

Red Dog Port, Alaska to Kivalina, Alaska Transmission Line

Final Report of
Right-of-Way Considerations
Intertie Transmission Line Options
Environmental Process
Permitting Requirements
Business Case

to

Alaska Village Electric Cooperative

May 2014

by

WHPacific

and



Contents

Introduction.....	1
Executive Summary	1
Right-of-Way Considerations	2
Analysis	2
Right-of-Way Conclusion.....	4
Lead Federal Agency	5
Analysis	5
Lead Federal Agency Conclusion.....	5
Intertie Transmission Line Options.....	6
Analysis	6
Calculations	6
Evaluations – System and Equipment Cost.....	9
Intertie Transmission Line Conclusion.....	10
Distribution Line Analysis.....	11
Wind Resources	13
Wind Power Consideration.....	13
Environmental Process.....	13
Introduction	13
Involved Agencies	13
Impact Categories	14
Permitting.....	15
Business Case.....	18
Options	18

Acronyms

ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act
AVEC	Alaska Village Electric Cooperative
BMPs	Best Management Practices
BLM	Bureau of Land Management
CAKR	Cape Krusenstern National Monument
CFR	Code of Federal Regulations
EA	Environmental Assessment
ISER	Institute of Social And Economic Research (Univ. of AK Anchorage)
K-Hill	Kisimigiuktuk Hill
KIV	Kivalina
MOA	Memorandum of Agreement
NEPA	National Environmental Policy Act
NHL	National Historic Landmark
NPS	National Park Service
NWI	National Wetland Inventory
NW	Nationwide Permit
NWAB	Northwest Arctic Borough
O&M	Operations and Maintenance
PCE	Power Cost Equalization
RDP	Red Dog Port
ROW	Right-of-Way
RUS	Rural Utility Service
SHPO	State Historic Preservation Office
TAK	Teck Alaska Incorporated
USACE	United States Army Corps of Engineers
USF&WS	United States Fish and Wildlife Service

Introduction

The Alaska Village Electric Cooperative (AVEC) authorized a feasibility study to evaluate several options to construct a 22 mile aerial (overhead) electrical intertie transmission line between the Red Dog Port (RDP) diesel powered electrical generation station and the community of Kivalina (KIV) to assure electrical power availability to KIV. If the transmission line is approved for construction, RDP will transmit electrical energy to KIV using this new intertie transmission line.

Recent alarm about global warming is focusing the need to safeguard basic community resources that sustain livability in Alaska especially in remote regions of Alaska that are susceptible to resultant global warming effects. Currently, KIV's 35 year old power plant is at risk due to its location on the shore line of the Kivalina spit on the Chukchi Sea. The KIV power plant is the sole source of electricity in the local area and cannot afford to be off line for any length of time, particularly during winter months. Funding available for plant upgrade is extremely rare. Moreover, an increase in winter storms and their intensity are causing shore erosion at an unpredictable and disquieting rate. Existing expensive shore protection is not long lasting, sustainable nor economically feasible. Immediately adjacent to KIV's power plant is the community's aging diesel fuel storage location and is subject to the same shore line erosion. The fuel storage is the power plant's fuel source and its capacity is also in question thus exacerbating the issue and is a looming concern. A reliable source of electrical power outside of KIV and a new associated transmission line from this electrical power source to KIV is a reasonable long term solution to erosion. RDP is the closest reliable source of supply.

There are two proposed aerial electrical intertie transmission line solutions from RDP. Route A and Route B. Route A connects RDP and KIV with a 20 mile aerial transmission line. Routing B is comprised of two components, B1 (22 mile aerial transmission line) and B2 (7 mile aerial distribution line). This two component solution provides electrical power over a transmission line from RDP to Kivalina's proposed new school and village site and, over a distribution line, to the existing village site on the spit. The new school and village site is approximately 7 miles northeast of KIV in the vicinity of Kisimigiuktuk Hill (K-Hill). Route B1 connects RDP and K-Hill. Route B2 connects K-Hill and KIV. Option B provides the added benefit of transmission line access to potential wind turbine development on K-Hill. The two proposed solutions, A or B, construct an aerial system that delivers electricity to KIV thus providing a secondary source of electrical power. Looking to the future, the transmission line may someday allow the KIV plant to cease generation of electrical power and thereby saving scarce village funding and easing KIV fuel storage capacity concerns.

This document analyzes factors that affect the feasibility of this proposal, including right-of-way, federal agency involvement, transmission line voltages and design considerations, a brief synopsis of wind power viability, environmental considerations and processes, regulatory permitting at a very basic level and lastly cost considerations.

Executive Summary

This report concludes that an intertie transmission line connecting RDP and KIV is technically feasible. The report examines five main areas. The first main area addresses in detail any land ownership conflicts along the proposed route for the electrical intertie transmission line installation between RDP diesel power generation station, KIV and K-Hill. The report concludes there are no extraordinary right-of-way conflicts that would impede the construction of a transmission line. The second main area addresses the design of the aerial transmission/distribution line. The design recommendation for route A, approximately 20 miles in length, is a 69kV voltage class aerial transmission line using #4/0 sized conductors. The design recommendation for Route B1, approximately 22 miles in length, is the same as Route A. The recommendation for Route B2 is to make an appropriate connection to B1 for a 12.5kV distribution

system and extend 7 miles to KIV adjacent to a proposed new road from KIV to K-Hill. An appropriate connection at KIV to the existing 12.5kV electrical distribution grid would then be made. The third main area addresses the environmental process. The environmental process for the proposed Kivalina Intertie will require a scoping effort, Federal, state and local agency consultation, and the completion of National Environmental Policy Act (NEPA) document that will analyze project alternatives and identify project impacts. The NEPA process is anticipated to require 12 to 18 months to complete including stakeholder Memorandum of Agreement (MOA) negotiations. The fourth main area addresses the environmental permits necessary to complete the project and are listed herein. Lastly, a business case is presented.

Right-of-Way Considerations

Analysis

There are three corridors that were considered for this report. The corridors would allow for a connecting electrical transmission or distribution line from the Red Dog Mine to K-Hill to Kivalina. The first corridor considered tracks from the Red Dog Mine dock located in Section 10, T26N R24W to the Cape Krusenstern National Monument border. This corridor was transferred to NANA. However, the U. S. Department of the Interior, Bureau of Land Management (BLM) conveyed those lands based only on township, range and section boundaries (without acknowledging drainages, curves, or topography), thus there is no corridor available in Section 28 of T26N, R 24W. The second corridor available, Route A, tracks through Section 29, adjacent to Ipiavik Lagoon or on the spit in Sections 32, 29, and 30 as shown on the potential route map (Figure 1). Alternatively, this alignment would have to cross the lagoon twice in order to avoid two native allotments and the monument. Regardless, the transmission line would have to cross the mouth of Kivalina Lagoon. Burying the line underneath the sea floor at the crossing would be extremely costly so an overhead span of approximately 500 feet is proposed. Supporting a span of that distance would subject the cabling to the weight of considerable ice buildup which could cause excessive sag resulting in phase slap. Larger conductors, dead-ends, and poles would likely be required for this span.

Crossing Ipiavik Lagoon and using the spit will need to be properly analyzed in any environmental document prepared for this project. The U.S. National Park Service (NPS), which regulates the Cape Krusenstern National Monument, requires that any utility corridor they permit has “no practicable alternative.” A full NEPA process per NPS regulations may be required if it is determined that there is no practicable alternative to crossing monument lands.

The length of transmission line between Section 12, T26N, R24W and Section 30 T27N, R25W crosses Alaska Native Claims Settlement Act (ANCSA) selected land and NANA may work internally and with other property owners to designate a utility corridor across the land. However, those lands not conveyed are still under the purview of the BLM. The roles of the NPS and BLM will be further explored in the Lead Federal Agency discussion below.

The second corridor, Route B1, starting at RDP, follows Route A for two thirds of the distance and then tracks north to K-Hill. All assumptions stated above for Route A are the same. Route B1 is primarily on NANA owned or NANA selected land and, as stated above, NANA may work internally and with other property owners to designate a utility corridor across the land. The third corridor, Route B2, is entirely on NANA owned land and is intended to follow a proposed new 7 mile long road that will link KIV with the proposed new school and KIV town site.

R.S. 2477 easements were researched. There are no R.S. 2477 easements in the State of Alaska, Department of Natural Resources database that would conflict with the routing of the transmission line.

Revised Statute 2477 is found in section 8 of the Mining Law of 1866. It granted states and territories rights-of-way over federal lands that had no existing reservations or private entries. The law remained in effect until Congress repealed it in 1976. In Alaska, the opportunity to establish new R.S. 2477 rights-of-way generally ended January 17, 1969, when the federal government issued PLO 4582 – the “land freeze” – to prepare for settlement of Alaska Native land claims. Though no new rights-of-way could be established after federal land was reserved or appropriated, or after the law was repealed in 1976, these actions did not extinguish pre-existing rights.

The following web sites were reviewed for maps, Interim Conveyance (IC) documents, and potential RS 2477 easements.

<http://sdms.ak.blm.gov/sdms/index.html>

http://dnr.alaska.gov/mlw/trails/17b/easement_maps.htm

<http://dnr.alaska.gov/mlw/trails/rs2477/>

<http://dnr.alaska.gov/mlw/factsht/rs2477.pdf>

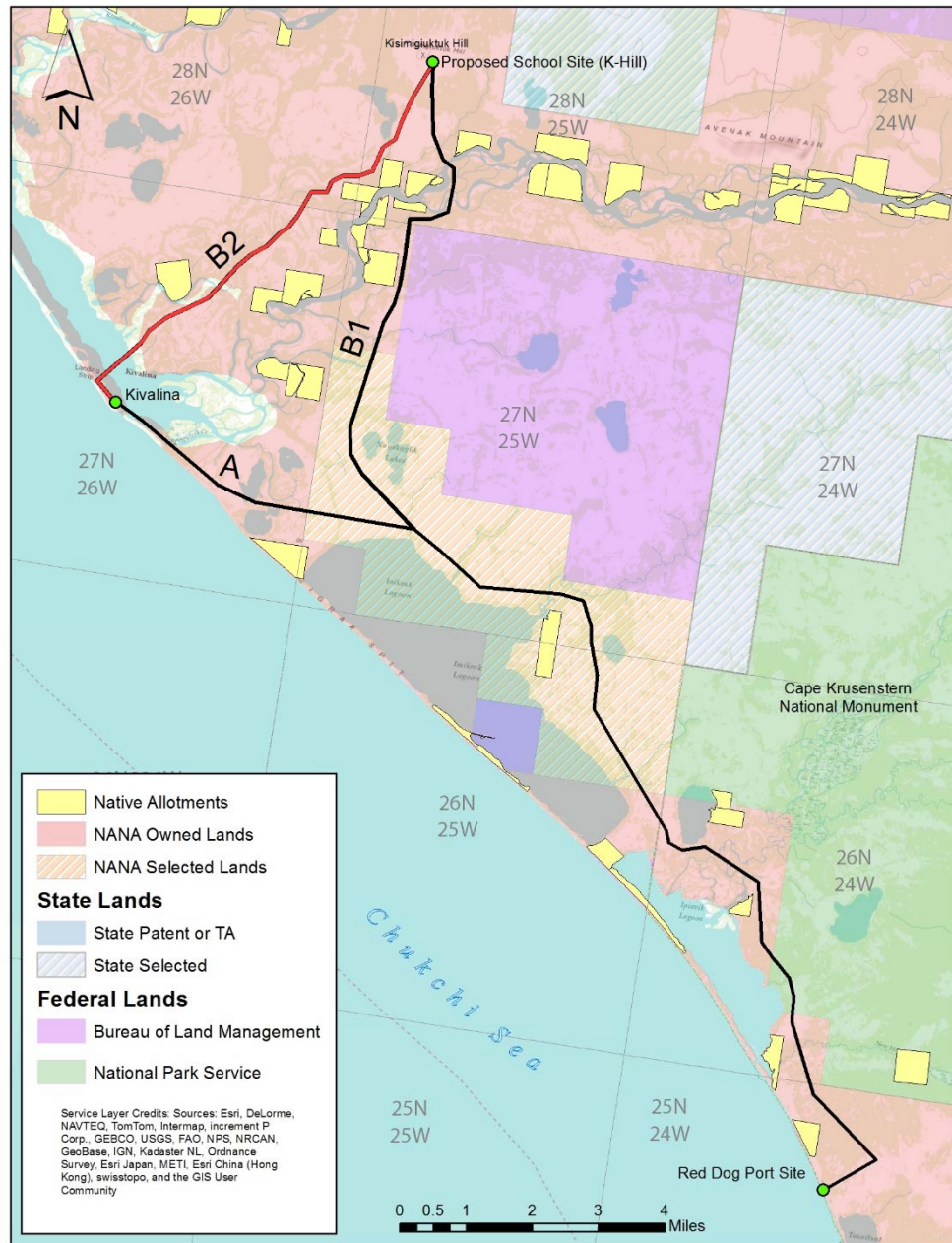


Figure 1: Conceptual Transmission Lines Alignment

Right-of-Way Conclusion

There are potential rights-of-way across the monument, across BLM lands, and across the lagoons and along the coast. While further analysis is required to determine alternative alignments for environmental documentation, it appears that a transmission line between Red Dog Port, K-Hill and Kivalina is feasible. There are a number of processes that must be completed prior to a right-of-way being granted by the two primary federal agencies involved. Interaction with NANA is necessary as well because of the need for the project to cross NANA land. Steps involved include:

1. Establish a lead federal agency, such as the BLM or the NPS.
2. Consult with the two federal agencies about what special studies they believe are necessary.

3. Establish an agreement with each federal agency for reimbursement of permit-associated costs.
4. Decide whether a consultant or the lead federal agency should prepare the Environmental Assessment (EA). If a consultant is chosen, request a scope of work that includes the special studies needed for an EA as noted by the federal agencies listed above.
5. Establish an agreement with each federal agency for reimbursement of costs associated with the review and approval of a consultant-provided EA.
6. Meet with a potential consultant(s) and use the information from No. 2 above to establish base line studies to be included in an EA. Any cost estimate will need to reflect these studies at this time.
7. Select a consultant and meet with the two federal agencies to determine the appropriate range of alternatives for the EA.
8. Determine appropriate costs for the consultant and establish a time line with the two federal agencies.

Lead Federal Agency

Analysis

The proposed transmission lines cross two properties held by different federal agencies. The NPS and the BLM both control property over which the line will traverse. Consequently, an environmental document is needed that meets the requirements of the lead federal agency.

The NPS wishes to minimize adverse impacts to the monument over time, so any alternatives that avoid impacts to the monument or minimize such impacts are preferable. The monument was established by the Alaska National Interest Lands Conservation Act (ANILCA). The legislation, quoted below, gives the purposes for which the monument was established.

The monument shall be managed for the following purposes, among others: To protect and interpret a series of archeological sites depicting every known cultural period in arctic Alaska; to provide for scientific study of the process of human population of the area from the Asian Continent, in cooperation with Native Alaskans, to preserve and interpret evidence of prehistoric and historic Native cultures, to protect habitat for seals and other marine mammals; to protect habitat for and populations of, birds, and other wildlife, and fish resources; and to protect the viability of subsistence resources. Subsistence uses by local residents shall be permitted in the monument in accordance with the provisions of Title VIII.

ANILCA Section 1107(a)(1) requires NPS to put terms and conditions in a ROW “to insure that, to the maximum extent feasible, the right-of-way is used in a manner compatible with the purposes for which the affected conservation system unit, national recreation area, or national conservation area was established or is managed.”

The BLM has similar issues with environmental documentation and alternatives. Their mission may be slightly different from that of the NPS, but, nonetheless, the requirements must be met.

Lead Federal Agency Conclusion

NPS staff has stated that the lead federal agency responsibility can be assigned to the agency that manages more of the impacted land. The NPS has a relatively small parcel of impact area and the BLM impact area would be rather large. Therefore, the BLM is more likely to be the lead federal agency.

Intertie Transmission Line Options

Analysis

Kivalina, as well as the proposed location for the new school and new Kivalina town site, is approximately 25 miles northwest of Red Dog Port (RDP). Both Kivalina and Red Dog Port use a diesel power generating station. Different transmission line voltages were analyzed as well as both alternating current (AC) and direct current (DC), to determine which transmission system would be most practical.

Analysis of power generation capacity at RDP, and the existing fuel storage capacity of RDP were also necessary to prevent a possible reduction in power reliability that would affect mining operations. In 2011 data was gathered from both RDP and KIV and included site loads, generator quantities and sizes, and fuel consumption and storage capacity information from both sites. The total load from both sites was modeled on the current redundant power generation output capability of RDP. Only minor changes in the Kivalina load have occurred in the intervening years since the data was collected so more recent data was not collected and analyzed.

Consideration was also given to the logistics involved in transporting numerous power poles, hardware, and miles of primary cable to the sites.

Calculations

System Modeling

Calculations for the proposed transmission line distance, voltage, resistance, voltage drop, and load capacity were performed to determine appropriate study parameters. Using SKM Powertools™ engineering software, transmission system models were developed to compare scenarios by system voltage and cable size. An estimated future load growth factor over a 20-year period was applied to verify the proposed system can accommodate projected growth. Power generation data for KIV and RDP was collected and evaluated to determine current and future station loading to better arrive at a total power generating requirement if both sites were combined.

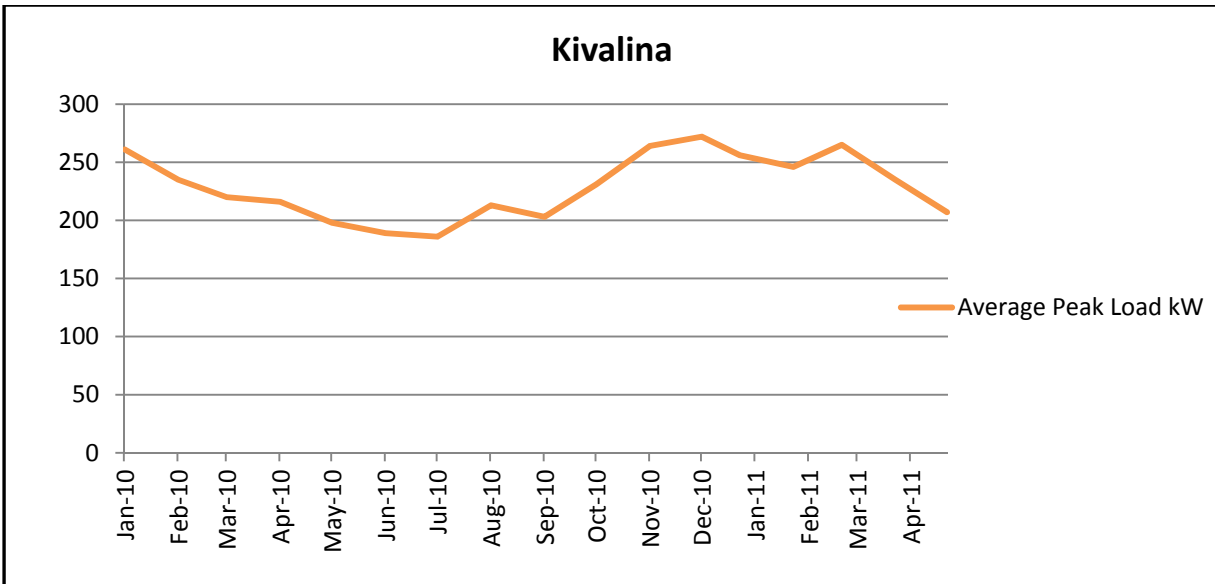
The single most important parameter defining an electric power system is the peak electrical demand. This peak demand determines the necessary reliable minimum capacity of the transmission or distribution systems. The peak demand is the instantaneous demand that occurs during a specified time period.

Cable sizes of AWG #1/0 and AWG #4/0 and voltage classes of 15kV, 25kV, 35kV and 69kV were modeled. Cable size was maintained at #4/0 for voltage classes of 35kV and 69kV meeting the minimum recommended Rural Utility Service (RUS) standard size for these voltage classes.

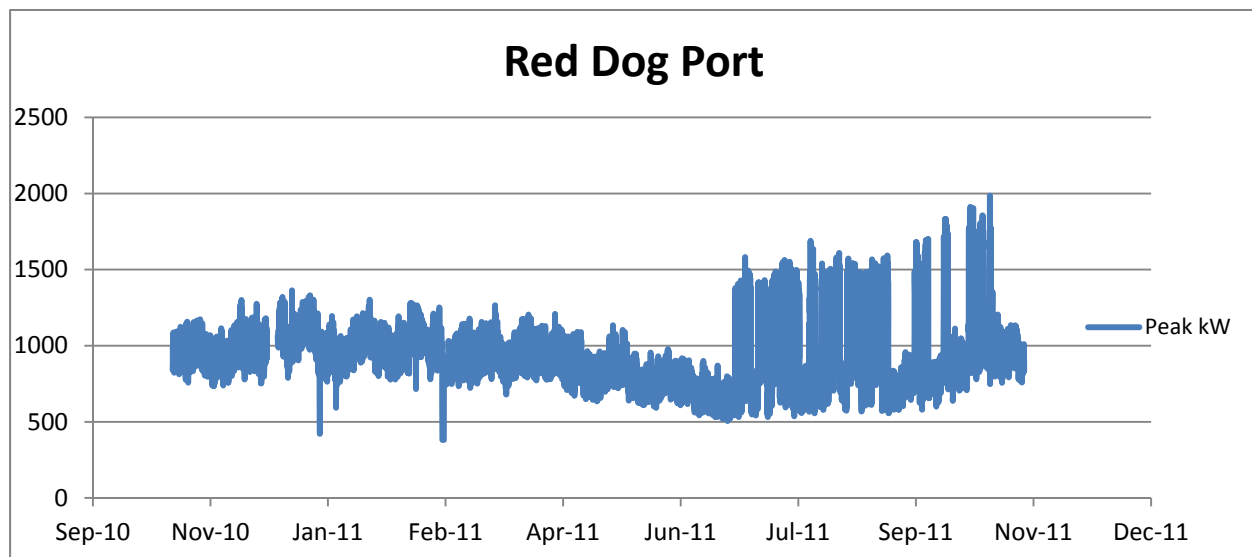
Power

Based on the load data provided, current Kivalina system peak loading is 272 kW. To accommodate the potential of a new school and village relocation to K-Hill a peak future load of 550 kW is used. The use of 550 kW results in 611 kVA at an estimated power factor of 90%. Adding 25% for future load growth over a 20-year period results in a maximum of 764 kVA. A 750 kVA transformer at each end of the transmission line was selected for our model. Given the cold average temperatures, the transformers should continue to operate reliably for many years.

Existing load data for Kivalina between January 2010 and May 2011 is shown in the graph below. For this study, an instantaneous peak load of 550 kW at Kivalina was used as a future peak load.



An instantaneous peak load of 1,812 kW at RDP was used in the study as shown in the graph below.



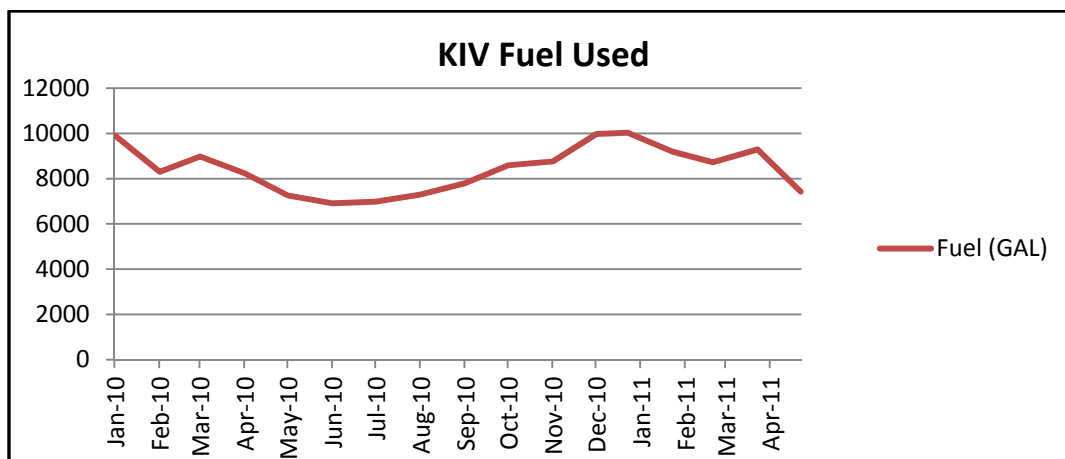
It should be noted the power generation voltage at both sites are equivalent at 480Y/277V. Kivalina's generation was recently upgraded from 208Y/120V. Port site operations are mostly fed by a 4160V distribution system due to large horsepower motors, while Kivalina's distribution is at 12,470V.

While the load profile over 16 months at KIV appears fairly consistent, RDP has a significant increase (approx. 800 kW) from June to October. This corresponds with port off-loading operations.

The total load projected to be supplied from RDP for all sites is estimated to be 2,362 kW peak.

Fuel

Fuel storage requirements were evaluated at both sites. Total fuel usage at KIV is estimated at 106,895 gallons for 2011. KIV data collected for 12 months resulted in the usage profile shown below.



Reported fuel use at RDP site for 2011 was 60,000 gal/day for mining operations and between 1300 and 2300 gal/day for port generation. This extrapolates to 21,600,000 gal/yr for mining operations and between 520,000 and 768,000 gal/yr for port operations. The corresponding total diesel fuel extrapolated to be stored and used in one year for both sites is approximately 22,475,000 gallons, assuming the more heavily loaded port case. Adding KIV power generation fuel load to the RDP site would result in approximately a 0.5% increase (negligible) to the total fuel requirement of this site as shown in the following table.

		Projected	Total	Day Tank	Day Tank	Day Tank	Projected	Projected
	2010 (gal)	2011 (gal)	Capacity (gal)	Light Load	Load-out	Capacity (gal)	Light 2011 (gal)	Heavy 2011 (gal)
Kivalina	98976	106895	108522					
Red Dog		768000	13000000	1300	2300	2500	520000	768000
Mining		21600000	(60000 gal/day)					
Total		22474895						

Generation

The current redundant power generation capability at RDP is 1,300 kW. This is comprised of two 650 kW generators running in parallel with one extra as backup. In order for RDP to provide full redundancy at the projected output requirement of 2,362 kW peak, two sets of one 1285 kW generator and one 650 kW generator running in parallel are required. Hence, one new 1285 kW generator would be required. Future provisions in the existing distribution equipment exist for this; however, the current-carrying capacity of the generator paralleling power system is insufficient at 3000 amps.

A total new RDP station load of 2,362 kW equates to 3,552 amps at 0.80 power factor. The existing distribution equipment would need to be upgraded to at least 4000 amps with the addition of the new 1285 kW generator mentioned above. Should the potential addition of mining equipment or infrastructure become necessary in the future, taking a long range view on the power distribution equipment would justify upgrading the distribution equipment to 6000 amps now to prevent additional down time.

Evaluations – System and Equipment Cost

Alternating Current (AC)

Different transmission voltages were analyzed. 15kV, 25kV, 35kV, and 69kV transmission systems were compared. As a rule, the higher the system voltage, the less total power is lost in the transmission system and more power is delivered to the load.

#1/0 and #4/0 aluminum conductor, steel reinforced cable (ACSR) was modeled for transmission cabling options since this type and these sizes are most commonly used for this transmission voltage class.

Pad-mounted, oil-filled, air-cooled, 750 kVA distribution transformers were modeled for use at each end of the transmission system. Selected transformers are capable of a minimum; 1.15% overload capacity; and have two 2.5% taps above and below providing voltage adjustment capability. The modeled 480V supply (RDP) circuit breaker and 480V load (Kivalina) circuit breaker are the fully adjustable electronic type.

The 480V three-phase feeder from the RDP generation switchboard to the new RDP distribution transformer consisted of four parallel runs of 350 kcmil THW (75 deg. C) sheathed copper cable in metallic conduit. The 480V three-phase feeder from the Kivalina station switchboard to the Kivalina distribution transformer consisted of six parallel runs of 750 kcmil THW copper cable in metallic conduit.

At a transmission voltage of 15kV, the step-up and step-down distribution transformer taps would have to be adjusted to maximum for #1/0 cable yielding a final 480V system voltage at Kivalina of 418.3V after a distribution voltage drop of 14.3%. Transmission line power loss was calculated to be 6.7%, or 36,901W. This would not be acceptable. Increasing the cable size to #4/0 reduced the voltage drop to 8.6% with a calculated system loss of 3.4%, or 18,575W. From there, increasing the transmission voltage from 15kV to 25kV, 35kV, and then to 69kV, substantially reduced the overall system losses. At a transmission voltage of 25kV the model resulted in an optimum selection of #4/0 cable. Transmission line losses were calculated to be 1.2% (6,598W) and 0.6% (3,321W) for #1/0 and #4/0 cable, respectively. Transmission line voltage drop was also reduced to 2.9% and 1.9%, respectively.

At a transmission voltage of 35kV, the #4/0 cable is the minimum size allowed by the RUS guidelines. Transmission line voltage drop was now reduced to 0.8%, resulting in a system loss of 0.4% (2,427W). At a transmission voltage of 69kV, the #4/0 cable resulted in a voltage drop of 0.1%, resulting in a system loss of 0.1% (643W).

Selecting the 69kV system will yield the lowest operating losses of the studied systems. Based on 550kW, the #4/0 cable will be loaded less than 1.5%, allowing ample room for future growth.

Transmission Line Tie-in Locations

For safety reasons during operation and maintenance, the intertie transmission line tie-in locations at both Kivalina and RDP are proposed to be through an appropriately sized transformer. Connecting the new transmission line at Kivalina directly to the existing 12,470V (12.5kV) distribution system would result in a potential back feed situation at the power station, remove one transformer needed for voltage adjustment, and make future system changes more difficult, resulting in longer power outages.

Equipment Cost Evaluation

Major equipment changed by the study scenarios was evaluated. #1/0 and #4/0 ACSR cable raw costs were compared. The #4/0 cable raw cost is about 82 percent higher than #1/0 cable, resulting in about \$140,000 in additional cost (not including additional labor for installation). Freight based on weight for

the delivery of the #4/0 cable would also be roughly double. Also, as the modeled system voltage increases, so does the voltage class of post insulators and transformers. Insulators are the smallest cost factor, accounting for an estimated \$115,000 in additional cost for changing from a 15kV to a 69kV transmission system. Transformers would be approximately \$500,000 more. In addition, poles need to be slightly longer versus the 25kV system.

High Voltage Direct Current (HVDC)

Also evaluated was a HVDC transmission system. These type of systems are easily capable at transmitting electrical power at 69kV and higher. Below are advantages and disadvantages to using this system of electrical transmission.

Advantages

- Asynchronous bi-directional system, permitting power sharing from either end of the transmission line
- Fewer cables per pole reducing net line costs per mile
- Fewer poles required per mile making it more suitable to preserving local conditions
- No electrical reactance losses or voltage compensation required
- Alumoweld transmission cable with fiber optic core available, which integrates communications in the same cable
- Increased grid stability preventing cascading failures
- Good for integrating renewable energy (wind) farm generated electricity

Disadvantages

- Distances less than 40 miles will likely result in higher power losses than the AC system (Red Dog Port to Kivalina transmission line length is about 20 miles)
- Typically used for 20 MW and larger applications (Kivalina is 0.75 MW)
- Rectification/inversion equipment required at each end is not currently commercially available for the small load size
- Single wire earth return (SWER) scenario currently does not provide ground fault detection
- A 60 mile intertie is required before the life cycle costs move in favor of HVDC over traditional AC power transmission methods. (Alaska Center for Energy and Power, 2012)

For an isolated installation only between Kivalina and RDP, selecting the HVDC transmission system over the AC system does not appear to be a practical option.

Intertie Transmission Line Conclusion

The clear recommendation for an AC system is to select the 69kV AC transmission voltage with #4/0 cable and 750 kVA transformers at each end of the transmission circuit.

Estimated power line losses and percent for the modeled systems are shown in the table below. While one Kivalina data sheet showed a high value of 272 kW for the year, another showed an overall average station service load of 550 kW. Both values were studied and 550 kW was used for the worst-case future peak value.

Peak Load	Voltage/Cable	Pwr Loss (W)	Loss	Future Peak Load	Voltage/Cable	Pwr Loss (W)	Loss
272 kW @	15 kV, #1/0 =	9025	3.30%	550 kW @	15 kV, #1/0 =	36901	6.70%
272 kW @	15 kV, #4/0 =	4543	1.70%	550 kW @	15 kV, #4/0 =	18575	3.40%
272 kW @	25 kV, #1/0 =	1614	0.60%	550 kW @	25 kV, #1/0 =	6598	1.20%
272 kW @	25 kV, #4/0 =	812	0.30%	550 kW @	25 kV, #4/0 =	3321	0.60%
272 kW @	35 kV, #4/0 =	594	0.20%	550 kW @	35 kV, #4/0 =	2427	0.40%
272 kW @	69 kV, #4/0 =	157	0.10%	550 kW @	69 kV, #4/0 =	643	0.10%

As system voltage increases, the power losses subside. Values in the left section represent average peak load and values in the right section represent highest annual future peak load. At an estimated fuel cost of \$4.46 per gallon, extrapolating the projected power losses resulted in an annual fuel charge for modeled voltages as shown in the table below.

System Type	gal/loss @ 272kW	Cost	gal/loss @ 550kW	Cost
15 kV, #1/0 cable =	44468	\$198,327	89916	\$401,027
15 kV, #4/0 cable =	22384	\$99,832	45261	\$201,864
25 kV, #1/0 cable =	7951	\$35,462	16078	\$71,706
25 kV, #4/0 cable =	4002	\$17,851	8093	\$36,095
35 kV, #4/0 cable =	2924	\$13,043	5913	\$26,372
69 kV, #4/0 cable =	775	\$3,458	1568	\$6,993

As the load increases/voltage decreases, the amount of power and fuel lost increases.

It is worth considering the fact that the highest voltage class that exists in the AVEC system is 25kV. Although this report recommendation is to construct a 69kV transmission line, it is feasible to transmit the required power at 25kV, but there is a cost. Specifically, there would be a perpetual incremental monthly fuel cost. The cost in fuel as it relates to the 25kV transmission voltage inherent line losses is about \$1,200 per month (\$17,851 - \$3,458 = \$14,393/year divided by 12 month/year ~ \$1,200/month). Contrast this fuel cost to a 69kV transmission voltage fuel cost of about \$300/month (\$3,458 divided by 12 months/year ~ \$288/month). The line loss fuel costs on a monthly basis comparing 25kV transmission (~\$1,200/month) to 69kV transmission (~\$300/month) is more expensive thus making the incremental cost (\$1,200 - \$300 =) approximately \$900 more per month at a 25kV transmission voltage.

Training for 69kV Operation

Lastly and very significantly, no training for certification upgrade is required for journeymen linemen regarding operation and maintenance of a 69kV system past that training needed for operations and maintenance of 12.5kV systems.

Distribution Line Analysis

Route B2 12.5kV Distribution to KIV

The selected voltage class for Route B2, an approximate 7 mile distance from K-Hill to KIV, is 15kV and is a common voltage class for distribution of short distances specific to this project. The specific selected distribution voltage is 12.5kV. This voltage was chosen to match the distribution voltage currently in KIV

and thus lend itself to familiarity and ease of operations and maintenance by village electrical maintenance staff.

As mentioned above, the worst case average power plant demand for KIV was 550 kW. The base load, or minimum load during the year, is approximately 175 kW. As stated above, a transformer size of 750 kVA was chosen for connection at KIV.

The factors deemed important in the power line design include good reliability in an extreme climate, efficient power transfer for the anticipated present and future electrical loads, relatively low cost and ease of construction in the Alaska bush. The anticipated high wind conditions, extreme temperature fluctuations and ice loading mandate a robust design.

Although satisfactory power transfer could be obtained with smaller wire size, such as #2 ACSR, #1/0 AAAC was selected to provide higher strength to support longer spans in conditions of extreme ice load and high wind. AAAC is an abbreviation of “all-aluminum alloy conductor”, a type which does not utilize a steel reinforcing strand as does the more commonly used ACSR (aluminum conductor, steel reinforced). AAC is constructed of 6201-T81 aluminum alloy which has an ultimate strength of 45,000 psi. By comparison, the aluminum strands of ACSR and AAC (all aluminum conductor) are 1350-H19 aluminum alloy with an ultimate strength of about 25,000 psi. ACSR utilizes a single or multiple steel strands to provide adequate strength in overhead power lines with wider spans. AAAC conductor may be used in aerial construction with much shorter spans.

#1/0 AAAC has a tensile strength of 4460 pounds compared to a tensile strength of 4380 pounds for #1/0 ACSR. The elastic coefficients of both conductors are approximately the same. The AC electrical resistance of #1/0 AAAC is approximately 10% lower than that of #1/0 ACSR. The weight of #1/0 AAAC is 115 pounds per 1,000 linear feet, which is 20% lighter than #1/0 ACSR with a weight of 145 pounds per 1,000 linear feet. For a given tensioning criteria, AAAC can be installed with less sag than comparable ACSR.

The power pole framing design with 10-foot long cross arms is chosen. Typical RUS design would utilize 8-foot cross arms. This design modification allows greater spacing of conductors to improve immunity to phase-to-phase and phase-to-ground faults (conductor strikes) in high winds during warm weather when conductor sag is maximum. The modified conductor spacing allows longer spans and fewer poles, to reduce construction costs and lessen the impact on the tundra during construction. Appropriate wind vibrations dampeners on the conductors are considered and included.

The proposed road is anticipated is built up considerably from the surrounding tundra with a rock base. The road cross-section may have relatively steep embankments with slopes of up to 50% slope. To achieve satisfactory offset between the pole line and the edge of road surface, and still maintain safe, overhead clearances for the large, off-road type trucks. For these reasons, approximately 40 each, 45 foot, class 3 power poles will be mounted to 40-foot driven steel H-piles in the low lying areas where periodic flooding is anticipated. Guy anchors for these poles will also be constructed of driven H-pile to support line angles. Structures close to the village will be direct buried, 55-foot, class 3 poles, with conventional cross-plate guy anchors to support line angles. The 55-foot poles will be buried 8.5 feet. Where crossing guy poles are required, on inside road bends, 35-foot poles will be mounted to H-pile supports in low-lying, flood prone areas and direct buried, 45-foot guy poles will be used elsewhere.

Cost consideration for this type of aerial construction for Route B2 includes all labor and materials for approximately 140 poles, 2 750 kVA transformers, #1/0 AAAC conductor, H-piles and all guying and anchors is approximately \$2.0M.

Wind Resources

Wind Power Consideration

In a general sense, wind classification at Red Dog Port should be viewed with caution because the statistical characteristics of the wind at this site are somewhat unusual with a wind speed probability distribution skewed toward lower wind speeds but also comprised of high-wind events, and the latter strongly influence the mean annual wind power density. Intuitively, this can be grasped by considering that although the mean annual wind power density is quite high, the site experiences 45 percent calm winds (wind speeds less than four meters per second). Another indication of the periodic high winds at Red Dog Port is the extreme wind probability calculation, which, depending on one's assumptions, classifies the site as IEC Class I or II. As noted above, this requires the selection of wind turbines that are designed for such winds.

In other respects, however, Red Dog Port wind characteristics are ideal with exceptionally low turbulence and low surface roughness. The port experiences very cold temperatures, which will increase energy production of both variable pitch and stall-regulated wind turbines, but the low elevation of the site keeps it free of problematic rime icing problems that have been noted elsewhere in northern Alaska.

Further analysis and documentation will be pursued in a follow-on conceptual design report to include consideration of a wind turbine at the proposed K-Hill site.

Environmental Process

Introduction

At a minimum, an Environmental Assessment (EA) will be needed to document environmental impacts from a transmission line between Red Dog Port and Kivalina. The parties intimately involved in the process include the NPS, the BLM, AVEC, Red Dog Mine, NANA, Kivalina, and other resource agencies. All impact categories must be analyzed.

Involved Agencies

The following Federal, State and Local agencies would be involved in scoping, providing input to the EA, and/or involved in permitting.

- **National Park Service:** An NPS ROW permit would be required to construct, maintain and terminate the electric line on NPS administered lands. The authority to issue the ROW permit is discretionary. NEPA analysis, likely an EA would be required. Alternatives to the proposed action and impacts to archeological and historic resources, visual resources, vegetation, and critical polar bear habitat inland of and along Ipiavik Lagoon would be considered in the EA. Assessment of impacts on subsistence is required by Section 810 of ANILCA. Two sets of federal regulations would apply to applying for ROW: NPS nationwide ROW regulations at Title 36 Section 14 of the Code of Federal Regulations (36 CFR 14) and ROW regulations applicable to parks and other conservation system units in Alaska at 43 CFR 36.
- **Bureau of Land Management:** The BLM administers land between the monument and Kivalina. A BLM ROW permit would be needed where the proposed electric line would cross their lands. Work with BLM ROW permit would be coordinated through the Central Yukon District Office.
- **State Historic Preservation Officer (SHPO):** The SHPO would be consulted to evaluate the effects on cultural resources within Cape Krusenstern National Monument (CAKR) and within the

overlapping Cape Krusenstern Archeological District which is a National Historic Landmark (NHL). Actions affecting the NHL outside the monument on BLM lands also require consultation with the SHPO. SHPO consultation is also necessary on private and native corporation lands.

- **US Army Corps of Engineers (USACE)/Alaska Department of Environmental Conservation (ADEC):** A USACE Clean Water Act Section 404 Permit would be required where the project could affect waters of the USA, including wetlands. A EPA Section 401 water quality certification permit administered by the ADEC would be obtained concurrently with the Section 404 permit
- **US Fish and Wildlife Service (USF&WS):** The USF&WS would be consulted about threatened and endangered species and migratory birds. Primary project concerns are related to the potential of electrical transmission lines and wind turbines to impact migratory birds and endangered eiders.
- **State of Alaska Department of Fish and Game (ADF&G):** ADF&G Title 16 Fish Habitat Permits would be required at all water body crossings designated as fish habitat.
- **State of Alaska Department of Natural Resources (ADNR):** A ROW permit from the ADNR may be required if the electric line crosses tidelands below ordinary high water that are owned the State of Alaska.
- **Northwest Arctic Borough (NAB):** Projects within the NAB require a development permit that typically requires a 20 review period and approval by the planning board for projects of this scale.

In addition the coordinating with the above agencies, the Alaska Native Claims Settlement Act (ANICLA) requires federal agencies to consult with the State of Alaska, affected units of state government, and affected Native corporations concerning projects on federal lands.

Impact Categories

Wetlands and Waterways

A review of the project area, including lands from Kivalina south to the Red Dog Port, was conducted for the presence and distribution of wetlands and aquatic resources. The USF&WS National Wetland Inventory (NWI) Wetland Mapper (2011) was utilized to identify wetlands and water bodies in the project area.

The NWI Wetland Mapper indicated near complete coverage of the proposed project area by freshwater emergent, freshwater forested scrub, freshwater pond, lakes, and rivers. All of these features and resources are regulated by the USACE. Fill placement and other discharges of construction materials into these features requires a section 404 permit from the USACE and may require mitigation and/or restoration of impacted habitats.

The proposed project intertie would cross numerous waterways that may be navigable waters and may require Coast Guard and USACE approval for in or over-water structures. At a minimum, the intertie would cross the Wulik River, Imikruk Creek, Omikviorok River, and a number of smaller order streams.

Avian Resources

Preliminary research indicates that the project corridor and the Kivalina vicinity are an important migration corridor and summer foraging area for waterfowl, shorebirds, and seabirds. In an interview with Mr. Julian Fisher from the Migratory Birds Division of the USF&WS (personal communication with C. Storey, June 24, 2011), the area was identified as an important resource for these groups. Mr. Fisher indicated that the region harbors one of the largest colonies of seabirds in the state. In addition, the near

shore area, including the proposed intertie route, is an important migration corridor during foggy and inclement weather.

Migration timing for birds has northern migrants arriving or passing through the Kivalina area between the last week of March and early June (personal communication with Julian Fisher, June 24, 2011). South migrating species would be anticipated before ice-up.

Pre-construction surveys of bird use in planned turbine placement areas may be needed depending on consultation feedback from the USF&WS and Park Service biologists.

Ground clearing and construction activities associated with the project should take into account the recommended “no-clearing” windows established by the USF&WS (2007). The no-clearing window during which vegetation removal should be avoided is June 1 to July 31. Adhering to the no-clearing window restriction will help the project comply with the Migratory Bird Treaty Act.

Bats

While some bat species do occur in portions of Alaska, the project area is not in the current range of any bat species.

Other Mammals

The project corridor is expected to be within the range of numerous large and small mammals. Further consultation and analysis of the effects of the intertie and turbine placement is needed to ensure limited disruption to migrations and habitat access on a specific site basis.

Fisheries

Fish collection records provided by the Alaska Department of Fish and Game (ADF&G) indicate the use of project area waterways by numerous resident and anadromous fish species (ADF&G 2011). Records indicate the occurrence of pink salmon (*Oncorhynchus gorbuscha*), chum salmon (*Oncorhynchus keta*), coho salmon (*Oncorhynchus kisutch*), sockeye salmon (*Oncorhynchus nerka*), Chinook salmon (*Oncorhynchus tshawytscha*), whitefish (*Prosopium cylindraceum*), and Dolly Varden (*Salvelinus malma*) in project area waters that may be effected by the project intertie and other project development activities.

Waterway crossings and in-water structures in rivers, streams, and other waterways will require a Fish Habitat Permit from ADF&G and may trigger the need for mitigation activities and implementation of specific Best Management Practices (BMPs) during project operation, maintenance, and development.

Endangered Species

USF&WS migratory bird biologist Julian Fisher mentioned during an interview that the project area and Kivalina vicinity could be a migration corridor for the federally threatened Steller’s Eider (Alaska breeding population) and the threatened Spectacled Eider (personal communication, June 24, 2011). The use of the project corridor by these species may be considered in future consultation efforts for the project and should be reviewed with USF&WS personnel prior to final site determination and development.

Permitting

The following are the minimal known permits needed:

- NANA Land Use Permit;
- Northwest Arctic Borough Title 9 Development Permit;
- USACE Section 404 Permit with ADEC 401 Certification;
- BLM Right-of-Way Permit;
- National Park Service Right-of-Way Permit;

- ADNR Tidelands Easement Permit;
- FAA Obstruction Evaluation.

NANA Land Use Permit

This permit would allow the transmission line to cross NANA-owned lands. Processing would probably not be time consuming.

Northwest Arctic Borough Title 9 Development Permit

The Title 9 development permit application must be accompanied by a fee. The fee is \$750 if in a Resource Development Zone or Transportation Corridor Zone. The Conditional Use Permit fee is \$500. The permit can take 6 to 9 months to process depending on when the council meets.

USACE Section 404 Permit/ADEC Section 401 Permit

Once the permit application is assigned, the public notice may not go out for a month. A typical permit application public notice period for an individual permit is 30 days. The USACOE has no regulatory requirement for issuing the permit within a certain timeframe.

Note that they require compensatory mitigation in all cases for wetlands loss. Utilities require a Nationwide Permit (NW). A NW 12 permit could cover the project if the total wetlands impacts are 0.5 acres or fewer. A NW permit typically requires a 15-day review. The ADEC 401 certification is issued at the same time as the 404 permit. There is a permit fee of \$100. Total processing time can be 3 to 6 months. Note that the USACOE will assess compensatory mitigation as a 1:1.5, 1:2 or 1:3 metric. This means that for every acre of impact, 1.5 acres, 2 acres, or 3 acres will have to be compensated for. The cost is based on the land values.

The ADEC will issue the Section 401 water quality certification concurrently with the issuance of the USACE Section 404 permit.

Bureau of Land Management Right of Way Permit

The right-of-way process will be similar to the description below for the NPS. The BLM will want to create an agreement with the Alaska Village Electric Coop where funds are set aside for BLM staff to process the permit application. A decision will need to be made between the BLM and the NPS which agency is the lead federal agency (most likely that will be BLM based on the amount of land impacted by the project). The resulting environmental document required would be prepared based on the lead federal agency statutes and regulations. If BLM is the lead federal agency, the agreement between AVEC and BLM will include funds for NPS staff as well.

There may be other fees besides the cost reimbursement to the federal agencies for staff time. As discussed below for the NPS, the BLM staff may author the Environmental Assessment or the applicant may hire a consultant to complete it. This can take at least a 6 to 9 months and possibly a full year if the BLM is the lead federal agency and they decide to conduct field work.

National Park Service Right-of-Way Permit

Processing this permit application will not begin until the NPS is satisfied that the application is complete. There are several fees involved:

- Land Use fee (rent): This depends on the funding source; if REA funds are used, then no rent fee is assessed.
- Monitoring fee: Typically \$100/year or more if NPS needs more funding to monitor the area.

- Processing fee: This is a sliding scale of fees. Basically, the NPS will enter into a cost reimbursement agreement with the applicant. Every NPS staff person who is involved with the application process will charge the applicant for his/her time. This varies on the complexity of application and can range from a few thousand dollars to more than \$15,000.

The NPS will also require an EA per their regulations. The NPS may choose to complete this document, in which case it will require reimbursement from the applicant. The applicant may have the opportunity to hire a contractor to do the EA; however, note that the AVEC will want to coordinate with agencies prior to selecting a consultant and getting cost estimates. Cost estimates will depend on what special studies may be needed for the corridor. A contractor may be less expensive and more efficient, depending on the NPS staff availability. However, it is still subject to the NPS approval and must satisfy their requirements. ***The NPS reserves the right to deny a right-of-way permit even after the applicant pays these fees and conducts this research.*** The NPS suggests that applicants schedule a pre-application conference with their staff to learn about their issues and concerns. In general, the staff will be concerned about reasonable alternatives and why a certain route was selected over other routes.

The NPS estimates a wait time of 6 to 9 months for this process unless field studies are needed and cannot be accommodated until the following summer.

State Historic Preservation Office Section 106 Consultation Concurrence

The proper format for this process is a “consultation” rather than a permit, meaning that the applicant consults with the SHPO on the projects’ potential impacts on cultural resources. Cultural resources may be both historic and prehistoric and, in the case of Cape Krusenstern National Monument, are already analyzed for their eligibility to the National Register. Consequently, consultation will likely consist of a Determination of Effect unless additional archeological survey work is deemed merited.

Mitigation will be necessary if a Determination of Adverse Effect is made. Mitigation measures, if necessary, will be found in a Memorandum of Agreement (MOA). Likely parties to that MOA at this time include the AVEC, NANA, NPS, BLM, Red Dog Mine, Kivalina IRR, and the City of Kivalina. Other parties may be discovered through the process.

It is important to note that the lead federal agency for the EA will not sign a Finding of No Significant Impact if the Section 106 consultation process has not been completed. Getting a signed MOA can take considerable time. Allow 18 to 24 months for this process. Expenses will revolve around whether additional archaeological survey is required and/or whether professional assistance is needed in developing a Determination of Effect.

ADF&G Title 16 Permits

Any stream crossing or lagoon crossing will involve coordination with the Alaska Department of Fish and Game (ADF&G). Their permit processes allow for certain culverts or bridges that allow for resident fish passage and for anadromous fish in streams known to support such species. Fish passage permits are not difficult to obtain and do not routinely take more than a couple of months. Expenses in obtaining a fish passage permit should be minimal.

ADNR Tidelands Easement

Tidelands impacts may result in coordination with the Alaska Department of Natural Resources (ADNR). Tidelands easements can take a considerable time to acquire. Please allow at least one year for permitting if tidelands are impacted by a preferred alternative. The ADNR has at least one, if not two or more specific periods of time that they must advertise for public comment during the tidelands permit process. Expenses (fees) will be dependent on the magnitude of impact.

Business Case

Options

We analyzed three different options for providing power to Kivalina:

- Operate Status Quo.
- Power Plant at New School Site. Build a new power plant and bulk fuel storage facility near the new school at the K-Hill location. Build a new 12.5kV electrical distribution line along the new road from K- Hill to provide power to the existing community and tie into existing infrastructure. Decommission the existing power plant and bulk fuel storage facility.
- Intertie Between Red Dog Port and Kivalina or New School Site. Build a 69kV electrical intertie between the Red Dog Port site power plant and the community of Kivalina or the new school site, following Route A or B, to provide power to the existing community or school site. Build a 12.5kV distribution line along the new road between the existing community and the new school site to provide power to the other site.

Operate Status Quo:

The first option analyzed ‘do nothing’ thus maintaining current operations at the Kivalina power plant. Continue to operate as status quo. The existing Kivalina power plant and bulk fuel storage facility will provide for the electrical needs of the community at its current location into the foreseeable future assuming current operation and maintenance actions remain constant. When a new school and new connecting road are constructed a distribution line would need to be built to provide power to the school from the existing Kivalina power plant.

In 2011 the condition of the existing power plant and bulk fuel storage facility was analyzed and found to be capable of meeting current peak load and annual fuel storage requirements, however there is no space to upgrade the power plant beyond its current footprint should the load requirement substantially increase. A load analysis including the new school is outside of the scope of this report and was not performed.

While little in the way of capital expenditures would be required for this option, operational costs are high. According to 2013 State of Alaska Power Cost Equalization (PCE) data, Kivalina generated 1,285,613 kWh of electricity from 94,112 gallons of diesel fuel. Reported fuel costs were \$392,057 and non-fuel expenses were \$331,049 for a total of \$723,106 for the year. 93.9% of this power was sold. AVEC charges a flat rate of \$0.27/kWh for non-fuel related expenses. If we divide the cost of generation (\$723,106) by the kWhs generated (1,285,613 kWh) divided by the efficiency (93.9%) we come up with a raw electricity cost of \$0.60/kWh. Using the Institute of Social and Economic Research (University of Alaska, Anchorage) (ISER) medium projected fuel cost of \$4.44/gal, the gallons of diesel fuel consumed (94,112gal), and AVEC's flat rate of \$0.27/kWh for non-fuel expenses, divided by the efficiency, the raw cost of electricity is \$0.62/kWh.

Additionally, in the long term and with its close proximity to the Chukchi Sea, the life expectancy of both the existing power plant and bulk fuel storage facility is uncertain due to shore erosion concerns.

Power Plant at New School Site:

This option is predicated on the road and then the school being built. Assuming this were the case, the capital costs for providing a new power plant and bulk fuel storage facility is estimated at \$14 million to \$16 million. A 12.5kV electrical distribution line would need to be constructed along the new seven mile road when the new school is built.

Construction of the 12.5kV distribution line to provide power to the existing community is estimated at about \$400K per mile¹ or \$2.8 million, for a total capital expenditure of \$17 million to \$20 million for this option. If we assume the community load and percentage of power generated sold remain constant, and an increase in generator efficiency of 10%, the cost of energy would be approximately \$0.58/kWh based on ISER fuel cost projections.

Intertie Between Red Dog Port and Kivalina or New School Site:

The destination of the intertie would also be predicated on the new road and school being built. The logical destination would be the new school site if it exists. Otherwise the intertie would terminate at the existing community site. The cost of this transmission line is estimated at \$15 million, or roughly equivalent to the cost of the new power plant and bulk fuel storage facility.

Based on conversations between WHPacific and Teck Alaska Incorporated (TAK), it is estimated that TAK would sell electricity from the Red Dog Port Site to AVEC for around \$0.25/kWh. Assuming all else remains constant including non-fuel related costs, the cost of energy would be equivalent to approximately \$0.52/kWh.

A further facet to this option is the potential to eliminate the existing KIV power plant and portion of the fuel tankage and thus the on-going associated operation and maintenance costs. It is recommended to have a backup source of electrical power for KIV should there be an extended transmission or distribution line outage. The existing power plant can serve this purpose or a smaller sized generator could be purchased and substituted for the existing power plant. Should the new transmission line and new distribution line be constructed, the existing KIV power plant could be decommissioned and a small single unit 750kW enclosed and insulated skid mount standby unit could be purchased complete with a suitably sized transfer switch to serve as a back-up source of electrical power to KIV. If the Red Dog Port power plant suffered an unexpected but long term outage or if there is an unforeseen transmission/distribution line disruption for an extended length of time, this 750kW standby generator will serve as an emergency electrical source for KIV. The old plant may possibly be dismantled thus making a vacant area in KIV that may be used for other pressing community purposes.

Submarine Cable Consideration

The market for submarine cables is specialized and its demand is growing. Although this transmission line report is based on an aerial distribution design, discussion regarding the use of a 69kV underwater submarine cable is useful.

There are two possible locations a submarine cable may be used. The first location considered is along Route A, would be about a mile in length and would be used to bypass the Cape Krusenstern National Monument (See Figure 1) through the Ipiavik Lagoon thus eliminating need for a right-of-way on federal property. The second location would be along Route B2, would be less than a mile in length and would cross the Kivalina Lagoon near the mouth of the Wulik River on its way to Kivalina village (See Figure 1). Of note, this second underwater crossing would be eliminated if the road and bridge was constructed across the lagoon as part of the project to construct a road from Kivalina to K-Hill site. The distribution line at this second lagoon crossing would utilize the road and bridge infrastructure to cross the lagoon and rather than using a submarine cable the preferred method of electrical distribution construction would be appropriately rated conductor in conduit.

¹Discussions with AVEC in April 2014 reveal recent experience regarding 12.5kV line construction cost per mile is approximately \$350K to \$400K per mile.

An important consideration regarding this type of installation is an integrated communication cable (fiber optic) as part of the power cable. Including the fiber strands in the submarine cable is estimated to add approximately 4% to the material cost of the cable.² Other salient factors related to submarine cable design are burial depth, wave action and submarine cable termination yards (transition from land to water or water to land). An environmental study or permit of an electric power cable introduced to either or both lagoons and its effect on the marine environment will be required. The overall cost of submarine cable installation would roughly be the same per mile as the cost of aerial distribution.

Estimated Cost of Construction

The overall cost of the 69kV 22 mile transmission line for Route A or Route B1 would be approximately \$12M-\$15M.³ The overall cost of the 12.5kV seven mile distribution line for Route B2, is \$2.8M and is assumed to be constructed along the new road. Construction cost, as previously assumed, is \$400,000 per mile. Final design costs are estimated at \$409,000.⁴ Total cost of construction for Route A or B is approximately \$15M-\$18M.

Estimated Cost of Operation and Maintenance (O&M)

Operation and maintenance of either transmission line route will be an annual cost and will directly affect the reliability of electrical power delivery from Red Dog Port to Kivalina regardless of which route is selected. The approximately 20 mile and 22 mile length, respectively, of Route A or B1 (See Figure 1- Conceptual Transmission Line Alignment) will need to be physically examined periodically. The frequency of inspection is recommended at least twice per year for the first three years then annually.

Summer time inspection access will likely be by helicopter and wintertime inspection access will likely be by snow machine. The seven mile B2 route inspection will be the most accessible and can be accomplished by line maintenance truck easily and such inspection cost will be minor.

In general the repairs to the transmission line will be minor repairs, especially for a new installation during the first few years. Items of visual inspection will include the pole and structures, guys, insulators, conductors and submarine cable terminations. Contracting for inspection services is expected. O&M annual costs estimates are presented below.⁵

Item	Cost
Overhead Line Inspection	\$22,300
Regular Repair/replacement	\$21,500
Switchyard Maintenance	\$6,000
Subtotal	\$49,800
Contractor Fee (15%)	\$7,470
Total	\$57,270

²*Southeast Alaska Intertie Study, Phase 2 - Final Report, 2003*, prepared for The Southeast Conference, Juneau, Alaska, page 6-1.

³ & ⁴*Kake – Petersburg Transmission Intertie Study – Final Report, 2005*, prepared for The Southeast Conference, Juneau, Alaska, page 4-4 to 4-5, Table 4-3. Center-South Alternative cost used on per mile basis and adjusted for inflation. Final design cost prorated and adjusted for inflation.

⁵*Kake – Petersburg Transmission Intertie Study – Final Report, 2005*, prepared for The Southeast Conference, Juneau, Alaska, page 6-7, Table 6-8. Center-South Alternative cost used on per mile basis and adjusted for inflation.