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REPORT

Yukon Government

Faro Mine Complex
Grum Complex Transmission Line
Relocation Assessment

October 2015

CANADA'S BEST MANAGED COMPANIES Platinum member

ASSOCIATED ENGINEERING

QUALITY MANAGEMENT SIGN-OFF

Signature .....

Date DEC 7, 2015

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1 Terms of Reference

The Faro Mine Complex have been undergoing a transformation in recent years with the addition of the water treatment facility and mothballing of most of the mill infrastructure.

In anticipation of the Rose Creek North Fork Diversion project it is necessary to review the possible power feed options to the Grum/Vangorda sites, because the proposed cut through the haul road will necessarily destroy the existing overhead line.

For this purpose the Yukon Government retained Associated Engineering to carry out an assessment of the technical feasibility to review the various options available to power the Grum/Vangorda sites

2 Feasibility Assessment

Existing conditions

A simplified single line diagram of the existing electrical distribution network is attached to this report for reference. This drawing provides a diagrammatic overview of the existing active electrical distribution system at the Faro site – large sections of the distribution system are no longer in use and have been de-energised. These de-energised parts of the system are not shown for clarity. Also, the 69kV transmission line to the Grum and Vangorda sites is only shown partially, to illustrate the connection to the main distribution system on site.

The electrical load at the Grum/Vangorda side consists of the following:

- 2 x 350hp FVNR pumps from the Vangorda pit
- 120hp FVNR pump from the Grum pit
- 75hp Sludge pump
- Approximately 50kW within the operations of the Vangorda water treatment plant
- Miscellaneous small loads such as site lighting, radio repeater, etc.

The estimated total load for the Grum/Vangorda side is approximately 700kW, taking into account the diversity between various loads.

At the present time the Grum/Vangorda side of the complex is supplied with power from the existing substation 2 on the main site. A dedicated feeder exits Substation 2 at a supply voltage of 4160V and is stepped up to 69 kilovolt (kV) at a transformer outside the substation. The power is then carried by a 69kV overhead transmission line that runs along the south side of the waste rock pile and joins the haul road, where it also crosses over to the north side of the haul road. The 69kV line then follows the haul road along the north side all the way to the Grum substation, which converts the voltage to 4160V for local distribution.

While the purpose of this report is not a condition assessment of the existing installation, it is important to consider the existing condition of critical equipment because the need to upgrade in the not too distant future may impact the decision about the most desirable path forward.

The existing 69kV line is in reasonable working condition, and is easily repairable due to the overhead construction in the case when problems crop up. There is no imminent reason to upgrade or replace the existing line based on condition.

The existing step-up and step-down substations are in working condition, but these are old and will require upgrading in the near to medium future. In addition, the Grum substation is relatively close to the pit edge of the Grum Pit. The Grum Pit walls are known to be unstable, but the substation is not in imminent danger of collapsing. However, it would be prudent to select a location further away from the pit when upgrades to the existing substation are considered to eliminate any future risk to the substation.

Along the south side of the waste rock pile and along a section of the haul road the 69kV transmission line does not meet the statutory clearances to ground (Yukon OH&S Safety Regulations). The actual ground clearance in these areas varies from as little as 3m depending on the specific ground below the line, while the statutory requirement is 4.6m. This is discussed in more detail later in the report. The problems exist in specific locations with some spans affected and others not. See Figure 2-1 below illustrating the extent of the vertical ground clearance non-compliance issue. The red line on the picture indicates the extent of the spans that are affected. Note that this markup is based on a visual inspection of the line because approach distance to the line is limited while energised.

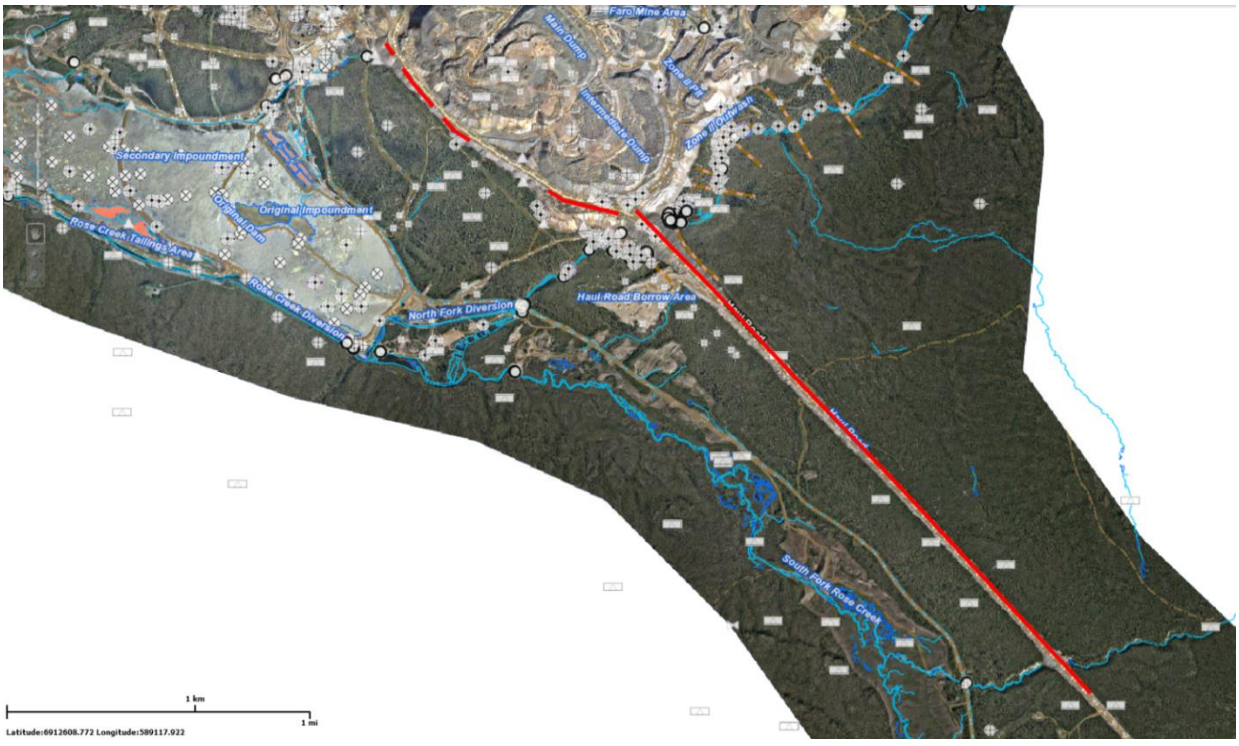

Figure 2-1
Spans with Insufficient Vertical Clearance (Red Line)

It appears that the construction of the line was carried out with poles of sufficient height to meet the statutory clearances, but that waste rock and other surplus material was dumped underneath the line and around poles as a way to protect the line and the poles from close approach by mining trucks and other

vehicles. In some cases it appears that the surplus material was also placed along the high sections of the haul road to create a barrier to prevent vehicles from going over the steep edge. The reduced height due to the presence of surplus material reduces the vertical clearance in many instances to be below the statutory requirements.

Upgrade Options

This section refers to options for upgrading the system rather than simply reviewing the re-routing of the 69kV overhead line, because the condition of the various components and the vertical clearance issue may be compelling reasons to consider completely different approaches.

1 RE-ROUTING OF EXISTING LINE

The first option is to install a new pole at the bottom of the haul road slope close to the existing pond on the north side of the haul road, and install a single overhead span from the top of the haul road to the bottom pole. This is perfectly feasible and was done for the power feed to the rock drain pump station on the south side of the rock drain. From this new pole the line diversion can continue past the proposed cut through the haul road and tie back into the existing overhead line in the same way. See Figure 2-2 showing the proposed re-routing. Also see Figure 2-3 that shows the existing power pole at the rock drain pump station, as an example of the simplicity of re-routing the line in this method.

Note the red and turquois lines indicate the possible extents of the cut, while the blue line indicates the proposed new route of the overhead line.

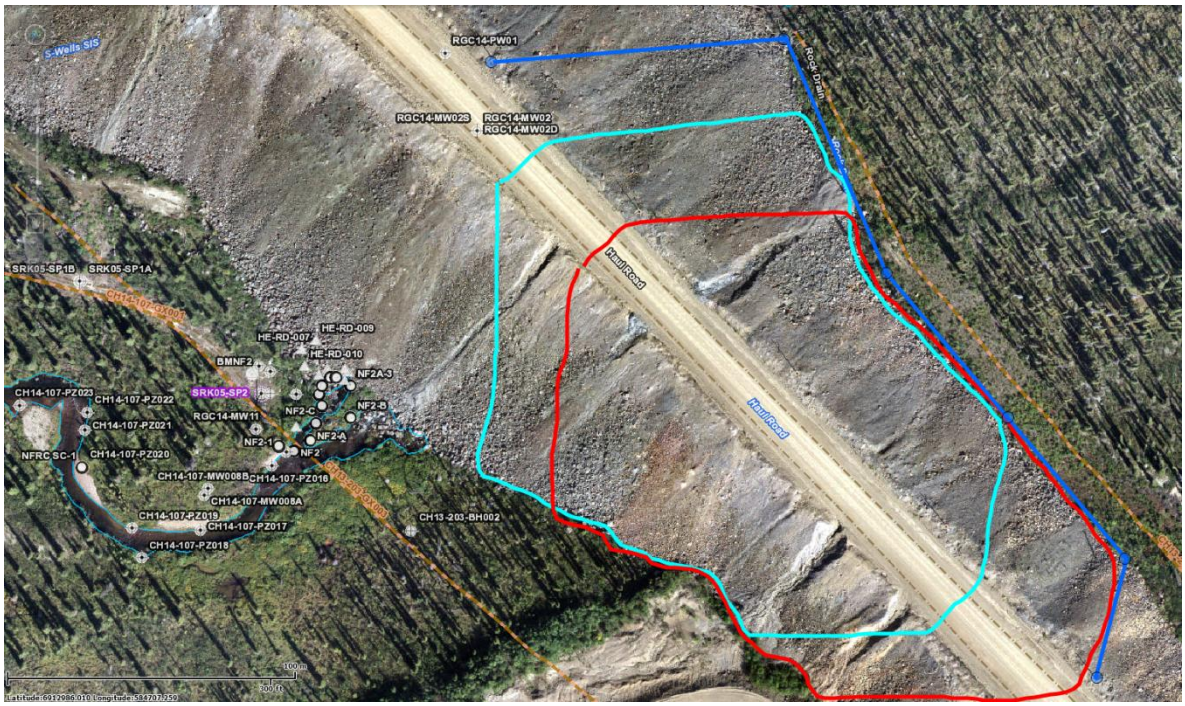

Figure 2-2
Option 1 - Proposed Re-routing (Blue Line)

Figure 2-3
Existing Power Pole – Single Span Down Slope of Haul Road

The big advantage of the approach is that it can be done prior to the cut through the haul road and will limit the outage of power to the Grum side.

The downside of this approach is that it does not address the vertical clearance issue with the existing line, nor does it address the poor condition of the existing step-up and step-down substations and the need to upgrade those sometime in not too distant future.

The estimated cost for this option can be derived by using an industry average cost of $600 000/km (average 70m spans for 69kV single pole).

Activity	Cost
Construction - $ 42 000 / span	**$ 210 000**
Allowance For Remote Location	**$ 30 000**
Engineering	**$ 20 000**
Total	**$ 260 000**

2 LONG SPAN ACROSS

Based on the preliminary sketches by CH2M Hill the proposed cut through the haul road will be approximately 230m wide at the top. The existing pole configuration in that area is such that the proposed cut will be approximately two and a half spans of the existing overhead line. This approach will require the installation of specially designed line structures on either side of the cut, with a long engineered span across the cut. As with the previous option this is a feasible technical solution, and it does not require a re-routing. The existing lines can be raised with the installation of the new pole structures to allow for excavation of the cut below the lines. The disadvantage of this approach is that the existing overhead line has to be de-energised for the duration of the installation of the new support structures. This will require a power interruption to the Grum side for the duration of the construction of the support structures. While it is possible to power the Grum with a mobile generator during that time, this could be done during time when the disruption to the Grum will be minimal. See Figure 2-4 showing the proposed long span across the cut in the haul road.

It has the same disadvantage as option 1, in the sense that it does not address the vertical clearance issue and the upgrade requirements for the step-up and step-down transformers. One major benefit of this option is that the line will already be in place and accessible from the road once the cut is backfilled.

Note the red and turquois lines indicate the possible extents of the cut, while the blue line indicates the proposed new route of the overhead line.

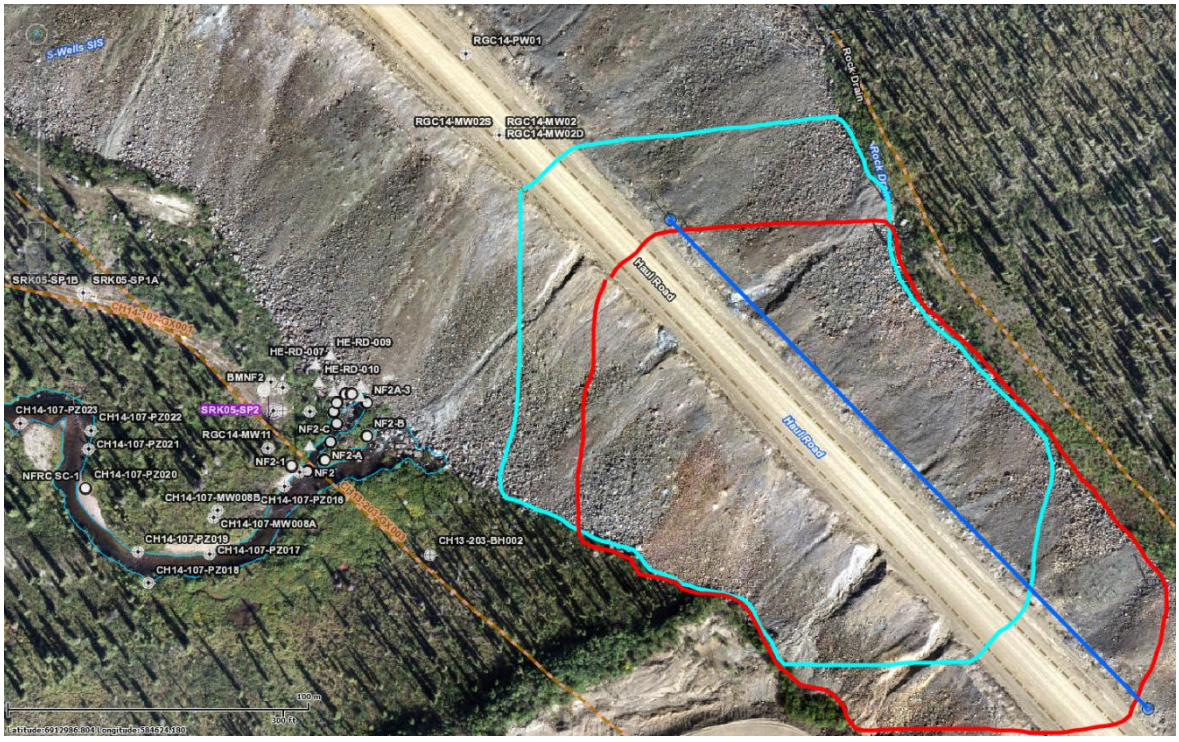

Figure 2-4
Proposed Long Span Across Cut (Blue Line)

The estimated cost for this option is approximately $220 000.

Activity	Cost
Construction - $600/m for 230m	**$ 140 000**
Allowance For Remote Location	**$ 30 000**
Engineering	**$ 50 000**
Total	**$ 220 000**

3 NEW SERVICE POINT FOR GRUM / VANGORDA

The existing 138kV transmission line (operated by Yukon Energy Corporation) feeding power to the main mine site roughly follows the road from the Town of Faro up to the mine. The 138kV line runs to the east of the road and between the road and the Grum / Vangorda site as it passes that location. As part of this assignment we were specifically tasked to review the possibility to provide a separate service point for the Grum / Vangorda sites, fed directly off this feeder line where its comes closest to this site.

The benefits of such a new service for the Grum/Vangorda site are that the existing step-up and step-down substations for the 69kV line will become obsolete and not require future upgrading. Also, the vertical clearance issue for the existing 69kV line will become inconsequential since the line will no longer be needed.

The approach for such a new service would be to construct a new substation and metering point to step down from the 138kV line to a 4160V service, which will then be connected to the existing 4160V distribution system on the Grum/Vangorda site, eliminating the need to upgrade the existing 69kV to 4160V step-down substation.

We approached Yukon Energy Corp. (YEC) to obtain their opinion about the feasibility of such a separate service. During discussions YEC provided the following comments:

- A 138kV substation and service point is technically feasible.
- A 138kV substation is very expensive and is only cost effective for servicing large loads of multiple megawatts. According to YEC a substation of this type will be in the order of $ 5M, based on recent data published by the Alberta Electric System Operator (AESO).
- The existing load at the Grum/Vangorda site is extremely small (approx. 700kW) and is not cost effectively serviced from a dedicated 138kV substation.
- YEC can provide a relatively inexpensive single phase tap for a new service, but given the size of the load this is not an option.
- The service voltage would be 4160V.
- The Owner (YG) would be required to design and construct such a substation, for take-over and operation by YEC.
- The lead time for such a new service will be approximately two years, including engineering, procurement of long lead items such as the transformer and circuit breaker, and construction.

The following additional items should be considered in the assessment of a new service.

- During our research we became aware of the availability of high voltage padmounted transformers that would eliminate the need for substation structures and provide a slightly cheaper solution, but on closer inspection these are not appropriate for the voltage class of this application.
- The demand charge for a separate service will be higher as described below:
  - The tariff for each service consists of two components, a demand charge ($/kW) and an energy charge (c/kWh).
  - The demand charge is a cost based on the maximum demand for the service and is currently $15.42 / kVA (YEC). The energy charge is not affected by this issue and is not considered any further.
  - There is a natural diversity between all the individual loads connected to a service – all the connected loads are never on at the same time.
  - The result of this is that the real total load (maximum demand) is always less than the sum of the connected loads.
  - If Grum / Vangorda is fed from the main mine site that load is hidden within the overall load of the entire site, and the increase to the overall maximum demand due to Grum / Vangorda is likely as small as 100kW.
  - If Grum / Vangorda is on a separate service, it will be charged a maximum demand charge for 700kW in addition to the demand charge for the main site.
  - At a rate of $15.42/kW the demand charge for two separate services is approximately $9000 per month more, than for one single service.
- Any future power supply requirements along the line between the main mine site and the Grum Complex will be hard to meet if the existing 69kV line is decommissioned.

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Other Considerations

The Yukon OH&S Safety Regulations requires that all overhead lines and equipment follow the requirements of CSA Standard *C22.3 No. 1, Overhead Systems*. Section 15 of the OH&S Safety Regulations (Surface & Underground Mines) is silent on this issue, but references CSA Standard *M42, Use of Electricity in Mines*. CSA M42 does not provide any relief from these requirements, but instead specifies even stricter requirements in specific areas where vehicle crossings occur and mining equipment operate in close proximity with electrical lines.

Fortunately none of these special circumstances apply in this case; therefore the only standard to be met is CSA C22.3 No.1. Based on our assessment of the haul road, we believe that the 69kV line can be classified as *"Alongside roads and highways in areas unlikely to be travelled by road vehicles"* and therefore the required vertical clearance is 4.6m. While the actual clearances vary, there are significant sections of the line where the actual clearances do not meet this requirement.

The only upgrade option discussed above that eliminates the vertical ground clearance non-compliance issue is the new service for the Grum Complex, because the existing 69kV line would be decommissioned in that instance. However, there are other considerations to be taken into account regarding this issue.

While the existing line does not meet the strict statutory requirements in certain specific locations and the Yukon WCB can conceivably take action to force remedy of the situation, the actual hazard level is relatively low for the following reasons:

- This is not a public area and only authorised personnel are allowed after proper safety indoctrination.
- The very piles of surplus material stacked around the poles and underneath the lines limit access to the poles and the area below the lines. It is impossible to drive a vehicle into the danger area underneath the lines.
- The nature of operations on site limit pedestrian activity in these areas, and just like the vehicles the piles of material is a barrier for pedestrians. While possible, it is a challenge to climb on top of one of these piles to the danger locations underneath the overhead lines.

A different approach to reduce/eliminate this issue is to operate the line at a lower voltage. The line was originally designed to carry a much higher load than the current day 600kW and for that reason it was designed to operate at 69kV. The much lower present day load can easily be transmitted over this distance at a voltage of say 25kV. This would require upgrading of the existing step-up and step-down substations, but this would also solve the requirement to upgrade these substations due to end of life reasons. Padmount versions of 1000kVA, 25/4.16kV transformers are easily obtainable and relatively cost effective. The procument lead time can be as little as 11 weeks, if a standard off the shelf item is ordered, or up to 24 weeks for a custom unit. The estimated cost to replace the existing step-up and step-down substations with new pad mounted equipment, and operate the overhead line at a lower voltage, is shown below:

Activity	Cost
Transformers (2 Qty)	**$ 80 000**
Removal of Existing Substations	**$ 20 000**
Connections & Cabling	**$ 20 000**
Allowance For Remote Location	**$ 30 000**
Engineering	**$ 30 000**
Total	**$ 180 000**

However, for the purpose of resolving the vertical ground clearance issue this is not a definitive solution. The required vertical clearance for any line below 38kV (and above 1.2kV) is 4.15m – less than the 4.6m required for a 69kV line, but not a complete solution for the problem. A detailed survey of the available vertical clearance will be required to determine how much of the line would still be non-compliant if the operating voltage is reduced.

In addition to the option to reduce the operating voltage of the line, the piles of surplus material can also be flattened to the point where the statutory clearances are satisfied. Even piles that are partly flattened will still be effective as barriers to prevent vehicles from getting too close to poles or driving over the edge of the

haul road. Doing this work will require that the power to the overhead line be shut down while heavy earthmoving machines work in close proximity of the lines, but it is certainly feasible to shut the power down for a few hours at a time.

3 Recommendations

The appropriate recommendations for this report depend partly on the need/desire to upgrade existing equipment nearing end of life, and thereby choosing options that facilitate such upgrading.

For the purpose of accommodating the proposed diversion of the north fork of Rose Creek without any other consideration, we recommend that the existing 69kV overhead line be raised as described above as the long span option. Both options are practical solutions and the costs are comparable, but this option is preferred because the line will continue to follow the road once the cut is backfilled. If the line is re-routed then a section of line will be difficult to reach and maintain after backfilling of the cut. While neither option solves any of the other issues identified both are simple solutions that can be done cost effectively with very little throw-away cost (if any) if another upgrade solution is implemented in the future.

On the issue of the vertical ground clearance of the existing overhead line we previously stated that the risk is low due to the specific circumstances and operation on site. However, we have a duty to identify the deficiency. Given the fact that the deficiency exist to make the site safer for vehicles, and that the mine operated in this way for years, it may be appropriate to approach Yukon WCB and obtain their opinion on the matter. To our knowledge this has never been identified as a problem during their previous inspections on site.

If there is a desire to make the overhead power line compliant with the vertical clearance requirements it is recommended that this be done through a combination of a lower operating voltage for the line, and by flattening the piles of surplus material below the line and around the poles. This will also provide an upgrade for the step-up and step-down substations at either end of the line, which will be required in the near to medium term.

The option of a separate service to the Grum Complex is not recommended primarily due to the cost and the fact that a substation of that voltage class is simply not cost effective to provide such a small service.

REPORT

Certification Page

This report presents our findings regarding the Yukon Government
Faro Mine Complex Grum Complex Transmission Line Relocation Assessment

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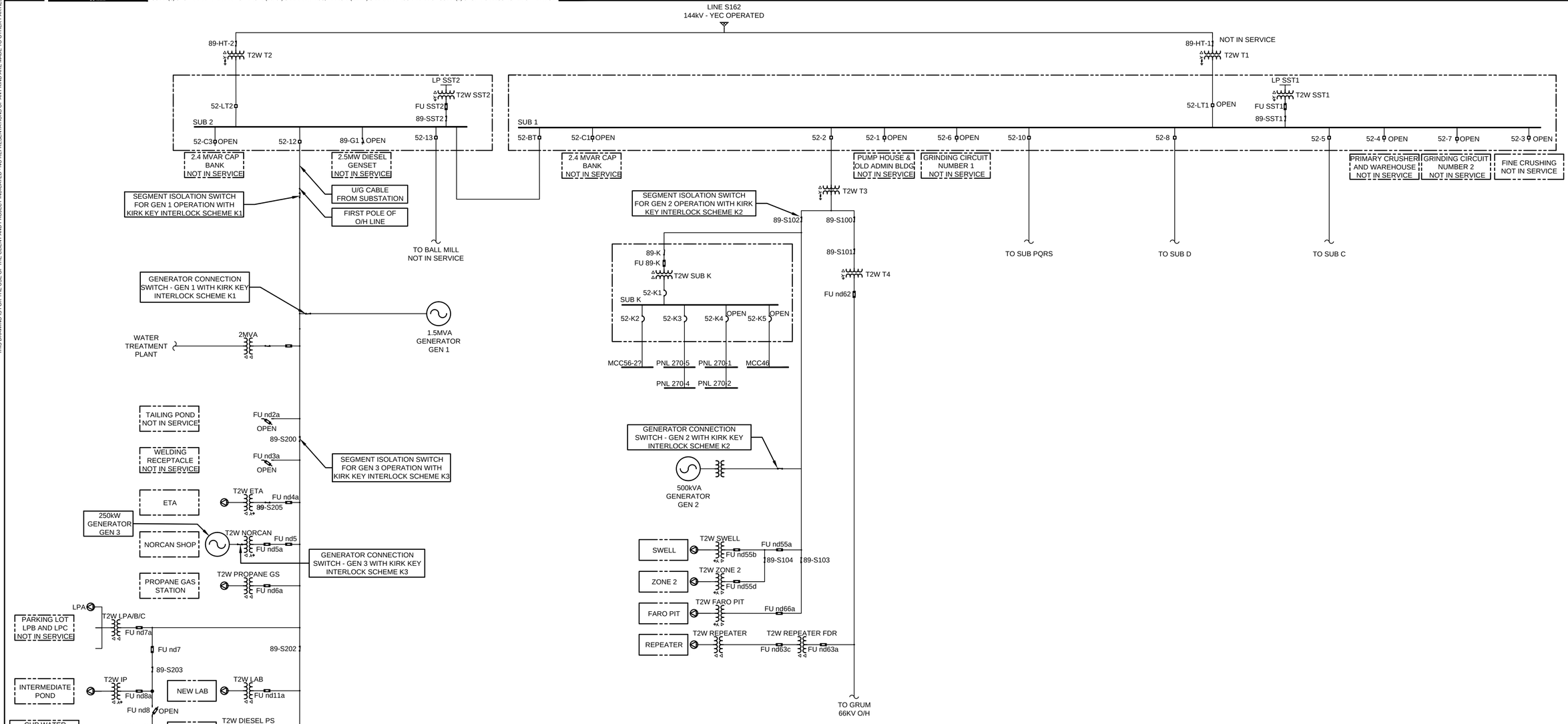

NOTES:

1. INTERLOCK SCHEME K1 TO WORK WITH 2 SWITCHES WITH LOCKS AND 1 KEY. SWITCH CAN ONLY BE CLOSED IF KEY IS INSERTED AND CAPTURED.

2. INTERLOCK SCHEME K2 TO WORK WITH 2 SWITCHES WITH LOCKS AND 1 KEY. SWITCH CAN ONLY BE CLOSED IF KEY IS INSERTED AND CAPTURED.

3. INTERLOCK SCHEME K3 TO WORK WITH 2 SWITCHES WITH LOCKS AND 1 KEY. SWITCH CAN ONLY BE CLOSED IF THE KEY IS INSERTED AND CAPTURED

4. K1, K2 AND K3 WILL USE DIFFERENT KEYS.

Associated Engineering

PRELIMINARY/ FOR DISCUSSION
NOT FOR CONSTRUCTION
DRAFT

REV	DATE	DESIGN	DRAWN	DESCRIPTION
B	2015JUL	L. De LANGE	M. KAPINIAK	ISSUED FOR STANDARD OPERATING PROCEDURE
A	2015FEB	L. De LANGE	S. LUI	ISSUED FOR REPORT

YUKON GOVERNMENT

FARO MINE COMPLEX

20152916-00

SCALE: N.T.S.

ELECTRICAL
OVERALL SINGLE LINE DIAGRAM

DRAWING	REVISION	SHEET
2916-00-601	B	X / XX