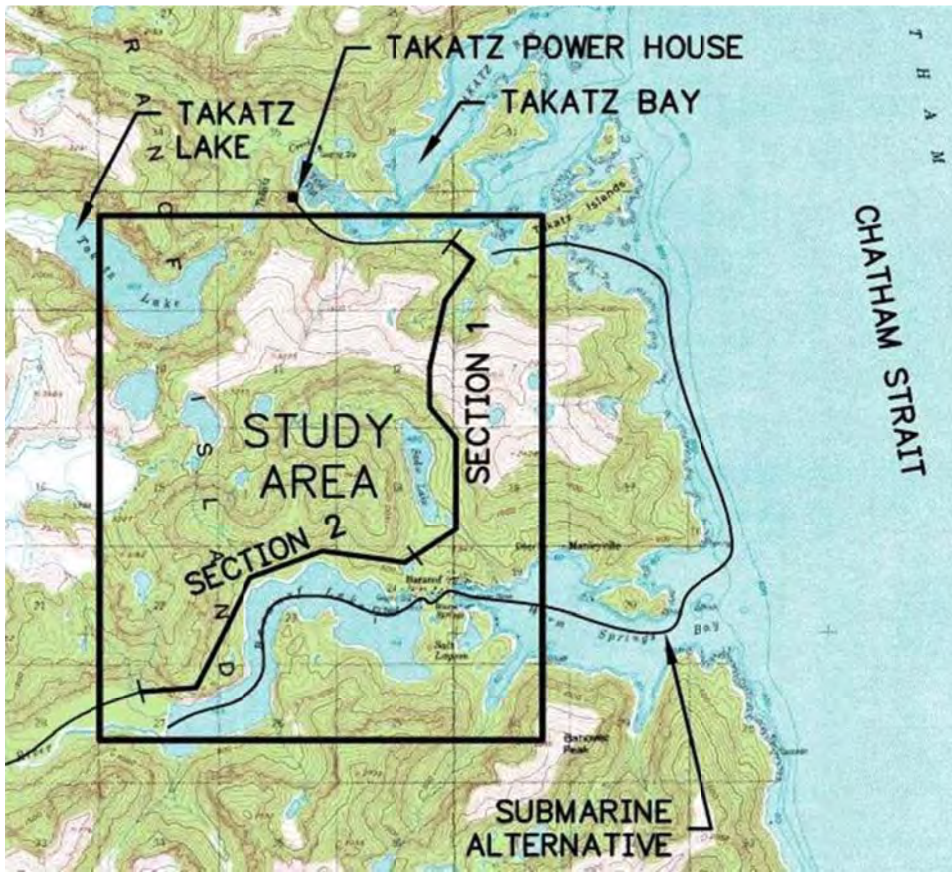
Takatz Overhead Transmission Line

Alternative Feasibility Review

Report Summary



Submitted to the
City and Borough of Sitka
Electric Department

February 10, 2011

Commonwealth associates, inc.

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Executive Summary

The proposed Takatz hydroelectric plant will be located approximately 20 miles east of Sitka, Alaska, and will require an electrical transmission interconnection to the City and Borough of Sitka electrical system. The plant will have an output capacity of 26 MW. The interconnection line will be designed to the established regional transmission voltage, which is expected to be 115 kV or 138 kV. The line will be approximately 21 miles long and is anticipated to operate initially at 69 kV. Early Federal Energy Regulatory Commission (FERC) scoping documents have shown the line to be mostly a traditional overhead design with portions being submarine cable and one portion being a cable passing through a tunnel.

This study reviews two specific overhead alternative sections of the line to determine the feasibility of eliminating two submarine cable sections. The two sections will be identified as:

- Section 1 – Overhead alternative to Chatham Strait (Takatz Bay, into Chatham Strait and then Warm Springs Bay) submarine segment, approximately 3 miles in length.
- Section 2 – Overhead alternative to Baranof Lake segment, approximately 3 miles in length.

Earlier scoping documents indicated that these two sections of line would be constructed as submarine cable. Determining the feasibility of constructing these line segments as submarine cables is not part of this study. However, the cost and difficulty of constructing a submarine cable are clearly of concern. Section 1 reviews an overhead alternative to replace the need for a cable through Chatham Strait and Warm Springs Bay. Section 2 reviews an overhead alternative to replace the need for a cable traversing Baranof Lake. The Chatham Strait/Warm Springs cable section is anticipated to be fraught with difficulty due to water depths, currents, and generally rugged underwater terrain. A submarine cable section traversing Baranof Lake is not perceived to be as onerous as the Chatham Strait section and may provide benefits over an overhead line by reducing the visual impact as well as the avalanche/rock slide risk associated with an overhead line.

This study is the first step in determining if an overhead line is feasible and if it would provide a viable alternative to a submarine cable. The study was conducted in two phases:

- Phase 1 included a site review and preparation of overhead line design criteria with development of a design concept.
- Phase 2 included development of a preliminary plan and profile layout based on the Phase 1 design concept and terrain mapping data provided by Aero-Metric, Inc., as well as a feasibility-level estimate of construction cost.

The design concepts and costs developed for this study were based on recent experience and data available from Southeast Alaska Power Agency's (SEAPA) Swan-Tyee Intertie near Ketchikan, which was completed in 2009.

Phase 1 work identified a preliminary route that appears feasible for the two line segments. The potential for rock slides and snow avalanche exists along both segments; however, it appears that careful placement of structures can significantly reduce this risk. Tree clearing requirements will be minimal along Section 1. Portions of line Section 2 are forested and will require considerable clearing to minimize risk of tree strikes to the overhead line. The clearing will increase the visibility of this line section.

The support structures assumed are generally single-shaft tubular steel poles supported on a micropile foundation system. Angle structures are assumed to be guyed. Based on discussions with local residents, the study area receives large quantities of snow and high winds, especially at higher elevations. The rugged terrain of southeast Alaska creates micro-climates that often create weather extremes. Therefore, the conceptual design assumes wind and ice loading greater than the loading required by the National Electrical Safety Code (NESC). In anticipation of extreme snow depths, ground clearance was increased over NESC minimum requirements by approximately 14 feet.

Further field studies are required prior to committing to constructing an overhead line and/or proceeding to final design. Specialists must be consulted to review the preliminary layout for the following:

- Geotechnical Consultant, to evaluate:
    - Foundation requirements
    - Mass movement (slide area risk)
- Meteorologist, to evaluate:
    - Physical loading; wind, ice
    - Snow depth expectations
- Avalanche expert, to evaluate:
    - Avalanche risk

Based on a preliminary layout and actual costs experienced for construction of the Swan-Tyee Intertie, with adjustments for a base construction year of 2011, the following costs were developed:

- Section 1 – 3.4 miles in length, $7,035,338 ($2,069,217 per mile)

- Section 2 – 2.8 miles in length, $4,673,411 ($1,663,135 per mile)

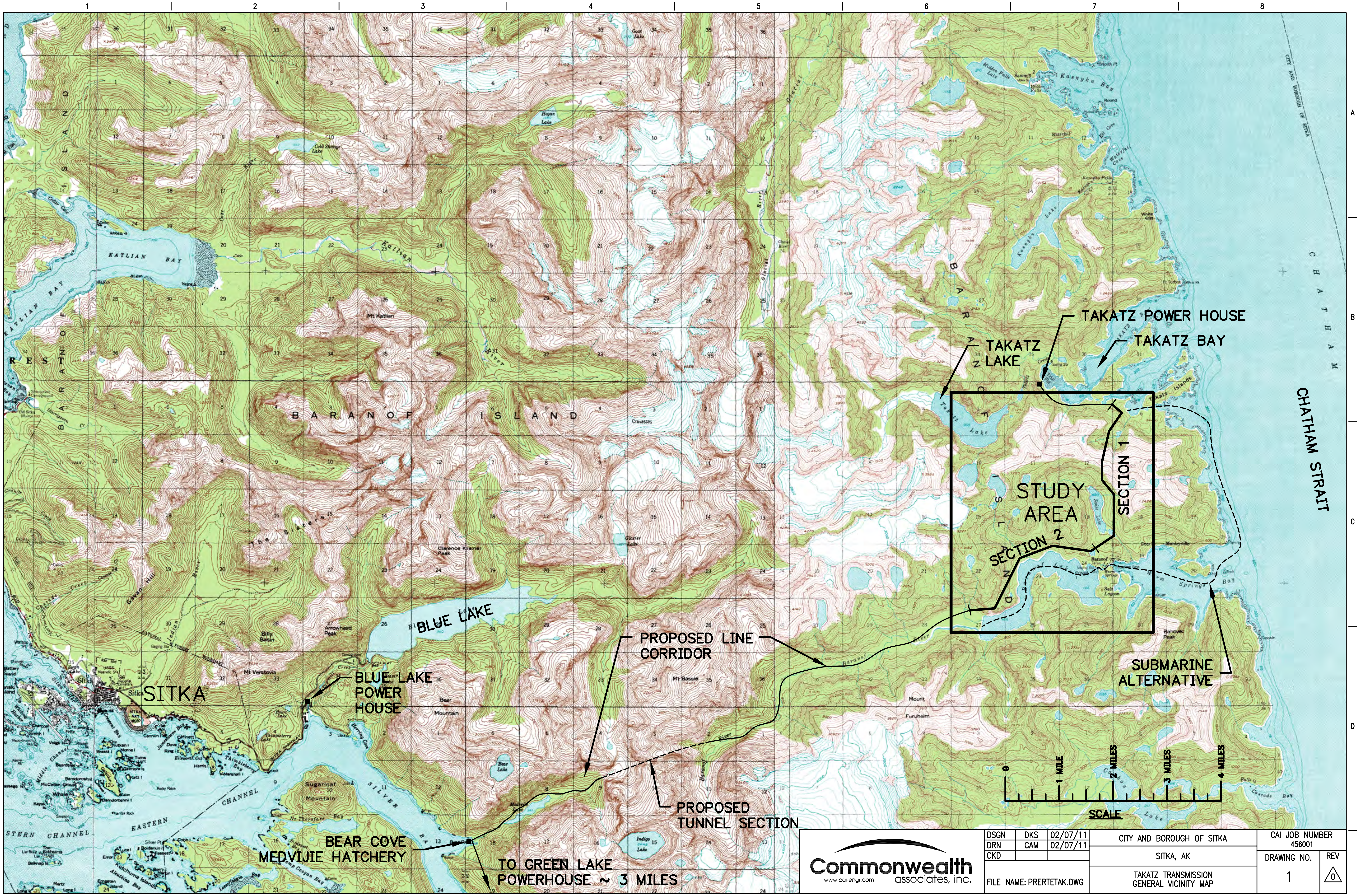
As we cannot establish precise transmission line material procurement and construction costs to build the line, it is expected that actual costs realistically could vary 20 percent from the estimate.

The above costs do not include the following project-related costs, which, although are part of overall development, are outside the scope of this study:

- Project Management
- Permitting/Environmental Impact Statement
- Design Engineering
- Material Procurement (development of specifications, management of the bid process)
- Clearing/Logging
- Engineering Support During Construction
- Construction Management
- Inspection

General vicinity and study area maps follow this Executive Summary.

The detail report is presented in two Parts: A summary of Phase 1 work is provided in Part 1, and Phase 2 work is summarized in Part 2. Supporting photos, three dimensional views, plan and profile and limited technical discussion are included in the appendix following Part 2.



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CKD			TAKATZ TRANSMISSION GENERAL VICINITY MAP	REV 0
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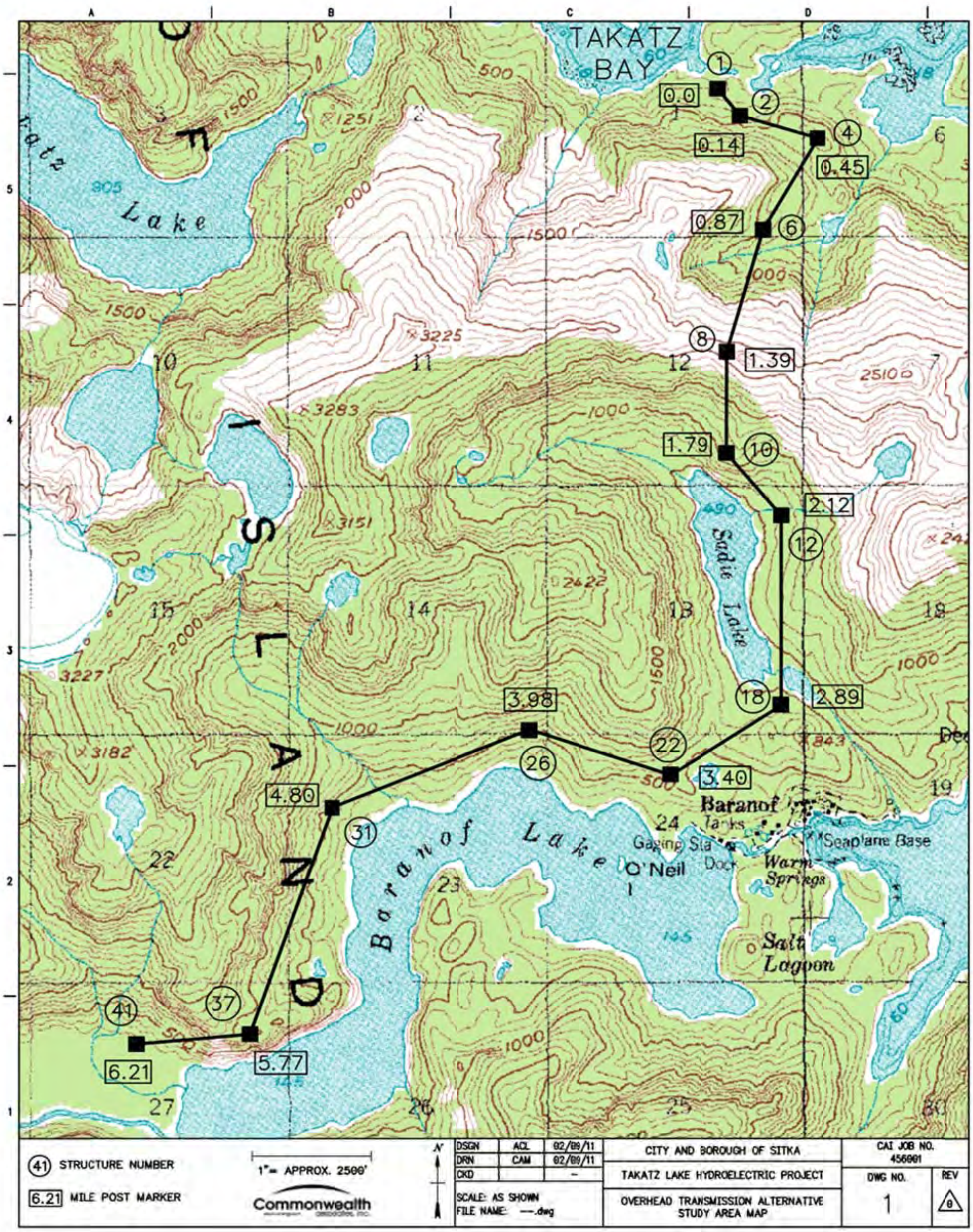
Map of Study Area - 138 kV Transmission Preliminary Alignment

(Includes Phase 2 Revisions)



Part 1, Summary of Phase 1 Work

General Approach

The goal in establishing design criteria and design concepts at this stage of a project is to establish the viability of constructing the line. The review is not intended to establish final design criteria. The conductor and structure types discussed in this review have been selected based on being adequate, not on necessarily being the optimum choice. It is expected that the design criteria will be refined as the project progresses and more data becomes available.

This review has considered loading criteria and construction approaches used on other lines in southeast Alaska which also experience extreme weather conditions and rugged and remote geography. With these considerations in mind our resulting approach is conservative in the selection of the physical loading criteria used as a basis for sizing conductor and structures. If later studies indicate that the loading criteria can be reduced, a smaller conductor and, hence, smaller (less expensive) structures would be used.

The recently constructed (2009) Swan-Tyee Intertie (STI) has been used as a comparative basis for much of this review. Although the STI line is 180 miles to the south, the general southeast Alaska terrain and weather are believed to be reasonably similar to the Takatz area. The STI project was developed over an extended period of time, and the design criteria and design approach were reviewed by several engineering firms during the project's development. The STI project also had the benefit of experience gained from the operating history of both the Tyee line (since 1984) and the Swan Lake line (since 1985). Another line that has been considered is the Snettisham line near Juneau. The Snettisham line had an early history of failures due to wind and ice and, more recently, avalanches.

The largest unknown in the study is determination of appropriate physical loading criteria for the area being reviewed. What weather conditions will the line likely encounter over its service life? The Takatz and Warm Springs area is known for having unusually heavy snow accumulations, and it is expected that the ridge area will experience extreme wind, ice, and snow. We have approached the loading on the basis of what has been used on other transmission lines in southeast Alaska.

A feasibility-level alignment and design concept are presented in this study based on available USGS mapping. In Phase 2, and after receipt of LiDAR survey data to be provided by others, a representative plan and profile will be developed using PLS-CADD software to establish reasonable structure types and a structure count. This data will be used to develop a feasibility cost estimate.

Site Review

Two of Commonwealth's senior transmission engineers, Claude Smith and Dean Scott, arrived in Sitka on July 13, 2010. Meetings were held with Chris Brewton, Utility Director Electric Department, and Robert Dryden, P.E., System Engineer, on July 13 and 14, 2010. Robert Dryden made arrangements with a helicopter company, Temsco, for a helicopter (Hughes 500) tour of the study area. Robert Dryden accompanied the Commonwealth engineers on the tour and provided a much-appreciated local perspective. The flight was scheduled for July 14, but it was delayed until the afternoon of July 15 due to weather (low clouds, poor visibility).

The tour consisted of a flyover of the area, which included the entire proposed line route (approximately 21 miles) except for the proposed tunnel section. The high elevation of the tunnel section could not be flown due to cloud cover. The area where the tunnel would exit on both sides of the mountain was flown, as was the Takatz Lake, dam and outlet area. Also, the Warm Springs Resort near the outfall of Baranof Lake was flown. The tour gave the engineers a good understanding of the terrain, vegetation, and relationship to key features of the area.

The primary emphasis of the flyover was the overhead route study area. The starting point at the bay was at the proposed end of the Takatz access road one bay east of Takatz Bay. Portions of Takatz Bay freeze in the winter; thus, the access road will extend to this saltwater bay east of Takatz Bay.

Four fly-over passes (two each way) were made along the anticipated overhead line route: from near the starting point, south over the ridge, and over Sadie and Baranof lakes. The helicopter also landed on the ridge (approximately 2,000' elevation) so that the area could be observed from ground level.

Route Description

A general vicinity map and a study area map with mile post (MP) designations are included in this report following the Executive Summary.

Section 1 - Alternative to Submarine Section (0.0 to 3.40)

MP 0.0 to 2.12

The first part of the route, MP 0.0 to MP 1.39, climbs quickly from sea level to the ridgetop (2,100' elevation). This area has few trees and is mostly exposed rock. This line section was still covered with patches of snow on July 15. It is anticipated that this section of line will receive the most severe wind and icing due to its exposure on the ridge, particularly at the higher elevations.

Upon reaching the ridge top, MP 1.39 the line route continues south to a plateau on the north side of Sadie Lake (MP 1.79) at an elevation of approximately 1,150'. From the plateau, the line would angle east until it reached MP 2.12 at an elevation of approximately 600' (lake elevation 490'). The west side of the lake is extremely steep, with obvious slide areas, and does not appear to be a good location for line placement.

The steepness of the route, combined with the large amounts of snow reported to accumulate during winter months, gives concern of general snow movement risk, including possible avalanche risk, that could impact an overhead line. Although we have concerns, we are confident that locations for structures where risk will be minimized can be found. The steep rock grade has some small plateau areas where structures can be sited without being placed on extreme side slopes. Although this area is anticipated to receive significant snow accumulations, the steepness of the slopes reduces the likelihood of hunters and other recreational hikers moving about during the winter months when there may be significant snow depth.

MP 2.12 to 3.40

After reaching the 600-700' elevation, the route would continue south, paralleling Sadie Lake on the east side to a low area that separates Sadie Lake from a smaller pond area south of Sadie Lake. The Sadie Lake area (MP 2.12 to MP 2.89) can be characterized as relatively flat and wet with low-growing scrub trees. It does not appear to be muskeg, as short trees are growing and it is expected that bedrock is near the surface. A hiking trail from the Warm Springs Lodge area reportedly goes to Sadie Lake, and although the trail was not observed, it is expected that any new overhead line would cross the trail.

From the south end of Sadie Lake (MP 2.89), the line is anticipated to angle southwest toward

Baranof Lake to a point north of O'Neil Island approximately 1,000' from the lake at an elevation of approximately 500' (MP 3.40). Should the decision to place a submarine cable in the lake be reached, it is anticipated that the overhead line would extend to the lakeshore. It appears the line and/or the submarine landing site can be positioned such that the terrain and trees will visually shield the facilities from the small boat area on the northeast side of Baranof Lake and also from the trail that goes between Warm Springs Bay and Baranof Lake.

This section of line is not expected to have as severe weather as the ridge due to the lower elevation and the terrain is much gentler. This area has few tall trees. The elevation varies from approximately 600' to 750'. Being at lower elevations, this area should have less snow but may also be a more likely area where hunters and other recreational hikers will be moving about during the winter months.

This area is a rolling terrain and due to being a more moderate slope does not appear to have a high risk of snow movement or avalanche. No noticeable snow chutes were observed. The rolling terrain will allow placement of structures at most locations, and it is anticipated that the structure locations will be determined primarily based on optimizing the span length, structure height, and structure strength capability.

Section 2 - North Side of Baranof Lake (MP 3.4 to 6.21)

MP 3.40 to 4.80

Assuming the line continues (from MP 3.40) as an overhead line, it is anticipated to generally follow the Baranof Lake shoreline at an elevation of approximately 300' to 800' (lake elevation, 145') based on an average setback of approximately 1,000'. This section is on a relatively steep side hill. A few avalanche chutes were noted. However, it is thought that structures can be located away from the slides and the slide areas can be spanned to avoid risk. The area is forested and will require clearing along the lake. It is anticipated that the line can be positioned far enough away from the shore to allow trees to shield the line from the lake. As this section is heavily forested and the line would be severely damaged by tree strikes, the width of clearing needs to consider the tree heights and uphill slope, which will significantly increase the desired clearing width. It is anticipated a screening of trees along the shoreline will be required, and this may push the line farther from the lake and farther up the hillside.

MP 4.80 to 6.21

This section also generally parallels the lake and is similar to the previous section (MP 3.40 to 4.80) except that, at the west end of the lake, a cliff along the lakeshore requires that the alignment move away from the lakeshore and gradually climb in elevation. At the west end of the lake, the cliff forces a rapid descent to the valley floor. The elevation at MP 4.80is approximately 500', and at the top of the cliff (near MP 5.97) it is approximately 1,000'. From this 1,000' high point, the line will need to meet up with the line route that will be followed up the valley, which is at an elevation of approximately 150'. This section is forested, but as the elevation increases, the trees become shorter. The higher elevation is exposed rock.

The west end of the lake would also be the exit point for a submarine cable if the cable alternative is selected. The ending location at the west end of the lake or the exit point for a submarine cable at the west end of the lake needs to be coordinated with the overhead line route continuing up the Baranof River valley. The southwest end of the lake has been reported to be a goat kidding area, which may impact scheduling of construction. Also, a cabin on the south side of the west end was noted, and care needs to be taken to minimize visual impact.

Physical Loading Criteria

Based on discussions with local residents, the study area receives large quantities of snow and high winds are experienced, especially at the higher elevations. We have been unable to obtain any firm data on wind, snow, or ice. The rugged terrain of southeast Alaska creates micro-climates that often create weather extremes. Therefore, it is reasonable to assume that the area being studied may experience loads greater than the loading that is required by the National Electrical Safety Code (NESC).

The goal in establishing design criteria for the design concept stage is to be reasonable while also generally erring on the conservative side. Although the criteria selected are based on the more severe criteria used on other southeast Alaska lines, we have purposely avoided using the most extreme criteria because it does not seem appropriate to assume the Takatz area is the most extreme of all extreme locations in southeast Alaska.

The NESC is the mandated safety code for Alaska. The NESC requires three specific physical loading conditions:

- NESC Heavy Loading: ½" ice with 4 psf (40 mph) wind at 0 degree F with
    - Grade B Over Load Factors (OLFs) of the following: tension=1.65, wind=2.5, vertical=1.5
- Extreme Wind: 120 mph (37 psf wind) at 60 degrees F with 1.0 OLF
- Combination Wind/Ice Loading: ½" ice with 50 mph (6.4 psf) at 15 degrees F wind with 1.0 OLF

Most lines are designed in excess of the NESC minimum requirements, especially in locations where evidence suggests micro-climates may create unusual or extreme conditions (channeling of wind or excessive ice).

Attachment D in the Appendix provides additional discussion on design criteria in general and the design criteria used on the Swan Tyee Intertie.

Following are the loading conditions this Design concept has assumed:

Long Spans and High Elevations (more than 1,500' and/or above 1,200' elevation):

- NESC Heavy Loading: ½" ice with 4 psf (40 mph) wind at 0 degree F with
    - Grade B OLFs (tension=1.65, wind=2.5, vertical=1.5)
- Extreme Wind: 140 mph (50 psf wind) at 40 degrees F with 1.1 OLF
- Combination Wind/Ice Loading: 1.75" ice with 40 mph (4 psf) at 20 degrees F wind with 1.1 OLF
- Unbalanced Longitudinal: 1" radial ice to no ice at 30 degrees F with 1.1 OLF

Shorter Spans and Lower Elevations (less than 1,500' and below 1,200'):

- NESC Heavy Loading: ½" ice with 4 psf (40 mph) wind at 0 degree F with
    - Grade B OLFs (tension=1.65, wind=2.5, vertical=1.5)
- Extreme Wind: 120 mph (37 psf wind) at 40 degrees F with 1.1 OLF
- Combination Wind/Ice Loading: 1.5" ice with 40 mph (4 psf) at 30 degrees F wind with 1.1 OLF
- Unbalanced Longitudinal: 1/2" radial ice to no ice at 30 degrees F with 1.1 OLF

Prior to final design, we recommend a meteorological consultant be retained to evaluate and recommend the final design loading criteria.

Electrical Loading and Conductor Selection

The stated electrical load for the Takatz hydroelectric plant is 24 MW. The line is anticipated to be operated at 69 kV even though it will be designed for and may someday operate at a higher voltage. A higher operating voltage would, from an electrical standpoint, reduce the conductor size needed. The large physical loading requirements discussed under Physical Loading Criteria above result in the electrical loading being a relatively minor consideration. The physical loading is what will drive the conductor selection.

Again leaning on work previously completed on the STI line, we believe the following two conductors are appropriate for this study:

- Long spans and higher elevations– 37#8 Alumoweld
- Shorter spans and lower elevations– 397.5 AACSR/AW 30/7

Realistically, it is expected that an in-depth study may point to a smaller conductor for the Takatz line. But, again being conservative and based on the extreme physical loading being considered, we feel it is reasonable to base the conceptual design on these larger and stronger conductors. Prior to final design and after final physical design criteria are established, an in-depth conductor analysis should be performed to refine the selection.

The following maximum conductor limits were used to develop sag/tension data for the study case:

397.5 kcmil AACSR/AW 30/7

- 15% RTS, @ 0 degrees F final
- 16% RTS @ 0 degrees F initial
- 70% RTS, final @ extreme ice or extreme ice/wind combinations

37 # 8 Alumoweld

- 22% RTS, final @ 40 degrees F
- 35% RTS, Initial at 60 degrees F
- 70% RTS, final @ extreme ice or extreme ice/wind combinations

Clearances

The NESC requires basic clearance to ground values under various described conditions based on final sags at maximum operating temperature or ½” radial ice at 30 degrees F, whichever is greater.

To compensate for conductor blowout, survey and plotting inaccuracies and other contingencies, a plotting margin of 2’ to 4’ is typically applied. For purposes of this study we have used 4’.

The NESC clearance plus the plotting margin of 4’ results in values as follows:

- At 138 kV, over roads, 22’+4’ = 26’
- At 138 kV, pedestrian only, 20’+4’=24’

The NESC does not address snow pack; however, we feel it should be considered, particularly in an area where snowmobiles and hunters or recreational users are possibly traveling cross-country. The snow in the study area has been reported to accumulate to depths of 30’ to 35’. This extreme snow depth needs to be considered, as it potentially creates a significant design impact, depending on what is determined as reasonable for line clearance over snow.

The physical loading of 1.75” radial ice case discussed earlier could also create a significant design impact, depending on what is determined as reasonable. It is standard practice to provide strength for an extreme ice loading condition but not use the extreme ice loading as a basis for vertical clearance.

For purposes of this study we have established a clearance limit to 38' (14' more than the NESC base pedestrian only requirement) under ½" ice. This clearance provides NESC clearance (pedestrian only) with a 4' plotting margin and an additional 14' margin to allow for snow accumulation. The 38' clearance will also keep the conductor above the snow even under NESC ½" ice requirements at the reported extreme snow depths of 30' to 35'.

Prior to final design we recommend that a meteorologist consultant be retained to evaluate and recommend appropriate snow depths.

Structure Types

MP 0.0 to 2.12

The steepness of this section causes concern for snow movement and possible avalanche risk. We believe it will be important to minimize the number of support structures and selectively locate structures on the isolated flatter areas (small plateaus) that are present to reduce the possibility of structures being affected by snow movement or an avalanche. Using a high-strength Alumoweld (aluminum-coated steel cable) as the conductor will allow the design to accommodate extreme ice and wind loads and also accommodate extremely long spans.

MP 2.12 to 3.40

Although this section of line could be constructed on single poles, a traditional wood H-frame or tubular steel Y-structure would accommodate the terrain and result in significantly longer spans, thereby reducing the number of structures needed. With traditional H-fame or Y-type structures the span lengths are anticipated to be in the 600' to 1,200' range. It is anticipated that a traditional ACSR conductor could be used. However, with the extreme wind and snow loads typical of southeast Alaska, the higher-strength AACSR conductor is perhaps the better choice.

MP 3.40 to 4.80

The rolling terrain along this section is similar to that along the previous section (MP 2.12 to 3.40) and will allow placement of structures at most locations. It is anticipated that the structure locations will be determined primarily based on optimizing the span length to optimize structure height and strength capability. The structure types and conductor selected will most likely be the same as those selected for the previous section.

MP 4.80 to 6.21

The rolling terrain along this section is similar to that along the previous section (MP 3.40 to 4.80) and will allow placement of structures at most locations. It is anticipated that the structure locations will be determined primarily based on optimizing the span length to optimize structure height and strength capability. The structure types and conductor selected will most likely be the same as those selected for the previous section until the drop to the valley, where it is anticipated a long span will be needed and the Alumoweld conductor suggested for the MP 0.0 to 1.92 section may be appropriate.

Following are photographs of typical structures used on the lower-elevation sections of the STI line. Based on using a similar conductor and similar loading conditions, these structures would be appropriate for the line being studied.

Tubular Steel Tangent

Tubular Steel In-Line Dead-End

Tubular Steel 3-Pole Angle Dead-End

Below are photographs of typical structures used on the high-elevation and long-span sections of the STI line. These structures may be appropriate for supporting long spans up and over the ridge and for one long span coming off the cliff area at the west end of Baranof Lake.

Tubular Steel H-Frame

Tubular Steel 3-Pole Angle Dead-End

Tubular Steel A-Frame Dead-End

Clearing and Trees

One of the greatest risks to transmission lines in forested areas is strikes from falling trees. Lines are not designed to withstand the impact of a tree falling on either the conductor or the structures. The easiest way to prevent tree strikes is to remove the trees. However, this is not always acceptable or practical, especially on steep side hills.

The study area--particularly the section over the ridge--has few tall trees. Thus, risks posed by trees are to a large extent eliminated. The section along Baranof Lake does have sizable trees, and if an overhead line is constructed, it is anticipated that the clearing width will need to be 200 plus feet in width to reasonably minimize this risk. A secondary consideration is that the trees do provide a visual screen, and along the lake there are visual reasons to leave a tree screen. However, a narrow screen will be prone to blow down, forcing the line farther up the hill to provide an adequate tree screen.

Input from a forester is recommended.

Foundations

On a cross-country line in southeast Alaska, access to the site is difficult and is normally accomplished with the use of helicopter transport. Thus, any equipment that needs to be transported must be relatively small, and structural backfill and/or placement of concrete is normally avoided. This line section is close to saltwater access and any helicopter lifts would be relatively short runs, so direct embedment of structures with structural backfill including concrete is a possibility.

The study section appears generally to have rock near the surface. Although rock is not easy to excavate, it does provide a good foundation and a foundation system that uses rock anchors will be relatively easy to install. On the STI line, micropile foundations were used for support of all structures. The advantage that a micropile foundation offers is that it is adaptable to a wide variety of geotechnical conditions from rock to muskeg. It is also constructed with relatively small equipment and can be easily modified at the site to fit the specific conditions.

Micropile Foundation Drilling

Micropile Foundation – Tangent Structure

Hazards

Overhead lines can be designed to withstand extreme wind and ice loading. The hazards that lines are not designed to withstand are slides (snow or soil) and direct tree strikes.

Wind and Ice

The line can be designed to withstand wind and ice, but there needs to be a balance between the probability of weather occurrence and economics.

Mass Movement of Earth/Debris

The danger of slides can generally be reduced by careful selection and placement of support structures to allow spanning over the highest-risk areas. A few slide areas were noted on the site review; however, they appeared to be avoidable through careful structure placement. It is recommended that a geotechnical consultant be retained to evaluate the route prior to final layout and placement of structures.

Avalanche

The danger of avalanche can generally be reduced by careful selection and placement of support structures to allow spanning over the highest-risk areas. A few slide areas were noted on the site review. However, they appeared to be avoidable through the careful placement of structures. It is recommended that an avalanche expert be retained to evaluate the route prior to final layout and placement of structures. This is particularly important for the section over the ridge.

Trees

Avoidance of tree strikes is generally achieved by clearing a right-of-way width to the extent that most trees located within striking distance are eliminated.

Part 2, Summary of Phase 2 Work

Introduction

Commonwealth was contracted to provide the following:

Phase 1 included a site review and preparation of overhead line design criteria with development of a design concept.

Phase 2 included development of a preliminary plan and profile layout based on the Phase 1 design concept and the LIDAR data provided by Aero-Metric, Inc. The phase 2 effort also included a preliminary line layout to be used to develop a pre-feasibility level estimate of the expected construction cost.

Simultaneous to Phase 1 work being initiated by Commonwealth the City and Borough of Sitka contracted with Aero-Metric, Inc, Anchorage, AK for a LIDAR survey of the study area. The LIDAR data was received by Commonwealth October 25, 2010. Commonwealth's Phase 2 work consisted of using this LIDAR data to develop a terrain model for input into PLS-CADD transmission design software. Using the base criteria developed in Phase 1, Commonwealth refined the initial alignment and developed a proposed preliminary line layout. Using this preliminary line layout Commonwealth developed a feasibility level cost estimate.

As in Phase 1 of the study, the Phase 2 layout work was limited to two specific line sections. These two sections account for approximately 6.2 miles of the line's estimated overall length of 21 miles. The two sections considered are:

- Section 1 - Alternative to submarine segment (Takatz Bay, into Chatham Strait and then Warm Springs Bay), 3.4 miles in length.
- Section 2 - North side of Baranof Lake, 2.81 miles in length

General Approach

Using the design criteria and structure types suggested in Phase 1, Commonwealth engineers used PLS-Cadd transmission line design software with the LIDAR data received from Aero-Metric to create a three dimensional view of the terrain to refine the alignment and spot Points of alignment Intersections (PI's). Following refinement of the alignment a profile was cut and a preliminary layout was developed showing potential structure locations, types, heights and resulting span lengths.

The design criteria and structure types suggested as being appropriate for the Takatz transmission line study was based on SEAPA's Swan Tyee Intertie (STI) line that was constructed in 2008 and 2009. Unit costs for line construction and material costs were developed based on actual costs experienced on SEAPA's STI line.

A feasibility cost estimate was developed based on the unit costs and a tabulation of units taken from the preliminary layout.

PLS-CADD Layout

The PLS_CADD layout was based on the following conductor, structure types and assumptions:

Conductor:

397.5 kcmil AACSR/AW 30/7 except from MP 0.45 to 1.79 (22% of the line length) which used 37 # 8 Alumoweld.

Structure Types:

Tangent

Maximum Wind span - 1,600’
Maximum Weight span – 2,800’
Foundation: 1 Micro-Pile foundation consisting of 4 vertical piles and assuming 50% will require 3 additional battered piles.
Average Casing per pile – 10 ft
Average Rock Anchor per pile – 20 ft

In-Line Deadend

Maximum Wind span - 1,600’
Maximum Weight span – 2,800’
Foundation: 1 Micro-Pile foundation consisting of 4 vertical piles and assuming 50% will require 3 additional battered piles.
Average Casing per pile – 10 ft
Average Rock Anchor per pile – 20 ft
4 down guys and 2 anchors

3-Pole Deadend

Maximum Wind span - 1,600’
Maximum Weight span – 2,800’
Foundation: 3 Micro-Pile foundations consisting of 3 vertical piles and 2 battered piles.
Average Casing per pile – 10 ft
Average Rock Anchor per pile – 20 ft
2 span guys, 8 down guys and 8 anchors

Heavy Tangent

Maximum Wind span - 2,300’
Maximum Weight span – 4,000’
Foundation: 2 Micro-Pile foundations consisting of 4 vertical piles and 3 battered piles.
Average Casing per pile – 10 ft
Average Rock Anchor per pile – 20 ft
4 down guys and 2 anchors

Heavy 3-pole Deadend

Maximum Wind span - 2,300’
Maximum Weight span – 4,000’
Foundation: 3 Micro-Pile foundations consisting of 3 vertical piles and 2 battered piles.
Average Casing per pile – 10 ft
Average Rock Anchor per pile – 20 ft
2 span guys, 14 down guys and 14 anchors

Heavy A-Frame Deadend

Maximum Wind span - 3,000’
Maximum Weight span – 8,000’
Foundation: 6 Micro-Pile foundations consisting of 4 vertical piles and 3 battered piles.
Average Casing per pile – 10 ft
Average Rock Anchor per pile – 20 ft
2 span guys, 4 down guys and 4 anchors

Terrain Model

Included as Attachment B are three-dimensional views showing the routing of the preliminary transmission line layout.

Plan and Profile Drawings

Included as Attachment C are plan and profile drawings showing the preliminary layout developed with the aid of PLS-CADD transmission design software.

Cost Estimate

Below is the feasibility level cost estimate developed in Phase 2. The estimate is based on the PLS-CADD layout and from unit prices developed from the STI line construction experience.

These costs do not include the following project related costs which although are part of overall development are outside this studies scope of work.

- Project Management
- Permitting/Environmental Impact Statement
- Design Engineering
- Material Procurement (development of specifications, management of the bid process)
- Clearing/logging
- Engineering support during construction
- Construction Management
- Inspection

The previously listed items of work will vary significantly depending on the overall project approach and whether the study section is completed independently or as part of the overall project development.

Cost Estimate Summary

		Section 1 MP 0.0 to 3.4	Section 2 MP 3.4 to 6.21	Total MP 0.0 to 6.21
Materials	Miles	3.4	2.81	6.21
Structures		$ 412,390	$ 364,540	$ 776,930
Conductor		$ 143,768	$ 72,356	$ 216,124
Insulators		$ 36,900	$ 23,400	$ 60,300
Conductor Accessories		$ 14,377	$ 7,236	$ 21,613
Guy Assemblies		$ 124,000	$ 58,000	$ 182,000
	Subtotal	$ 731,435	$ 525,532	$ 1,256,967
Construction				
Foundations & Anchors		$ 3,279,702	$ 2,088,709	$ 5,368,411
Structures & Guys		$ 1,229,454	$ 805,682	$ 2,035,136
Conductor & Misc.		$ 972,499	$ 712,460	$ 1,684,959
	Subtotal	$ 5,481,655	$ 3,606,851	$ 9,088,506
Mob/Demob (1)		$ 822,248	$ 541,028	$ 1,363,276
TOTAL		**$ 7,035,338**	**$ 4,673,411**	**$ 11,708,749**
	$ per Mile	$ 2,069,217	$ 1,663,135	$ 1,885,467

Notes

(1) At 15% of construction cost this is a pro-rated value that assumes the study section is contracted as part of the entire approximately 21 mile long line.

The above cost estimate is based on actual costs experienced for the Swan Tyee Intertie Construction adjusted for a base construction year of 2011. A 3% per year inflation factor was used. Due to the variability in transmission line material procurement and construction costs it is expected that actual costs realistically could vary 20% of the estimate.

Construction Costs by Structure

Structures	Angle	Span Ahead	Struc Type	Ht	# of Guys	Construction Fdns and Anchors	Construction Strucs and Guys Incl Caps and S. Pipes	Construction Cond. And Misc. (1)	Total Construction
1	??	731	3-pole DE	50	10	$ 213,327	$ 80,567	$ 37,582	$ 331,476
2	35	1031	3-pole DE	55	10	$ 213,327	$ 80,567	$ 53,005	$ 346,899
3		627	Tangent	70	0	$ 54,576	$ 23,069	$ 32,235	$ 109,880
4	105	994	HVY 3-Pole DE	50	16	$ 271,315	$ 104,257	$ 51,103	$ 426,675
5		1243	HVY Tangent	60	4	$ 137,928	$ 45,124	$ 63,904	$ 246,956
6	17	2373	HVY 3-Pole DE	50	16	$ 271,315	$ 104,257	$ 121,999	$ 497,571
7		312	HVY Tangent	80	4	$ 137,928	$ 45,124	$ 16,040	$ 199,092
8	15	424	HVY A-Frame DE	65	6	$ 376,060	$ 122,462	$ 21,798	$ 520,320
9		1728	HVY Tangent	70	4	$ 137,928	$ 45,124	$ 88,839	$ 271,891
10	40	609	HVY 3-Pole DE	50	16	$ 271,315	$ 104,257	$ 31,310	$ 406,882
11		1124	Tangent	60	0	$ 54,576	$ 23,069	$ 57,786	$ 135,431
12	40	687	3-pole DE	65	10	$ 213,327	$ 80,567	$ 35,320	$ 329,214
13		659	Tangent	70	0	$ 54,576	$ 23,069	$ 33,880	$ 111,525
14		721	Tangent	70	0	$ 54,576	$ 23,069	$ 37,068	$ 114,713
15		306	Tangent	65	0	$ 54,576	$ 23,069	$ 15,732	$ 93,377
16		540	Tangent	60	0	$ 54,576	$ 23,069	$ 27,762	$ 105,407
17		1114	In-line DE	50	4	$ 86,335	$ 35,731	$ 57,272	$ 179,338
18	57	578	3-pole DE	50	10	$ 213,327	$ 80,567	$ 29,716	$ 323,610
19		588	Tangent	70	0	$ 54,576	$ 23,069	$ 30,230	$ 107,875
20		331	Tangent	60	0	$ 54,576	$ 23,069	$ 17,017	$ 94,662
21		1205	In-line DE	60	4	$ 86,335	$ 35,731	$ 61,951	$ 184,017
22	52	991	3-pole DE	50	10	$ 213,327	$ 80,567	$ 50,949	$ 344,843
			Sub-Total for 37 # 8 Conductor			$ 1,603,789	$ 570,605	$ 394,994	$ 2,569,388
			Sub-Total for 397.5 kcmil Conductor			$ 1,675,913	$ 658,849	$ 577,505	$ 2,912,267
						$ 3,279,702	$ 1,229,454	$ 972,499	$ 5,481,655
23		714	Tangent	65	0	$ 54,576	$ 23,069	$ 36,708	$ 114,353
24		451	Tangent	75	0	$ 54,576	$ 23,069	$ 23,187	$ 100,832
25		904	In-line DE	55	4	$ 86,335	$ 35,731	$ 46,476	$ 168,542
26	41	1049	3-pole DE	70	10	$ 213,327	$ 80,567	$ 53,931	$ 347,825
27		736	Tangent	60	0	$ 54,576	$ 23,069	$ 37,839	$ 115,484
28		665	Tangent	80	0	$ 54,576	$ 23,069	$ 34,189	$ 111,834
29		1297	Tangent	75	0	$ 54,576	$ 23,069	$ 66,681	$ 144,326
30		621	In-line DE	60	4	$ 86,335	$ 35,731	$ 31,927	$ 153,993
31	48	919	3-pole DE	70	10	$ 213,327	$ 80,567	$ 47,247	$ 341,141
32		1214	Tangent	65	0	$ 54,576	$ 23,069	$ 62,414	$ 140,059
33		893	Tangent	75	0	$ 54,576	$ 23,069	$ 45,910	$ 123,555
34		1055	Tangent	75	0	$ 54,576	$ 23,069	$ 54,239	$ 131,884
35		398	Tangent	60	0	$ 54,576	$ 23,069	$ 20,462	$ 98,107
36		605	Tangent	60	0	$ 54,576	$ 23,069	$ 31,104	$ 108,749
37	66	566	3-pole DE	60	10	$ 213,327	$ 80,567	$ 29,099	$ 322,993
38		255	HVY A-Frame DE	60	6	$ 376,060	$ 122,462	$ 13,110	$ 511,632
39		521	In-line DE	60	4	$ 86,335	$ 35,731	$ 26,785	$ 148,851
40		995	Tangent	85	0	$ 54,576	$ 23,069	$ 51,154	$ 128,799
41	??		3-pole DE	50	10	$ 213,327	$ 80,567	$ -	$ 293,894
						$ 2,088,709	$ 805,682	$ 712,460	$ 3,606,851
						$ 5,368,411	$ 2,035,136	$ 1,684,959	$ 9,088,506
						59.1%	22.4%	18.5%	100%

LEGEND	
(397.5 kcmil colour)	397.5 kcmil AACSR Conductor
(37 # 8 colour)	37 # 8 Alumoweld Conductor
(Section 1 colour)	Section 1, MP 0.0 to 3.4
(Section 2 colour)	Section 2, MP 3.4 to 6.21
(Total colour)	Total, MP 0.0 to 6.21

Construction Fdns and Anchors	Construction Strucs and Guys Incl Caps and S. Pipes
$ 54,576	$ 23,069
$ 86,335	$ 35,731
$ 213,327	$ 80,567
$ 137,928	$ 45,124
$ 271,315	$ 104,257
$ 376,060	$ 122,462

Material Costs by Structure

Structures	Angle	Span Ahead	Struc Type	Ht	# of Guys	Wt	Material Structure Cost (1)	Material Wire Cost (2)	Material Insulators (3)	Material Cond Accessories (4)	Material Guy Assemblys (5)	TOTAL Materials
1	??	731	3-pole DE	50	10	5700	$ 12,540	$ 3,817	$ 1,800	$ 382	$ 10,000	$ 28,538
2	35	1031	3-pole DE	55	10	7200	$ 15,840	$ 5,383	$ 1,800	$ 538	$ 10,000	$ 33,561
3		627	Tangent	70	0	8600	$ 18,920	$ 3,274	$ 600	$ 327	$ -	$ 23,121
4	105	994	HVY 3-Pole DE	50	16	9700	$ 21,340	$ 11,514	$ 4,200	$ 1,151	$ 16,000	$ 54,205
5		1243	HVY Tangent	60	4	8800	$ 19,360	$ 14,398	$ 900	$ 1,440	$ 4,000	$ 40,097
6	17	2373	HVY 3-Pole DE	50	16	9700	$ 21,340	$ 27,486	$ 4,200	$ 2,749	$ 16,000	$ 71,775
7		312	HVY Tangent	80	4	11900	$ 26,180	$ 3,614	$ 900	$ 361	$ 4,000	$ 35,055
8	15	424	HVY A-Frame DE	65	6	21250	$ 46,750	$ 4,911	$ 4,200	$ 491	$ 6,000	$ 62,352
9		1728	HVY Tangent	70	4	10400	$ 22,880	$ 20,015	$ 900	$ 2,002	$ 4,000	$ 49,797
10	40	609	HVY 3-Pole DE	50	16	9700	$ 21,340	$ 3,180	$ 4,200	$ 318	$ 16,000	$ 45,038
11		1124	Tangent	60	0	6600	$ 14,520	$ 5,869	$ 600	$ 587	$ -	$ 21,576
12	40	687	3-pole DE	65	10	9250	$ 20,350	$ 3,587	$ 1,800	$ 359	$ 10,000	$ 36,096
13		659	Tangent	70	0	8600	$ 18,920	$ 3,441	$ 600	$ 344	$ -	$ 23,305
14		721	Tangent	70	0	8600	$ 18,920	$ 3,765	$ 600	$ 376	$ -	$ 23,661
15		306	Tangent	65	0	7100	$ 15,620	$ 1,598	$ 600	$ 160	$ -	$ 17,977
16		540	Tangent	60	0	6600	$ 14,520	$ 2,819	$ 600	$ 282	$ -	$ 18,221
17		1114	In-line DE	50	4	5250	$ 11,550	$ 5,816	$ 1,800	$ 582	$ 4,000	$ 23,748
18	57	578	3-pole DE	50	10	5700	$ 12,540	$ 3,018	$ 1,800	$ 302	$ 10,000	$ 27,660
19		588	Tangent	70	0	8600	$ 18,920	$ 3,070	$ 600	$ 307	$ -	$ 22,897
20		331	Tangent	60	0	6600	$ 14,520	$ 1,728	$ 600	$ 173	$ -	$ 17,021
21		1205	In-line DE	60	4	5900	$ 12,980	$ 6,292	$ 1,800	$ 629	$ 4,000	$ 25,701
22	52	991	3-pole DE	50	10	5700	$ 12,540	$ 5,174	$ 1,800	$ 517	$ 10,000	$ 30,032
		Sub-Total for 37 # 8 Conductor				81450	$ 179,190	$ 85,118	$ 19,500	$ 8,512	$ 66,000	$ 358,320
		Sub-Total for 397.5 kcmil Conductor				106000	$ 233,200	$ 58,650	$ 17,400	$ 5,865	$ 58,000	$ 373,115
						187450	$ 412,390	$ 143,768	$ 36,900	$ 14,377	$ 124,000	$ 731,435
23		714	Tangent	65	0	7100	$ 15,620	$ 3,728	$ 600	$ 373	$ -	$ 20,321
24		451	Tangent	75	0	9800	$ 21,560	$ 2,355	$ 600	$ 235	$ -	$ 24,750
25		904	In-line DE	55	4	5600	$ 12,320	$ 4,720	$ 1,800	$ 472	$ 4,000	$ 23,312
26	41	1049	3-pole DE	70	10	9900	$ 21,780	$ 5,477	$ 1,800	$ 548	$ 10,000	$ 39,605
27		736	Tangent	60	0	6600	$ 14,520	$ 3,843	$ 600	$ 384	$ -	$ 19,347
28		665	Tangent	80	0	10100	$ 22,220	$ 3,472	$ 600	$ 347	$ -	$ 26,639
29		1297	Tangent	75	0	9800	$ 21,560	$ 6,772	$ 600	$ 677	$ -	$ 29,609
30		621	In-line DE	60	4	5900	$ 12,980	$ 3,242	$ 1,800	$ 324	$ 4,000	$ 22,347
31	48	919	3-pole DE	70	10	9900	$ 21,780	$ 4,798	$ 1,800	$ 480	$ 10,000	$ 38,858
32		1214	Tangent	65	0	7100	$ 15,620	$ 6,339	$ 600	$ 634	$ -	$ 23,192
33		893	Tangent	75	0	9800	$ 21,560	$ 4,663	$ 600	$ 466	$ -	$ 27,289
34		1055	Tangent	75	0	9800	$ 21,560	$ 5,508	$ 600	$ 551	$ -	$ 28,219
35		398	Tangent	60	0	6600	$ 14,520	$ 2,078	$ 600	$ 208	$ -	$ 17,406
36		605	Tangent	60	0	6600	$ 14,520	$ 3,159	$ 600	$ 316	$ -	$ 18,595
37	66	566	3-pole DE	60	10	8700	$ 19,140	$ 2,955	$ 1,800	$ 296	$ 10,000	$ 34,191
38		255	HVY A-Frame DE	60	6	20000	$ 44,000	$ 1,331	$ 4,200	$ 133	$ 6,000	$ 55,665
39		521	In-line DE	60	4	5900	$ 12,980	$ 2,720	$ 1,800	$ 272	$ 4,000	$ 21,772
40		995	Tangent	85	0	10800	$ 23,760	$ 5,195	$ 600	$ 520	$ -	$ 30,075
41	??		3-pole DE	50	10	5700	$ 12,540		$ 1,800	$ -	$ 10,000	$ 24,340
						165700	$ 364,540	$ 72,356	$ 23,400	$ 7,236	$ 58,000	$ 525,532
						353150	$ 776,930	$ 216,125	$ 60,300	$ 21,612	$ 182,000	$ 1,256,967
							61.8%	17.2%	4.8%	1.7%	14.5%	100.0%

Cost Assumptions:

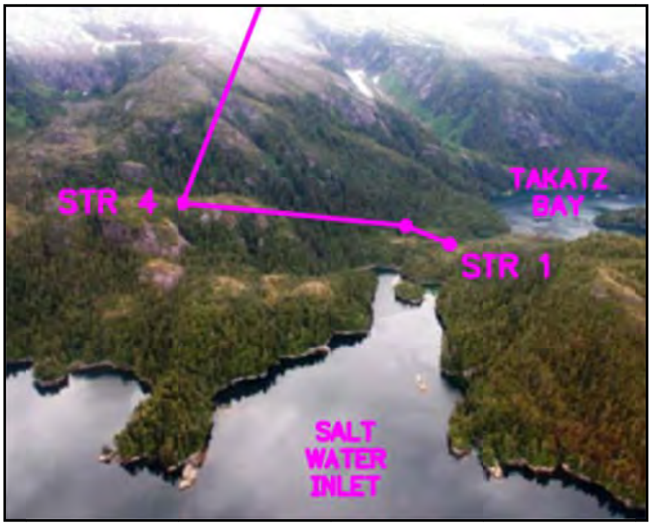
1) Tubular steel cost based on FOB Sitka — $2.20 per lb
2) Conductor Cost based on:
   - 397.5 AACSR — $1.61 per ft
   - 37#8 — $3.58 per ft
3) Insulator Cost based on
   - Tangent — $ 600 per struc
   - In-line DE — $ 1,800 per struc
   - 3-pole DE — $ 1,800 per struc
   - HVY Tangent — $ 900 per struc
   - HVY 3-Pole DE — $ 4,200 per struc
   - HVY A-Frame DE — $ 4,200 per struc
4) Assume 10% of Conductor cost
5) Assume $1,000 per guy

LEGEND

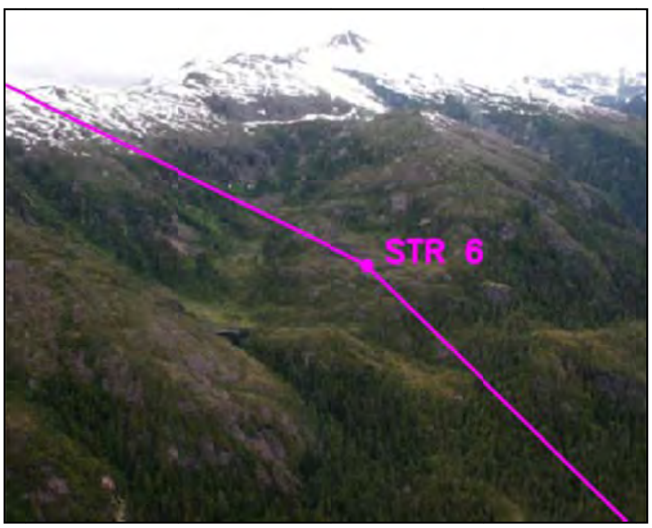
- 397.5 kcmil AACSR Conductor
- 37 # 8 Alumoweld Conductor
- Section 1, MP 0.0 to 3.4
- Section 2, MP 3.4 to 6.21
- Total, MP 0.0 to 6.21

Appendix

Attachment A - Study Area Photographs



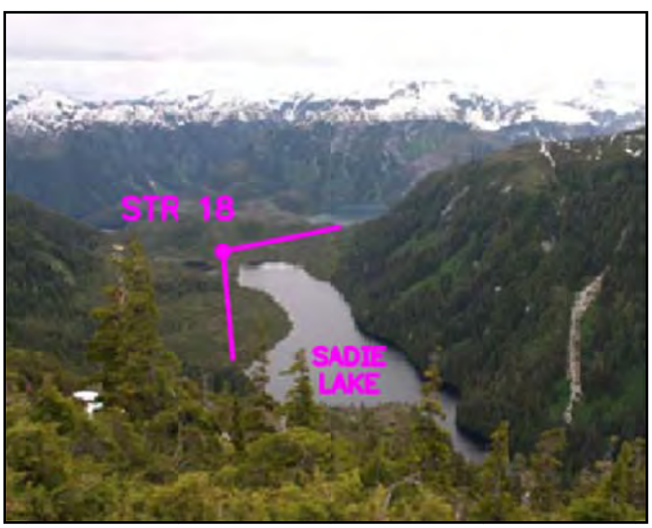
1. Looking west. Takatz Bay is in the background. The small inlet is the anticipated end of the access road (water landing) from the proposed power house. The transmission line is anticipated to follow the road from the power house to the head of the small inlet. At the inlet location the overhead transmission alternative would head southeast and then south to the top of the ridge (MP 1.39). The elevation change from base to top of ridge is approximately 2,100'.



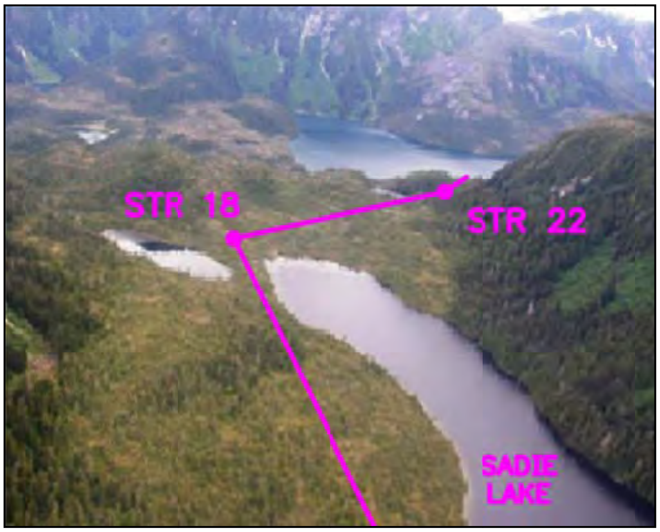
2. Looking southwest. The line is anticipated to cross the ridge near the saddle on the left side of photo. The steep grade has some plateau areas where structures can be sited without being on steep slope.

3. Taken from the ridgetop (near MP 1.39), looking north toward Takatz Bay.

4. Photo shows typical terrain on ridge-top, mostly rock. East of proposed crossing point.

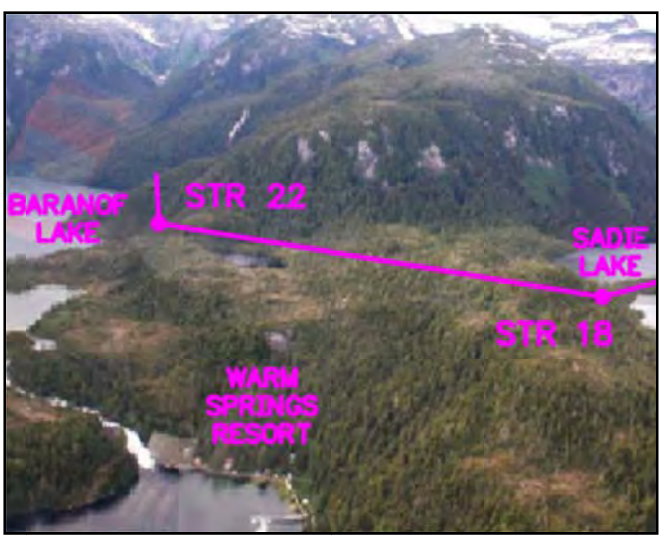


5. Taken from ridgetop looking south toward Sadie Lake.



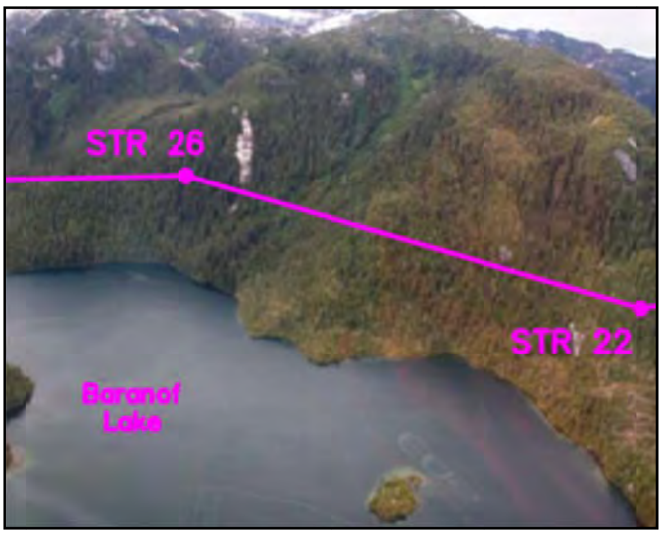
6. Looking south toward Sadie Lake. Baranof Lake is in the background. The east side of the lake is relatively flat with sparse vegetation. The transmission line is anticipated to parallel the east side of the lake and cross the narrow strip of land between the smaller pond and Sadie Lake.

7. Looking southwest. The photo shows the south end of Sadie Lake with Baranof Lake in the background. The line is anticipated to turn southwest soon after crossing narrow strip of land at the south end of Sadie Lake.

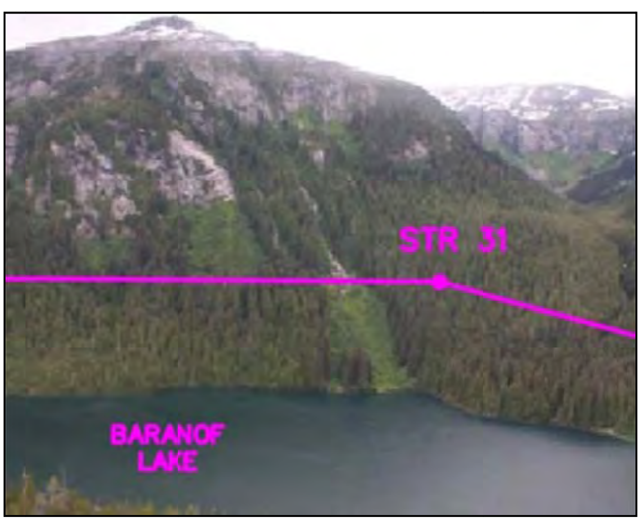


8. Looking west. Warm Springs Resort in the foreground. The photo shows Sadie Lake on the right and Baranof Lake on the left.

9. Looking northeast. O'Neil Island is in the foreground. The transmission line is anticipated to pass behind the small pond and head toward O'Neil Island to a point north of O'Neil Island and approximately 1,000' from the lake. A small boat area is located in the cove on the right side of the peninsula. A trail is reported to connect the small boat area with Warm Springs Resort.

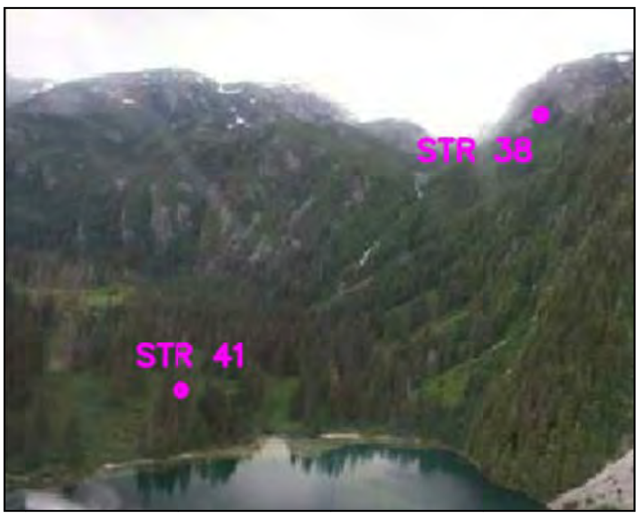


10. Looking northwest with O'Neil Island in foreground. The photo shows typical terrain and vegetation along the north shore of Baranof Lake.



11. Looking northwest at north shore of Baranof Lake near midpoint. The photo shows typical terrain and vegetation along the north shore of Baranof Lake. Note the slide area.

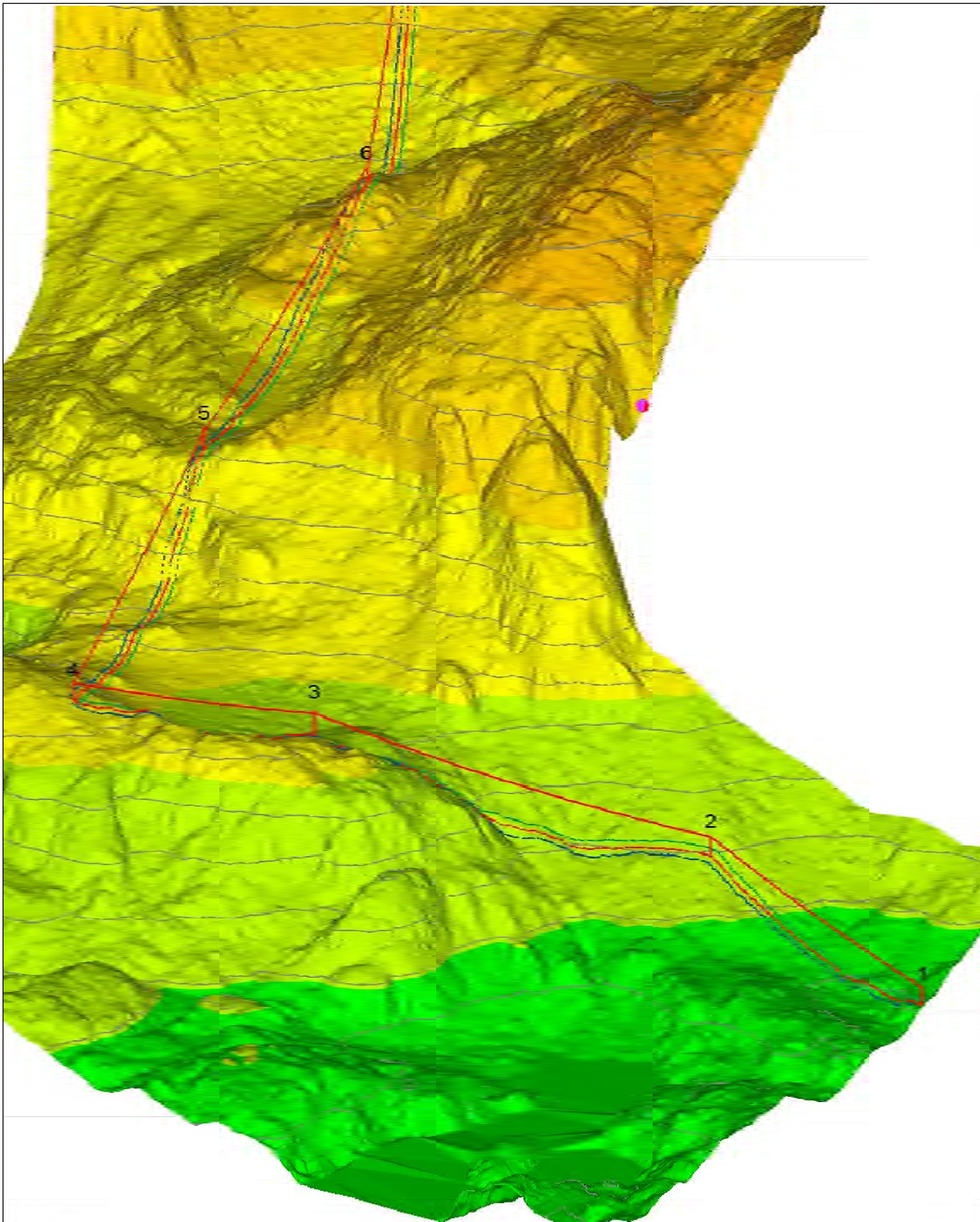
12. Looking southwest at steep cliff on the west end of Baranof lake. The transmission line is anticipated to stay on top of the cliff, gradually climbing to approximately 1,050' elevation.



13. Looking northwest. The photo shows the west end of Baranof Lake. The cliff along the lakeshore will force the line to climb to a higher elevation before dropping to the valley floor. Note the slide area.

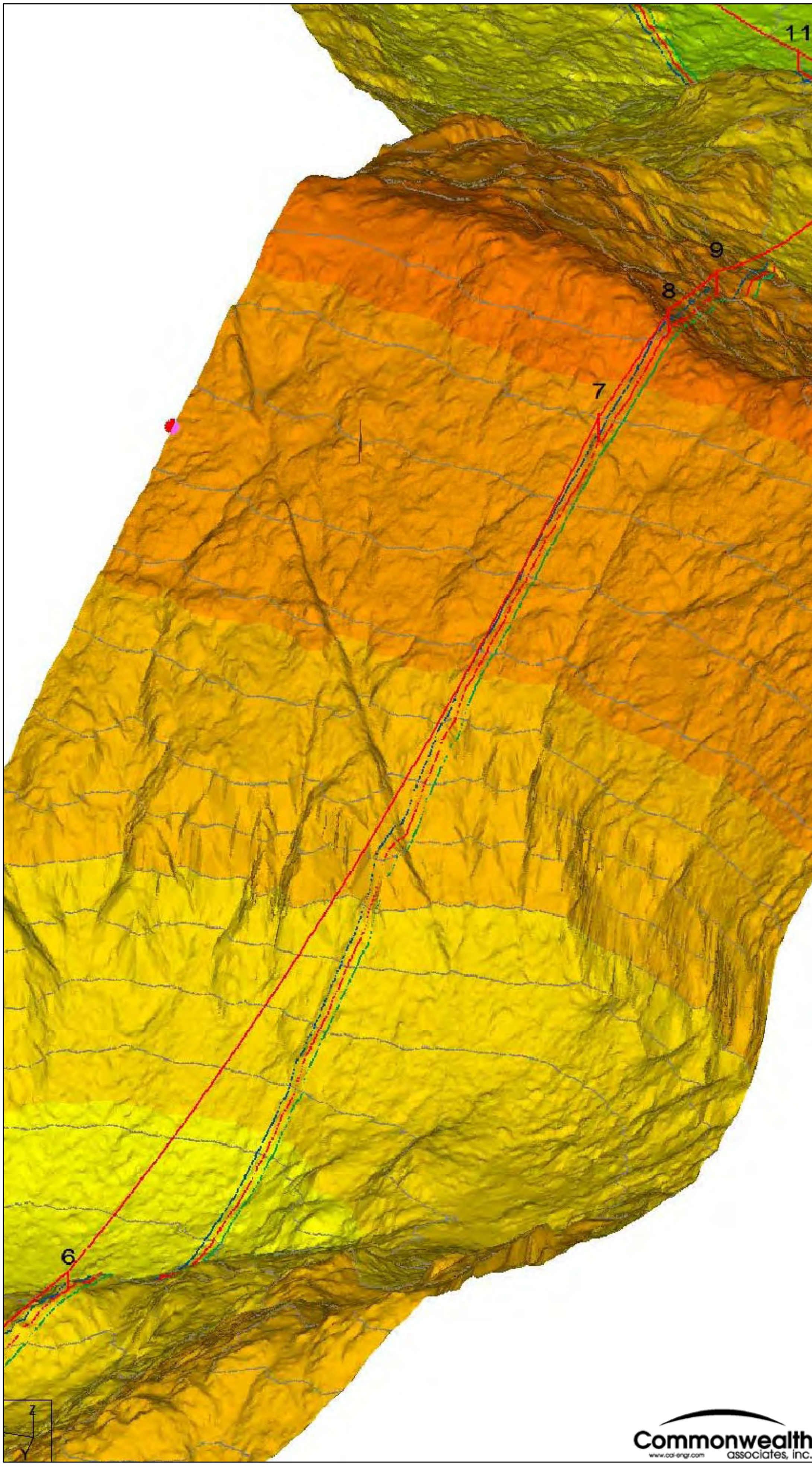
14. Personnel that participated in flyover of line route: Claude Smith, Robert Dryden, Dean Scott. Temsco provided the Hughes 500 helicopter shown and the pilot.

Attachment B – Three Dimensional Layout

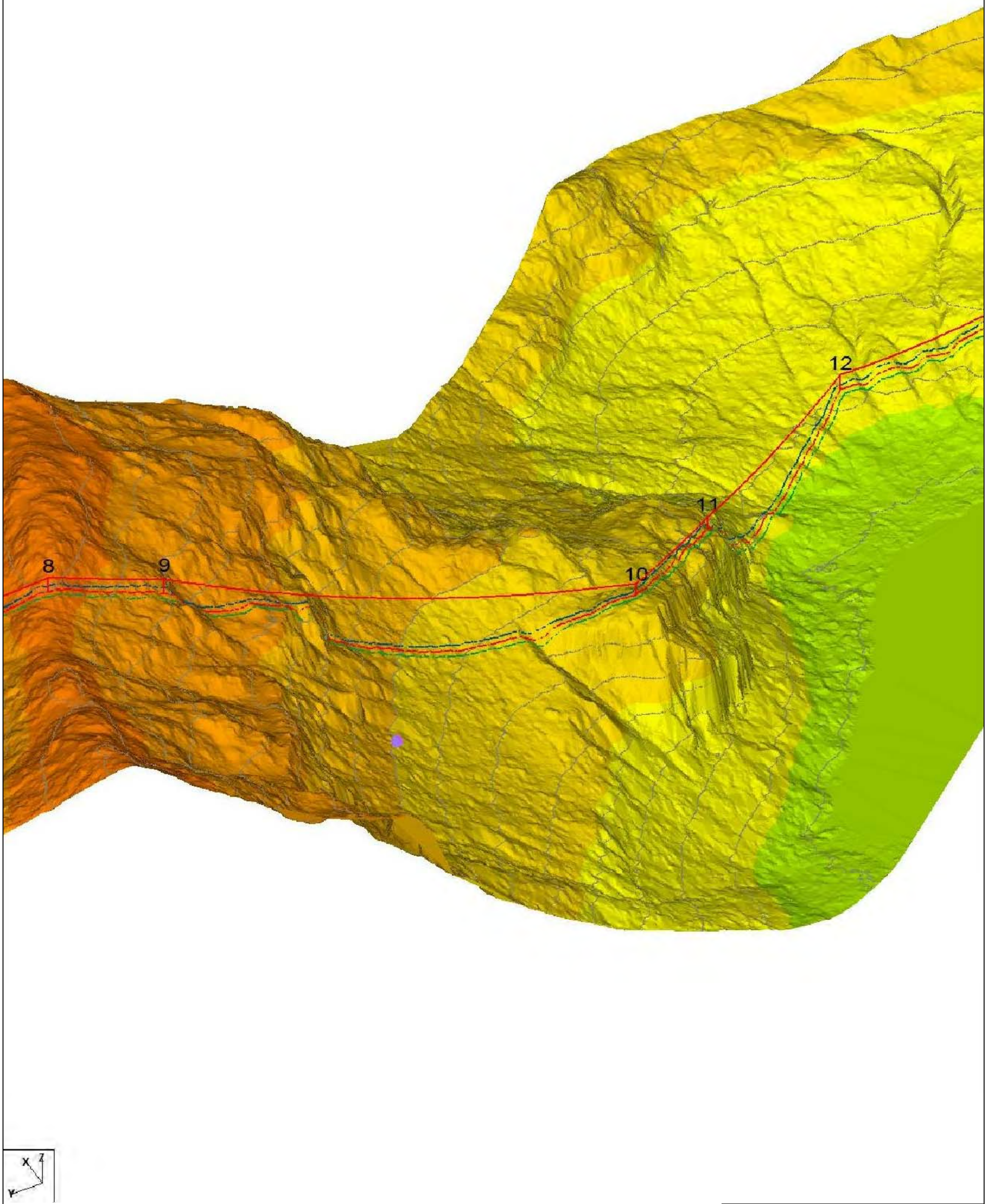


Commonwealth associates, inc.

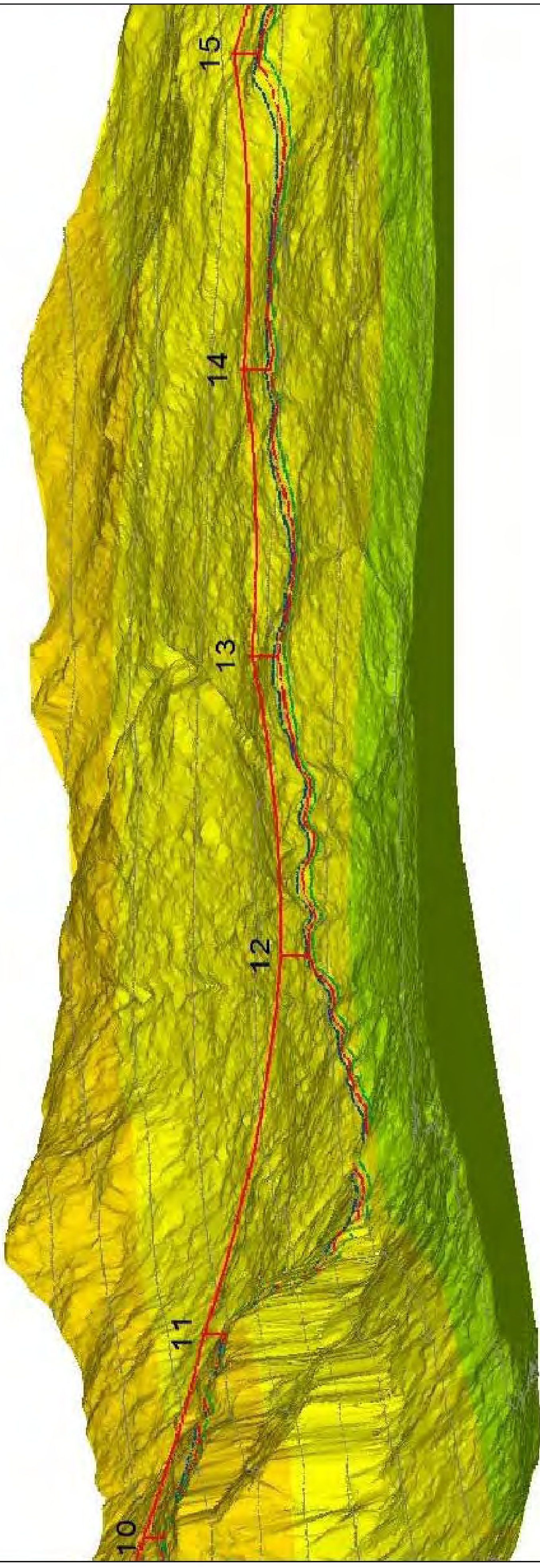
Lake Takatz 138kV 3D View
Str 1 to 6 12/16/10



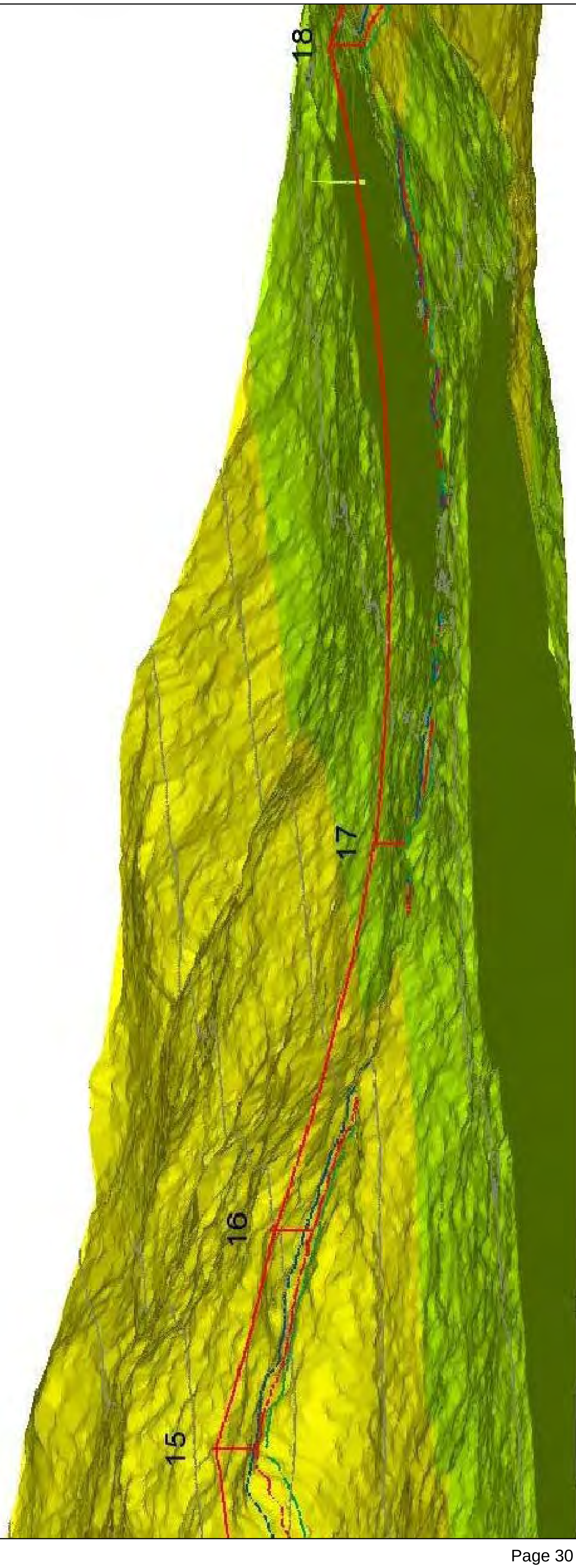
Lake Takatz 138kV 3D View
Str 06 to 11 12/16/10



Lake Takatz 138kV 3D View
Str 8 to 12 12/16/10

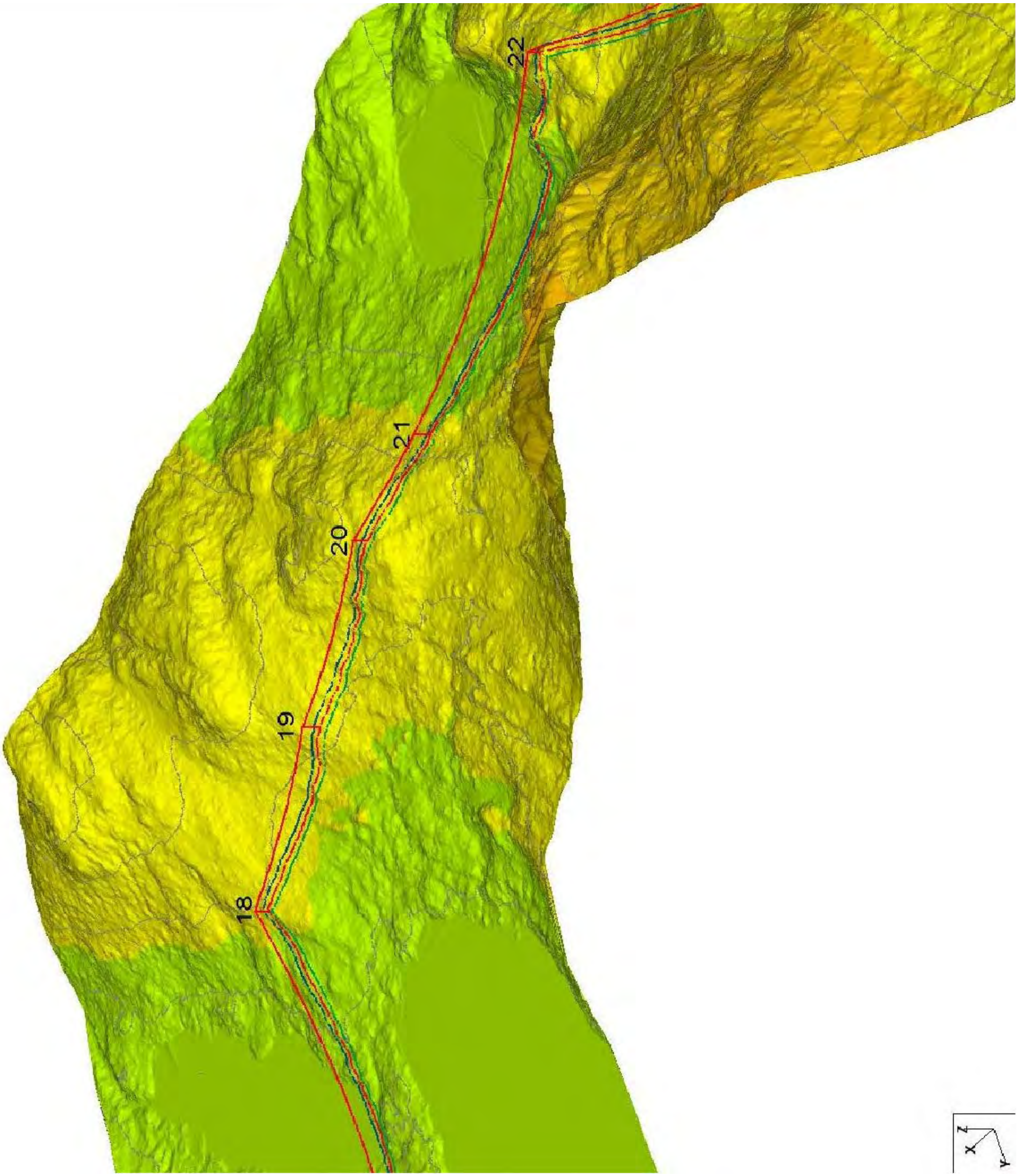


Lake Takatz 138kV 3D View
Str 10 to 15 12/16/10



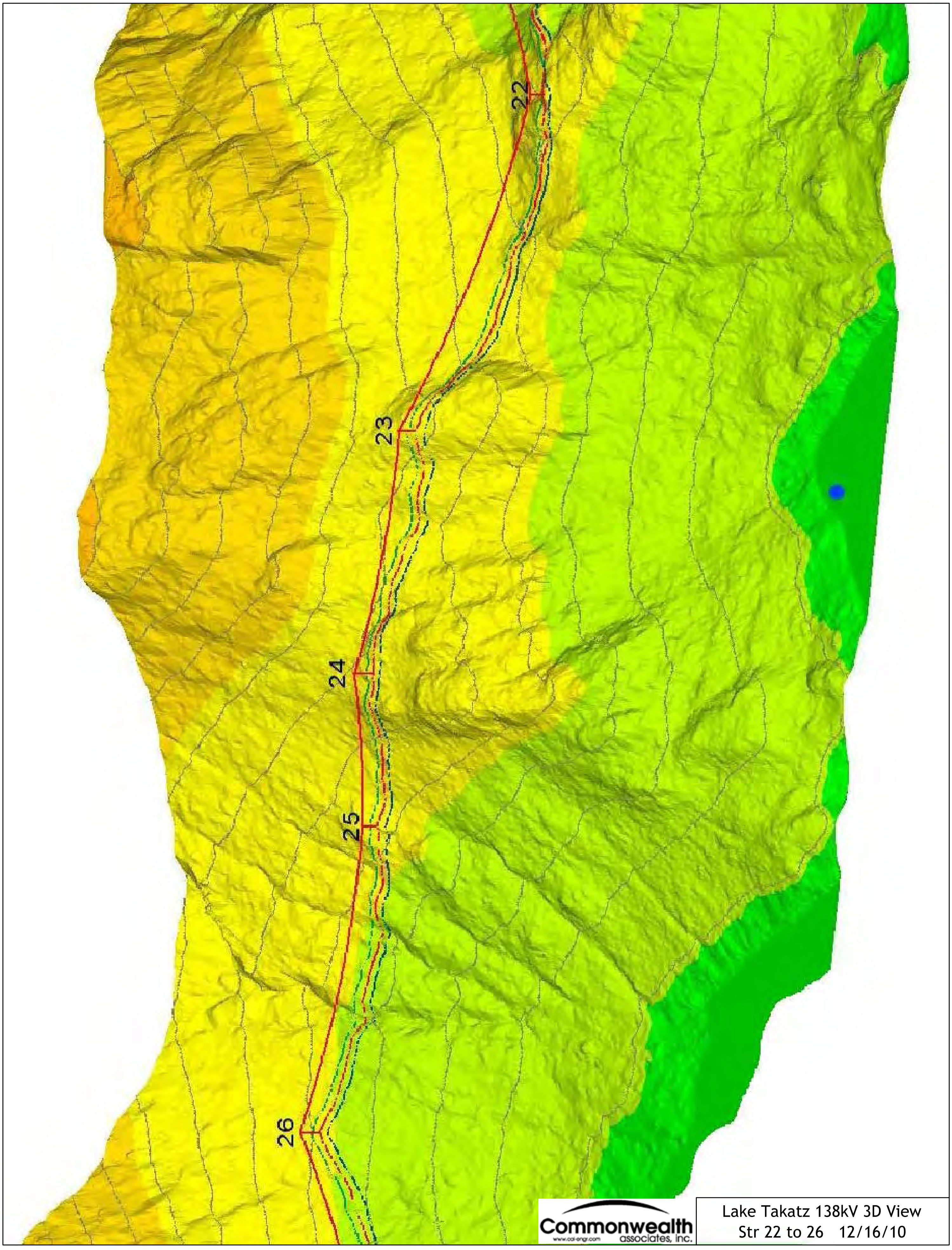
Commonwealth associates, inc.

Lake Takatz 138kV 3D View
Str 15 to 18 12/16/10

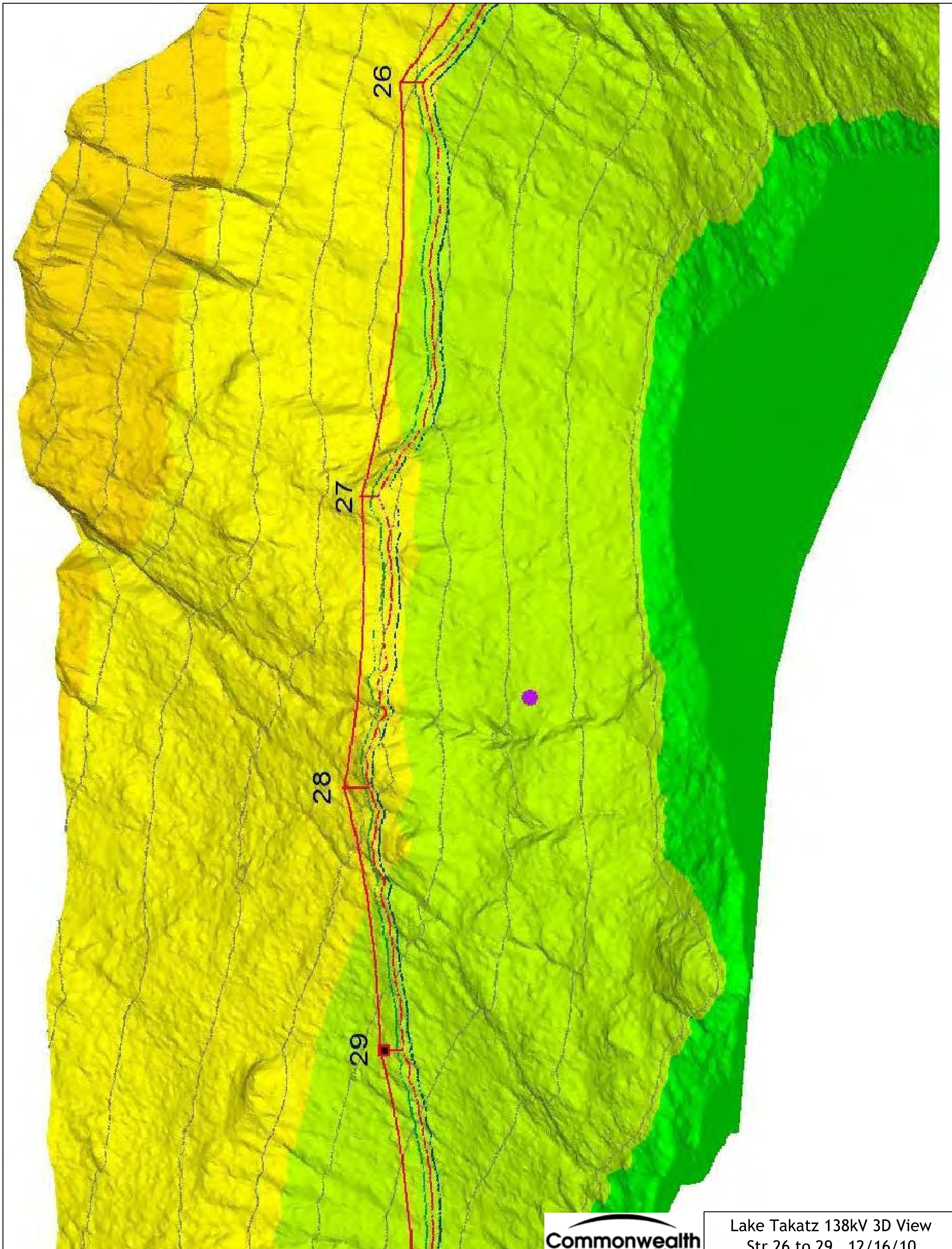


Commonwealth associates, inc.

Lake Takatz 138kV 3D View
Str 18 to 22 12/16/10

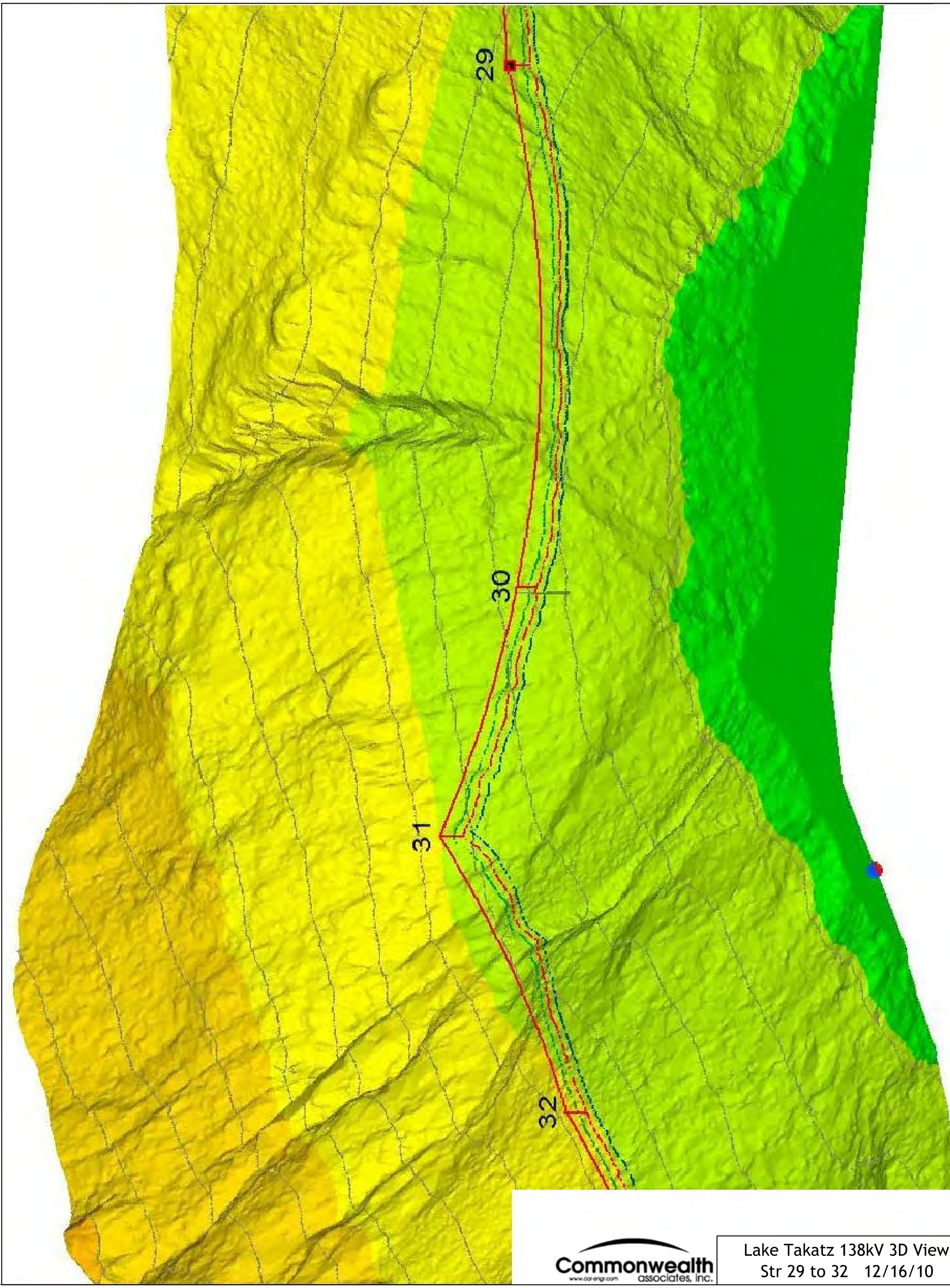


Lake Takatz 138kV 3D View
Str 22 to 26 12/16/10



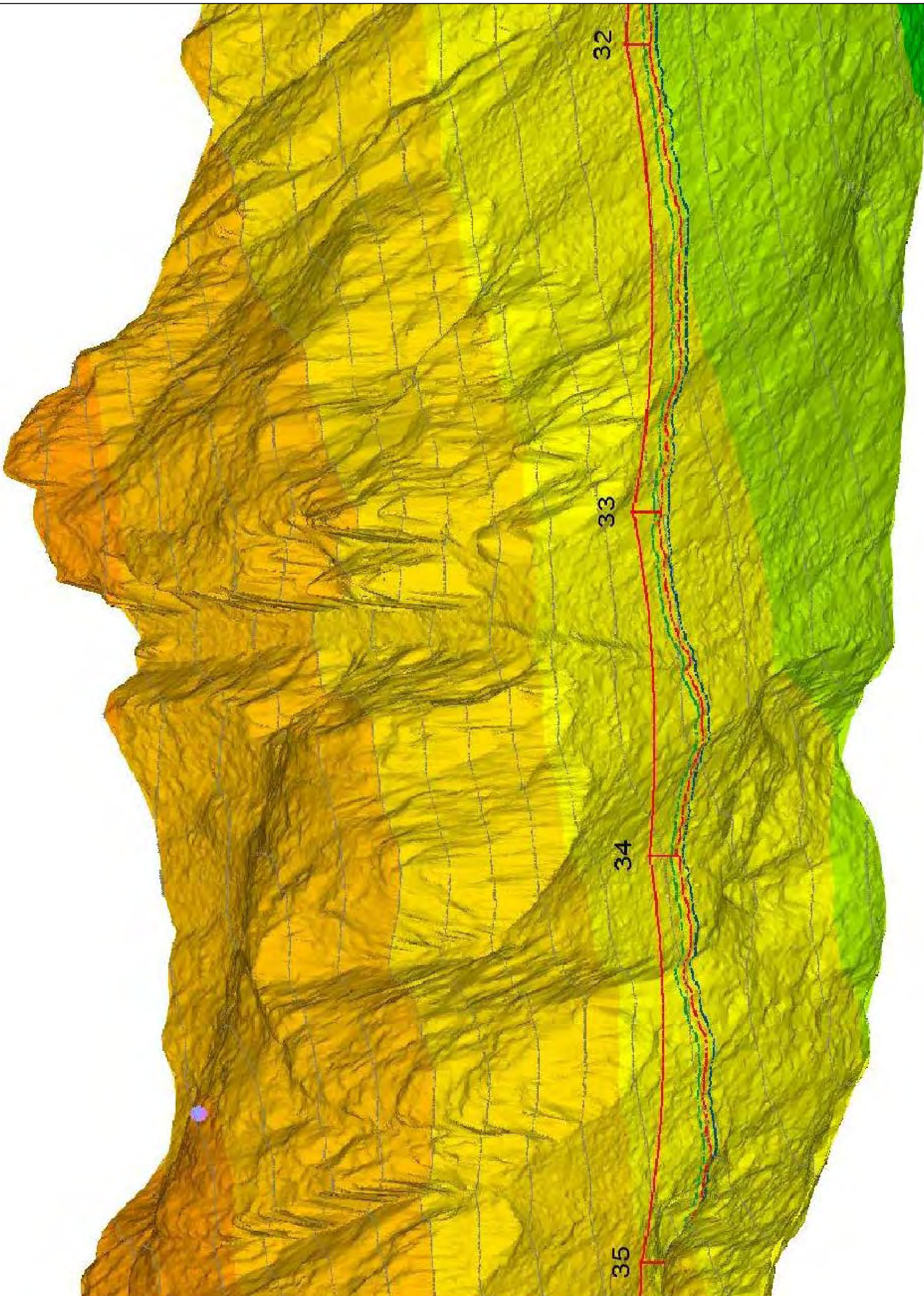
Commonwealth associates, inc.

Lake Takatz 138kV 3D View
Str 26 to 29 12/16/10



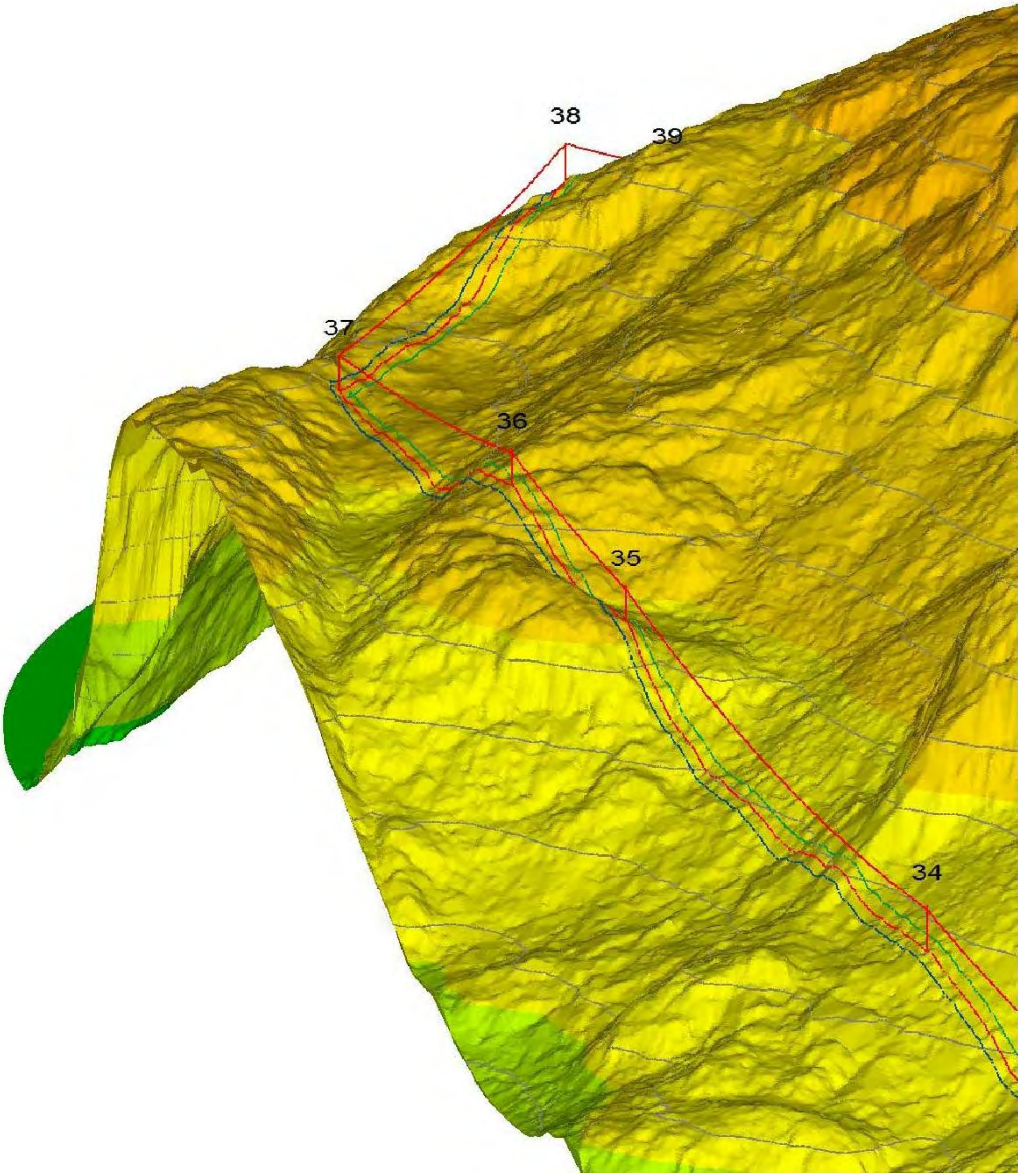
Commonwealth associates, inc.

Lake Takatz 138kV 3D View
Str 29 to 32 12/16/10



Commonwealth associates, inc.

Lake Takatz 138kV 3D View
Str 32 to 35 12/16/10



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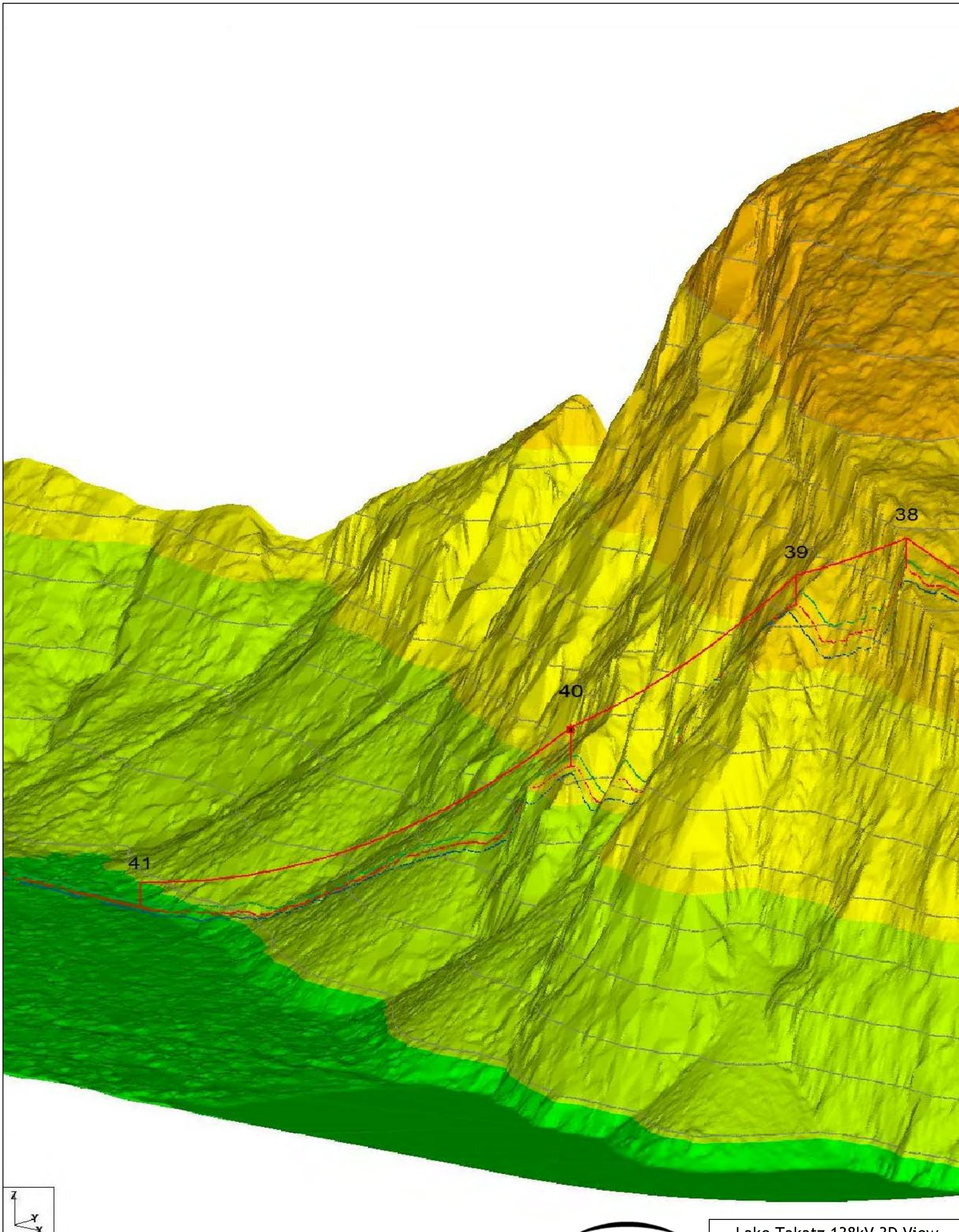
Lake Takatz 138kV 3D View
Str 34 to 38 12/16/10

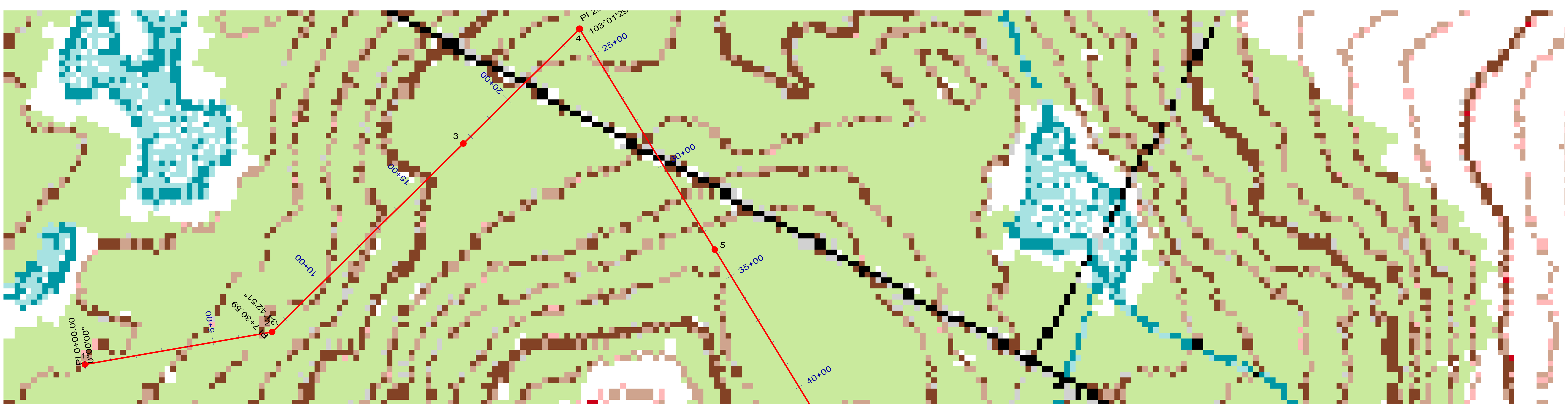


Commonwealth associates, inc.

Lake Takatz 138kV 3D View
Str 38 to 41 12/16/10

Attachment C – Plan and Profile

PLS-CADD Drawing



4 - 6, 37no_8_alumoweld.wir, Ruling Span 1119 (ft), Tension 10911 (lbs) at 60 (deg F) Initial, Displayed .5" Ice Max Sag 14557 (lbs)
1 - 2, lark_aacsr_aw 101025.wir, Ruling Span 707 (ft), Tension 8849 (lbs) at 60 (deg F) Initial, Displayed .5" Ice Max Sag 6113 (lbs)
2 - 4, lark_aacsr_aw 101025.wir, Ruling Span 874 (ft), Tension 3094 (lbs) at 60 (deg F) Initial, Displayed .5" Ice Max Sag 4417 (lbs)

200.0 ft. Horiz. Scale

80.0 ft. Vert. Scale

Left and right profile at 18`
Clearance line at 38`

REV	DESCRIPTION	DATE	DRN	DSGN	CKD	APP	REFERENCE DRAWINGS

DSGN	ACL	12/06/10	CITY AND BOROUGH OF SITKA
DRN	ACL	12/06/10	TAKATZ LAKE HYDROELECTRIC PROJECT
CKD	DKS	12/06/10	138 kV TRANSMISSION LINE
SCALE:			
FILE NAME: --.dwg			

CAI JOB NO. 456001

DWG NO. 1/7 REV 0

PLS-CADD Drawing

4 - 6, 37no_8_alumoweld.wir, Ruling Span 1119 (ft), Tension 10911 (lbs) at 60 (deg F) Initial, Displayed .5" Ice Max Sag 14557 (lbs)
6 - 8, 37no_8_alumoweld.wir, Ruling Span 2077 (ft), Tension 11013 (lbs) at 60 (deg F) Initial, Displayed .5" Ice Max Sag 16052 (lbs)
8 - 10, 37no_8_alumoweld.wir, Ruling Span 1432 (ft), Tension 10554 (lbs) at 60 (deg F) Initial, Displayed .5" Ice Max Sag 14884 (lbs)
10 - 12, lark_aacsr_aw 101025.wir, Ruling Span 932 (ft), Tension 2442 (lbs) at 60 (deg F) Initial, Displayed .5" Ice Max Sag 4131 (lbs)

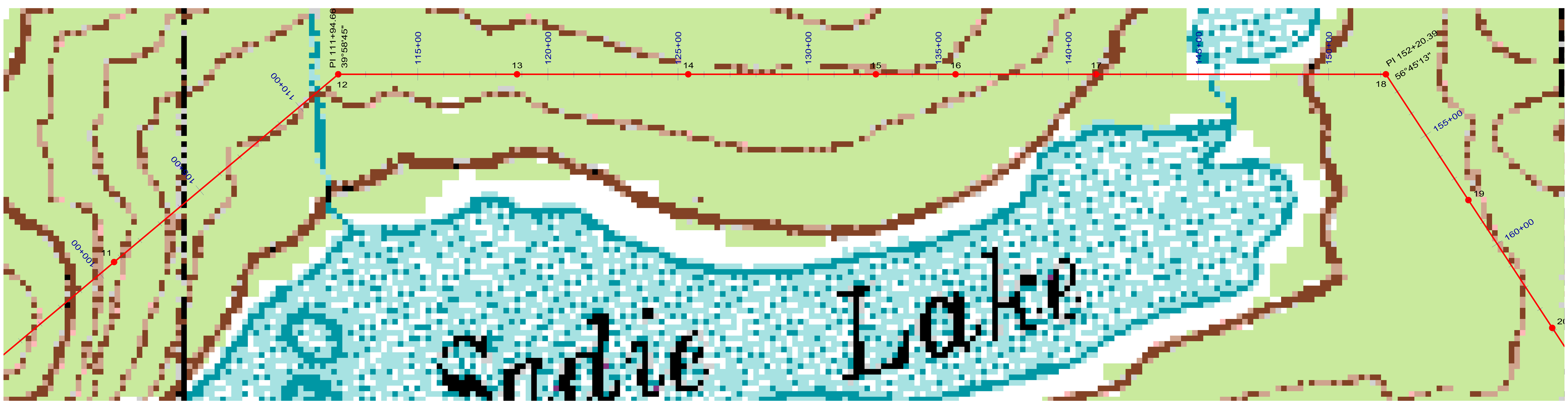
200.0 ft. Horiz. Scale
80.0 ft. Vert. Scale

Left and right profile at 18`
Clearance line at 38`

REV	DESCRIPTION	DATE	DRN	DSGN	CKD	APP	REFERENCE DRAWINGS

DSGN	ACL	12/06/10	CITY AND BOROUGH OF SITKA	CAI JOB NO. 456001
DRN	ACL	12/06/10	TAKATZ LAKE HYDROELECTRIC PROJECT	DWG NO. 2/7
CKD	DKS	12/06/10	138 kV TRANSMISSION LINE	REV 0
SCALE: FILE NAME:--.dwg				

PLS-CADD Drawing



10 - 12, lark_aacsr_aw 101025.wir, Ruling Span 932 (ft), Tension 2442 (lbs) at 60 (deg F) Initial, Displayed .5" Ice Max Sag 4131 (lbs)
12 - 17, lark_aacsr_aw 101025.wir, Ruling Span 628 (ft), Tension 4304 (lbs) at 60 (deg F) Load, Displayed .5" Ice Max Sag 6398 (lbs)
17 - 18, lark_aacsr_aw 101025.wir, Ruling Span 1112 (ft), Tension 2111 (lbs) at 60 (deg F) Load, Displayed .5" Ice Max Sag 4489 (lbs)
18 - 21, lark_aacsr_aw 101025.wir, Ruling Span 533 (ft), Tension 4441 (lbs) at 60 (deg F) Load, Displayed .5" Ice Max Sag 6618 (lbs)

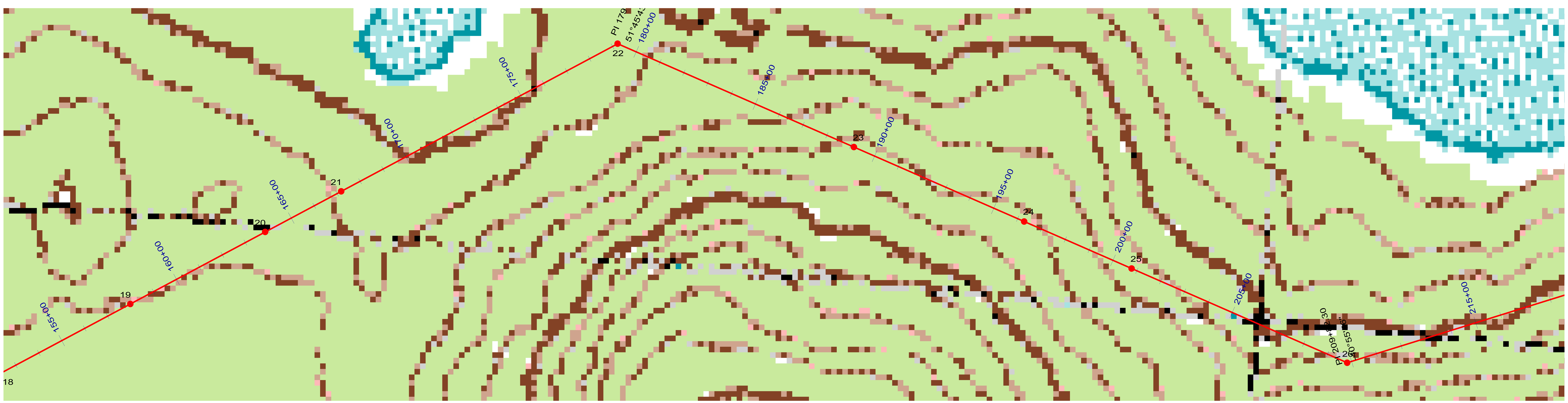
200.0 ft. Horiz. Scale
80.0 ft. Vert. Scale

Left and right profile at 18`
Clearance line at 38`

REV	DESCRIPTION	DATE	DRN	DSGN	CKD	APP	REFERENCE DRAWINGS

DSGN	ACL	12/06/10	CITY AND BOROUGH OF SITKA	CAI JOB NO. 456001
DRN	ACL	12/06/10	TAKATZ LAKE HYDROELECTRIC PROJECT	DWG NO. 3/7 REV 0
CKD	DKS	12/06/10	138 kV TRANSMISSION LINE	
SCALE: FILE NAME:--.dwg				

PLS-CADD Drawing



200.0 ft. Horiz. Scale

80.0 ft. Vert. Scale

Left and right profile at 18`
Clearance line at 38`

18 - 21, lark_aacsr_aw 101025.wir, Ruling Span 533 (ft), Tension 4441 (lbs) at 60 (deg F) Load, Displayed .5" Ice Max Sag 6618 (lbs)
21 - 22, lark_aacsr_aw 101025.wir, Ruling Span 1203 (ft), Tension 1957 (lbs) at 60 (deg F) Load, Displayed .5" Ice Max Sag 4288 (lbs)
22 - 25, lark_aacsr_aw 101025.wir, Ruling Span 799 (ft), Tension 2890 (lbs) at 60 (deg F) Load, Displayed .5" Ice Max Sag 5072 (lbs)
25 - 26, lark_aacsr_aw 101025.wir, Ruling Span 903 (ft), Tension 3055 (lbs) at 60 (deg F) Load, Displayed .5" Ice Max Sag 5412 (lbs)
26 - 30, lark_aacsr_aw 101025.wir, Ruling Span 1031 (ft), Tension 2109 (lbs) at 60 (deg F) Load, Displayed .5" Ice Max Sag 4427 (lbs)

REV	DESCRIPTION	DATE	DRN	DSGN	CKD	APP	REFERENCE DRAWINGS

DSGN	ACL	12/06/10	CITY AND BOROUGH OF SITKA
DRN	ACL	12/06/10	TAKATZ LAKE HYDROELECTRIC PROJECT
CKD	DKS	12/06/10	138 kV TRANSMISSION LINE

SCALE:
FILE NAME:--.dwg

CAI JOB NO. 456001
DWG NO. 4/7
REV 0

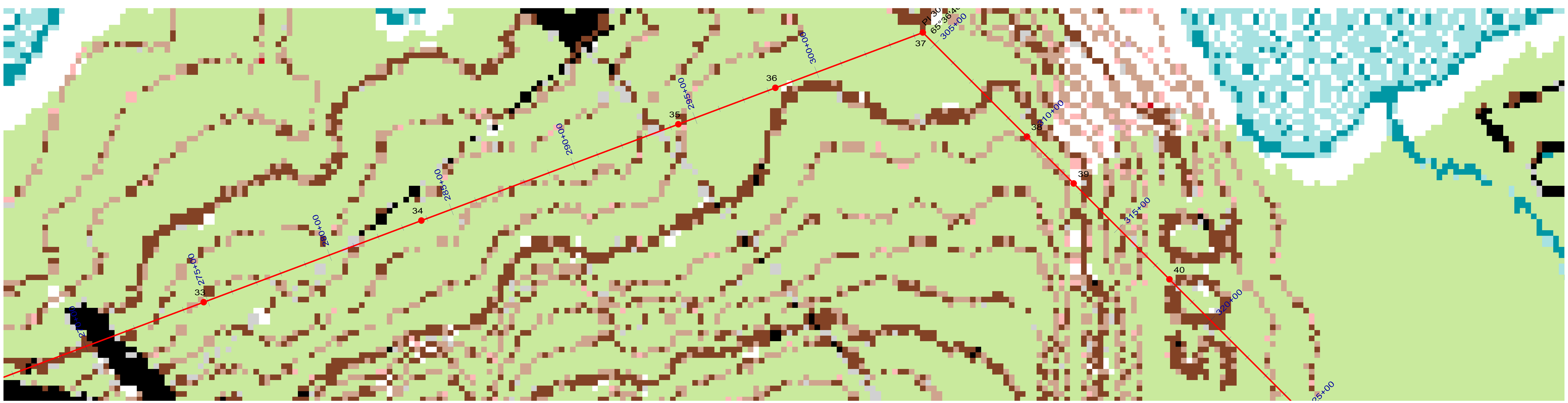
26 - 30, lark_aacsr_aw 101025.wir, Ruling Span 1031 (ft), Tension 2109 (lbs) at 60 (deg F) Load, Displayed .5" Ice Max Sag 4427 (lbs)
30 - 31, lark_aacsr_aw 101025.wir, Ruling Span 596 (ft), Tension 4313 (lbs) at 60 (deg F) Load, Displayed .5" Ice Max Sag 6412 (lbs)
31 - 37, lark_aacsr_aw 101025.wir, Ruling Span 959 (ft), Tension 2327 (lbs) at 60 (deg F) Load, Displayed .5" Ice Max Sag 4667 (lbs)

200.0 ft. Horiz. Scale
80.0 ft. Vert. Scale

Left and right profile at 18`
Clearance line at 38`

REV	DESCRIPTION	DATE	DRN	DSGN	CKD	APP	REFERENCE DRAWINGS

DSGN	ACL	12/06/10	CITY AND BOROUGH OF SITKA	CAI JOB NO. 456001
DRN	ACL	12/06/10	TAKATZ LAKE HYDROELECTRIC PROJECT	DWG NO. 5/7
CKD	DKS	12/06/10	138 kV TRANSMISSION LINE	REV 0
SCALE: FILE NAME:--.dwg				



31 - 37, lark_aacsr_aw 101025.wir, Ruling Span 959 (ft), Tension 2327 (lbs) at 60 (deg F) Load, Displayed .5" Ice Max Sag 4667 (lbs)
37 - 38, lark_aacsr_aw 101025.wir, Ruling Span 539 (ft), Tension 4377 (lbs) at 60 (deg F) Load, Displayed .5" Ice Max Sag 6531 (lbs)
38 - 39, lark_aacsr_aw 101025.wir, Ruling Span 231 (ft), Tension 4645 (lbs) at 60 (deg F) Load, Displayed .5" Ice Max Sag 5825 (lbs)
39 - 41, lark_aacsr_aw 101025.wir, Ruling Span 754 (ft), Tension 1693 (lbs) at 60 (deg F) Initial, Displayed .5" Ice Max Sag 3291 (lbs)

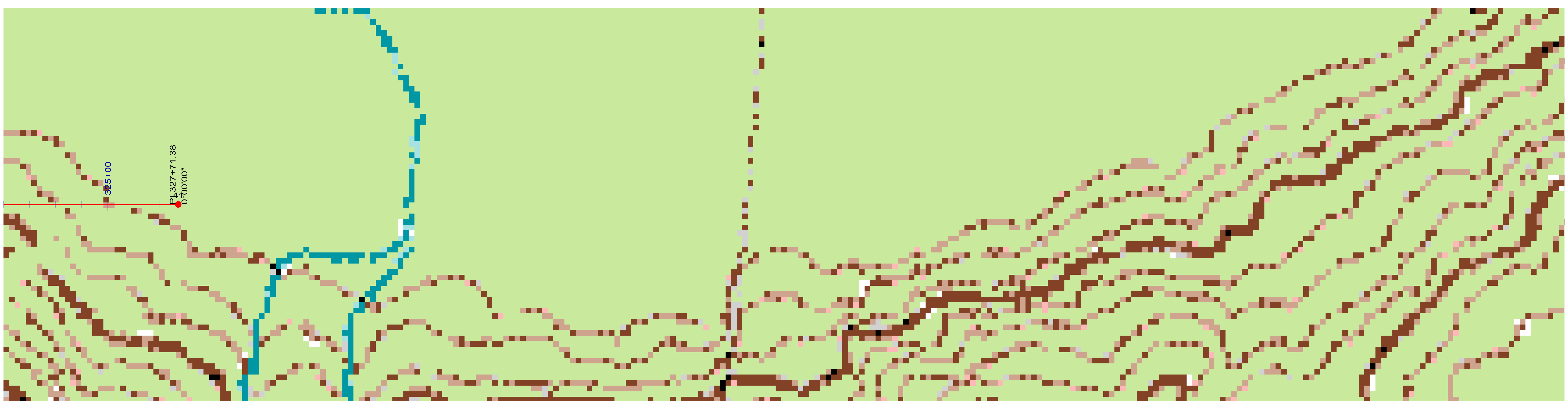
200.0 ft. Horiz. Scale

80.0 ft. Vert. Scale

Left and right profile at 18`
Clearance line at 38`

REV	DESCRIPTION	DATE	DRN	DSGN	CKD	APPD	REFERENCE DRAWINGS

DSGN	ACL	12/06/10	CITY AND BOROUGH OF SITKA	CAI JOB NO. 456001
DRN	ACL	12/06/10	TAKATZ LAKE HYDROELECTRIC PROJECT	DWG NO. 6/7
CKD	DKS	12/06/10	138 kV TRANSMISSION LINE	REV 0
SCALE: FILE NAME:-.dwg				



39 - 41, lark_aacsr_aw 101025.wir, Ruling Span 754 (ft), Tension 1693 (lbs) at 60 (deg F) Initial, Displayed .5" Ice Max Sag 3291 (lbs)

200.0 ft. Horiz. Scale

80.0 ft. Vert. Scale

N

Left and right profile at 18`
Clearance line at 38`

REV	DESCRIPTION	DATE	DRN	DSGN	CKD	APP	REFERENCE DRAWINGS

DSGN	ACL	12/06/10	CITY AND BOROUGH OF SITKA	CAI JOB NO. 456001
DRN	ACL	12/06/10	TAKATZ LAKE HYDROELECTRIC PROJECT	DWG NO. 7/7
CKD	DKS	12/06/10	138 kV TRANSMISSION LINE	REV 0
SCALE:				
FILE NAME:--.dwg				

Attachment D –
Additional Discussion, Design Criteria and Conductor Selection

Additional Discussion, Design criteria

The recently completed (2009) Swan-Tyee Intertie (STI) line used two sets of design criteria: one for lower elevations (less severe, 47 miles of line) and one for higher elevations and extremely long spans (most severe, 10 miles of line). The STI tubular steel line physical design criteria were as follows:

Long Spans and High Elevations:

NESC Heavy Loading: ½" ice with 4 psf (40 mph) wind at 0 degree F with
Grade B OLFs (tension =1.65, wind =2.5, vertical=1.5)
Extreme Wind: 120 mph (37 psf wind) at **40 degrees F** with **1.1 OLF**
Combination Wind/Ice Loading: **1.75" ice** with **40 mph** (4 psf) at **20 degrees F** wind with **1.1 OLF**
Unbalanced Longitudinal: 1" radial ice to no ice at 30 degrees F with 1.1 OLF

Lower Elevations:

NESC Heavy Loading: ½" ice with 4 psf (40 mph) wind at 0 degree F with
Grade B OLFs (tension=1.65, wind=2.5, vertical=1.5)
Extreme Wind: 105 mph (27.5 psf wind) at **40 degrees F** with **1.1 OLF**
Combination Wind/Ice Loading: **1.5" ice** with **40 mph** (4 psf) at 30 degrees F wind with **1.1 OLF**
Unbalanced Longitudinal: 1/2" radial to no ice at 30 degrees F with 1.1 OLF

Note: **BOLD** indicates differences from the NESC criteria.

The above loading conditions are generally more extreme than those used on either of the two lines to which the STI line segment connects: Tyee line (80 miles) and Swan Lake line (31 miles). Other lines in southeast Alaska which have been designed for extreme loading includes the Snettisham rebuild at Salisbury Ridge which was designed for a 160 mph wind, and the Swan Lake Carroll Inlet crossing at Swan Lake hydroelectric which was designed for a 180 mph wind.

Although Commonwealth has no specific data to establish an extreme wind or ice loading for the micro-climate at the Takatz location, we think it is reasonable to use the criteria established for the STI line with one exception: We suggest using a higher extreme wind at the higher elevations, considering the location's proximity to the coast and the fact that the NESC extreme wind chart shows the wind to be approximately 10 mph stronger in this area compared to the STI location.

Note that the extreme wind shown in the NESC (120 mph) is statistically a 50-year mean reoccurring wind. This is not a guarantee of a once-in-50-years occurrence. It means that the loads have a 2% probability of being exceeded each year and a 64% probability of being exceeded at least once during the 50-year period. Considering the possibility of wind channeling due to the extreme terrain, we believe increasing the wind value is appropriate. We think it is not necessary to use the extreme winds that have been used on the Snettisham line or the crossing at Swan Lake noted above.

Additional Discussion, Conductor Selection

A detail conductor study was completed for the Swan Tyee Intertie line. We believe the conclusions are appropriate for the Takatz line. The STI line was designed for 138 kV to be operated at 69 kV. Two conductors were selected for the STI line:

Long spans and higher elevations (10 miles) – 37#8 Alumoweld
Shorter spans and lower elevations (47 miles) – 397.5 AACSR/AW 30/7

The selected conductors were based on diameter and strength characteristics to handle the large physical loading. In both cases the electrical ratings far exceed the minimum required. The AACSR conductor is a modified ACSR conductor that uses high-strength aluminum alloy. The AACSR conductor has an outstanding strength-to-weight ratio. The AACSR conductors offer approximately 40% more strength for essentially the same diameter and weight as a similar ACSR conductor. The AACSR conductors have been used on several projects in Alaska due to their strength-to-weight characteristics. The 37#8 Alumoweld conductor used on the STI higher elevations is essentially aluminum-clad steel cable. Again, the strength characteristics are what make it desirable for extreme physical loading and long spans.