400

Appendix E - Part II cont.
Areas/Volumes

	High Volume Estimate	Low Volume Estimate
"Oxide fines - Green" Volume (m3):	21000	21000
"Oxide fines - Brown" Volume (m3):	38000	38000
"Oxide fines - Medium Grade" Volume (m3):	50000	50000
"Crusher stockpile" Volume (m3):	95000	42000
"Medium Grade Stockpile" Volume (m3):	138000	10000
"Oxide fines #2" Volume (m3):	67000	10000
"Oxide fines #3" Volume (m3):	39000	39000
"Low grade ore" Volume (m3):	44000	44000
"Low grade Stockpile A" Volume (m3):	555000	71000
"Low grade Stockpile C" Volume (m3):	723000	333000

Assumptions

Oxide bulking factor	1.3

Hauling Unit Rates

Actions	Source	Truck Type	Unit Cost	Unit
Load, Haul, Dump, Spread bedding	North Fork	777	$ 5.15	Lm3
		773	$ 7.64	Lm3
Load, Haul, Dump, Spread, Compact Oxides	Various	777	$ 4.88	Lm3
		773	$ 6.78	Lm3
Load, Haul, Dump, Spread, Compact Till	Vangorda	777	$ 12.61	Lm3
		773	$ 18.37	Lm3
Load, Haul, Dump, Spread Till	Vangorda	777	$ 12.12	Lm3
		773	$ 17.41	Lm3