DATE: 8/27/2014

AUTHOR/TITLE: Syd De Vries, SURF Mining Engineer

TRADE STUDY NUMBER: 1313

TRADE STUDY TITLE: Waste Rock Disposal Options Revision 5

1. INTRODUCTION

Previously completed Trade Study #1313 compared three methods for transporting waste rock to the Open Cut. The three methods considered the following options:

1. **Track Haulage/Pipe Conveyor Method**
2. **Conveyor/Truck Haulage Method**
3. **Rail-Veyor Haulage Method**

The conclusions drawn from this Trade study indicated that the Rail Veyor option appeared to be an attractive alternative. However, the level of design of the Rail Veyor method that was used in this analysis was only at the conceptual level. Given that option 1 and 2 were at designed at the Preliminary Design level, it was decided that the Rail Veyor option be advanced to a Preliminary Design Level to enable a comparison with a higher level of confidence. The Preliminary Design for the Rail Veyor method has now been completed and this trade study is being updated to reflect that.

In addition to the inclusion of an updated design of the Rail Veyor System to this analysis, a new option for waste rock disposal is being considered. This option would provide for waste rock to be disposed of at the Gilt Edge mine waste dump, located just over 8 miles from the Kirk Road Loading point. This option is being considered in light of recent developments regarding the use of Barrick's Open Cut for waste rock storage. As it currently stands, SURF would be required to take ownership of the Open Cut and assume all of its liabilities should it be decided to use this location for waste rock storage.

This Trade Study will provide an updated review of the Rail Veyor waste rock disposal method as well as include the new option of disposing of waste rock into the Gilt Edge Mine.

For this comparison, the following assumptions are made:

- The base case for determination of total waste rock excavated is the LBNE 10 + 24KT LAr option which has a total excavated waste rock quantity of 655KT.
- It is assumed that the period of waste rock disposal will be over a period of 2 years for all options
- All waste rock produced from lab excavations are hoisted up the Ross shaft. The costs of all options begin at the dump from the Ross Shaft Skipping system.
- A rock geochemical assessment to determine potential water treatment requirements will not be included in this analysis as this is being completed independent of this analysis. The costs of this are not included in this study.

2. TRADE STUDY MEMBERS AND ORGANIZATION THEY REPRESENT

Syd De Vries - SURF

3. DEFINITION OF OPTIONS

1. Track Haulage/Pipe Conveyor Method

The first option, the Track Haulage/Pipe Conveyor system, is to utilize the historical ore haulage route, passing from the Ross Shaft skips through the crushing system, fine ore bin, into a Track Haulage system within the tramway. Upon exit of the Tramway, waste rock would be dumped into a storage bin from which it would be transferred to a new pipe conveyor operating in reverse direction of the former conveyor and discharging into the south side of the open cut. This option was selected for inclusion into the DUSEL PDR. The following graphic provides an outline of this system:

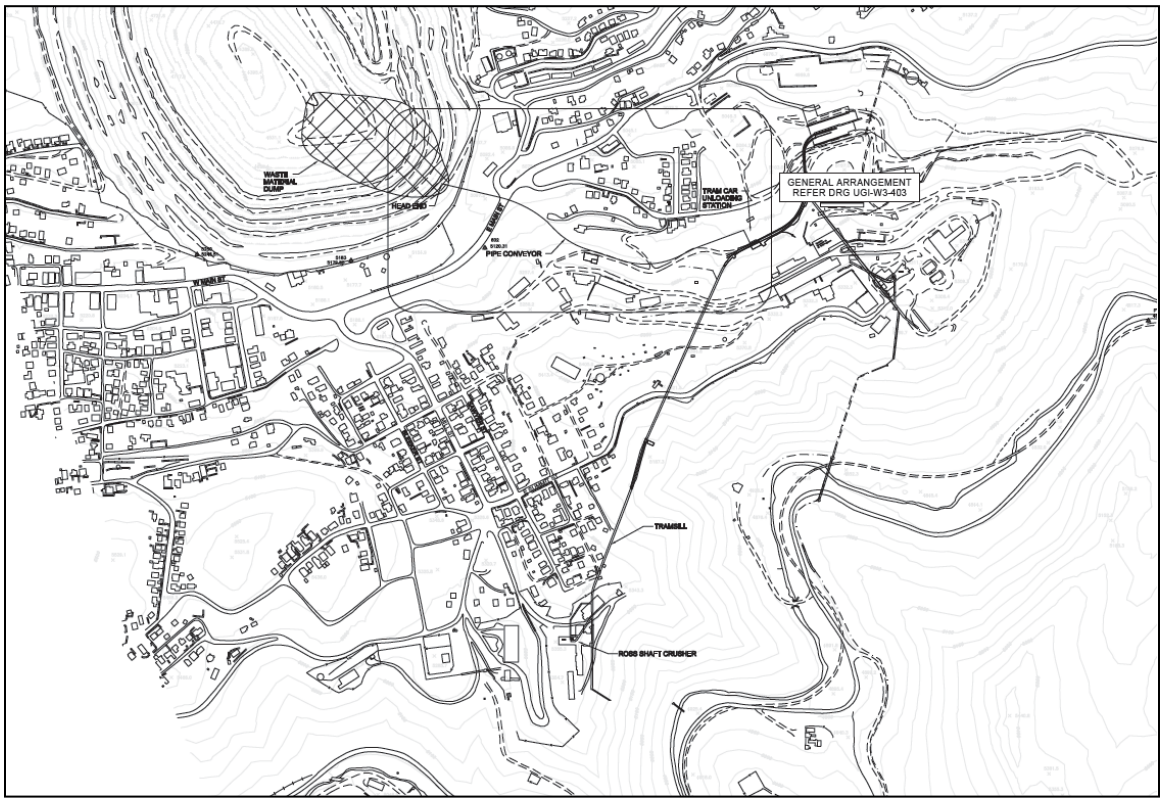

Figure 1: Overview of Track Haulage/Pipe Conveyor Method

Figure 2 – Existing Tramway Loadout Chute for Track Haulage (Requires Refurbishment)

Figure 3 – Existing Tramway

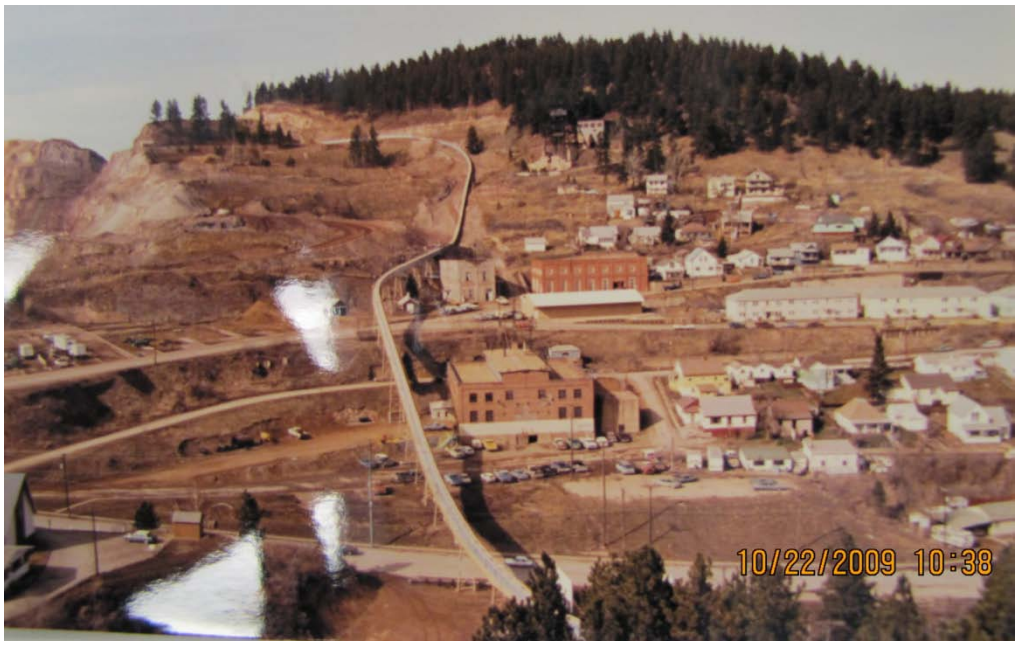

Figure 4 – Photo of Pipe Conveyor Installation during Mine Operation

Figure 5 – Photo of Pipe Conveyor during Mine Operation at Homestake Mine

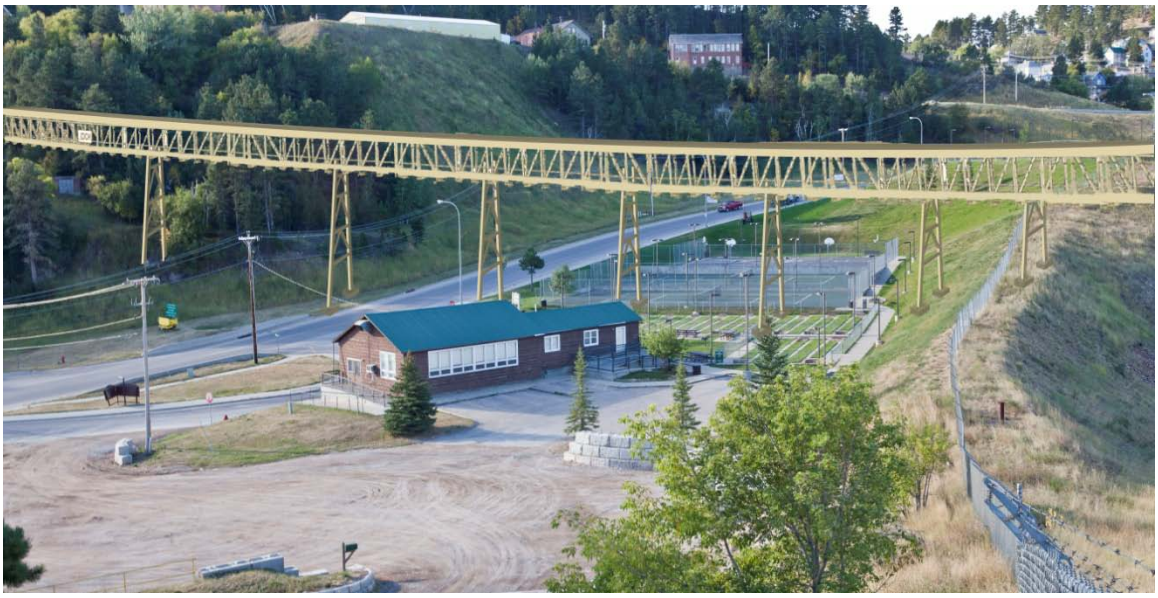

Figure 6 – Computer Generated Graphic of Pipe Conveyor Crossing Hwy 85

2. Conveyor/Truck Haulage Method

The second option uses the same skips and crusher, but bypasses the ore bin using a new conveyor to a new steel bin on Kirk Road below the Ross complex. From this bin, trucks would deliver the material to a final storage location where a dozer would maintain the disposal pile. The following graphics provide an outline for the system:

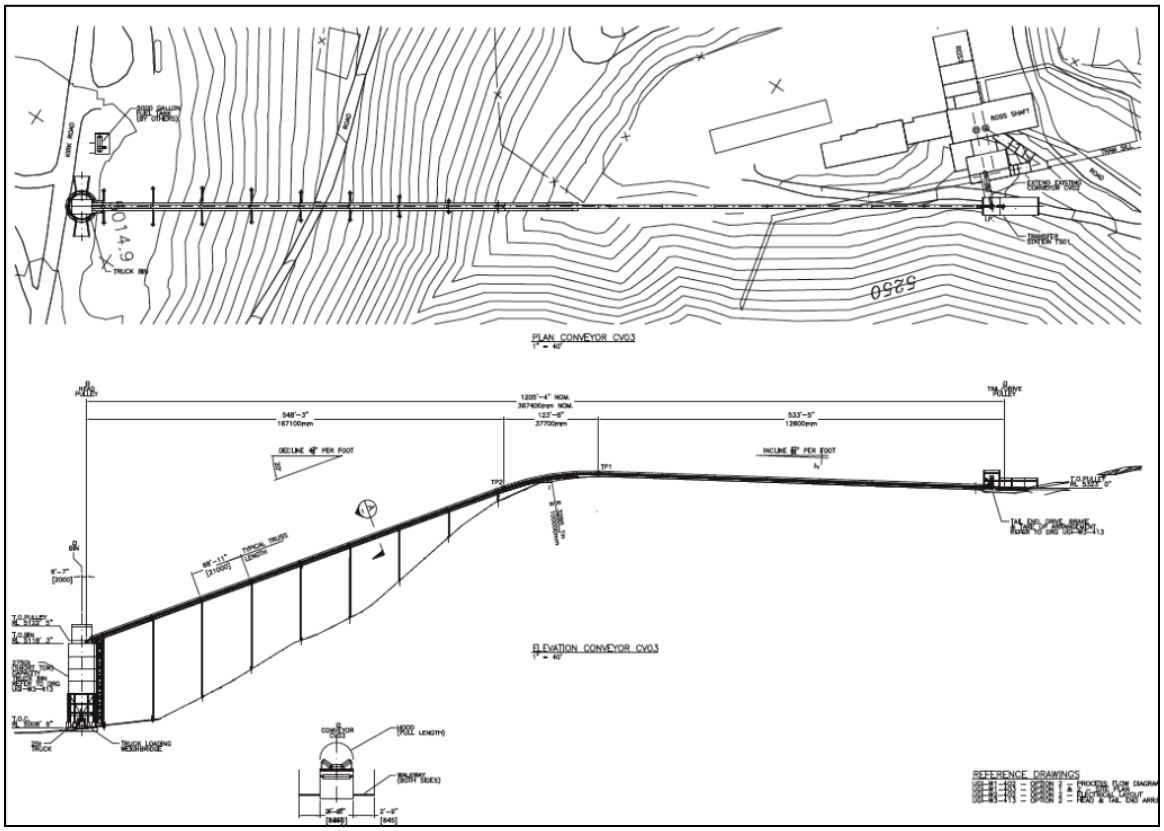

Figure 7 - Plan and Section View of Surface Conveyor to Truck Load Out

Note: As part of this analysis, the Truck Loading Bin shown in the section view of Figure 7 has not been included in the cost estimate. Given the over $3MM capital cost of this bin vs. the relatively low volume of waste rock to transport, it was deemed to be more cost effective to include the loading of the trucks using a front end loader as part of the haulage costs.

a. Disposal to Open Cut

In this option, waste rock is hauled using 20T dump trucks from the Kirk road dump shown in Figure 7 to the historic Open Cut owned by Barrick Mining Company. The

route that the haulage trucks would take would follow a 6 mile path that would include the Kirk Road, Highway 85 through Lead to Highway 14A into Barrick's property and over a new haulage road to the final storage location as shown in Figure 8 below:

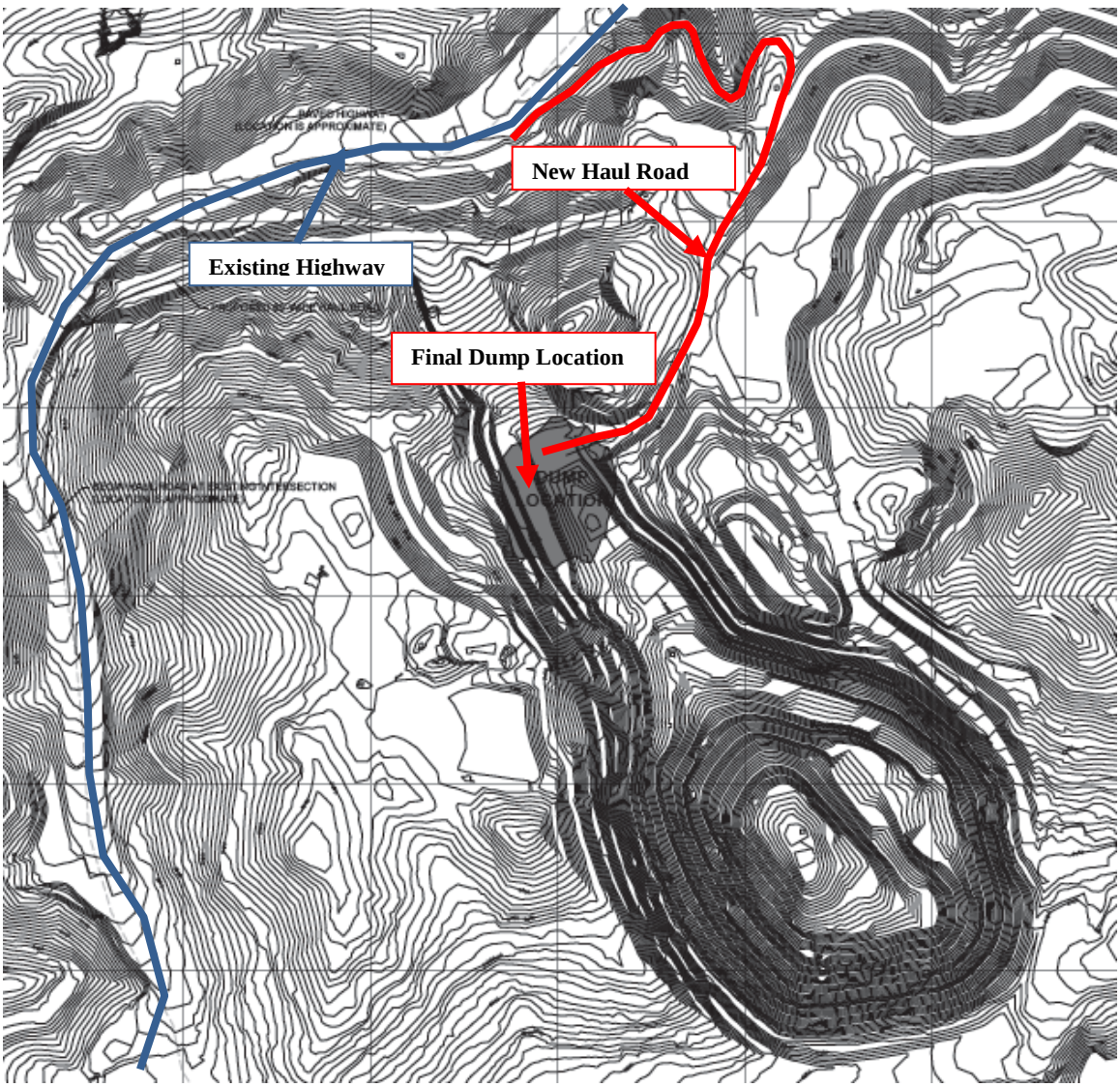

Figure 8 - Haulage Road and Open Cut Final Dump Location

b. Disposal to Gilt Edge Mine

In this option, waste rock is hauled using 20T dump trucks from the Kirk road dump shown in Figure 7 to the Gilt Edge Mine owned by Barrick Mining Company. The route that the haulage trucks would take would follow a 8 mile path that would include the Kirk

Road, Highway 385 to the Gilt Edge Mine and over the mine's existing access road to the final storage location as shown in Figures 9 and 10 below:

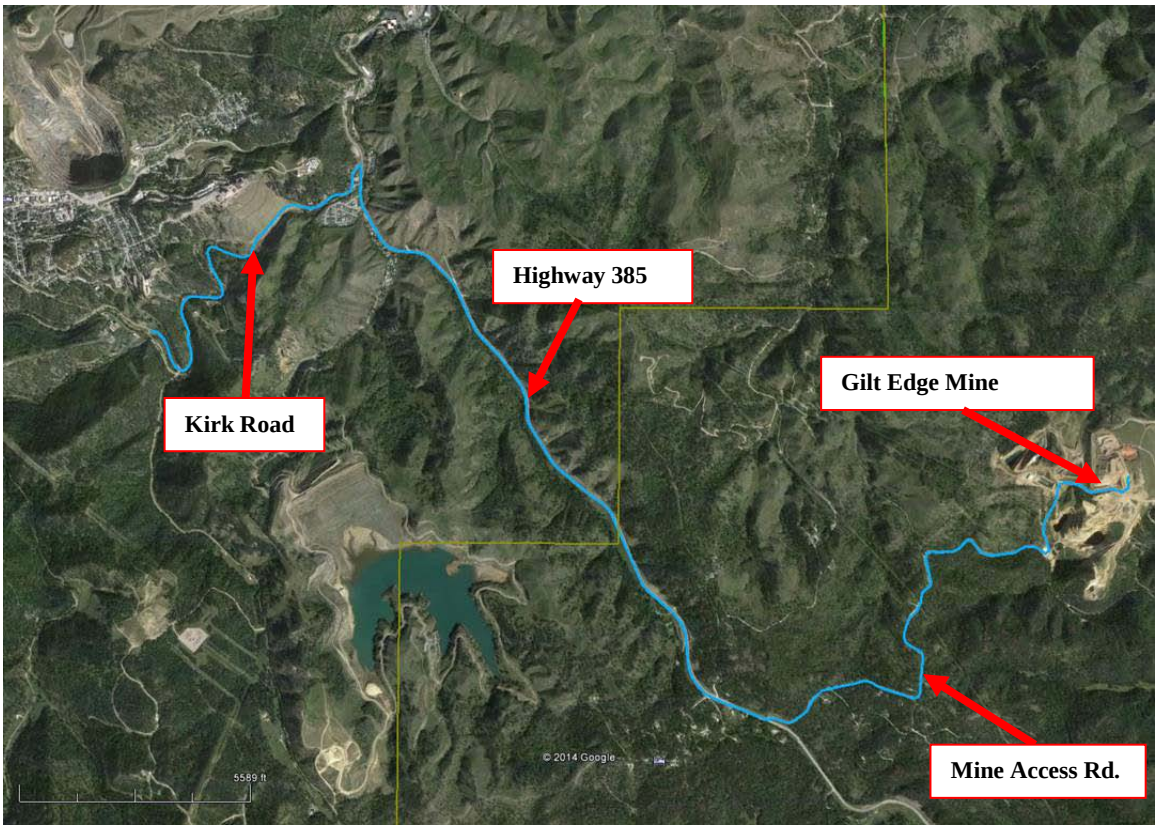

Figure 9 - Haulage Road and Gilt Edge Mine Final Dump Location

Figure 10 – Gilt Edge Mine Final Dump Location

3. Rail-Veyor Haulage Method

The third option, the Rail-Veyor System, uses the same skips, crusher and Fine Ore bin, but transfers the waste rock into a Rail-Veyor mechanism that transfers the waste rock to the Open Cut. The Rail-Veyor system, as shown in the photos below, is a hybrid between a conventional Track Haulage system and a Conveyor. A Rail-Veyor train consists of a number of rail cars that are connected in a continuous length like a section of trough conveyor. The train is driven through external electric drive motors which rotate foam filled tires that make contact with the Rail-Veyor cars to advance the train either forwards or backwards. Cars are dumped from a trestle that elevates the train through a 180 degree dump loop. A video of showing the operation of a Rail-Veyor that describes the details of its operation can be viewed using the following link:

http://www.google.com/url?sa=t&rct=j&q=rail%20veyor&source=web&cd=2&cad=rja&ved=0CDcQtwIwAQ&url=http%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DhctG2dQzHwg&ei=6evuUZ6lIqLtiwLOuoHgAQ&usg=AFQjCNH76bwY0SChKAYnz1zl_kZnON6YxA&bvm=bv.49641647,d.cGE

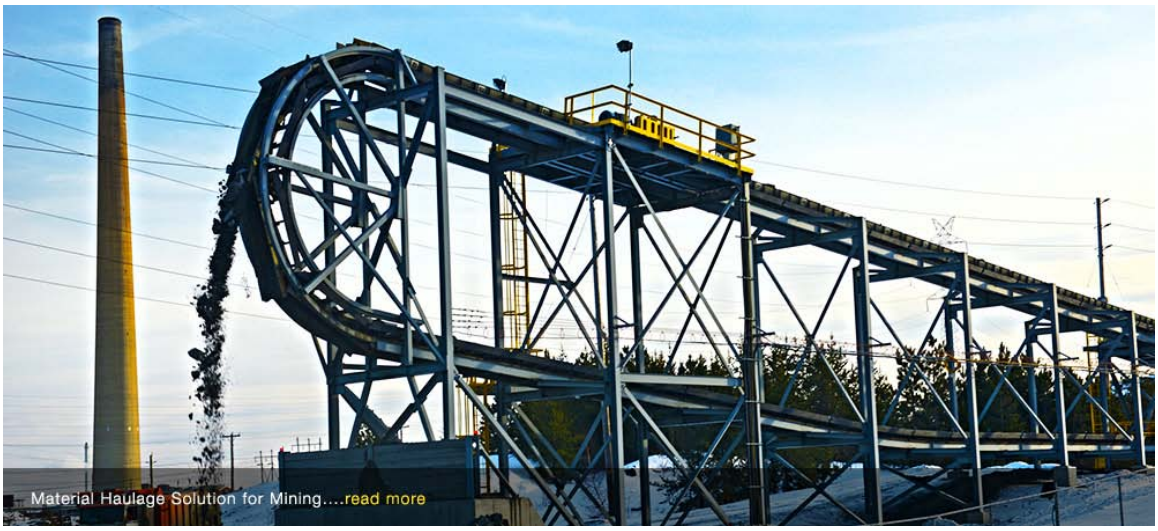

Figure 11 – Rail-Veyor Dump Installation

Figure 10 Rail-Veyor Entry into Tunnel

Figure 11 Rail-Veyor on Track

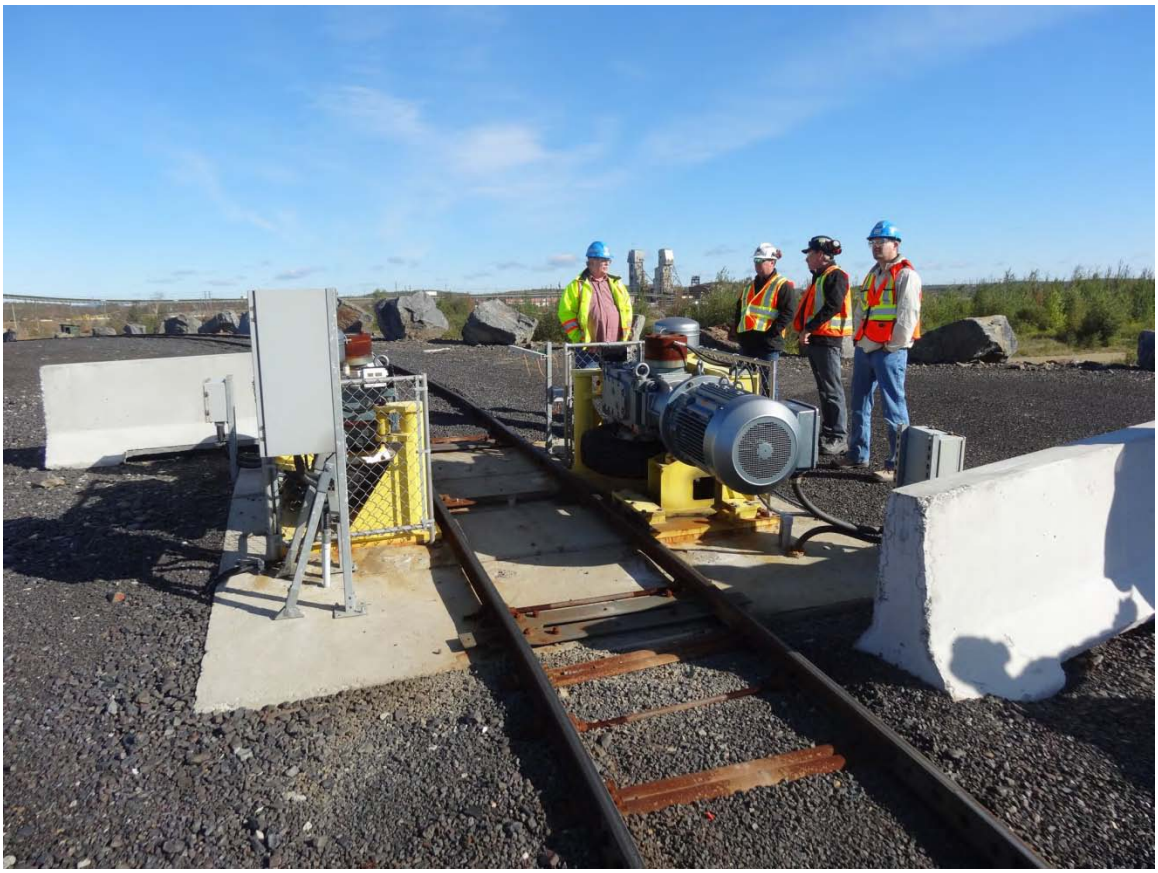

Figure 11 Rail-Veyor typical Drive Station

The Preliminary Design for the Rail Veyor System has provides for a waste removal system that is capable of transferring up to 3,000 tons per day over an 11 hour per day operation. The key system operating parameters are listed in Table 1 below:

System Parameters	
Configuration	Shuttle
Total Installed Track	11962 feet
Capacity	284 Tons/Hour
Operating Hours	10-12 Hours/Day
Bulk Density	115 Lbs/Cu. Foot
Loaded Speed Tramming	6.7 Mile/Hour
Empty Speed Tramming	9.0 Mile/Hour
Loading Speed	2.5 Mile/Hour
Unloading Speed	6.7 Mile/Hour
Car Dimensions	30" wide x 96" long
Number of Cars per Train	154 Cars
Number of Trains	1 Train
Train Length	1230 feet
Material Weight per Train	173 Tons
Loaded Train Weight	251 Tons
Number of Drive Stations	29

Table 1 – Rail Veyor Operating Parameters

The Scope of Work for the installation of the Rail Veyor System at SURF will utilize the following:

1. Ross Shaft Crusher and Waste Rock Storage Bin
2. Load Out System
3. Tramway for Haulage
4. Tramway portal and Portal Exit
5. Overhead Crossing at Highway 85
6. Track installation from Highway 85 along the Open Cut to the final Dump Location

Figure 13 below shows the overall route that the Rail Veyor system will follow to the Open Cut Dump location:

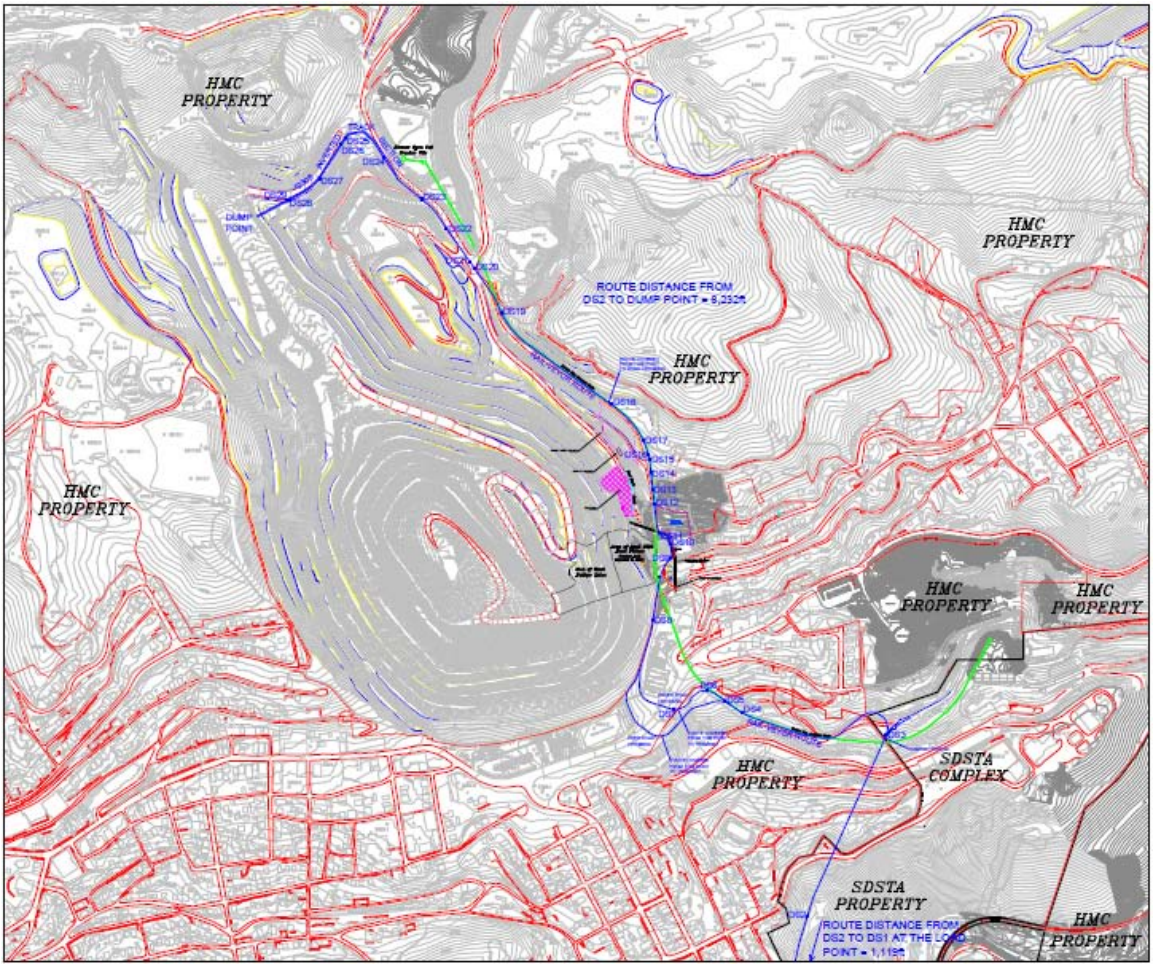

Figure 13 - Rail-Veyor Route

- **Ross Shaft Crusher and Waste Rock Storage Bin**

Similar to Option 1, the existing Ross Shaft Crusher and Waste Rock storage bin will be refurbished. The costs for this scope of work will be the same for this option as is for Option 1.

- **Load Out System**

The Load Out system for the Rail Veyor method will utilize the existing location at the bottom of the waste rock storage bin in the Tramway but will include the following scope:

- Demolition of the Existing Loading Platform and Chutes
- Excavation at the Chute Location for a Drive Station installation

- Excavation for Over/Under Loop
- Ground Support Installation
- Relocation of Utilities as required
- Enlargement of two chutes for use as loading chutes for the Rail Veyor System
- Installation of two new shut off gates
- Installation of Over/Under support Steel, Rail, Invert Loop, and Access Platforms including all footings
- Installation of Load Point Drive Station
- Installation of Two Loading Chutes

Figures 14 and 15 below show the scope of work included in the Load Out System

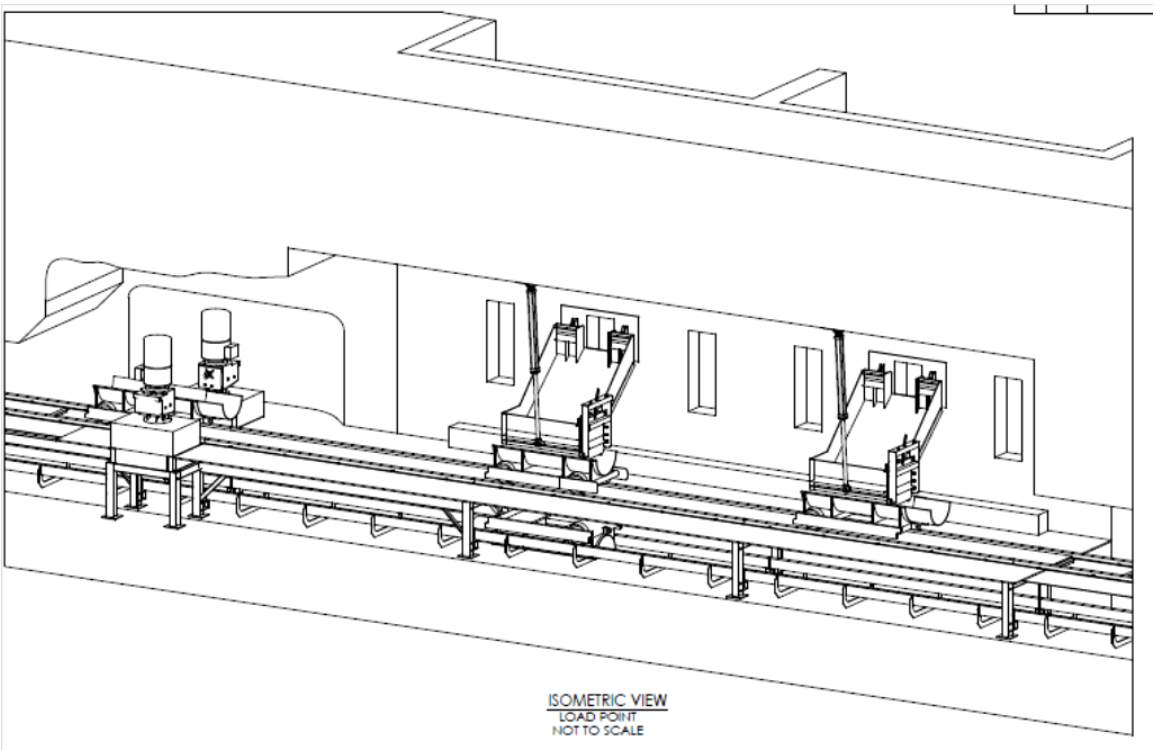

Figure 14 – Tramway Load Out System

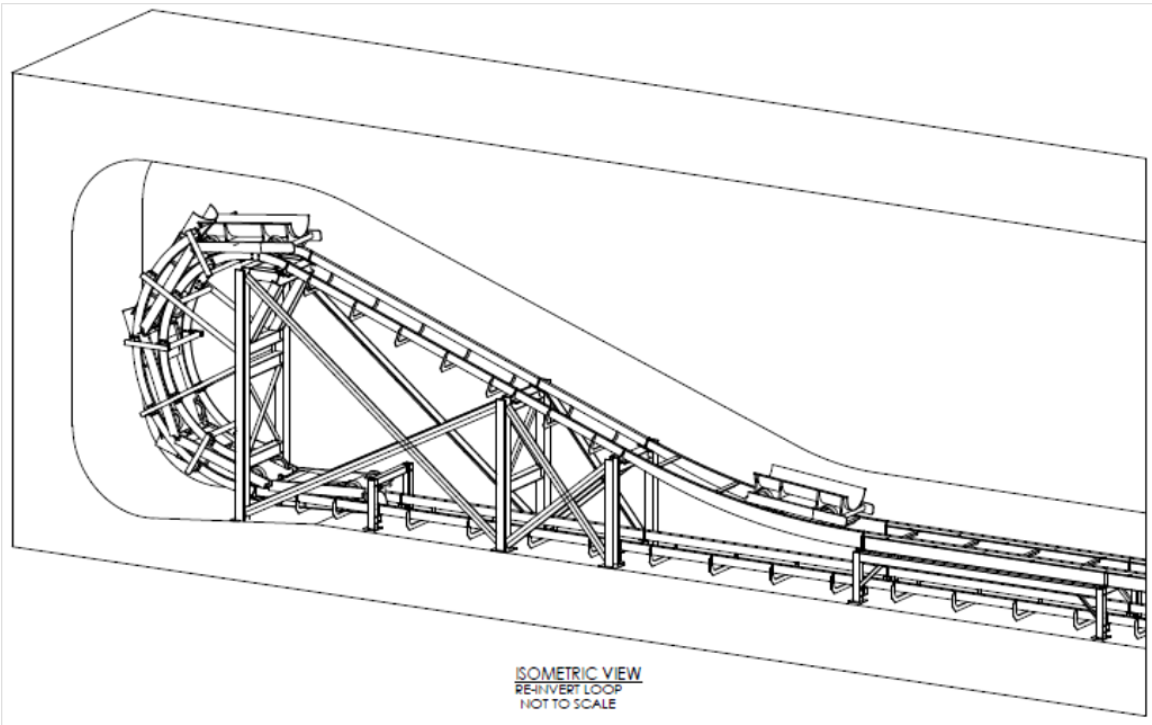

Figure 15 – Tramway Over/Under Loop

- **Tramway for Haulage**

The scope of work included within the existing Tramway beyond the Loading station includes the following:

- Maintenance and repair to the existing Tramway mid-point Surface Exposure Building
- Installation of light ballast over the track length
- Installation of Drive Station in the Surface exposure building
- Installation of Track and Ties

Figure 16 below shows a Typical section in the Tramway that shows the location of existing utilities in relation to the location of the Rail Veyor in its Over/Under location:

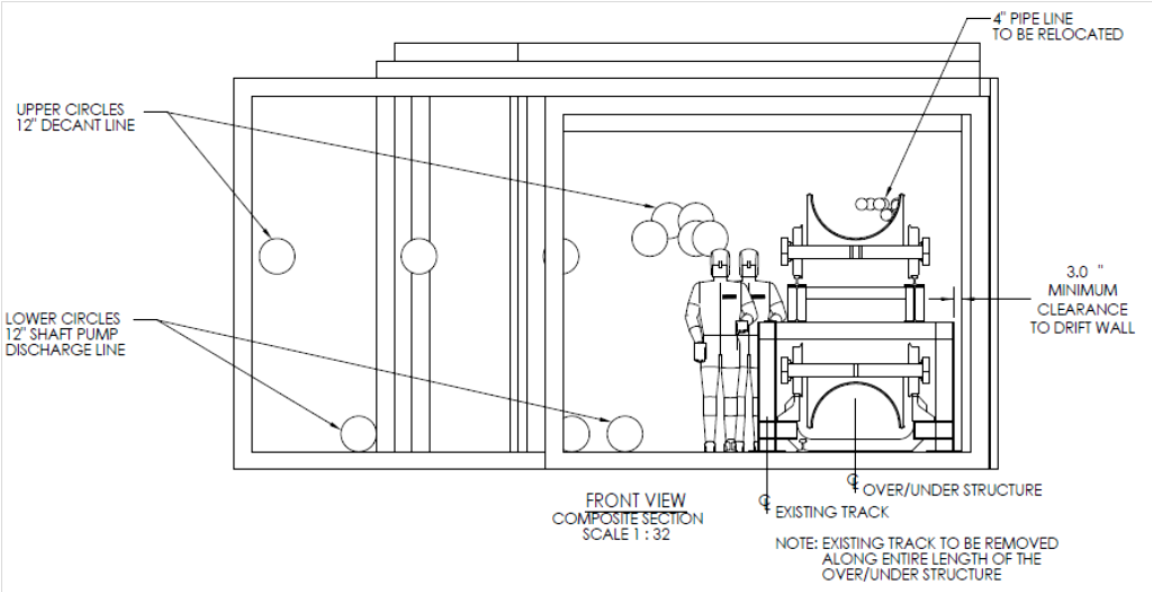

Figure 16 – Section View of Rail Veyor in Existing Tramway

Figure 17 below shows the location in Tramway system where the Rail Veyor transitions from a single level to an over/under section:

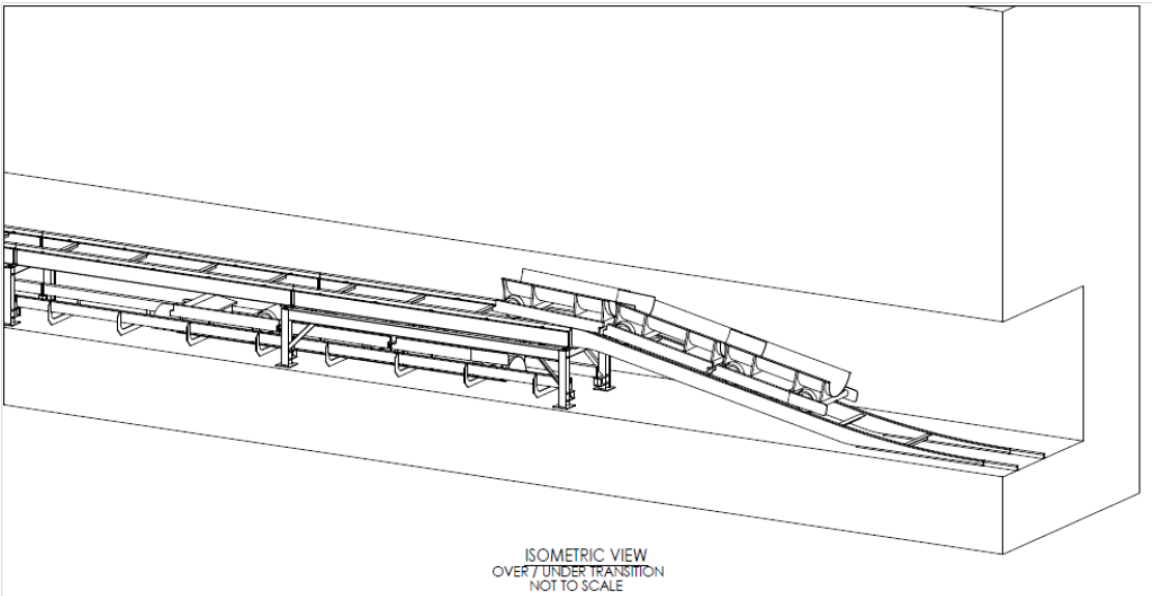

Figure 17 – Over/Under Transition in Tramway

- **Tramway portal and Portal Exit**

The Rail Veyor will transition from an Underground pathway to a Surface pathway at the Tramway exit Portal. At the exit location, the route will need to make a nearly 180 degree turn to swing back to the original pipe conveyor location. The minimum turning radius of the Rail Veyor System is 100 ft. When applying this turning radius to the required pathway, the existing topography will require a fill section at the portal exit location to provide for this curve. Figure 18 below shows this fill section:

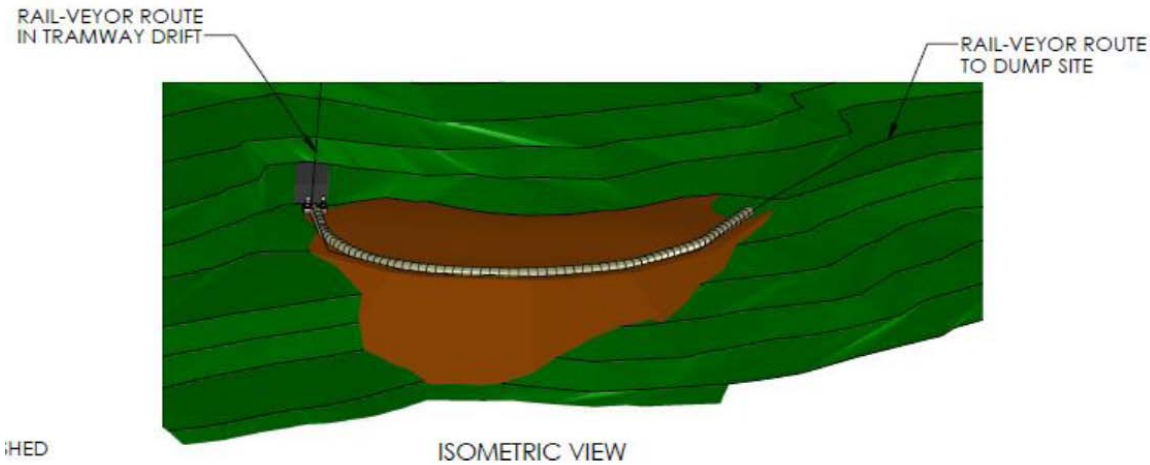

Figure 18 – Tramway Portal Exit showing Fill Section

The fill for this section is planned to be obtained from the cut required further down the Rail Veyor route where the Rail Veyor approached the Over Head Crossing as shown in Figure 19 below:

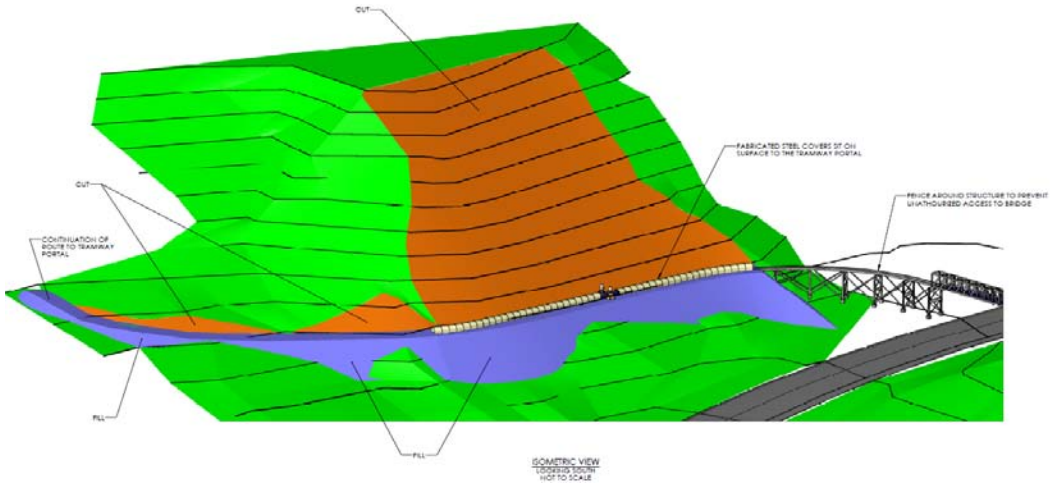

Figure 19 – Rail Veyor Approach to Overhead Crossing

- **Crossing Highway 85**
    a. Under the Highway Option

The Rail Veyor system will need to cross Highway 85 to reach its ultimate final disposal location. Two options were studied for this crossing. The first option considered a tunneling option under the highway. This option is shown in more detail in Figure 20 below:

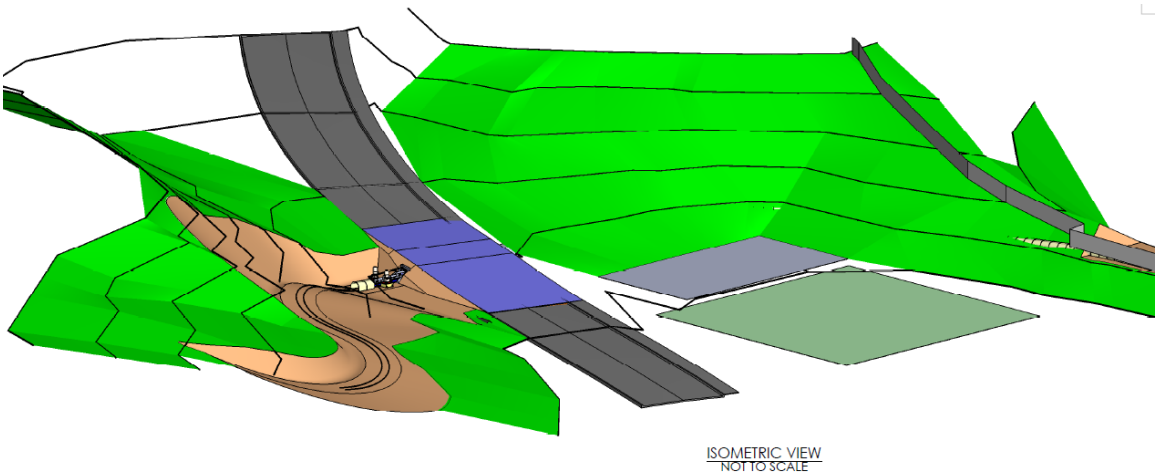

Figure 20 – Isometric View Highway 85 Crossing – Under the Highway Option

In this option, the approach to the crossing requires excavation of the east slope to enable the Rail Veyor to get low enough to tunnel under the highway. Unfortunately, the tunnel can't be excavated deep enough to avoid re-grading of the highway. This is due to the location of a storm sewer pipe that interferes with the preferred location of the tunnel as shown in Figure 21 below:

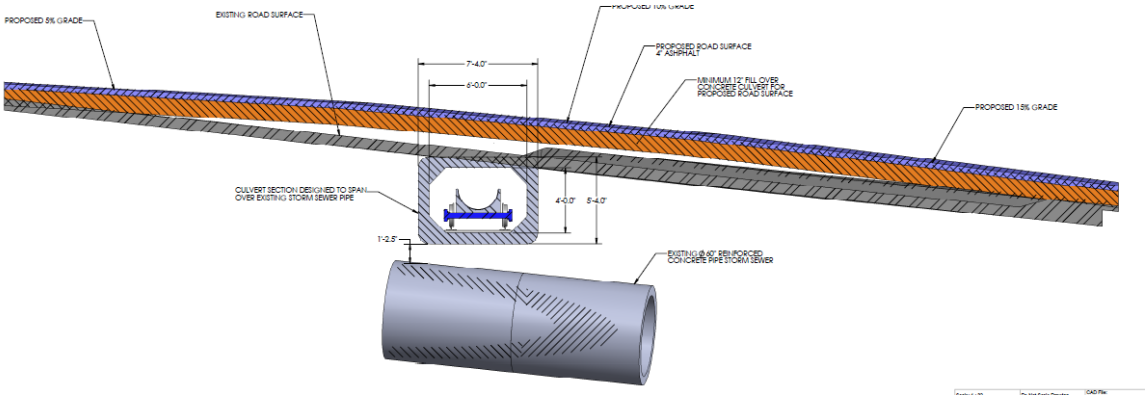

Figure 20 – Section View of Tunnel under Highway 85

On the west side of the Highway, the Rail Veyor continues to be buried below the current hillside unto it outcrops near the rim of the Open Cut. It was decided to keep the Rail Veyor buried over this section to protect the public as the hill is often used for recreational purposes.

b. Over the Highway Option

An alternative to the tunneling option incorporates the use of a bridge type structure to support the Rail Veyor over the Highway. This option is shown in Figure 21 below:

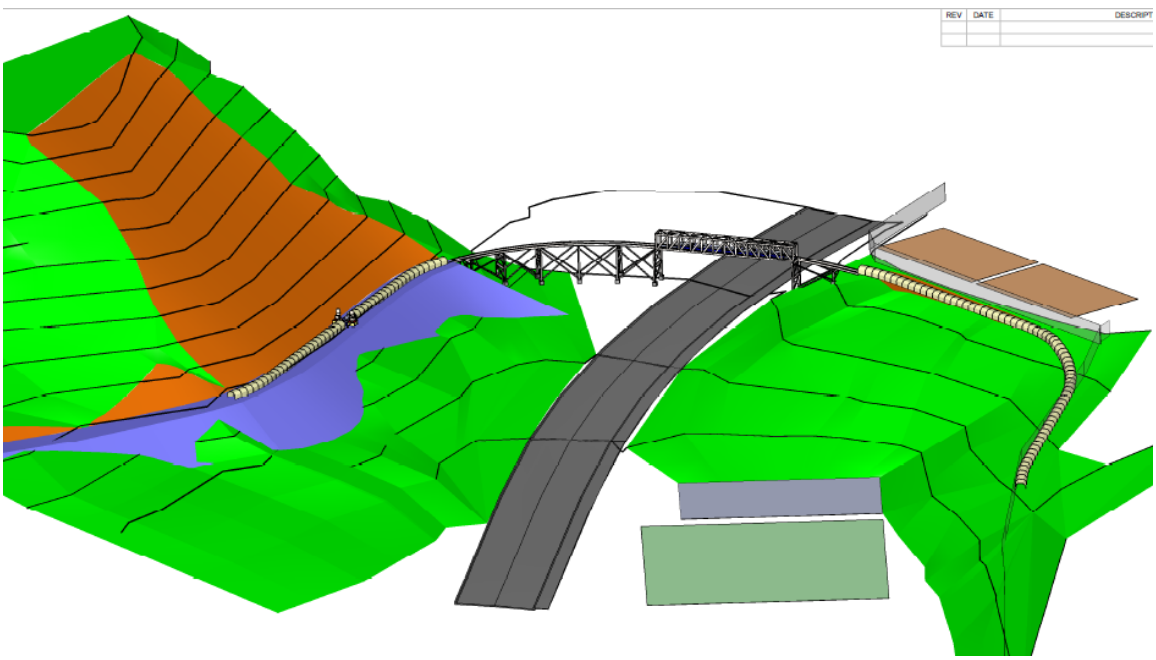

Figure 21 – Isometric View Highway 85 Crossing – Overhead Option

In this option, excavation is required on the east side of the highway to provide a level road to install the Rail Veyor on. A steel support trestle is constructed on both sides of the highway together with a steel bridge to provide support for the Rail Veyor to cross at the required elevation. The Rail Veyor comes off the trestle at the top of the recreational hill between the Volley Ball courts and the Tennis Courts at the bottom of the hill. The Rail veyor has been buried through the top of the hill to enable the hill to be maintained for recreational purposes.

In comparing the two options to cross the highway, it was decided that the most favored option would be the Overhead option. The selection was made based on the following determinations:

The Overhead option

- Would be the least disruptive to traffic flow during construction
- Had the lowest risk due to the associated unknowns with buried utilities along US 85, including a sewer drainage pipe location
- Would be the easiest to demobilize following the completion of the project
- Was the lower cost alternative by about 15% or $100K

Once the Rail Veyor has completed the crossing at Highway 85, the system will follow the rim of the Open cut until it swings away from an unstable section of the pit wall where there has been a pit wall failure. Figure 22 below shows the route of the Rail Veyor as it moves away from this unstable location and swings around an old power station and climbs up a steep hill:

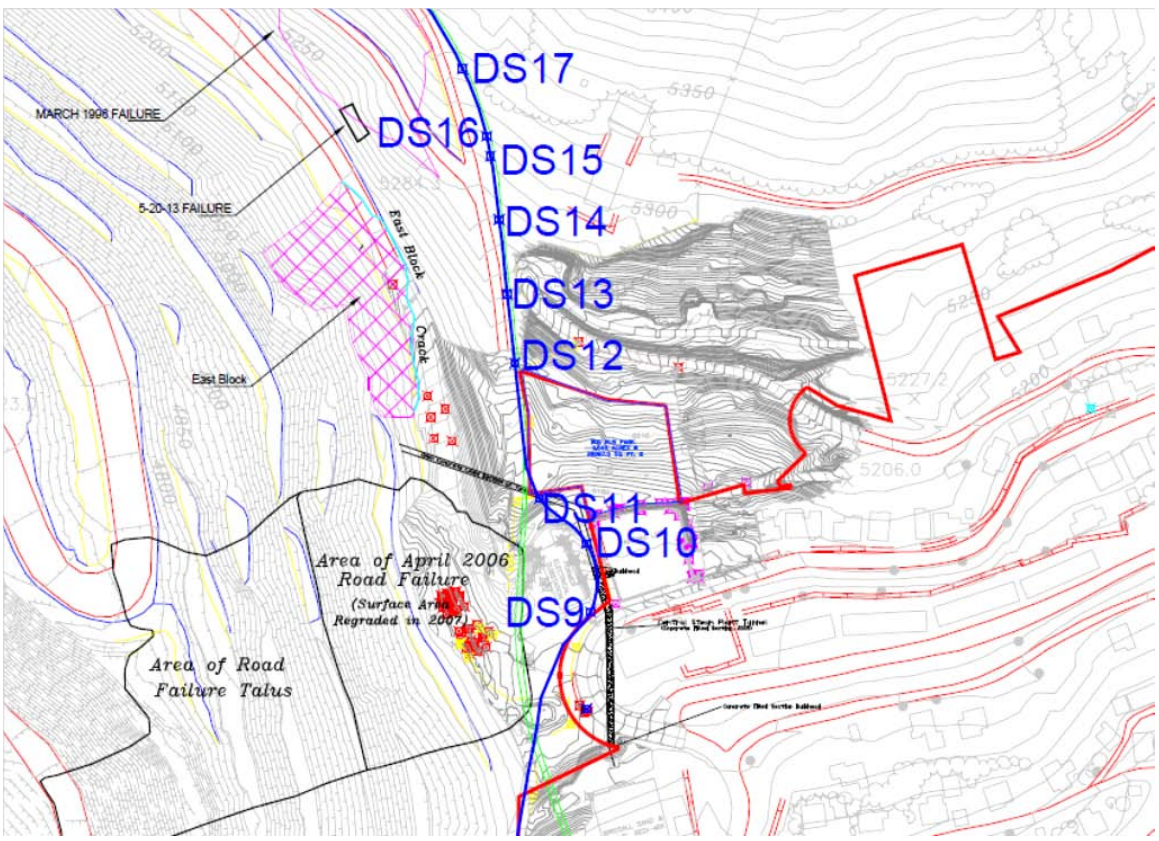

Figure 22 – Plan View of Rail Veyor Route along Steep Up Slope

Between Drive Station 9 and Drive Station 17, the Rail Veyor climbs approximately 200 vertical feet over a horizontal distance of 1,000 ft for an approximate grade of 20%. This is well within the range of operation for the Rail Veyor but also requires the most amount of Drive stations due the steep incline. Upon reaching the highest point of the route at

elevation 5360, the Rail Veyor follows a steep down slope to about 5140 to where the dump loop system is in place. Figure 23 below shows the route for the dump loop section and the path for the 1230 ft long section of inverted train which is necessary to enable the train to be completely unloaded:

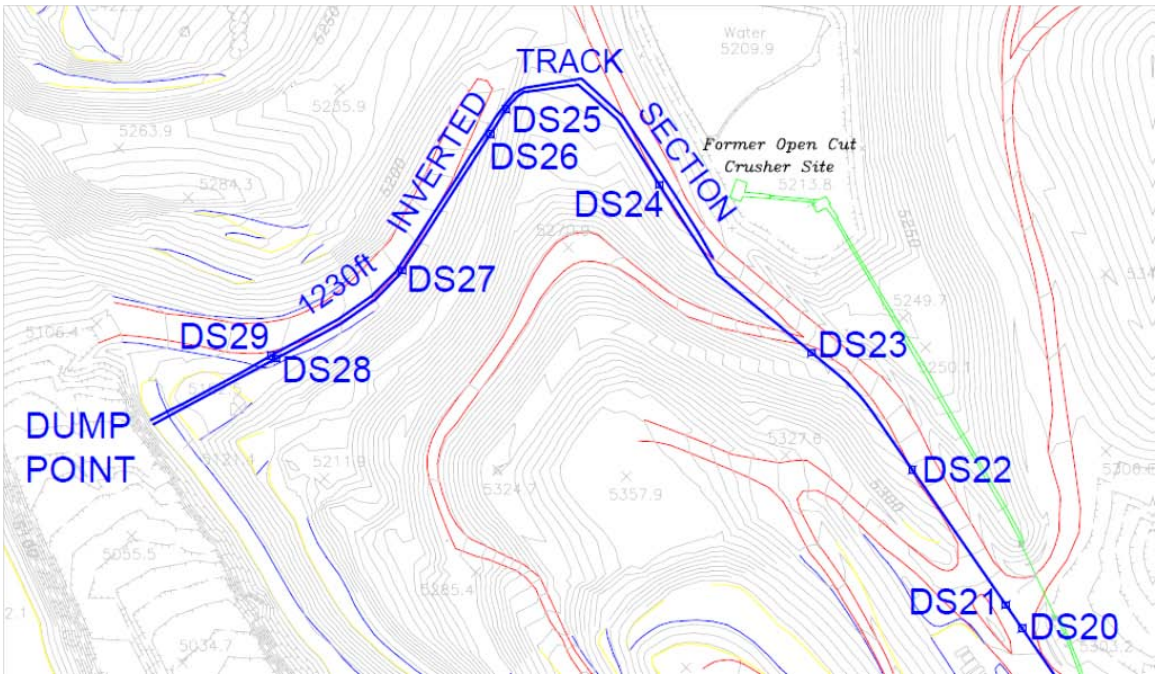

Figure 23 – Plan View of Rail Veyor Route showing Dump Loop and Inverted Train Section

The Dump Loop is constructed on a bench that enables approximately 11,000 tons of live storage capacity which represents nearly 4 days of maximum waste rock haulage. Figure 24 shows the Dump Loop arrangement as an isometric view:

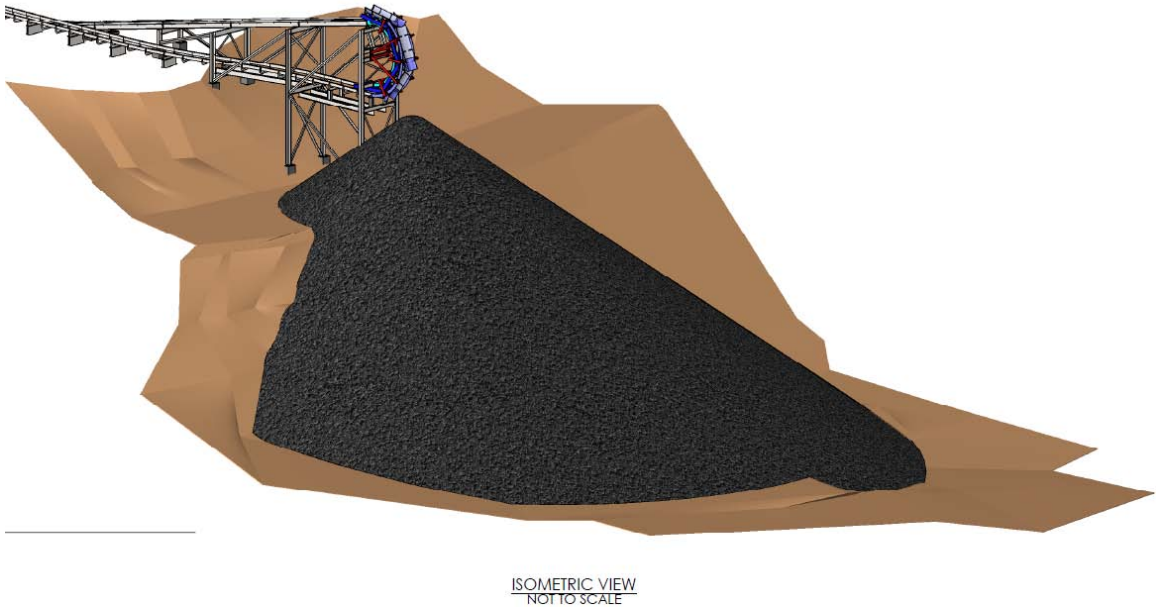

Figure 24 – Isometric View – Dump Loop Location

4. VALUE SYSTEM

The following is a list of Value Items from which a detailed Trade-Off Analysis of the methods is performed:

a. Total capital cost to transport Waste Rock from the Ross Shaft to the final storage location
b. Operating Costs
c. Safety impacts
d. Environmental impact of the options with respect to noise, dust and waste water treatment
e. Owner Liabilities

5. TRADE-OFF ANALYSIS

a. Capital Cost Comparisons

A cost comparison for each system was prepared for this study. An existing estimate prepared by SRK at the 100% PDR level for the Track Haulage/Pipe Conveyor system was used as a basis for the estimate work. Common to all options, the following is considered:

- All Crusher, Tramway and Discharge Gates systems would be installed using outside Contractors subject to markups for overhead and indirect costs.
- Tramway work including the refurbishment of the discharge chutes, removal of the existing track, excavation, installation of new ground support and removal of existing timber sets, and refurbishment of the Tramway Buildings mid way along the Tramway and at the exit would be performed using Sanford Lab personnel.
- All Surface civil work would be performed using outside Contractors
- All Electrical work would be performed using outside Contractors
- EPCM was added to all options under the consideration that the work would be performed under the direction of a Construction Manager.
- No contingency was added to any of the options as it was felt that for the purposes of comparison of options, contingency would not be necessary to add. However, contingency does need to be included to the selected option in accordance with the overall contingency plan of the Project.

For the Conveyor/Truck Haulage Method, an estimate prepared by SRK at the 60% PDR level was used as a basis for the estimate work. In addition, the following adjustment was made:

- The installation of a waste rock storage bin was removed and it was assumed that all trucks would be loaded with a Front end Loader.

For the Rail-Veyor estimate, the following assumptions were included

- The Rail-Veyor system would be installed by the vendor using his contracted workforce. This includes the installation of required rail, ties, ballast, splice plates and bolts, drive motors and some electrics, train or trains, and a dump loop. Estimates have been provided by Rail-Veyor and include all required markups and consequently do not need to be marked up again in the spread sheet.

Capital Cost Comparisons

The following Tables present summary cost estimates for the options reviewed.

Table 2 – Track Haulage/Pipe Conveyor Cost Estimate Summary

Track Haulage/Pipe Conveyor
June 17, 2014

SUMMARY									
	DIRECT COSTS						INDIRECTS & MARK-UPS		TOTAL
PIPE CONVEYOR OPTION	LABOUR		SUPPLIES & EQUIPMENT	SUB-TOTAL	EXCISE TAXES	FREIGHT	INDIRECT	OVERHEAD and FEE	
	HOUR	COST	COST	COST	COST	COST	8%	13%	
ROSS SHAFT	2,430	138,754	590,291	729,045	11,806	20,588	58,324	102,358	922,121
DISCHARGE GATES	850	48,544	170,711	219,255	3,414	10,963	17,540	30,783	281,955
TRAMWAY SYSTEM	3,848	145,454	1,747,500	1,892,954	-	94,523	-	-	1,987,477
DUMP CAR UNLOADING SYSTEM	4,467	255,118	619,082	874,201	12,382	43,710	69,936	113,646	1,113,874
DUMP HOPPER, BELT FEEDER & TRANSFER CONVEYOR	4,592	248,447	1,606,365	1,854,812	32,127	96,355	148,385	241,126	2,372,805
PIPE CONVEYOR	13,095	752,341	3,491,405	4,243,745	69,828	212,187	339,500	551,687	5,416,947
ELECTRICAL & INSTRUMENTATION	1,680	333,618	1,727,324	2,060,943	34,546	103,047	164,875	267,923	2,631,334
TOTAL CONSTRUCTION COSTS	**$ 30,962**	**$ 1,922,277**	**$ 9,952,678**	**$ 11,874,954**	**$ 164,104**	**$ 581,373**	**$ 798,560**	**$ 1,307,522**	**$ 14,726,513**
EPCM									**$ 2,208,977**
Total Project Costs									**$ 16,935,490**

Table 3 – Conveyor/Truck Haulage – Open Cut Disposal Location

Conveyor/Truck Haulage - Dump Site North Section of Open Cut
June 17, 2014

	DIRECT COSTS					INDIRECTS & MARK-UPS			TOTAL
KIRK ROAD TO North Open Cut Option	LABOUR		SUPPLIES & EQUIPMENT	SUB-TOTAL	FREIGHT	INDIRECT	OVERHAD AND FEE	EXCISE TAXES	
	HOUR	COST	COST	COST	COST	8%	13%	2%	
ROSS SHAFT	2,080	$ 118,788.80	$ 385,000.00	$ 503,788.80	$ 25,189.44	$ 40,303.26	$ 70,731.95	$ 12,800.27	$ 652,813.56
CV02 - CONVEYOR EXTENSION	3,930	$ 250,550.13	$ 785,725.19	$ 1,036,275.32	$ 51,813.77	$ 82,902.03	$ 145,493.05	$ 26,329.68	$ 1,342,813.85
CV03 - CLEATED CONVEYOR	13,036	$ 832,549.15	$ 2,679,209.70	$ 3,511,758.85	$ 175,587.94	$ 280,940.71	$ 493,050.94	$ 89,226.77	$ 4,550,565.22
WASTE ROCK DUMP	-	$ -	$ 305,000.00	$ 305,000.00	$ -	$ -	$ -	$ 6,100.00	$ 311,100.00
HAUL ROAD	-	$ -	$ -	$ 580,000.00	$ -	$ 46,400.00	$ 81,432.00	$ 14,156.64	$ 721,989
TRUCK HAULAGE				$ 4,742,634.40				$ 94,852.69	$ 4,837,487
ELECTRICAL & INSTRUMENTATION	2,680	$ 252,396.50	$ 872,536.33	$ 1,124,932.82	$ 56,246.64	$ 89,994.63	$ 157,940.57	$ 28,582.29	$ 1,457,696.95
TOTAL CONSTRUCTION COSTS	**21,726**	**$ 1,454,285**	**$ 5,027,471**	**$ 11,804,390**	**$ 308,838**	**$ 540,541**	**$ 948,649**	**$ 272,048**	**$ 13,874,465**
EPCM									**$ 1,203,849**
TOTAL COSTS	**21,726**	**$ 1,454,285**	**$ 5,027,471**	**$ 11,804,390**	**$ 308,838**	**$ 540,541**	**$ 948,649**	**$ 272,048**	**$ 15,078,314**

Table 4 – Conveyor/Truck Haulage – Gilt Edge Mine Disposal Location

Conveyor/Truck Haulage - Dump Site Gilt Edge Mine
June 17, 2014

	DIRECT COSTS					INDIRECTS & MARK-UPS			TOTAL
KIRK ROAD to Guilt Edge Mine Option	LABOUR		SUPPLIES & EQUIPMENT	SUB-TOTAL	FREIGHT	INDIRECT	OVERHEAD AND FEE	EXCISE TAXES	
	HOUR	COST	COST	COST	COST	8%	13%	2%	
ROSS SHAFT	2,080	$ 118,788.80	$ 385,000.00	$ 503,788.80	$ 25,189.44	$ 40,303.26	$ 70,731.95	$ 12,800.27	$ 652,813.56
CV02 - CONVEYOR EXTENSION	3,930	$ 250,550.13	$ 785,725.19	$ 1,036,275.32	$ 51,813.77	$ 82,902.03	$ 145,493.05	$ 26,329.68	$ 1,342,813.85
CV03 - CLEATED CONVEYOR	13,036	$ 832,549.15	$ 2,679,209.70	$ 3,511,758.85	$ 175,587.94	$ 280,940.71	$ 493,050.94	$ 89,226.77	$ 4,550,565.22
TRUCK HAULAGE				$ 5,489,402.80				$ 109,788.06	$ 5,599,191
ELECTRICAL & INSTRUMENTATION	2,680	$ 252,396.50	$ 862,036.33	$ 1,114,432.82	$ 55,721.64	$ 89,154.63	$ 156,466.37	$ 28,315.51	$ 1,444,090.97
TOTAL CONSTRUCTION COSTS	**21,726**	**$ 1,454,285**	**$ 4,711,971**	**$ 11,655,659**	**$ 308,313**	**$ 493,301**	**$ 865,742**	**$ 266,460**	**$ 13,589,474**
EPCM									**$ 1,198,543**
Operating Costs (Waste Rock Dump)								**$ 5,100**	**$ 260,100**
TOTAL COSTS									**$ 15,048,117**
Haulage Cost per ton									**$ 8.38**
Total Tons to Haul									**655,060**

Table 5 – Rail Veyor Haulage to Open Cut

Railveyor Estimate - Dump Site North Section of Open Cut
June 16, 2014

SUMMARY	DIRECT COSTS						INDIRECTS & MARK-UPS		
RAILVEYOR OPTION	LABOUR		SUPPLIES & EQUIPMENT	SUB-TOTAL	MATERIALS TAX	FREIGHT	INDIRECT	OVERHEAD and FEE	TOTAL
	HOUR	COST	COST	COST	COST	COST	8%	13%	
ROSS SHAFT	2,430	138,754	590,291	729,045	14,581	36,452	58,324	58,813	897,215
DISCHARGE GATES	450	25,700	120,711	146,411	2,928	7,321	11,713	24,362	192,734
TRAMWAY RE-HABILITATION	5,175	191,993	355,425	547,418	-	27,246	-	-	574,663
RAILVEYOR SYSTEM	-	622,241	7,194,458	7,816,698	156,334	390,835	625,336	260,274	9,249,478
ELECTRICAL & INSTRUMENTATION	-	414,678	1,066,716	1,481,394	25,708	64,270	102,831	59,003	1,733,206
TOTAL CONSTRUCTION COSTS	**$ 8,055**	**$ 1,393,365**	**$ 9,327,600**	**$ 10,720,965**	**$ 199,551**	**$ 526,123**	**$ 798,204**	**$ 402,453**	**$ 12,647,296**
EPCM									**1,897,094**
Operating Costs									**765,000**
Total Project Costs									**$15,309,391**

Based on the estimate summaries presented above, the cost estimate for the Conveyor/Truck Haulage to the Gilt Edge Mine is the lowest cost alternative. Even though the distance to the Gilt Edge Mine is greater than the Open Cut, the Gilt Edge option does not require any road construction.

b. Operating Costs

Operating costs are an important consideration when comparing waste rock disposal systems. A preliminary review of major operating costs has been performed to inform trade study. The following is a summary of key elements of comparison of operating costs between the various options:

- The Track Haulage/Pipe Conveyor option would require the use of two operators to drive the train. The Rail-Veyor system is completely automated and will require no operators other than someone manning the control station. This would result in the reduction in labor of two men or approximately $150,000 per year.
- The Rail Veyor system will require as much as 750HP to run. Energy costs will be significant and a very high level estimate of this cost is included in the analysis
- Option 2 includes a conveyor from the Ross shaft to the Kirk Rd which will be transporting waste rock on a down slope. It is expected that this system will be a net power generator so power costs have not been included in its estimate
- Truck haulage maintenance costs are captured within the Trucking quote provided and do not need to be included separately
- Ross Shaft Crushing operating costs have not been included as they are common to all options in equal amounts

- Options 2 and 3 will require stockpile leveling which has been included in their estimates

c. Safety Considerations

All mechanized systems have inherent safety risks that need to be considered in the design. In most cases, these risks can be managed within the design process and built into the systems. However, since there are differences between the systems, there are specific risks that are inherent to the system themselves that need to be addressed:

<u>Track Haulage/Pipe Conveyor</u>

- This option utilizes 2 train operators for the Track portion of the haul. Whenever humans are exposed to mechanical systems there is a higher risk of injury than if the system is entirely automated. These exposures include:
    - Potential train derailments
    - Personnel struck by falling material at the load out stations
    - Personnel struck by a moving train
- The Pipe Conveyor includes a conveyor belt that could ignite under certain conditions.
- The path for the Pipe Conveyor travels through a public residential area which presents a potential rick to the public through exposure to a remotely operated mechanical system. As such, the design for the pipe conveyor system has included a cover for the entire length of the system.

<u>Conveyor/Truck Haulage System</u>

- One of the more significant risks associated with this method involves the use of Haul Trucks that must travel over public highways to reach their final dumping destination. There are periods of time during the excavation cycle where as much as 3,300 tons per day will be hauled which at an average of 20 tons per truck, is as much as 165 truck loads per day. Within a 10 hr haulage window, there could be as much as 17 truck trips per hour. The risk of an accident can’t be ignored for this frequency of truck traffic, which only increases during periods of bad weather and during the vacation season.
- The haulage route to the Gilt Edge Mine follows the Kirk Rd, Highway 385 path which mostly avoids urban areas. This is a more favorable path as compared to the North Open Cut location where the route must follow a pathway through downtown Lead.
- Whenever trucks are used for waste haulage on public roads, a risk exists for a rock to fall off the truck and either strike a public vehicle or create a hazard on the road.

Rail-Veyor System

- Since this system operates entirely automated, there is a risk that a person who happens to be walking along the track in the Tramway could be struck by a moving train. However, this risk should be low as the Tramway is not planned to be used for anything other than rail haulage and a conduit for utilities. This should limit exposure to personnel. In discussions with personnel familiar with this type of haulage system, a Rail-Veyor system should not be installed in underground excavations that would include pedestrian traffic.
- The Rail Veyor system will be covered over all sections that are exposed to the public on the surface to ensure that the public is not exposed to this risk.

Based on the comparisons between safety considerations of the various systems, it is expected that the Rail-Veyor system should be a safer system due to the limited exposure to personnel and the public during operation

d. Environmental Impacts

Another consideration in the comparison of the three options is Environmental Impacts. The key areas of Environmental impacts include noise, dust, and water quality. The following is a comparison of the Environmental impacts of each of these areas within the various options:

Noise

- During operation, the Rail-Veyor system only makes noise when the train traveling. The Pipe conveyor makes noise continually during operation.
- The Rail-Veyor system is propelled by electric drive motors which rotate foam filled tires horizontally which come in contact with the outside of the rail veyor cars. The cars ride along a steel track and produce noise as steel wheels roll over the rail track. A Pipe conveyor makes noise as a conveyor belt travels over idlers. The amount of noise each makes is a function of the quality of the equipment used and the maintenance of that equipment.
- During a visit to Rail Veyor's demonstration installation in Sudbury, Ontario, it was discovered that there is a high pitched noise that is produced from the VFDs that would need to be mitigated. In addition, there was still enough noise that is produced from the actual riding of the system on the track that would require noise mitigation. Therefore, the cost estimate for the system has included provisions for a steel cover to be installed over the track in the public areas
- Noise from Truck Haulage is not insignificant. However, the noise is limited to existing roads and highways. For the option to dispose in the Open Cut, noise

from truck haulage will likely be an issue as the route goes through downtown Lead. For the Gilt Edge Mine disposal option, the route stays outside of urban areas, thereby limiting noise exposure to the public

- As part of the DUSEL Preliminary Design, the design contractor performed a preliminary analysis of noise generation from the Track Haulage/Pipe Conveyor system. This analysis revealed some areas of significant noise generation that would likely need to be mitigated in the final design process.

Dust

- The Track Haulage/Pipe Conveyor system includes a total of four locations where material is dumped along the way to the final dump location. Provisions for dust control have been added to this estimate, however the dump location for this option is relatively close to the public which will make dust control more important in this option
- The Conveyor/Truck Haulage option will create dust along the Kirk Rd and loading location as well as the final dump locations. However, the dump locations are far enough from the public in both cases to have a minimal impact to the public. In both cases, provisions for dust control have been added to minimize dust generation impacts.
- The Rail Veyor track is covered throughout the route where there is exposure to the public. The system only has one dump location. Provisions for dust control have been added to this estimate.

Effect on Water Quality

When comparing the various options for waste rock disposal locations, it's important to understand the affect on water quality and potential waste water treatment relating to affect of surface water exposure to the waste stockpiles. The following is a summary of water quality considerations for the two waste rock disposal sites:

Open Cut

- The Open Cut provides an excellent containment for the waste rock as material can be deposited into the mined out areas where surface water drainage is limited to the mined out opening from which the water is eventually directed into the SURF dewatering system and eventually into the Waste Water Treatment Facility. A preliminary geochemical study on waste rock was previously completed that indicated that it was not expected that there would need to be any changes to the existing water treatment facility due to changes in water quality relating to the exposure of the waster rock to surface water. However, the currently planned location for mining is in a different location than had been

tested which has resulted in the generation of a new study to determine if there are any changes to the waste rock geochemistry that would affect water quality.

Gilt Edge Mine

- The Gilt Edge dump location is located at an old mining operation that has serious environmental challenges. It is currently owned and operated by the State of South Dakota and has been designated as a "Super Fund Site" due to its requirement for long term environmental management. The State has indicated that the waste rock from SURF has potential mitigating impacts to the environmental challenges at this site. As such, disposal of waste rock from SURF at this location has the potential to benefit both parties. The results of the rock geochemical analysis are expected to confirm that.

e. Owner Liabilities

The final important consideration in the selection of the preferred option for waste rock disposal is related to Owner Liabilities. In each option, the State is exposed to liabilities due to the fact that all options consider waste rock storage off SDSTA property. The following is a comparison of the major Owner liabilities that are specific to each option:

Open Cut Storage Location

- During initial discussions with the owner of the Open Cut, Barrick Mining Company, it was understood that Barrick would allow SURF to dispose of waste rock in the Open Cut without taking ownership for the long term liabilities of the mined out opening. Recent discussions with Barrick have revealed that it is likely that any agreement that with SURF to dispose of waste rock into the Open Cut will require SURF to take ownership of the Open Cut and assume all of its long term liabilities. Given the potential for long term slope stability problems of the pit walls, it would not be favorable for SURF to assume ownership of the Open Cut.

Gilt Edge Mine

- Given that the State of South Dakota currently owns the Gilt Edge Mine, there would be no additional liabilities incurred by the State in using this location for waste rock storage.

Assessment Summary

In order to simplify the assessment process, a summary matrix has been prepared that that applies a comparison score to the various Trade Study assessment elements. A higher

score indicates a worse overall assessment and a lower score indicates a better assessment.

Table 5 – Waste Disposal Option Assessment Summary

	Pipe Conveyor/Track Haulage to Open Cut	Conveyor/Truck Haulage to Open Cut	Conveyor/Truck Haulage to Gilt Edge Mine	Rail Veyor Haulage to Open Cut
Project Cost	4	2	2	3
Safety	2	4	3	1
Environment				
Noise	3	4	3	1
Dust	3	2	1	2
Water Quality	2	3	1	2
Owner Liability	4	4	1	4

7. CONCLUSIONS AND RECOMMENDATIONS

Upon consideration of all the above mentioned factors, it is recommended to select the Conveyor/Truck Haulage to the Gilt Edge Mine as the preferred method and location for waste rock storage for SURF. The key reasons for this selection are outlined as follows:

1. Lowest cost option - Approximately $250K less than Rail Veyor Option
2. Lowest long term liabilities –
    a. Does not require ownership of the Open Cut
3. Lowest Environmental Impacts
    a. Mitigates Gilt Edge Mine Water quality problem
    b. Dust control manageable
    c. Noise impacts low due to haulage route outside of urban areas
4. Low Operating Costs
    a. Conveyor has the potential to be a power generator rather than consumer

8. NEXT STEPS/OPPORTUNITIES

1. The current design to haul waste rock to the Kirk Rd involves the use of a conveyor constructed from the Ross Shaft Crusher room to the Kirk Rd as shown in Figure 7. The haulage distance to the Gilt Edge mine from this location is approximately 8 miles. This distance could be reduced by nearly 1 mile by relocating this transfer site

to the Kirk Fan location. It is recommended that further study be made in relocating the transfer point for truck loading to a location that reduces the overall distance to the Gilt Edge Mine.

2. The Preliminary Design of the Rail Veyor system has revealed that this system provides for an attractive alternative to the use of conveyors for material haulage. It is recommended that the Rail Veyor system be evaluated as an alternative to the use of a conveyor to haul waste rock to that transfer point.

3. All options consider the use of a refurbished Ross shaft Crushing Plant as the system to size waste rock for conveyor haulage. This system may not be the best option. A trade study that compares the use of the existing crushing plant to the use of a subcontracted portable crushing plant or other systems should be performed to determine the optimum system

4. Given the relatively short term of waste rock generation and number of risks associated with this activity, it may be worth including this work as part of the scope of work for the Excavation Contractor. There are a number of potential benefits to this concept that include using the contractor's expertise to determine the best option and benefiting from competition to achieve the lowest possible cost.

5. SIGNATURE/APPROVAL PAGE

Approved By:

8/27/14

Tracy Lundin Date
LBNE L2 Project Manager

Concur By:

Joshua Willhite

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SURF Director of Engineering