#3 – 1101 Main Street, Penticton, British Columbia, V2A 5E6 Canada, phone +1 (778) 476 5833 fax +1 (250) 412 5681

16 November 2016

To:
Joshua Ojierenem
Project Manager
By Email: Joshua.Ojierenem@gov.yk.ca

RE: HAUL ROAD TRANSMISSION LINE TO GROUND CLEARANCES

Dear Joshua,

The previous engineering assessment of the 69 kV Over head system along Haul road had raised concerns with the line to ground clearances over the waste rock.

As a part of our scope of work, we have done a detailed engineering study by making field measurements and *reverse engineering the data on each span along the line to determine if any code violations exist.

**The reverse engineered data is used to determine what the "worst case" line to ground clearance is by modeling the conductor on PLS CADD. The results are then compared to the requirements listed in Table 2, CSA 22.3 No 1-06.*

A few parameters should be mentioned before exploring the results:

a) Worst case sag is defined by the condition at which the conductor will have the maximum sag. The condition used in this study was under heavy loading conditions for wind and ice required by code for the area.

b) The line to ground clearances were further reduced by 0.6 meters to account for the mean annual snow density for the region. This value is acquired from Table D.1, CSA 22.3 No 1-06.

c) The previous contractor mentioned the statutory requirement for the line to ground clearance is 4.6 meters. This is true for the case when the line could potentially have vehicular traffic underneath due to it's close proximity to the road. But this line is a special case in that the waste rock acts as a barrier that will only allow pedestrian, snow mobiles and personal terrain vehicles. Therefore, the requirement for pedestrian clearance of 3.6 meters has been used (See Table 2, CSA 22.3 No 1-06).

   Also in regards to "c" it should be noted that if the waste rock is removed and vehicular traffic is possible underneath the line, there will be gain (>1 meter) in line to ground clearance that will allow it to meet the 4.6-meter requirement.

Display of the Results

The drawings attached to this document have tables embedded in them with the clearance results for each span along the transmission line. Each column can be read as follows:

Pole Numbers: Corresponds to the span between poles along the transmission line.

Span Length: Length between the two poles mentioned in the previous column.

Distance @ Measured Clearance: Gives the distance at which the clearance was measured from the first pole in the span.

Clearance Measured: The field acquired measured clearance.

Temp: The ambient temperature (this is important factor in reverse engineering the data).

Worst Case Clearance: This is what the clearance will be with 0.5 inches of ice on the conductor, while exposed to winds speeds up to 93 km/hr (this is the heavy loading condition required in code).

Clearance Above Code Requirement: How much the worst-case clearance exceeds the pedestrian clearance with the addition of snow.

Meets Code: Simply yes or no. Shows there are no spans on the line that require upgrading.

For clarity, the poles in the drawings have been given numbers and overlaid with road boundaries and water outlines. Since the waste rock ended at pole 52, no further analysis was required.

Final Comments

The results show a few spans are within 0.5 meters of a code violation after worst case sag. We recommend taking no action on these spans because they still meet code and there is only a 0.3% chance of the heavy loading condition occurring over the next 15-years.

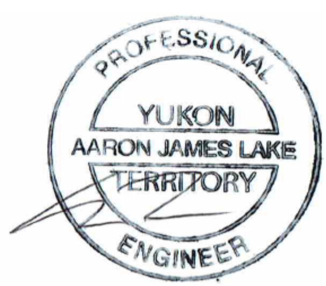
The heavy loading requirement used in this study is for overhead systems that are meant to last 50+ years but since there are no other alternatives in code, this scenario must be used.

The other condition that can cause a sag of this magnitude is 500 amps of load (~60MVA at 69kV) on the system, which causes the conductor to heat up and expand. Due to current and future loading at the Faro Mine Site, this condition was not considered.

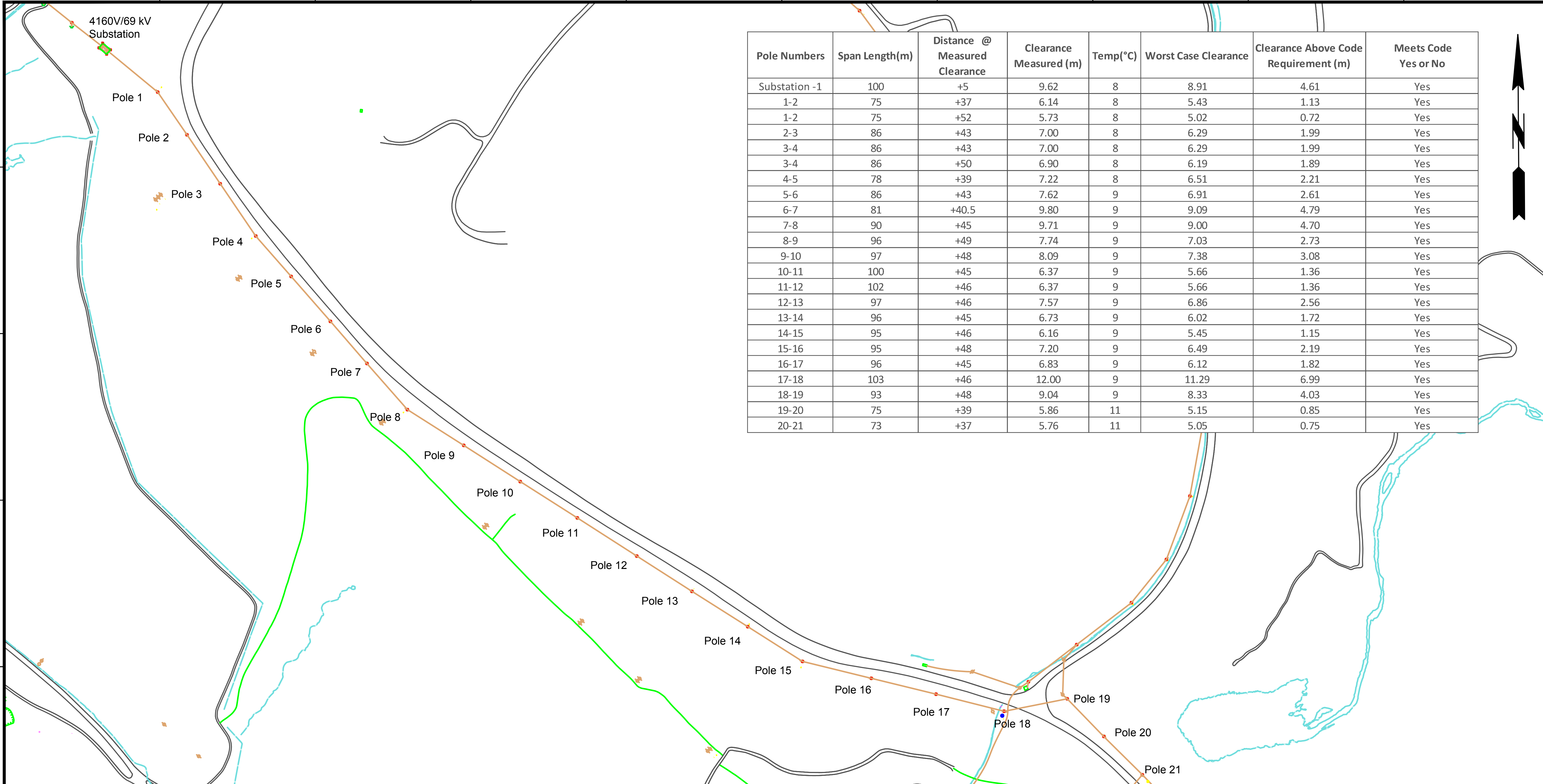
Sincerely,

Aaron Lake, P.Eng

Struthers Technical Solutions Ltd.



Nov.15/2016



Pole Numbers	Span Length(m)	Distance @ Measured Clearance	Clearance Measured (m)	Temp(°C)	Worst Case Clearance	Clearance Above Code Requirement (m)	Meets Code Yes or No
Substation -1	100	+5	9.62	8	8.91	4.61	Yes
1-2	75	+37	6.14	8	5.43	1.13	Yes
1-2	75	+52	5.73	8	5.02	0.72	Yes
2-3	86	+43	7.00	8	6.29	1.99	Yes
3-4	86	+43	7.00	8	6.29	1.99	Yes
3-4	86	+50	6.90	8	6.19	1.89	Yes
4-5	78	+39	7.22	8	6.51	2.21	Yes
5-6	86	+43	7.62	9	6.91	2.61	Yes
6-7	81	+40.5	9.80	9	9.09	4.79	Yes
7-8	90	+45	9.71	9	9.00	4.70	Yes
8-9	96	+49	7.74	9	7.03	2.73	Yes
9-10	97	+48	8.09	9	7.38	3.08	Yes
10-11	100	+45	6.37	9	5.66	1.36	Yes
11-12	102	+46	6.37	9	5.66	1.36	Yes
12-13	97	+46	7.57	9	6.86	2.56	Yes
13-14	96	+45	6.73	9	6.02	1.72	Yes
14-15	95	+46	6.16	9	5.45	1.15	Yes
15-16	95	+48	7.20	9	6.49	2.19	Yes
16-17	96	+45	6.83	9	6.12	1.82	Yes
17-18	103	+46	12.00	9	11.29	6.99	Yes
18-19	93	+48	9.04	9	8.33	4.03	Yes
19-20	75	+39	5.86	11	5.15	0.85	Yes
20-21	73	+37	5.76	11	5.05	0.75	Yes

NOTES:

1. **Worst Case sag has been calculated under heavy loading conditions.**
2. **Clearances have been reduced an additional 0.6 meters to account for mean annual snow depth data from Dawson.**
3. **All poles on this drawing meet code.**

REV.	DESCRIPTION	DRAWN	CHECKED	DESIGNED	DATE
A	CLEARANCE DATA	AL	AL	AL	15/11/16

REVISIONS

PROFESSIONAL ENGINEER
YUKON TERRITORY
AARON JAMES LAKE

Nov.15/2016

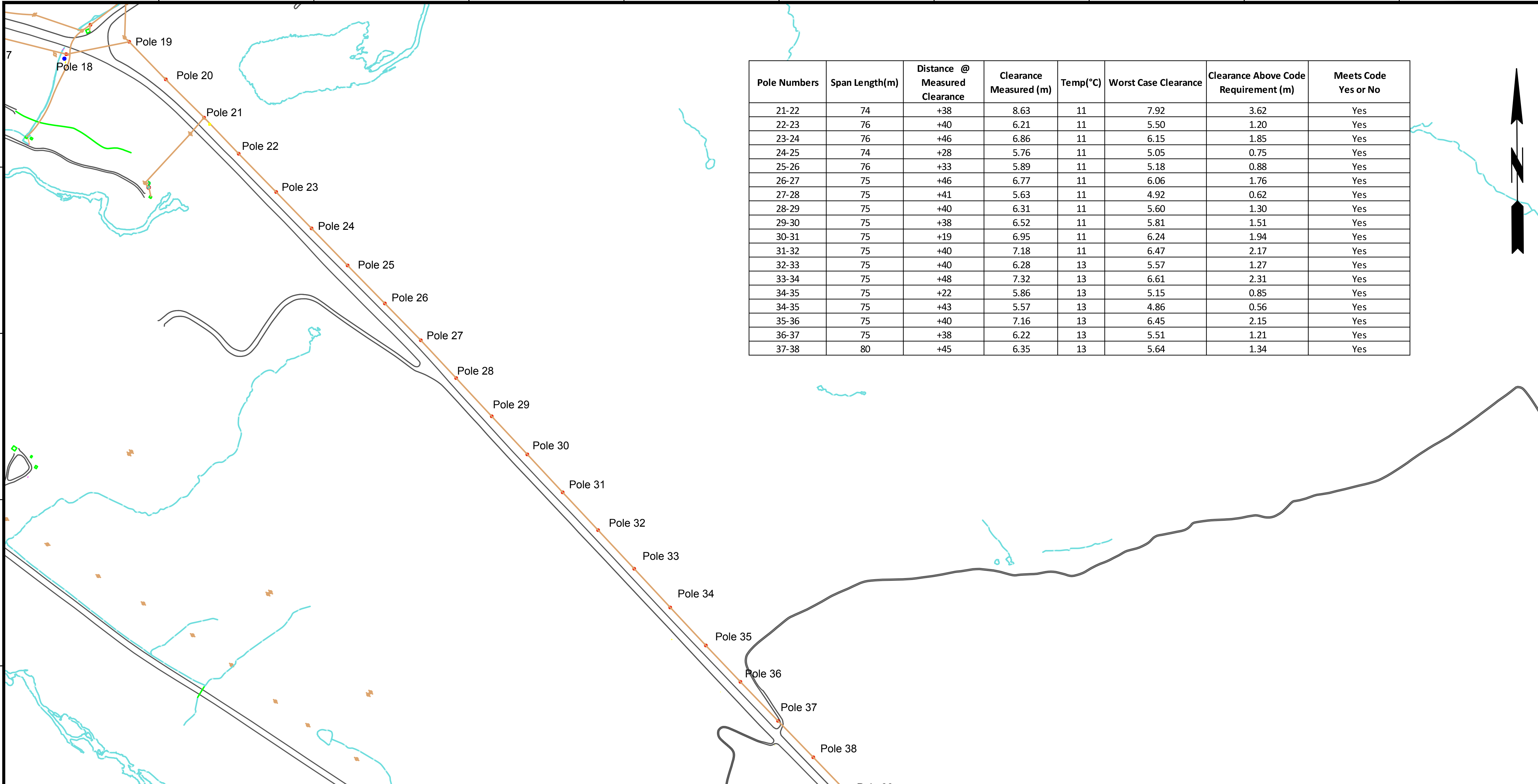
CLIENT:
Yukon Government

DESIGN BY:
StruthersTECH
#105 - 78 Industrial Ave. W Penticton BC. V2A6M2
www.struthersTech.com

PROJECT TITLE: FARO MINE ELECTRICAL ASSESSMENT

TITLE: **TRANSMISSION LINE CLEARANCES HAUL ROAD**

SCALE: NTS
JOB NO.: 1650
PROJECT: FARO MINE
DWG.No. **T100**
SHT. **1**
REV. **A**



Pole Numbers	Span Length(m)	Distance @ Measured Clearance	Clearance Measured (m)	Temp(°C)	Worst Case Clearance	Clearance Above Code Requirement (m)	Meets Code Yes or No
21-22	74	+38	8.63	11	7.92	3.62	Yes
22-23	76	+40	6.21	11	5.50	1.20	Yes
23-24	76	+46	6.86	11	6.15	1.85	Yes
24-25	74	+28	5.76	11	5.05	0.75	Yes
25-26	76	+33	5.89	11	5.18	0.88	Yes
26-27	75	+46	6.77	11	6.06	1.76	Yes
27-28	75	+41	5.63	11	4.92	0.62	Yes
28-29	75	+40	6.31	11	5.60	1.30	Yes
29-30	75	+38	6.52	11	5.81	1.51	Yes
30-31	75	+19	6.95	11	6.24	1.94	Yes
31-32	75	+40	7.18	11	6.47	2.17	Yes
32-33	75	+40	6.28	13	5.57	1.27	Yes
33-34	75	+48	7.32	13	6.61	2.31	Yes
34-35	75	+22	5.86	13	5.15	0.85	Yes
34-35	75	+43	5.57	13	4.86	0.56	Yes
35-36	75	+40	7.16	13	6.45	2.15	Yes
36-37	75	+38	6.22	13	5.51	1.21	Yes
37-38	80	+45	6.35	13	5.64	1.34	Yes

NOTES:

1. **Worst Case sag has been calculated under heavy loading conditions.**
2. **Clearances have been reduced an additional 0.6 meters to account for mean annual snow depth data from Dawson.**
3. **All poles on this drawing meet code.**

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SCALE: NTS
JOB NO.:1650
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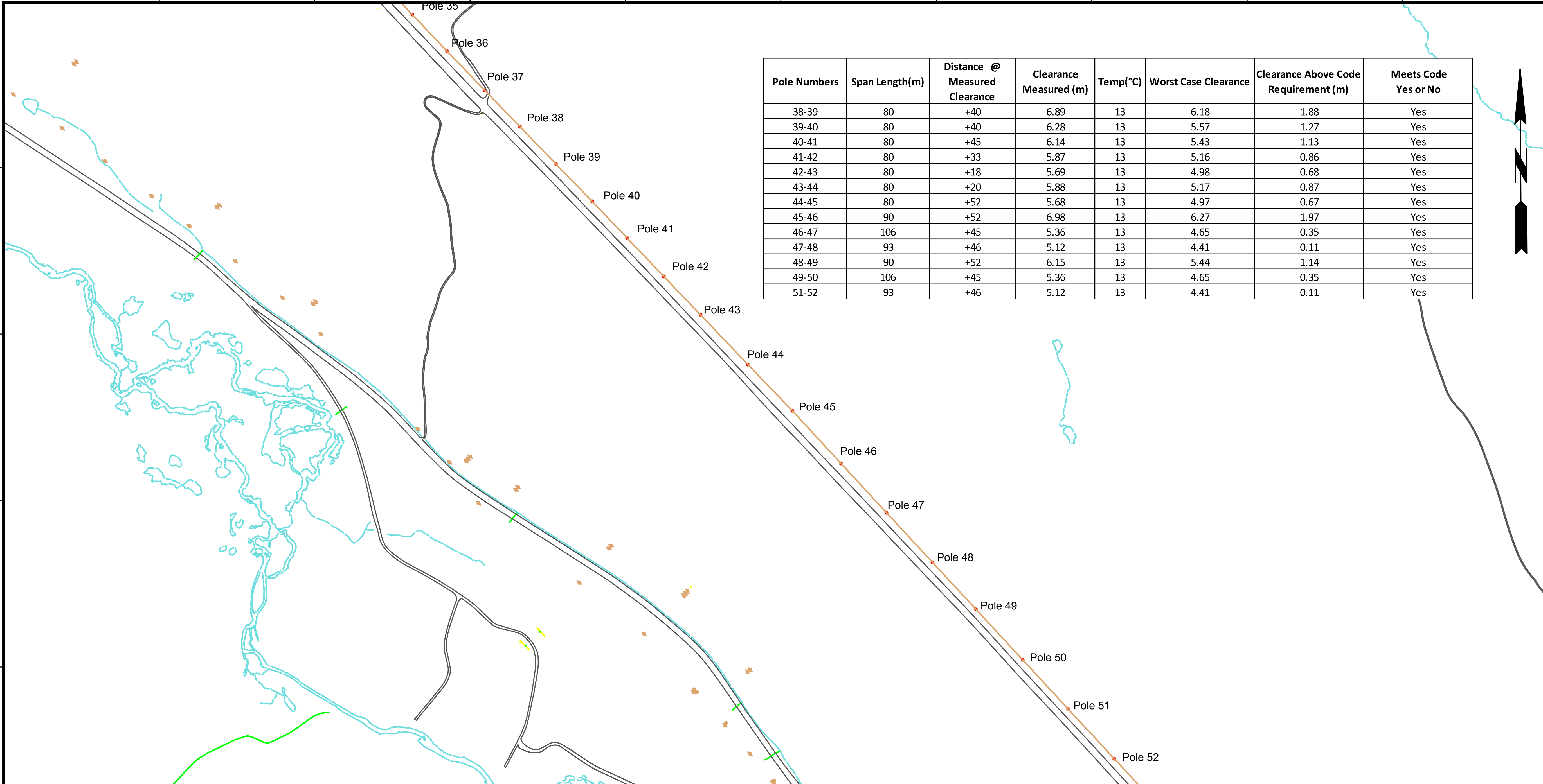
DWG.No. **T101**
SHT. **1**
REV. **A**



Pole Numbers	Span Length(m)	Distance @ Measured Clearance	Clearance Measured (m)	Temp(°C)	Worst Case Clearance	Clearance Above Code Requirement (m)	Meets Code Yes or No
38-39	80	+40	6.89	13	6.18	1.88	Yes
39-40	80	+40	6.28	13	5.57	1.27	Yes
40-41	80	+45	6.14	13	5.43	1.13	Yes
41-42	80	+33	5.87	13	5.16	0.86	Yes
42-43	80	+18	5.69	13	4.98	0.68	Yes
43-44	80	+20	5.88	13	5.17	0.87	Yes
44-45	80	+52	5.68	13	4.97	0.67	Yes
45-46	90	+52	6.98	13	6.27	1.97	Yes
46-47	106	+45	5.36	13	4.65	0.35	Yes
47-48	93	+46	5.12	13	4.41	0.11	Yes
48-49	90	+52	6.15	13	5.44	1.14	Yes
49-50	106	+45	5.36	13	4.65	0.35	Yes
51-52	93	+46	5.12	13	4.41	0.11	Yes

NOTES:

1. **Worst Case sag has been calculated under heavy loading conditions.**
2. **Clearances have been reduced an additional 0.6 meters to account for mean annual snow depth data from Dawson.**
3. **All poles on this drawing meet code.**
4. **The waste rock ended at pole 52 and no other analysis was required.**

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