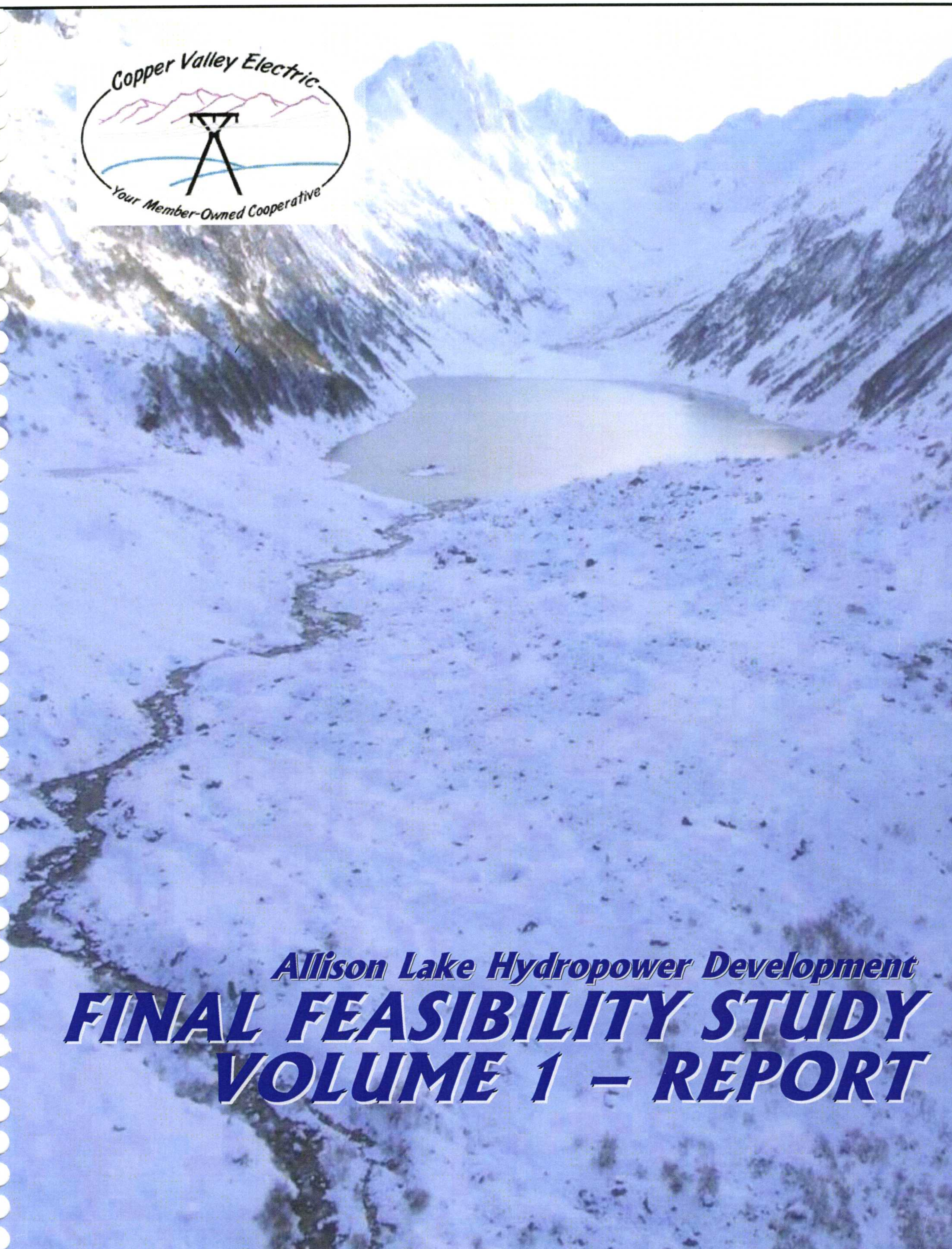
Copper Valley Electric
Your Member-Owned Cooperative



Allison Lake Hydropower Development
FINAL FEASIBILITY STUDY
VOLUME 1 – REPORT

May 2010

HATCH ACRES

HATCH ACRES Hatch Acres Corporation
6 Nickerson Street, Suite 101, Seattle, WA 98109 USA
Tel: 206-352-5730 • Fax: 206-352-5734 • www..hatchacres.com

May 17, 2010
H-327730

Robert A. Wilkinson, CEO
Copper Valley Electric Association
P.O. Box 45
Glennallen, AK 99588-2832

Dear Robert **Subject: Allison Lake Hydroelectric Project**
Final Feasibility Study

We are pleased to submit herewith our **Final Feasibility Study** for the Allison Lake Hydroelectric Project. The development of this study has been performed as Task Orders 01 through 05 under our Professional Services Contract for General Services between the Copper Valley Electric Association, Inc. (CVEA) and Hatch Acres Corporation.

The report presents our detailed analysis of the hydroelectric potential of the Allison Lake basin. Following the review of previous studies, completion of the **Pre-Feasibility Report**, the **Interim Feasibility Review** and a series of engineering and environmental field studies, three options for hydropower development of Allison Lake are presented in the present study as follows:

- **Alternative 1b** consisting of a weir at El 1365 and diversion tunnel from Allison Lake to the Solomon Gulch Reservoir in order to allow increased generation at the existing Solomon Gulch powerhouse. This alternative differs from the earlier studies in that it does not include the storage component as provided by the lake-tap proposed for **Alternative 1a.**
- **Alternative 3c** consisting of an independent development of Allison Lake including an dam that would raise Allison Lake to El 1410, an intake, power conduit and a new powerhouse near tidewater on Allison Creek.
- **Alternative 3d** consisting of an independent development of Allison Lake including an dam that would raise Allison Lake to El 1385, an intake, power conduit and a new powerhouse near tidewater on Allison Creek.

These three options are evaluated on the basis of their ability to contribute to the CVEA load, the potential cost of power and the environmental / regulatory issues associated with their development. All three options demonstrate technical and environmental feasibility. The report includes the recommendation that CVEA submit a FERC License Application for the project prior to the expiration of their existing FERC permit for the site. Further, it is recommended that outside sources of state and federal funding be sought for the project as a means to maximize the value of the project within the CVEA electric system.

We greatly appreciate the opportunity to work with you on this interesting project. If you have any questions regarding the subject report, be sure to give us a call.

Yours very truly,

A. Richard Griffith

A. Richard Griffith, P.E.
Project Manager

Table of Contents

Tables

Figures

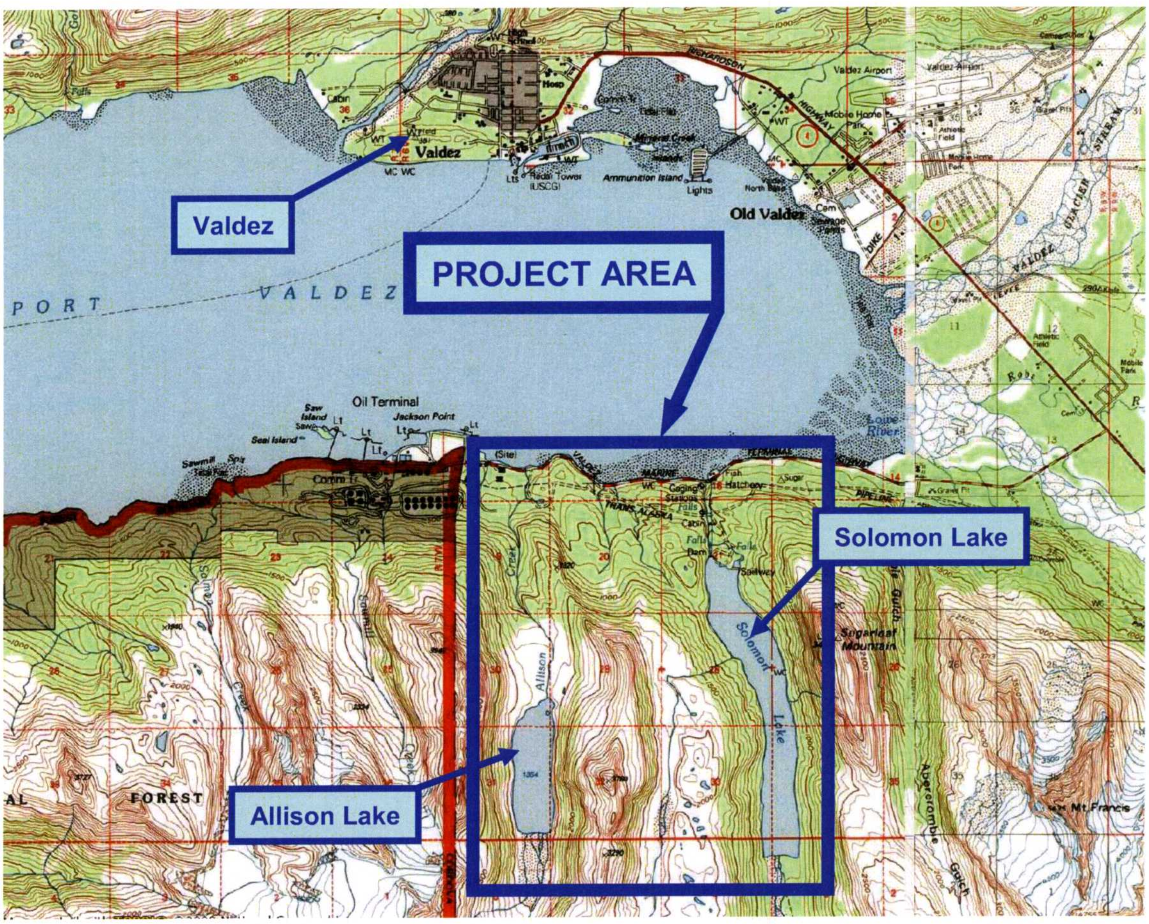
Appendices

1. Introduction

1.1 General

The purpose of this Final Feasibility Study is to evaluate the economic viability of alternative arrangements for the addition of the Allison Lake drainage to the generating resources within the existing Copper Valley Electric Association (CVEA) electric system. The Allison Lake Hydroelectric Project (Project) is located adjacent to Prince William Sound immediately south of Valdez, Alaska as shown in **Figure 1.1**.

Figure 1.1
Allison Lake Hydroelectric Project Location



Currently, CVEA's primary source of power is from the Solomon Gulch Hydroelectric Project, a 12-megawatt hydroelectric facility owned and operated by CVEA. Due to the seasonal pattern of the power production from this resource, CVEA must also rely on other resources during the winter months. Most important of these is a 5.2-megawatt cogeneration facility where exhaust heat is recovered and sold to and used by Petro Star for refining purposes. Diesel-fueled reciprocating gensets are also operated and maintained by CVEA for supplemental power requirements and for reserve purposes.

Although the Solomon Gulch Project operates year round, during winter months the Solomon Gulch Project operates at reduced levels and CVEA must rely heavily on the above listed fossil resources to meet system load. The objective for pursuing potential development of Allison Lake is to fill this gap with additional hydropower generation.

The scope of work leading to this Final Feasibility Study has included the following activities:

1. Data collection
2. Development of general arrangement details of alternative project arrangements consistent with the purposes of this study
3. Detailed engineering and environmental field investigations of the Allison Lake area
4. Analysis of Allison Lake hydrology and hydropower potential in relation to the existing Valdez electric system
5. Preliminary layout and cost estimate of hydroelectric project features for each of the identified project arrangements
6. Economic evaluation of the identified alternatives
7. Environmental review of the of the identified alternatives
8. Preparation of this Final Feasibility Report including the resulting conclusions and recommendations

1.2 General Arrangements Under Consideration

The three general arrangements reviewed as part of the present study include:

- Alternative 1 (**Alt 1**) would include an intake and diversion tunnel to the Solomon Gulch Reservoir in order to allow generation at the existing Solomon Gulch powerhouse during dry period conditions. **Alt 1** includes two optional configurations as described in the paragraphs that follow.

- Alternative 2 (**Alt 2**) would include an independent development of Allison Lake consisting of an intake, tunnel, power conduit and a new powerhouse near tidewater on Allison Creek.

- Alternative 3 (**Alt 3**) would also include an independent development of Allison Lake consisting of a low dam at the outlet of Allison Lake, an intake, a power conduit that includes a buried as well surface sections, and a new powerhouse near tidewater on Allison Creek. **Alt 3** includes three optional configurations as described in the paragraphs that follow.

The general arrangements for **Alt 1, Alt 2** and **Alt 3** are shown in **Figures 1.2, 1.3** and **1.4** respectively.

Figure 1.2
Alternative 1 General Arrangement

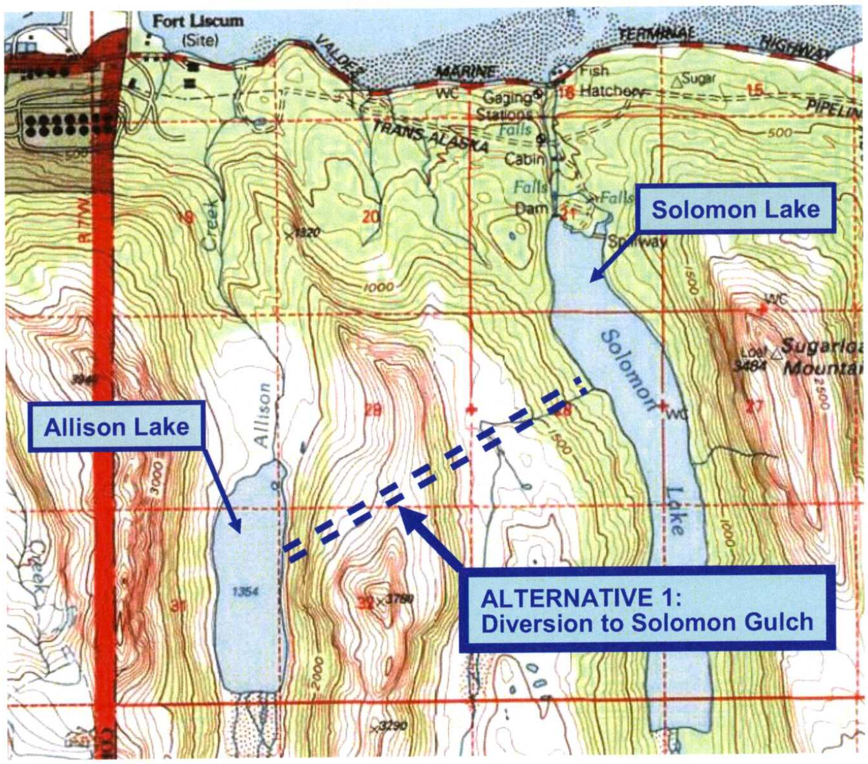


Figure 1.3
Alternative 2 General Arrangement

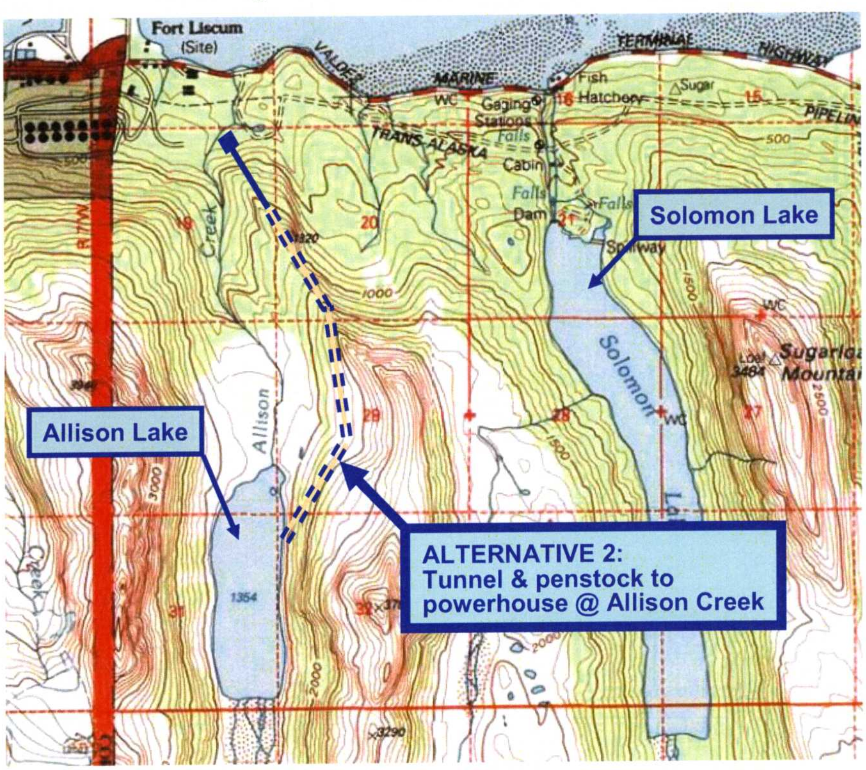
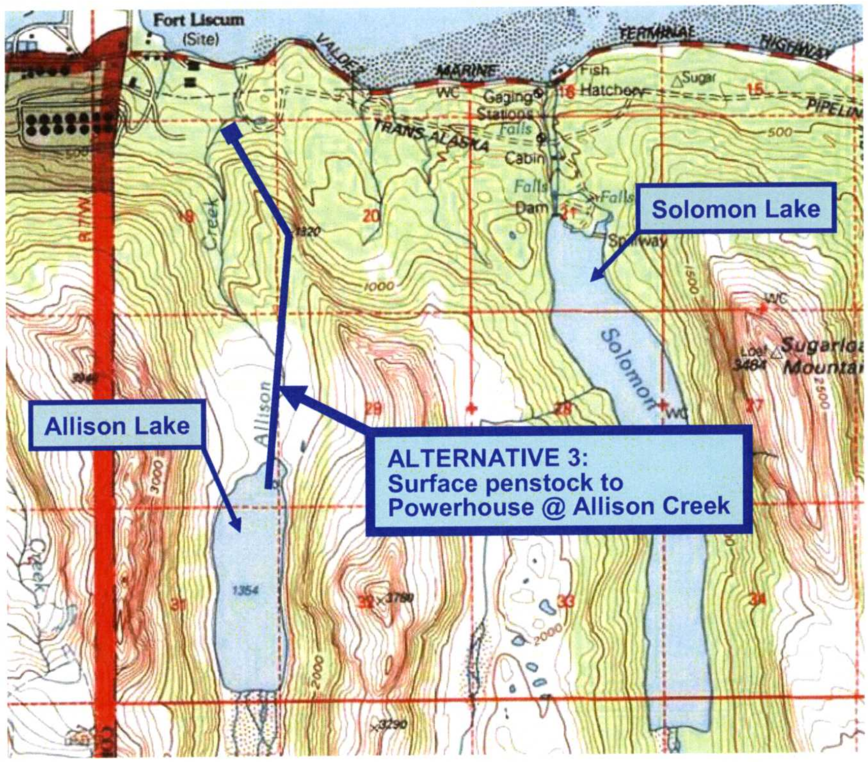


Figure 1.4
Alternative 3 General Arrangement



The details of and the options within each alternative are discussed further in the following sub-sections.

1.3 Alternative 1 – Allison Lake Diversion to Solomon Gulch Project, FERC P-2742 (Alt 1)

1.3.1 Alternative 1a

Under this scheme, the water from the Allison Lake would be diverted during the low-flow winter months to replenish the storage in Solomon Lake for hydro generation through the Solomon Gulch power plant at times when the hydro plant is under utilized or shut down due to lack of water. Then, when the Solomon Gulch Plant is normally at full output during the spring runoff, Allison Lake would be refilled.

Alt 1a would utilize a lake tap at El 1250 and a 36-inch conduit to divert water from Allison Lake to Solomon Gulch as shown in **Figure 1.5**. This plan would require a lake tap and rock traps, energy dissipating control valve and a concrete plug to protect the control valve. From the lake tap, the tunnel as shown in **Figure 1.6** would extend at a 3% grade for approximately 10,000 feet to Solomon Gulch.

Figure 1.5
Alt 1a and Alt 2 – Lake Tap

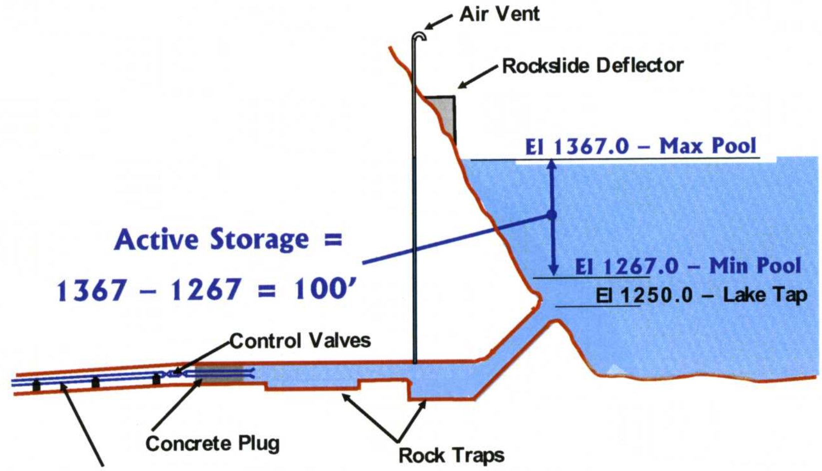
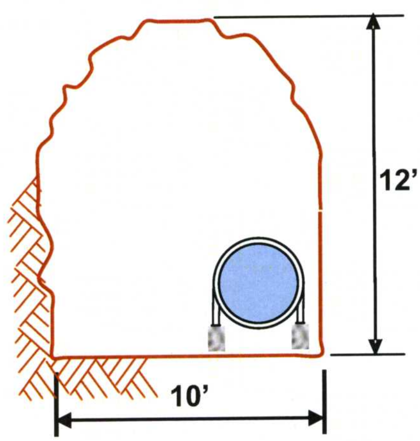


Figure 1.6
Alt 1a and Alt 2 – Tunnel and Pipeline



1.3.2 *Alternative 1b*

The concept for **Alt 1b** is a pure diversion of flow with minimal civil infrastructure at Allison Lake. The storage function of Allison Lake would be eliminated entirely. The tunnel discussed in Alternative 1a would be raised to El 1365. The lake tap, energy dissipating control valve and other control mechanisms would be eliminated to allow for free flow of water from Allison Lake to Solomon Gulch. Water volume would be controlled by way of two weirs at El 1365 and El 1370 with an additional small orifice to pass a minimum amount of flow down Allison Creek.

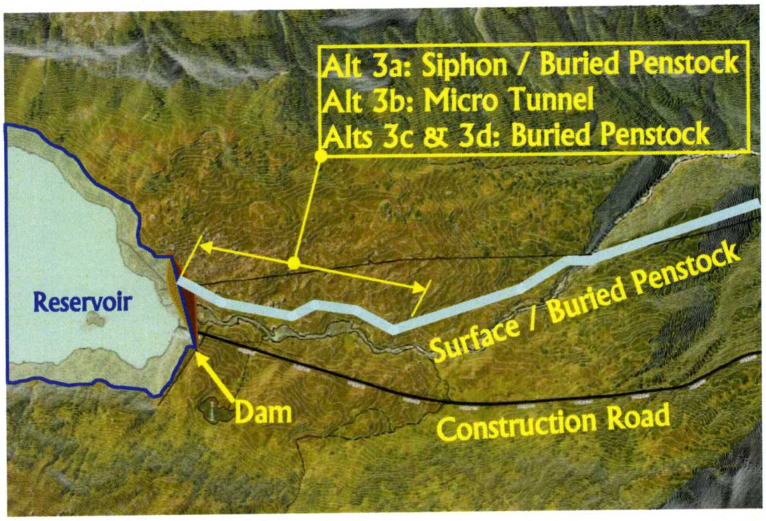
1.4 Alternative 2 – Allison Lake Tap with Powerhouse on Allison Creek (Alt 2)

Alt 2 would utilize a tunnel and penstock leading to a powerhouse located on Allison Creek at El 300. For this scheme, Drill & Blast (D&B) tunneling methods were considered. A D&B tunnel can be as small as a 10 foot by 12 foot horseshoe shape as shown in **Figure 1.6**, however, for this small of a tunnel hand tools will be required to drill each round of blast holes.

1.5 Alternative 3 – Allison Lake Intake with Powerhouse on Allison Creek (Alt 3)

The **Alt 3** group includes four sub-options for the surface / buried penstock configuration as shown in **Figure 1.7**. This group of alternatives makes use of a intake and a rockfill embankment dam that would develop lake storage within the upper portion of Allison Lake rather than all of the project storage being provided below El. 1364 as with the **Alt 1** and **Alt 2** alternatives.

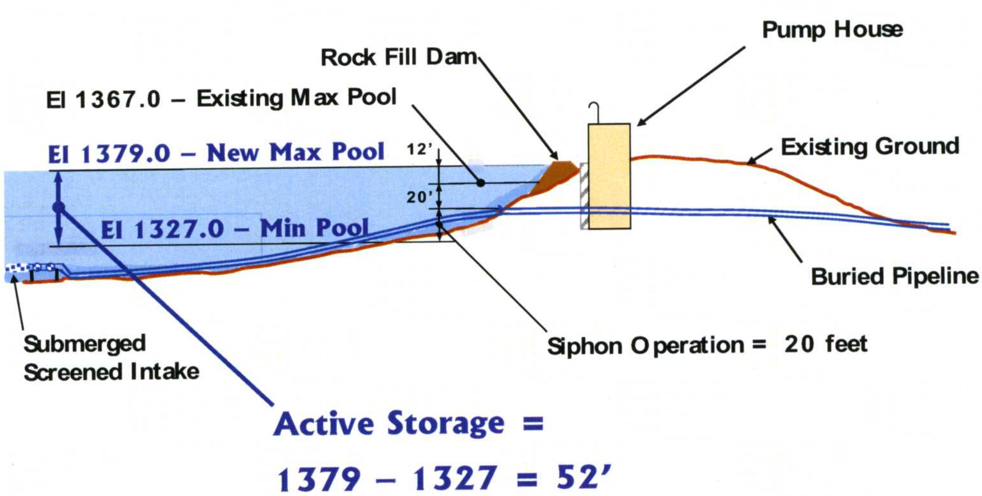
Figure 1.7
Alt 3 – Pipeline Options



1.5.1 *Alternative 3a*

Alt 3a utilizes a submerged screened siphon intake with a 30-foot high rock fill dam and pump house. With a maximum pool at El 1379 and minimum pool at El 1327, **Alt 3a** allows for 52 feet of active storage capacity as shown in **Figure 1.8**. To establish the maximum possible drawdown of the lake without the use of a tunnel, a deep trench about 24-feet below normal lake El. 1360 ft, would be excavated to the centerline of the proposed dam axis. This trench would then contain the siphon outlet pipe, which would then need to continue to the forebay pool to permit effective use of the siphon, once it has been primed by appropriate equipment. The siphon piping into the lake would need to be flexible piping, probably HDPE and extend about 330 feet out into the lake to a depth of about 1310 feet to permit lake drawdown to El. 1320 ft.

Figure 1.8
Alt 3a – Siphon Intake Facilities

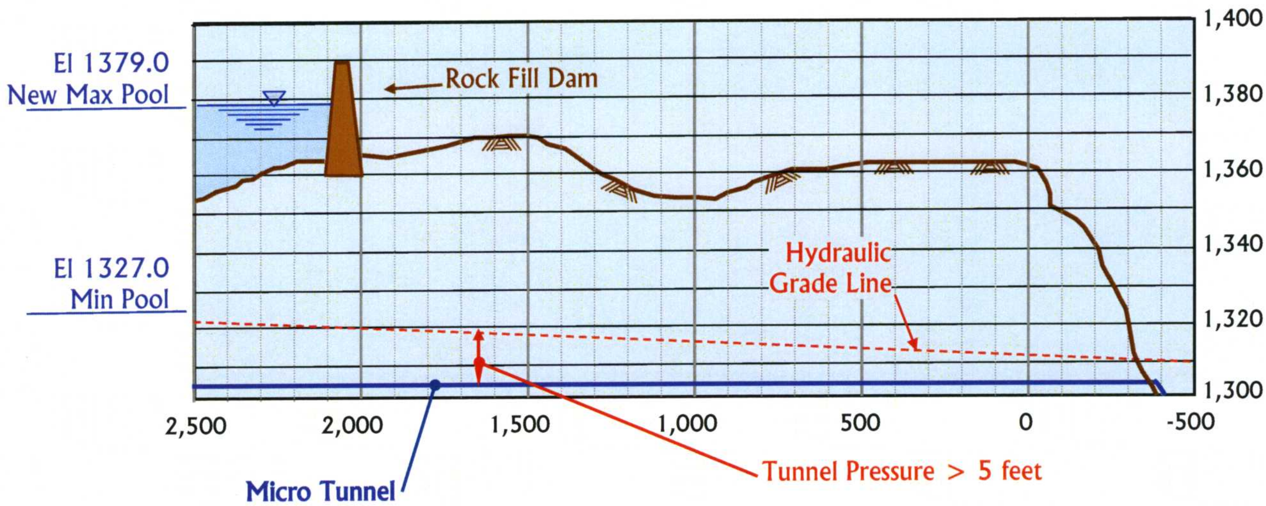


The first 2,000 feet of the siphon would be under negative pressure in the order of -25 feet due to the siphon running above the hydraulic grade line. From here, the penstock would continue downstream as a combination surface / buried arrangement until terminating at the powerhouse located at El 300 on Allison Creek. Trench excavation for the penstock would be in excess of 25 feet and pose significant construction challenges.

1.5.2 Alternative 3b

Alt 3b would utilize a micro tunnel and a 30-foot rock fill dam as shown in **Figure 1.9**. The surface / buried penstock and powerhouse would be located similarly to **Alt 3a**. The micro tunnel allows for construction of the tunnel at a greater depth than Alternative 3a and thus allows for positive pressure along the entire length of the penstock. With a maximum pool at El 1379 and a minimum pool at El 1327, Alternative 3b would provide 52 feet of active storage.

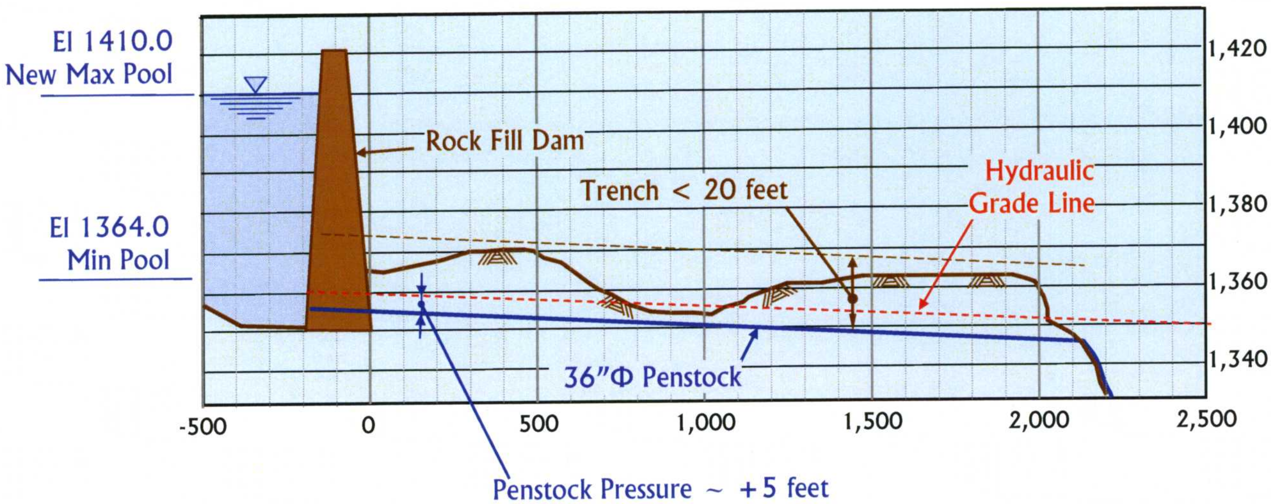
Figure 1.9
Alt 3b – Micro Tunnel



1.5.3 Alternative 3c

Alt 3c would utilize a 36-inch diameter surface / buried penstock with a 70-foot high rock fill dam at crest El 1420 as shown in **Figure 1.10**. The powerhouse would be located at El 300 with a capacity of 4 MW. With a maximum pool at El 1410 and minimum pool at El 1364, **Alt 3c** would allow for 46 feet of active storage. This alternative allows for reasonable trench excavation at depths of less than 20 feet. Due to the relatively low positive pressure in the penstock in the order of 5 feet of head, penstock pipe material could be made of either steel or HDPE.

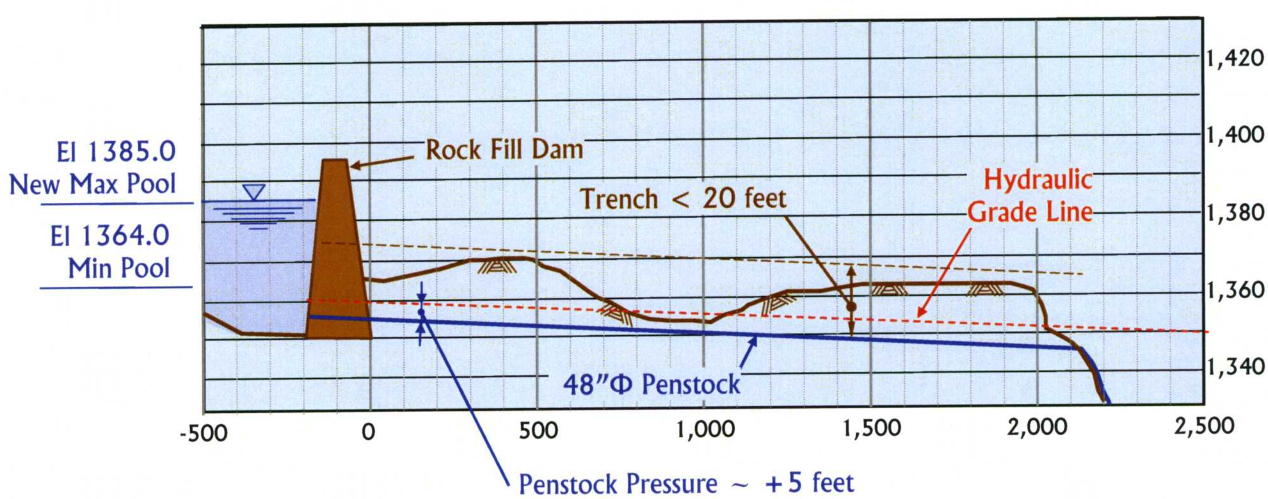
Figure 1.10
Alt 3c – High Dam with Buried Penstock



1.5.4 Alternative 3d

Alt 3d differs from **Alt 3c** in that the dam height is lowered to 45 feet as shown in **Figure 1.11** and the size of the powerhouse is increased from 4 MW to 6 MW. Alternative 3d utilizes a 48-inch diameter surface / buried penstock. Trench excavation depths and positive pressure along the penstock are both acceptable.

Figure 1.11
Alt 3d – Lower Dam with Buried Penstock



1.6 Previous Investigations

1.6.1 HDR Engineering, Inc. and Army Corps of Engineers

Previous investigations of the Project by HDR Engineering, Inc. (HDR) in 1992 and by the Army Corps of Engineers (COE) in 1982 evaluated potential project configurations for maximizing the

Allison Lake resource. In the HDR study, recommendations were made to develop a 12,000-ft-long tunnel and deep lake tap of Allison Lake for diversion to Solomon Lake. Under this project configuration, water could be diverted during the winter months for use through the Solomon Gulch turbine units in a manner comparable to **Alt 1a** as discussed above. In the COE study, which was completed prior to the construction of the Solomon Gulch Project, the COE recommended a stand alone hydro project similar to **Alt 2** as discussed above including a deep lake tap in Allison Lake and conveyance via tunnel and penstock to a powerhouse (8 MW) on Allison Creek at Tailwater El. 100 ft. More recently, a preliminary permit application was filed for a shallower lake tap on Allison Lake and siphon system feeding a buried / surface penstock leading to a downsized powerhouse (5 MW) on Allison Creek at Tailwater El. 150 ft, this arrangement being similar to **Alt 3a**.

1.6.2 Hatch Acres Corporation – Pre-Feasibility Study (2007)

In the fall of 2007, CVEA authorized Hatch Acres Corporation (Hatch Acres) to perform a pre-feasibility level review of the hydroelectric potential of the Allison Lake drainage basin.
The primary activities of the pre-feasibility study included the following:

- A reconnaissance review of the project site,
- identification of three potential physical means to develop the hydropower potential of Allison Lake,
- an evaluation of the power production capability of the selected arrangements,
- cost estimates of each arrangement leading to the cost of power there from and
- an evaluation of the environmental and regulatory issues involved with each arrangement.

The three potential configurations considered in the 2007 review included:

- A lake tap and tunnel diversion of Allison Lake inflow to the existing Solomon Gulch Reservoir, referred to as **Alt 1a** herein.
- A lake tap and tunnel / penstock connecting to a new powerhouse on Allison Creek, referred to as **Alt 2** herein.
- A low dam and siphon intake with an above ground penstock connecting to a new powerhouse on Allison Creek, referred to as **Alt 3a** herein.

The results of the study were included in a Pre-Feasibility Study report dated February 2008. The conclusions and recommendations resulting from study are included below.

1.6.2.1 Conclusions

The conclusions gained from the studies included:

- *"The three project configurations studied all have the appearance of being technically feasible. Arguments can be made on behalf of any of the three as" being the best in this regard, the truth is yet to be determined through detailed on the ground geotechnical investigations.*
- *The three project configurations would all appear to deliver power to the CVEA at a cost less than the current cost of fossil generation on the basis of reasonably conservative assumptions for construction cost estimating and financing arrangements.*
- *All three configurations would benefit greatly from grant monies from the state or more attractive financing arrangements as provided for under the recently enacted Federal Energy Act.*
- *Uncertainties exist in the area of environmental and regulatory process for each of the three arrangements as follows:*
    - ***Alt 1** involves an amendment to the existing license for the Solomon Gulch Project. The Amendment would be a Capacity Amendment and would potentially open the terms of the existing license. Issues of concern include:*
        - *Concerns raised by the Valdez Fisheries Development Association (VDFA) regarding interest in increasing the current minimum flow release from 2 cfs*

to 12 cfs and potential impacts on the hatchery from trans-basin delivery of water from Allison Lake affecting hatchery operations;

- o *potential for the resource agencies to request an increase in the minimum flow release and/or to require better management of the release given the history of interruptions in delivery of the current 2 cfs release requirement; and,*
- o *potential for interested participants to request increased recreational access and related improvements to the trail system. The VFDA raised issues related to the minimum flow release in the previous license transfer proceedings. If **Alt 1** is selected, CVEA should consider how to address these concerns given the proposed divestiture of the FDPPA and transfer of the Solomon Gulch license to CVEA.*

- ***Alt 2** and **Alt 3** would introduce a drawdown in the current lake level at Allison Lake and reduce the current flow from Allison Lake to Allison Creek and tidewater.*
- ***Alt 2**, the lake tap, would have the most significant drawdown of the Lake and the release to Allison Creek may require pumping from the lake to a release to the Creek.*
- ***Alt 3**, the siphon intake arrangement would have the most visual and terrestrial impact to the area owing to the surface conduit arrangement."*

1.6.2.2 Recommendations

Based on the conclusions outlined above, the Pre-Feasibility Study included the following recommendations:

- *"Of three alternatives considered in this study, Alternative 2, the proposed lake tap and tunnel/penstock with a new powerhouse on Allison Creek, appears to provide the greater long-term benefit to the CVEA system. However, to preserve any of the three options for further investigation, we recommend that CVEA prepare an application for preliminary permit for Allison Lake including the three alternatives stated in this report. CVEA's Application for Preliminary Permit should be filed at the earliest date possible following expiration of the permit in effect to Green Power.*
- *During the first six-month period of the three-year preliminary permit term, narrow the range of alternatives to focus on the "best fit" to meet CVEA's future demand for electric power.*
- *Consult with the VFDA, ADF&G, NMFS, USFWS, and the Alaska Department of Natural Resources (ADNR) water resources, land management and State Historic Preservation Officer in preparing its Application for Preliminary Permit. The Application for Preliminary Permit requires a detailed Work Plan be prepared and filed with the Application. These resource agencies and the hatchery will shape the studies program to be conducted under the terms of the Preliminary Permit.*
- *Request approval to use the Alternative Licensing Process (ALP) instead of the required default Integrated Licensing Process (ILP). The ALP allows greater flexibility in scheduling activities and conducting studies. The ILP is better suited to a relicensing where issues are related to continuing project operations".*

1.6.3 Hatch Acres Corporation – Interim Feasibility Review (2009)

Based on the results and recommendations within the 2007 Pre-Feasibility Study, a study plan for the summer season of 2008 was developed and implemented including the following:

- Topographic Mapping
- Geologic Mapping
- Seismic Refraction
- Construction Road Alignment Alternatives
- Stream Gage Installation (2 locations)
- Resource Agency Consultation
- Environmental Studies
  - Fish and Habitat
  - Water Quality
  - Kittlitz's Murrelet

- Mountain Goats
- Literature Review & Information Gap Analysis

Details of the 2008 engineering and environmental studies are included in **Sections 2 and 5** herein respectively. The findings, conclusions and recommendations resulting from the 2008 study program were presented to the CVEA during meetings on May 21, 2009. The set of PowerPoint Slides used to facilitate these presentations are included in **Appendix A.**

The focus of the Interim Feasibility Review was on **Alt 2**, **Alt 3a**, **Alt 3b** and **Alt 3c**. **Alt 3b** and **Alt 3c** were added to the study following concerns raised by CVEA over the reliability of the siphon operation arrangement for **Alt 3a**, particularly during the heavy snow conditions during the winter. **Alt 1b** and **Alt 3d** had not as yet been identified for study at the time of the of the Interim Feasibility Review. Conclusions reached for each of the alternatives under consideration at the time of the Interim Feasibility Review were as follows:

- **Alt 1a** was removed from further consideration on the basis of its high cost in combination with issues associated with the FERC License Amendment that would be required for the Solomon Gulch Project.
- With respect to **Alt 2,** the following conclusions were presented:
  - *Drill & Blast is a feasible method to construct the Allison Lake tunnel at a minimum cost of $2,000 per foot (2008 dollars).*
  - *A TBM-driven tunnel is a feasible method to construct the Allison Lake tunnel at a minimum cost of $2,500 per foot (2008 dollars).*
  - *The expected glacial morainal conditions in the lake bottom are unprecedented for lake tap construction and present an unacceptable risk to both the construction cost and reliable long-term operation.*

  Accordingly, **Alt 2** was removed from further consideration
- **Alt 3a** was removed from further consideration due to the following:
  - *The depth of excavation required for the penstock downstream of the outlet of Allison Lake.*
  - *The 2000 feet of the penstock under negative pressure with the siphon arrangement.*
  - *The accessibility of the siphon and penstock during winter conditions for maintenance or repair.*
- With respect to **Alt 3b**, the following conclusion was presented:
  - *A Microtunnel Boring Machine is an unfeasible method to construct an upper Allison Lake tunnel.*

  Accordingly, **Alt 3b** was likewise removed from further consideration.

Alt 3c, then, became the "Preferred Alternative" and was reviewed in more detail for the purposes of the present Final Feasibility Study pursuant to the results of the 2009 field study program, which included a focus on:

- Core Drilling
- Liquifaction
- Seepage
- Avalanche Hazard

General arrangement drawings for **Alt 3c** are included in **Appendix C**.

During the course of the review of **Alt 3c**, **Alt 1b** and **Alt 3d** were identified as technically feasible arrangements that could significantly reduce the capital cost of the project. These three alternatives remain as the focus of this Final Feasibility Report.

2. Engineering Field Investigations

2.1 Topographic Surveys

Topographic mapping for the project area from the outlet of Allison Lake to tidewater of Port Valdez was prepared using aerial photography and on the ground mapping control. Mapping control is based on the field survey performed by R&M in September, 2008.

Horizontal control for the field survey referenced NAD83(2007) Alaska State Plane Zone 3, U.S. Survey Feet values, based on GPS static ties to National Geodetic Survey (NGS) station POWER (PID no. UV3926). Geophone locations from the seismic refraction survey were surveyed using GPS RTK (Real-time Kinematic) controlled by broadcasts from project control. Vertical control for the topographic mapping references vertical datum NAVD88(GEOID06), based on GPS Static ties to NGS station POWER (PID no. UV3926). The NAVD88(GEOID06) elevation for NGS station POWER is 9.19 feet.

Aerial photograph-based mapping was provided by AeroMetric-Anchorage, using photography acquired on 28 August 2007 at a nominal scale of one inch equals 2,000 feet. The aerial photography was used to produce a digital elevation model (DEM) tied to R&M's field survey. The result was a topographic map in AutoCAD format with a contour interval of ten feet. The resulting topographic mapping is illustrated in **Appendix C.1**.

2.2 Stream Gage Monitoring Program

FERC regulations require at least two field seasons of data collection to support an Application for License. To fulfill these requirements the Allison Creek hydrology study was designed to meet two objectives:

1. Obtain a continuous record of stage and discharge on Allison Creek, and develop a flow-duration curve to display the relationship between stream flow and the percentage of time it is exceeded at two locations.
2. Describe Allison Lake/Creek watershed hydrologic regime, including tributary streams, source and seasonal variation of inflow, and identification of streams and water bodies that may be affected by construction and operation of the proposed project.

The study was performed by R&M Consultants, Inc. as a subconsultant to Hatch Acres and is fully described in the report entitled "Interim Report: 2008-2009 Water Use Study Allison Lake Hydroelectric Project", dated April 1, 2010, included herein as **Appendix C.2**. A summary thereof is included below.

The first phase of the hydrology study established stream gauges at two locations on Allison Creek. One gauging station was located at the lower end of Allison Creek near the proposed powerhouse site, and the other near the outlet of Allison Lake. An existing gauging station was located approximately 1,000 meters downstream from the lake outflow. A continuous record of stage is obtained by installing instruments that sense and record the water-surface elevation in the stream. Discharge measurements are then made periodically, to establish a stage-discharge relation and develop the discharge rating curve.

At each gaging station a pressure transducer/data logger instrument was installed. The pressure transducer was mounted inside a protective stilling well, which was anchored in the channel at a suitable location (stable bed and banks). Following the station installation, a channel cross-section was surveyed, and an arbitrary gage elevation was established, using a survey benchmark. The channel energy gradient was also surveyed both upstream and downstream of the gauging station. Lastly, a discharge measurement was taken at the gage station, using a wading rod and current meter.

In order to develop rating curves for each station, additional discharge measurements were required at various flow rates. Two discharge measurements were made at each gauging station during high water conditions in late summer. High water conditions were monitored by observing real-time discharge information from the adjacent USGS gauging station at Solomon Gulch, and from local reports. Though all efforts were made to complete discharge measurements at high flow, some locations and high flow levels presented difficult or unsafe conditions for wading. Therefore, a fluorescent dye tracer system was used for measuring discharge at high flow levels. A discrete amount of tracer was poured or injected into the stream over a short time period. At the downstream measurement site, the concentration was measured continuously with a calibrated fluorometer, from the first arrival of tracer until all had passed. The determination of the concentration of the entire dye cloud allowed for the computation of the stream discharge.

Based on the rating curve, the average daily discharge for December through April at Lower Allison Creek varies between 18 and 25 cubic feet per second (cfs). However, the historic average daily discharge for winter months at Solomon Gulch is much less; it varies between 10 and 15 cfs for the same winter period, even though the Solomon Gulch watershed (19.7 sq miles) is larger than the Allison Creek watershed (7.4 sq miles). Variations in local geology and groundwater seepage may be responsible for larger winter base flows in the Allison Creek watershed. Until additional winter discharge measurements are conducted to validate or modify the rating curve, the estimated discharge values during the winter months should be considered provisional and subject to change.

Previously recorded stream gage data gathered by Green Power Development (GPD) under a Preliminary Permit from FERC was also reviewed. Prior to recent and current interest, the U.S. Army Corps of Engineers studied the hydropower potential of Allison Lake in the late 1970's and early 1980's. This effort culminated in a document entitled "Electrical Power for Valdez and the Copper River Basin: Interim Feasibility Report and Final Environmental Impact Statement", published in March 1981 (USACE, 1981). This data was also reviewed.

At this time, the results of the stream gauging activities should be considered inconclusive. It is recommended that data collection be continued until a minimum of three years worth of readings have been obtained before any firm conclusions can be drawn.

2.3 Access Road Alignment

The preliminary design of a temporary construction access road for the proposed hydroelectric project at Allison Lake was developed using aerial photography and mapping. The study was performed by R&M Consultants, Inc. as a subconsultant to Hatch Acres and is fully described in a technical memorandum entitled "Allison Lake Concept Design (Temporary Construction Road)", dated April, 2009, included herein as **Appendix C.2**. A summary thereof is included below.

The goal was to identify the most feasible road alignment that allows for wheeled vehicles – such as pickup trucks and semi trucks with flat bed trailers – to travel along the project corridor for the purposes of moving equipment and materials to construct the proposed hydroelectric project. The project area is mountainous with very steep rocky grades rising 1,100 vertical feet from the powerhouse to the top of the first peak, a horizontal distance of approximately 3,000 feet. From this point to the outlet of the lake, a distance of approximately 6,000 feet, the grades are flatter but the ground is uneven due to intermittent drainages and large rocks projecting from the silty soils.

Several alignment alternatives were initially developed based on aerial photography and 100′ contour interval mapping. It was assumed that the temporary seasonal road would be constructed during the first half of the summer season and used to access the site that same year. Some cleanup due to sloughing slopes and erosion during spring break up would be expected prior to using the road during the following season. The final intended use, winter use, or decommissioning of the road has not been determined at this time.

It is anticipated that the construction in steep rocky areas will require significant rock blasting. Excess rock material will be generated to maintain reasonable grades and construct switch-back curves. The design uses this excess material ahead on the project to fill and smooth out uneven terrain along the remaining alignment, and to minimize excavation. Approximately one-half of the project is heavily covered with brush and some trees. It is assumed that this vegetative waste and any usable soils encountered would be placed within the footprint of the project.

The following roadway design criteria are for a low speed, one-way road with restricted access. Widths, grades and slopes are based on a combination of published highway, forestry, and mining road design criteria and guidelines as listed in **Table 2.1**.

Table 2.1
Roadway Design Criteria

Item	Criteria	Source
Design Vehicle	WB 50 semi-trailer (40′ flat bed trailer)	AASHTO 2004 (Ex2-14)
Design Speed	Varies ≤ 25 MPH	FSH 7709.56 (Sec. 4.25)
Roadway Width	16 ft. plus curve widening and turnouts	BOM (Table 9)
Grades	8% desirable, 20% maximum for short distances 5% maximum on switchback curves 9% maximum before & after switchback curves	BOM (Pg 11) FSH 7709.56 (Sec. 4.32) FSH 7709.56 (Sec. 4.32)
Curve Radius	50 ft minimum	ORDOF 2006 (Pg 3-6)
Embankment	Temporary life	
Side Slopes	Fill – 2:1 Cut – 1:1 in soil & .05:1 in rock	ORDOF 2006 (Table 3) & R&M Consultants

The preferred alignment would begin at an intersection with the existing Trans-Alaska Pipeline road and would be approximately 3.0 miles in length. This route would climb a 2.5:1 mountain slope to the plateau area in one continuous network of switch-back curves located on the rocky seaward face of the first mountain. Excavation would be located in what appear to be more stable rock slopes. Excess material could be used as fill in areas of less stable soils to minimize excavations in those areas. Since this route gains elevation more rapidly, it will cross natural drainages closer to the headwater so there will be less water, lessening the need for erosion protection.

The typical section for the road would have a 16-foot top width that is intended to function as a one-way temporary road. Switch-back curves should be widened to 25 feet or more and extend back to provide turn out space to accommodate approaching traffic. Additional turn outs or widened areas should be provided at inter-visible locations. A 20-inch thick layer of 3-inch minus material has been included to place on top of the shot rock for a driving surface. Geotextile fabric can be placed under the base course and over natural ground to provide separation and facilitate construction activities.

A rough order of magnitude construction cost estimate based on limited information calculated the construction cost for the road at $5,000,000. Costs are developed from unit prices and preliminary estimates for excavation, fill, imported surfacing material, and drainage quantities. A contingency has been included. Final design and construction engineering and administration are not included. Further field investigations should be conducted to better define soil conditions and verify construction costs. Rock and common excavation cost includes placing the material as embankment.

Constructing an access road to Allison Lake would indeed be very challenging due to the sheer steepness of the mountainous terrain. Of those alignments considered, the above described alignment has been recommended as the "preferred alignment" for the following reasons:

1. Shortest length
2. Avoids most of what appears to be unstable or questionable soils
3. Minimizes drainage crossings
4. Generates excess (shot rock) material to be used as fill in the uneven terrain.

2.4 Avalanche Hazard Study

An avalanche hazard assessment was conducted to assess the potential for snow avalanches to occur in the project area. The study was performed by Alaska Mountain Safety Center, Inc., which is fully described in the report entitled "The Allison Lake Hydro Project Snow Avalanche Hazard Evaluation And Mapping Study", dated June 16, 2009, included herein as **Appendix B.4**. A summary thereof is included below.

The avalanche study area encompasses approximately 3.5 square miles of avalanche terrain containing 114 major avalanche paths. Study of the area was complicated by a lack of onsite snow, weather, and avalanche data. Many assumptions had to be based upon nearest neighbor data sources and empirical evidence supported by modeling.

Despite the fact that the avalanche exposure in the Allison Lake drainage is extensive, the overall project appears well designed to avoid avalanche risk where possible. Two factors would dramatically increase the risk: a) extending the construction season from summer into winter or spring months when avalanches are prevalent, and b), excessive removal of vegetative ground cover (primarily alders) on steep slopes. This vegetation anchors the snowpack to the ground and is the least expensive, most abundant, and easiest mitigation available.

The entire proposed hydro project infrastructure is affected by avalanches to some degree, but in most cases the risk is manageable and infrequent. The proposed access road to the dam traverses numerous small avalanche paths and crosses the runout of several larger ones near the dam site. Though posing no risk in summer, this is not the case in winter. The projected dam site is also exposed — very infrequently — to potential runout from a large avalanche event. If hit, the dam would be unaffected, but the valve house could be damaged if the hazard is not mitigated with structural protection. Realignment, burying the pipe, or structural protection would reduce the risk of possible damage.

2.5 Penstock / Tunnelling – Feasibility and Costs

The conduit system for **Alt 1 & Alt 2** arrangements considered as part of the proposed Allison Lake Hydroelectric project calls for the use of a diversion tunnel under the ridge separating Allison Lake and the Solomon Gulch Reservoir. Three tunneling methods for construction were considered by the Hatch Mott McDonald Group as discussed in their memorandum entitled "Assessment of feasibility and cost to construction penstock tunnel", dated March 31, 2009, included herein as **Appendix C.5**. A summary thereof is included below.

2.5.1 Drill And Blast Tunneling

The first tunneling method considered was Drill & Blast (D&B). The D&B tunnel can be as small as a 10 foot by 10 foot horseshoe shape, however, for this small of a tunnel hand tools will be required to drill each round of blast holes. Similarly, all other activities necessary to construct a small D&B tunnel will require smaller equipment with lower productivity rates. Consequently, D&B construction costs for the minimum size tunnel can be equal to or greater that the cost of a larger, more efficiently constructed, D&B tunnel.

A D&B operation can be mobilized quickly and supported by either access road or helicopters. Helicopter support was the approach utilized for the recently completed Lake Dorothy Hydroelectric Project in southeast Alaska. However, helicopter-supported construction has a significant cost premium and a higher risk of weather delays.

Cost estimates for D&B tunnel construction can vary significantly and are dependent on crew size and experience, equipment costs, and market conditions. Upon review of recent construction costs for Lake Dorothy and using current labor and equipment rates, it is estimated that a 10-12 ft by 10-12 ft D&B tunnel supported by either access road or helicopter would cost a minimum of $2,000 per foot to construct at this site. The D&B tunnel is considered a feasible option.

2.5.2 Tunnel Boring Machine (TBM)

The second tunneling method considered requires a TBM-driven tunnel constructed from an access road midway to Allison Lake. This method is considered feasible but has the following significant constructability issues. TBM mobilization can require 20 to 30 semi-truck loads of equipment components and materials and the heaviest components require special multi-axle semi trucks that warrant consideration of roadway geometry and load restrictions. Staging, assembly, and launching a TBM requires a substantial yard area at the tunnel portal. TBM drives are typically supported by a railroad constructed in the tunnel to move spoil out and supplies in. A spoil dump and load out station are required to transfer the spoil to trucks for hauling to the disposal site. All of the above issues, as well as the need for maintenance shops and material stockpiles, make a TBM portal located in the middle of a steep slope midway through a series of access road switchbacks problematic.

2.5.3 Microtunnel Boring Machine (MTBM)

A third tunneling method would require a MTBM to construct an upper 4,000-foot long tunnel in two drives from a centrally located launch shaft. The first drive would be towards Allison Lake with a wet retrieval of the MTBM. The second drive would be towards a drop shaft site that connects to a lower rock tunnel. The subsurface conditions along the microtunnel alignment have not been explored with borings or trenches. Geophysical refraction surveys completed as part of the reconnaissance investigation indicate thick soils that range from 40 to more than 100 feet in thickness that overlay bedrock. Field reconnaissance by Hatch Energy identified numerous very large blocks of rock (greater than 1,000 cubic feet in volume) randomly scattered along the upper tunnel alignment.

Specially equipped MTBMs are capable of advancing through boulders at a reduced rate with increased wear on the cutting tools. Though it is technically feasible to drive a MTBM through large boulders, an unknown number of very large blocks of rock at random locations along the microtunnel alignment represents a significant risk to the successful completion of the drives. A worst case scenario for the MTBM drives would include unexpectedly encountering one or more very large blocks of rock that would necessitate either construction of temporary access roads and rescue shafts to recover and re-launch the MTBM or abandonment of the MTBM and completing the tunnel by conventional methods. In either case, cost and construction schedule could easily double. Therefore, the risk of encountering multiple very large blocks of rock represents a fatal flaw to the concept of microtunneling an upper tunnel for the Allison Lake Hydropower Project.

2.5.4 *Conclusions*

The conclusions resulting for the above described review include the following:

- Drill & Blast is a feasible method to construct the Allison Lake tunnel.
- A Drill &Blast tunnel constructed at this site would cost a minimum of $2,000 per foot.
- A TBM-driven tunnel is a feasible method to construct the Allison Lake tunnel.
- A TBM-driven tunnel constructed at this site would cost a minimum of $2,500 per foot.
- A Microtunnel Boring Machine is an unfeasible method to construct an upper Allison Lake tunnel.
- A soil lake-bed is considered to constitute a fatal flaw to the use of a lake tap as a tunnel intake.

2.6 Geotechnical Program

Allison Lake is located at an elevation of approximately 1,365 ft on the south side of the fjord of Port Valdez, and approximately 2 miles inland. Over the first 2,000 ft downstream of the lake outlet, Allison Creek drops in elevation to about El. 1,300 ft. Between approximately 2,000 ft and 3,000 ft downstream from the lake, Allison Creek drops from El. 1,300 ft to El. 1,200 ft, after which the creek descends the steep side of Port Valdez fjord to tidewater.

A program of geotechnical work was carried out in 2008 and 2009 by R&M Consultants, Inc. The geotechnical investigation program included:

- Geological mapping of the area of the Project
- Seismic refraction survey profiles taken across the lake outlet and along the valley bottom downstream from the lake.
- Drilling of six exploratory boreholes, consisting of one on either side of the creek at the lake outlet, one on either side of the creek on the upstream side of the proposed dam, and two on the valley floor approximately 1,200 ft and 2,200 ft downstream of the dam axis. The depth of the test borings ranged from 52.2 ft to 122 ft.

2.6.1 *Regional Geology*

Reference is made to the description of regional geology to be found in the report for the Four Dam Pool Power Agency, entitled "Solomon Gulch Hydroelectric Project, Supporting Technical Information (STI) Document" dated January 2008. That report drew upon information from the 2002 P12D Report, Section 4, and from an initial geology report for Solomon Gulch entitled "Geology and Foundation Investigations.

The geology of the area is characterized by its glacial and tectonic history. The regional bedrock is reported to be part of the Valdez Group, consisting of late Cretaceous marine sedimentary and metasedimentary rocks, which in the area of the site consist predominantly of graywacke, with lesser amounts of argillite and slate. On a regional scale, the bedrock is reported to occur in thin beds that dip steeply to the north and are strongly jointed, folded and extensively faulted. In the Allison-

Sawmill Creeks area, intercalated and interlayered metagraywacke and phyllitic argillite are reported to dominate the bedrock lithology.

2.6.2 *Seismicity*

Allison Lake is situated in a region of very active seismicity, primarily associated with the Pacific Plate moving north-northwesterly at about 45 to 50 mm/year, and subducting under the North American Plate. Known earthquake sources capable of producing strong ground motions at the project site include the Aleutian megathrust, the Wadati-Benioff zone, the Yakataga subduction and transition fault, the Kayak Island, Heney and Ragged Mountain faults, and possibly other less well known faults. The project area is less than 60 miles from the epicenter of the 1964 Great Alaska Earthquake, which was M9.2.

An evaluation of seismicity for the nearby Solomon Gulch Dam, reported in January 2008, recommended peak accelerations for rock foundations of 0.5g and 0.24g for the Safety Evaluation Earthquake and the Operating Basis Earthquake respectively. The bedrock accelerations at Allison Lake will not be significantly different. However, whereas Solomon Gulch Dam is founded on firm bedrock, the dam, spillway and penstock of the Allison Lake Project would be founded on a deep soil deposit. The effect of the soil foundation is that the bedrock accelerations will be amplified, producing greater accelerations at the ground surface.

2.6.3 *Geological Mapping*

2.6.3.1 *Description*

As part of a geotechnical reconnaissance investigation, geological mapping of the project area was undertaken by R&M Consultants Inc. in September 2008, using color aerial photographs, helicopter reconnaissance and field traverses. The investigation is fully described in the report entitled "Geotechnical Reconnaissance Investigation – Allison Lake Hydroelectric Project", dated April 1, 2009, included herein as **Appendix C.6**.

The surficial geology was mapped in terms of terrain units, and the interpretations were verified by drilling investigations, helicopter reconnaissance, and field traverses. In addition to mapping the surface geology, bedrock structures were mapped and measured to determine the rock mass quality and discontinuity characteristics. The mapping was recorded on a mosaic of aerial photographs.

2.6.3.2 *Findings*

The findings of the aerial photograph interpretation are to be found on figures in Appendix A of the above referenced report.

Glaciation has shaped the topography in the project area. The Allison Creek valley between Allison Lake and the steep wall of the Port Valdez fjord is covered by moraine and outwash deposits. The ground surface is hummocky and is littered with glacial erratic boulders. The areal density of large angular boulders is quite remarkable in the first 1,000 ft downstream from the lake outlet.

At the south (inlet) end of Allison Lake, the valley floor consists of glaciofluvial deposits. The east and west shores of the lake are mapped mainly as inactive talus slopes, with occasional alluvial fans where there are natural drainage gullies.

Allison Lake has been formed by a terminal moraine deposit that created a natural dam on Allison Creek. From the lake outlet, Allison creek occupies a broad flat U-shaped valley that extends for approximately 3,000 ft, after which the valley shape transitions to V-shaped and Allison Creek begins its rapid descent to the ocean. The depth of the moraine in the vicinity of the lake outlet is not precisely known. The moraine is described as unsorted, non-stratified, coarse to fine, angular rubble, with large angular erratics up to 20 ft or more in size dispersed throughout the deposit.

The steep portion of the Allison Creek valley has been mapped as covered by colluvium. Where the creek approaches the ocean, the ground is covered by alluvial fan deposits and fill.

2.6.4 *Geophysical Surveys*

2.6.4.1 *Description*

In September 2008, R&M Consultants Inc. carried out a series of seismic refraction profile surveys as described in the report entitled "Seismic Refraction Survey – Allison Lake Hydroelectric Project", dated April 1, 2009, included herein as **Appendix C.7**.

Lines 1, 2 and 3 join to give a profile across the valley at the outlet to Allison Lake. Lines 4 and 5 combine to give a profile approximately 5,000 ft in length along the valley from the lake outlet to the top of the steep slope of the fjord.

2.6.4.2 *Findings*

The results have been plotted in terms of contours of seismic velocity. They are interpreted to indicate an upper zone of poorly consolidated soil deposits, with more dense soil below. The lowest layer has seismic velocities that may indicate the presence of dense till. There were no distinct signals that would confidently indicate the presence of bedrock within 200 ft of the ground surface. The interpretation of the geophysical profile is doubtless hampered by the number of very large boulders that are present within the moraine.

The results are presented as three contours of P-wave velocity, namely 2,500, 4,500 and 6,500 ft/s. For comparison, seismic refraction profiling performed at Solomon Gulch, where the bedrock is exposed and is believed to be quite similar in quality to the buried bedrock at Allison Lake, gave much higher seismic velocities. At Solomon Gulch the reported seismic velocities were 14,500 to 17,500 ft/s in very hard rock, 11,500 to 13,200 ft/s for fine grained slate interbedded with argillite, and 8,500 to 9,700 ft/s for the weakest slates and argillites. Thus it is concluded that the materials with the greatest seismic velocities at Allison Lake are dense soil and dense soil with boulders.

2.6.5 *Borehole Drilling Program*

The program of geotechnical work carried out in 2009 by R&M Consultants, Inc. is described in the report entitled "Preliminary Geotechnical Investigation, Allison Lake Hydroelectric Project", dated March 26, 2010, included herein as **Appendix C.8**. A summary thereof is included below.

2.6.5.1 *Description*

Three test borings were made by the U.S. Army Corps of Engineers (COE) in September-October 1978, and six were made by R&M Consultants Inc. in July 2009. The locations of these nine holes are shown on Drawing A-01 in Appendix A of the report entitled "Preliminary Geotechnical Investigation Allison Lake Hydroelectric Project", dated March 26, 2010, by R&M Consultants Inc., which contains details of the 2009 campaign of field investigations and testing.

Of the 1978 USACE Drillholes, DH-1 was located in the area of a proposed lake tap and diversion tunnel, and DH-3 was located in the area formerly proposed for the powerhouse. Drillhole DH-2 was located roughly midway between Drillholes DH-1 and DH-3. The purpose of Drillhole DH-2 was to investigate ground conditions for a possible water tunnel between the lake and the powerhouse site.

Of the holes drilled in 2009, TH-3 and TH-4 were drilled into the moraine on a suggested alignment for an earth dam, one on each side of the creek; TH-1 and TH-2 were drilled in the moraine upstream of the suggested dam position and close to the seismic profile positions; and TH-5 and TH-6 were drilled some distance downstream, close to the seismic profile that was taken along the valley.

The purpose of the 2009 exploratory holes was:

- Characterize subsurface conditions at several points on the existing seismic refraction survey lines to add confidence in the interpretation of the seismic data;
- Investigate the foundation soil conditions, including liquefaction potential, at the proposed dam location;
- Characterize the hydraulic properties of the soils, and establish the existing phreatic surface downstream, to allow for an analysis of seepage beneath the proposed dam; and
- Characterize properties of potential materials for use as dam embankment material, and penstock backfill material.

Standard Penetration Tests were performed in all boreholes and soil specimens were obtained using split spoon samplers. Samples were submitted for gradation, moisture content and index testing.

A standpipe piezometer was installed in each borehole, and falling head percolation tests were performed in several of the boreholes.

2.6.5.2 *Findings*

Holes Drilled in 1978

Of the exploratory boreholes drilled in 1978, **Borehole DH-1** was drilled on the west side of Allison Lake, near where a lake tap had been proposed. The borehole penetrated to a depth 175.8 ft, of which 142.6 ft was drilled in bedrock. The overburden consisted of sand and boulders, and is probably colluvial in origin. The bedrock consisted of metagraywacke with sandstone and shale zones. Artesian flows were recorded in the top 10 ft of the hole and below 106 ft depth.

Borehole DH-2 was drilled approximately 4,000 ft downstream from the lake. It was advanced to a depth of 64 ft without reaching bedrock. The uppermost 20 ft contained from 50% to 70% boulders, mixed with sand and gravel. The largest boulder encountered by this borehole required 3.5 ft length of core drilling to go through it. Below 20 ft, there was gravelly sand, silty sand and cobbly sand. A weathered surface was identified at 48.9 ft depth, which was interpreted to be the interface between overlying re-worked till and the parent till. Permafrost was suspected at a depth of between 20 ft and 30 ft, although the region is considered to be generally free of permafrost.

Borehole DH-3 was located near tidewater at a location that was considered suitable for the powerhouse. This borehole revealed 17 ft of alluvial gravel and a 3 ft thick layer of boulders overlying till that contained 25% to 45% boulders. Metagraywacke bedrock was encountered at 68.8 ft depth.

Holes Drilled in 2009

None of the 2009 boreholes reached bedrock. The drill frequently encountered boulders. Where the borehole log records a length drilled through a boulder, it is unlikely that the length of drilling within the boulder corresponds to the true size of the boulder. In borehole TH-3, a boulder was penetrated for 27.2 ft, which informs us that the boulder was at least that size. The boulders consist predominantly of graywacke.

Groundwater observation wells (standpipe piezometers) were installed in all of the 2009 boreholes. However, because of difficulty of access in winter, to the present date no readings have been taken from these standpipes.

Borehole TH-1 was drilled on the right bank of Allison Creek near the lake outlet, and about 600 ft upstream of the proposed axis of the dam. It was drilled from El. 1,430 ft to depth of 90 ft. A boulder was recorded between 1 ft and 4 ft depth, below which is poorly graded gravel with silt and sand to silty gravel with sand containing cobbles and boulders. In this material, water circulation was lost at 9 ft, returned at 15 ft, was lost again at 28 ft, and returned at 36 ft. The water level in the borehole was measured during drilling at a depth of 84 ft (corresponding to El. 1,345 ft). However, circulation of drilling water was again lost at the end of the hole (90 ft depth), which suggests that the true water table may be lower. These data suggest that the foundation for the lake basin when raised by the dam will not be adequately watertight without an impervious blanket.

The Standard Penetration Test results for TH-1 indicate that the foundation would be adequately strong to support the load of an embankment dam of the planned height.

Borehole TH-2 is on the left bank of Allison Creek near the lake outlet, and about 750 ft upstream of the proposed axis of the dam. It was drilled from El. 1,370 ft to depth of 53.2 ft. Similar to TH-1, this hole encountered poorly graded gravel with silt and sand to silty gravel with sand containing cobbles and boulders. Circulation of drilling water was lost at 28 ft depth. The watertable was measured at El. 1,340 ft, which is similar to the elevation in TH-1, and some 25 ft lower than the water level of Allison Lake.

The Standard Penetration Test results for TH-2 indicate that the foundation would be adequately strong to support the load an embankment dam of the planned height.

Borehole TH-3 is on the left bank of Allison Creek about 250 ft upstream of the proposed axis of the dam. It was drilled from El. 1,382 ft to depth of 97.5 ft. Similar to TH-1 and TH-2, this hole encountered poorly graded gravel with silt and sand to silty gravel with sand containing cobbles and boulders. This hole was drilled through a massive boulder of graywacke between 10 ft depth and 37.2 ft depth. Circulation of drilling water was lost at 47 ft, returned at 53 ft, was lost again at 63 ft, returned at 75 ft, and was lost again at 78 ft. The water level in the borehole was measured at a depth of 57.5 ft, corresponding to El. 1,327.5 ft. This is some 40 ft lower than the water level of Allison Lake, which is some 600 ft upstream of TH-3.

The water losses and low water table suggest that control of seepage through the foundations will be necessary. However, the incidence of cobbles and boulders suggests that it would be difficult to create a narrow cutoff, and a wide excavated cutoff trench would be required. Access to the site by the construction road that will ascend the valley wall of the fjord will restrict the size of construction equipment that could be brought to the site.

The Standard Penetration Test results for TH-3 indicate that the foundation will be adequately strong to support the loading from an embankment dam of the planned height. The SPT results and the material gradations suggest that the foundation soils are dense, porous and well graded, and therefore unlikely to be susceptible to seismic liquefaction.

Borehole TH-4 is on the right bank of Allison Creek close to the position of the upstream toe of the proposed dam. It was drilled from El. 1,376 ft to depth of 62.2 ft. Similar to TH-3, this hole encountered poorly graded gravel with silt and sand to silty gravel with sand containing cobbles and boulders. Standard Penetration results are consistent with dense gravel. Circulation of drilling water was lost at 16 ft, returned at 35 ft, and was lost again at 48 ft. No groundwater was observed in the borehole, which is taken to mean that the water table is below the end of the borehole at El. 1,313.8 ft. Thus the water table at the dam site is more than 50 ft lower than the water level of Allison Lake. From this, it is interpreted that the foundations at the dam site are pervious and underdrained. It is judged that subsurface seepage control measures should be considered for a dam at this location.

Borehole TH-5 is on the left side of Allison Creek approximately 1,200 ft downstream of the proposed dam location. This hole was drilled from El. 1,365 ft to a depth of 122 ft through soils consisting of sand, gravel, cobbles and boulders similar the soils logged in the other boreholes. Bedrock was not reached. Groundwater was encountered at El. 1,293 ft.

Borehole TH-6 is also on the left side of Allison Creek and is approximately 2,200 ft downstream of the proposed dam location. This hole was drilled from El. 1,252 ft to a depth of 52.2 ft through soils consisting of sand, gravel, cobbles and boulders similar the soils logged in the other boreholes. Bedrock was not reached. No groundwater was encountered.

Laboratory Test Data

Split spoon samples were taken in each borehole. The sampling method excludes particles larger than about 2.5 inch size, and because the split spoon cannot be used where larger stones are present, the sampling method tends to over-represent the more fine-grained strata. A total of 20 particle size gradation tests were made. The samples contained between 4% and 20% fines (silt and clay), except for a sample from 105 ft depth in TH-5 that contained 40% fines. All of the samples that were tested were non-plastic. Throughout the range of sand and gravel sizes, all of the samples were well graded sandy gravel except for a sample from TH-6 at 30 ft depth that was 84% gravel sized.

Field Permeability Tests

It is difficult to obtain reliably accurate in situ permeability tests in dense gravels such as are present at this site. Nevertheless, six falling head tests were performed in boreholes TH-1, TH-2, TH-4 and TH-6. All of the tests reported low hydraulic conductivity, with the highest permeability reported being 5E-4 ft/s (1.5E-6 cm/s). During the drilling, loss of drilling fluid circulation occurred at least once in every test boring. This was interpreted to be caused by voids, or pockets of open coarse grained material. In most cases the circulation resumed, likely when the voids had become filled or plugged. Zones of high permeability are not expected to be connected.

All of the tests were performed in the HQ-size core barrel, with the end of the barrel on the bottom of the hole. Because the core barrel was equipped with a bit designed to allow drilling fluid to flow around the outside of the barrel, it was assumed for the purposes of the falling head tests that the hole could be considered as being effectively an uncased hole. The calculation of the *in situ* permeability is directly proportional to the length of hole that is assumed to be effectively uncased. If the end of the casing were assumed to be sealed onto the bottom of the hole, and the permeability calculated as an open-ended casing test, the calculated soil permeability values would have been orders of magnitude greater.

Standard Penetration Tests

Except for a single outlier, there are no tests below a depth of 15 ft that gave an N-value less than 25. This is indicative of dense well-graded soil below 15 ft depth.

2.6.6 *Recommendations – Geotechnical Program*

2.6.6.1 Reservoir

The material covering the bed of Allison Lake has not been tested to determine its impermeability. However, because the lake is fed by glacial headwaters, it has been conjectured that the bed below water level will be covered by a relatively impervious seal of glacial silt. If the lake level were to be raised by the proposed dam, the banks above the natural lake level will not be sealed with glacial silt and thus may not be as impervious as the natural lake bed. In fact the inflow of groundwater into DH-1 suggests that the colluvial soils along the shore are quite permeable. The proposed scheme as conceived requires the level of Allison Lake to be raised from about El. 1,365 ft to El. 1,410 ft in order to increase the live storage and also to provide the necessary minimum submergence on the intake and low pressure section of the penstock. With the raised reservoir level, Allison Lake will extend roughly 700 ft downstream to the proposed dam, so that the colluvial lake shores and a large unsealed area of granular moraine on the upstream side of the dam would become flooded. Further site investigations would be needed to confirm the permeability of the moraine, and even then it is unlikely that the amount of seepage could be predicted with any great accuracy. Apart from the possibility of systematic leakage under and around the ends of the dam, there are no indications of any buried valleys or other definable leakage paths that could compromise the reservoir watertightness.

In a major earthquake, there is the possibility that a landslide could develop in the steeply dipping beds on the slopes above the lake. This has not been examined in detail. However, a high velocity rockfall, if large enough, could generate a displacement wave that would be damaging to an embankment dam.

2.6.6.2 Dam

The location of the proposed dam is shown on **Figure B.2**. A cross-section of the highest part of the dam is shown on **Figure B.4**. The proposed dam site has been chosen based on topographic considerations. It is located on the moraine that blocks the natural drainage to retain the lake. This landform is most likely a terminal moraine. The ground surface at the dam site is covered by large angular glacial erratics that appear from the rock types to be of local origin. The exploratory boreholes encountered similar boulders throughout the depth that they were drilled. The foundation soils are judged to be adequately strong to support an embankment dam of the intended height with 3h:1v upstream and downstream slopes. That these are safe slopes must be verified for the design earthquake loadings.

In order to safeguard against seismic liquefaction, it is recommended to remove the uppermost 15 ft of soil and boulders under the entire footprint of the dam. This recommendation is based upon the observation that the SPT N-values below 15 ft depth are consistently better than 25. The largest boulders will need to be blasted to remove them. With the natural ground elevation at 1,364 ft, 15 ft of general stripping brings the foundation surface to El. 1,349 ft. A freeboard of 10 ft to allow for flood surcharge, wave run-up and settlement would bring the crest level of the dam to El. 1,420 ft. Thus the maximum dam height is 56 ft.

Because of uncertainty over the permeability of the dam foundations, subsurface seepage control has been included in the design. A cutoff trench has been recommended in preference to a diaphragm wall because the remoteness of the site will make it costly to mobilize specialized equipment, and because the difficulty of access along the site construction road will make it costly to bring large equipment to the site. Furthermore, a diaphragm wall excavator would almost certainly meet refusal on the large boulders that occur throughout the moraine foundation.

It may be possible at a later stage to reduce the depth and lateral extent of the cutoff trench if more exploratory drilling and permeability testing of the foundation soils were done. However, for this feasibility study it is recommended that a subsurface seepage cutoff should be included. The intended purpose of the cutoff is to reduce the quantity of seepage (the water available for power generation being more valuable than is usual for a dam of this type) and to control seepage gradients that might otherwise predispose to a piping failure of the dam. Under the highest section of the dam, the recommended cutoff trench is 40 ft deep below the general stripping level, and 40 ft wide at the base. The depth of the trench will reduce towards the abutments. The width of the trench bottom has been chosen to provide adequate access space for construction of a central asphaltic core and its sand filters, and to control seepage flows and seepage gradients under the asphaltic core. Safe temporary sideslopes for the trench excavation are judged to be 1h:1v. The extent to which the subsurface cutoff will need to continue beyond the ends of the dam has been determined only very approximately for this study.

The dam embankment is intended to be built of the morainal material after the boulders have been separated out. The boulders would be used for riprap. A 1-m wide vertical asphaltic core has been recommended to provide the impervious barrier in the embankment. The asphaltic core will be protected on its upstream and downstream sides by sand filter zones. The width of the core and the filter zones will be sufficient to maintain integrity after displacement by the design earthquake. Asphaltic material has been recommended for the core construction because suitable impervious fill has not been identified within reasonable distance of the site, and because asphaltic construction may continue at times when wet or cold weather conditions would be unfavorable for compacting silt and clay soils.

The location, cross section and profile of the proposed spillway is shown on **Figures B.4** and **B.5**. The drilling program as described above indicates that the bedrock in the area of the dam is too deep to provide an obvious location for a conventional spillway. Furthermore, the conditions around the dam do not provide a consistent foundation for a spillway structure. Accordingly, it is proposed to build an ungated overflow spillway on the dam embankment where it will be possible to have control of the foundation conditions. For this arrangement, energy dissipation would be provided by a stepped spillway and a stilling basin, with substantial rock armoring placed for some distance downstream from the dam to control erosion.

2.6.6.3 *Intake*

The intake for the penstock is shown on **Figure B.4** It would be a free-standing concrete structure founded on moraine soils. The inlet would be set low enough to operate at the lowest planned operating level, taking into account the maximum thickness of ice cover. This is assumed to be close to the present natural lake level.

The intake structure must be sufficiently massive to resist flotation and able to resist ice thrust. It may be necessary to excavate a 10 ft or so below the natural ground surface to provide adequate foundation conditions. If built close to the present lake shore, the excavation for the intake foundation may require measures to control inflows of water. Conventional sheet piling would almost certainly meet refusal on the boulders in the moraine. Consequently, it may be better to site the intake close to the dam where the watertable is known to be well below the lake level. An approach channel would then be excavated between the intake structure and the lake at its lowest operating level.

2.6.6.4 Penstock

The penstock route is shown on **Figures B.2 & B.3** and the overall plan, profile and details are shown on **Figure B.6**. The penstock will be buried for the first 2,300 ft of its length. In this length, the depth of excavation is generally less than 20 ft. Excavation will necessitate blasting the largest boulders. After Station 2,300 ft, the penstock may be founded at the ground surface on bedrock or colluvial soils. In this length, the slopes above the penstock will warrant careful examination to evaluate avalanche risk and the potential for landslides to develop.

2.6.6.5 Powerhouse

The locations of the powerhouse and tailrace channel are shown on **Figure B.7**. The powerhouse would be founded on gravels of an alluvial fan deposit where Allison Creek debouches into Prince William Sound.

3. Power Studies

AUTO *Vista* was used to evaluate the generation benefits of various upgrade configurations under consideration for the Project during the Pre-Feasibility Study and the Interim Feasibility Review. As stated at the close of Section 1, the focus of this Final Feasibility Report includes **Alt 1b**, **Alt 3c** and **Alt 3d** as discussed below.

AUTO *Vista* is one of the several components of a decision support system, *Vista*, which was developed by Hatch Acres for use by system dispatchers and engineering operations staff, to assist them in short- and long-term scheduling to achieve maximum value for the generation system. In this case, the AUTO *Vista* component was used as an analysis tool to evaluate the economic value of alternative project configurations and methods of operation. It considers plant characteristics, water, pricing, and system load constraints in its calculations.

The following is a description of the program and a discussion of the use of AUTO *Vista* on this project.

3.1 AUTO *Vista* Model: System Loads and Resources

The AUTO *Vista* model operates on an hourly time step to meet system loads in the most cost effective manner using available system resources as a function of their respective cost of production. For the present study, the system load was based on CVEA data for 2006. The system resources considered for the existing case included the combined diesel plant facilities in Valdez and Glennallen, the combined cycle unit as operated under the contract with Petro Star, and the existing hydropower facilities at the Solomon Gulch Project. The proposed development included the additions as discussed in **Section 2** above as well as retirement of the existing thermal generation resources to the extent possible in each respective case under consideration.

3.2 AUTO *Vista* Model: Allison Lake Hydropower Development

The AUTO *Vista* model for the Project includes the drainage basins for both the existing Solomon Gulch Hydroelectric Project and Allison Lake. It is comprised of a series of arcs and nodes with each element having its set of characteristics. These basic elements and typical data associated with each are summarized in **Table 3.1.**

Table 3.1
AUTO *Vista* Model Elements

Element	Typical Characteristics
Arcs	
Inflow	Hourly inflow at discrete points within drainage basin
Spillway	Spillway rating curves / discharge requirements
Open Channel (Streams)	Minimum flows / ramping rates
Closed Conduits (Penstocks)	Head loss coefficients
Nodes	
Reservoirs	Area-capacity data / elevation & discharge constraints
Powerhouse Units	Efficiency data / maximum & minimum flows

The graphical model for the existing system, **Alt 1b, Alt 3c** and **Alt 3d** as expressed in these terms is shown below in **Figures 3.1, 3.2 and 3.3.** Major features of the AUTO *Vista* model are briefly described below.

Figure 3.1
AUTO *Vista* Model Elements: Existing Hydro System

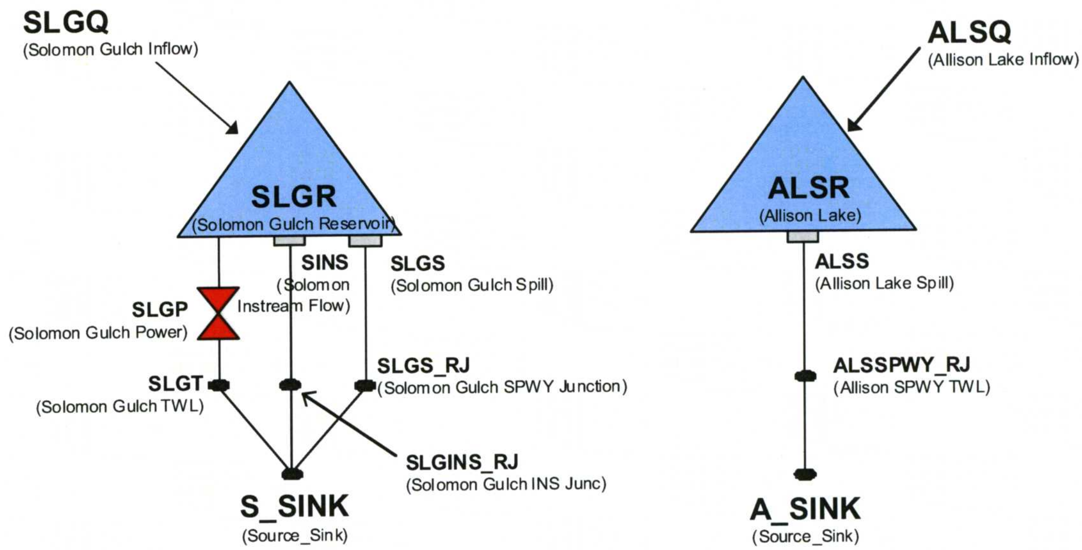


Figure 3.2
AUTO *Vista* Model Elements: Alt 1b

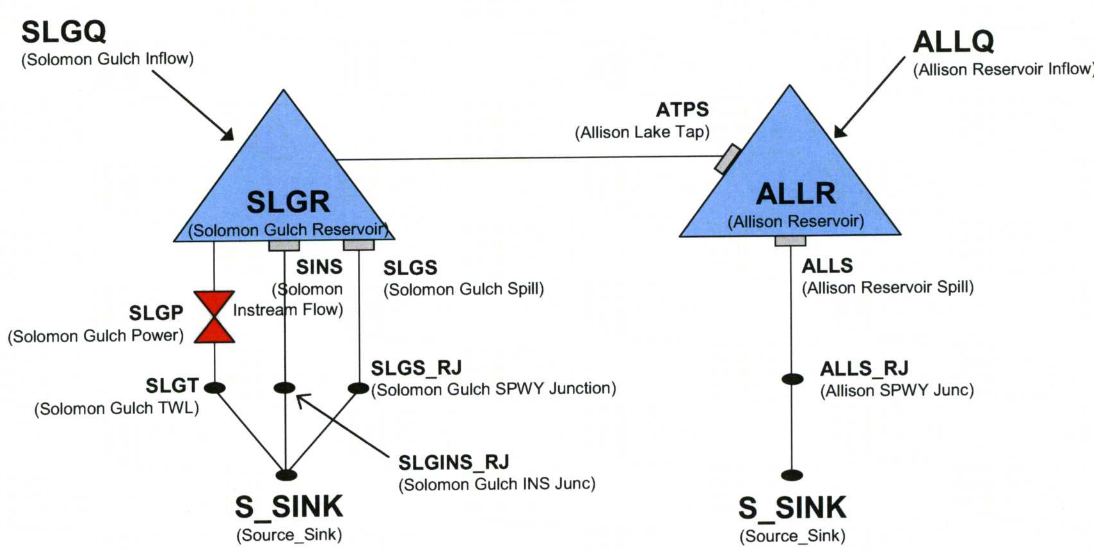
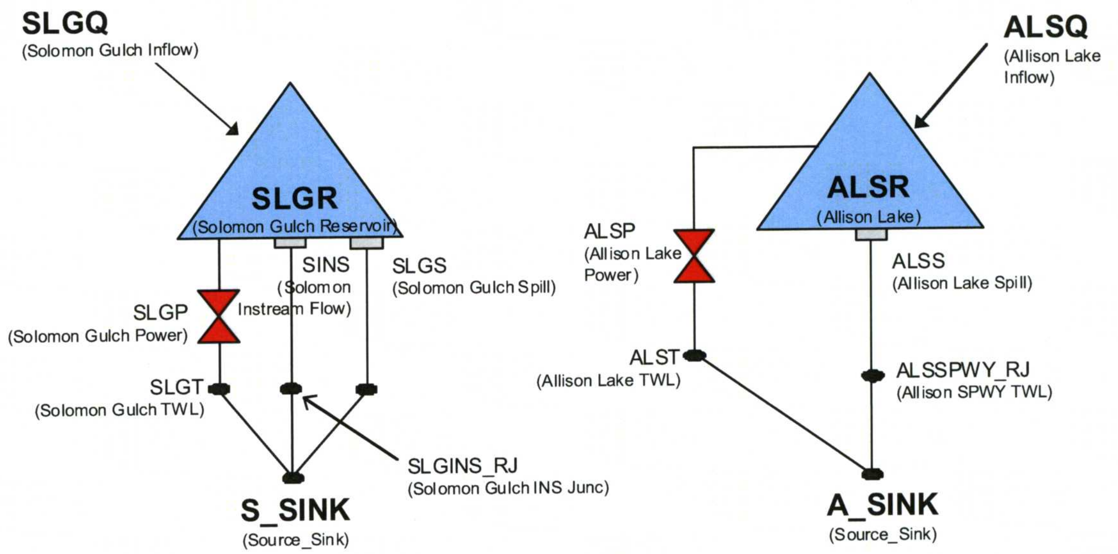


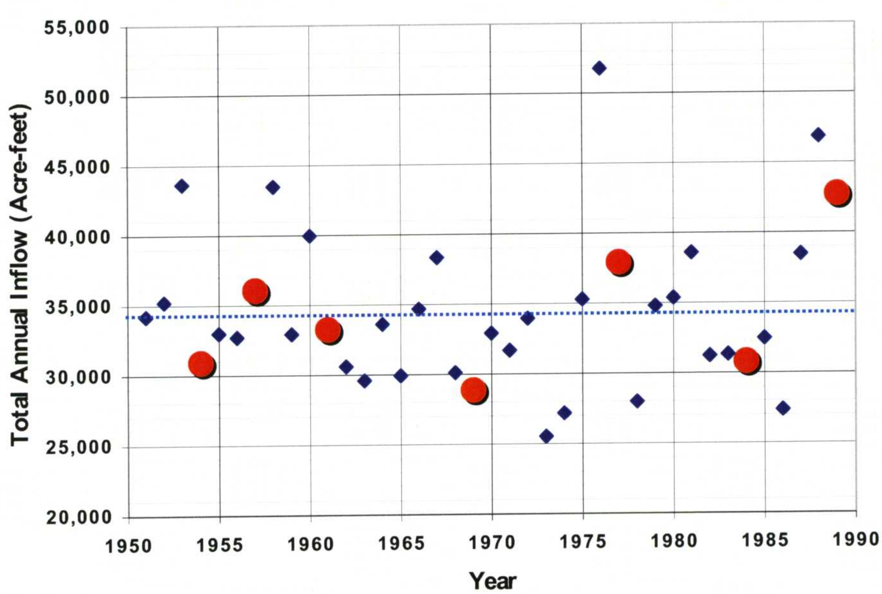
Figure 3.3
AUTO *Vista* Model Elements: Alt 3c and Alt 3d



3.3 Hydrology

The hydrology used for the AUTO *Vista* model is based on the work done by the COE in 1982 as part of their evaluation of the potential project configurations for maximizing the Allison Lake resource. The correlations developed from that study results in a 39-year period of average daily flows from 1950 through 1989. The annual inflow for each of the 39 years is shown on **Figure 3.4**.

Figure 3.4
Allison Lake Annual Inflow, 1951 - 1989



A statistical analysis of this period of record was performed to establish a representative smaller group of 7 years for use within the present AUTO *Vista*. The set of 7 years was chosen on the basis of balancing the wet to dry conditions of annual inflow to the two basins. The specific years chosen are indicated by the large red dots in **Figure 3.4** and the associated representative inflow conditions are summarized in **Table 3.2.**

Table 3.2
AUTO *Vista* Hydrologic Years

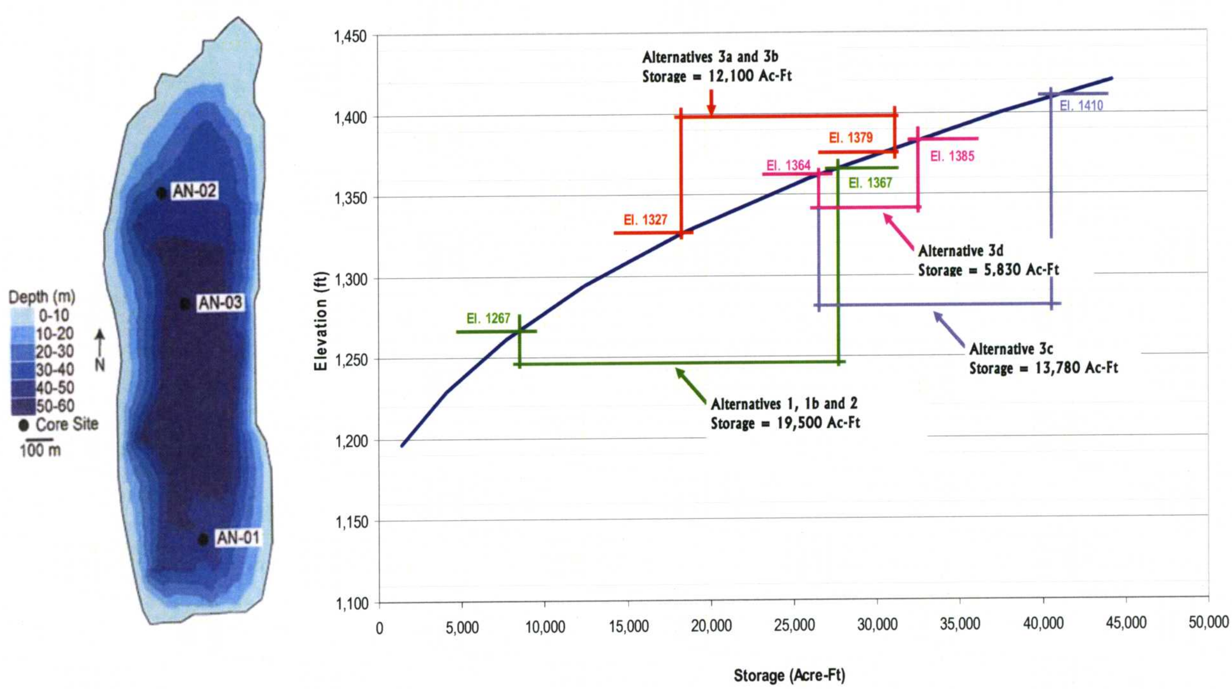
Year	Percentile	Total Inflow Acre-Feet
1969	10%	28,900
1984	25%	30,800
1954	25%	30,900
1961	50%	33,200
1957	75%	36,100
1977	75%	37,900
1989	90%	42,800
Average		**34,400**

3.4 Reservoir Characteristics

The minimum and maximum reservoir elevations and storage characteristics for the Solomon Gulch Reservoir were taken from the existing information for the project as included in the Supplemental Technical Information document as prepared in support of the FERC Part 12 Safety Inspection process for the project.

In the case of Allison Lake, stage relationships were taken from the previously referenced COE and HDR studies as appropriate for **Alt 1b, Alt 3c** and **3d**. The available storage relationships, however, were found through a recent study as performed by the Northern Arizona University as part of a research of the receding of glaciers. The image taken from the web site that includes a description and photographs of the research program and the resulting reservoir storage relationships are shown on **Figure 3.5**.

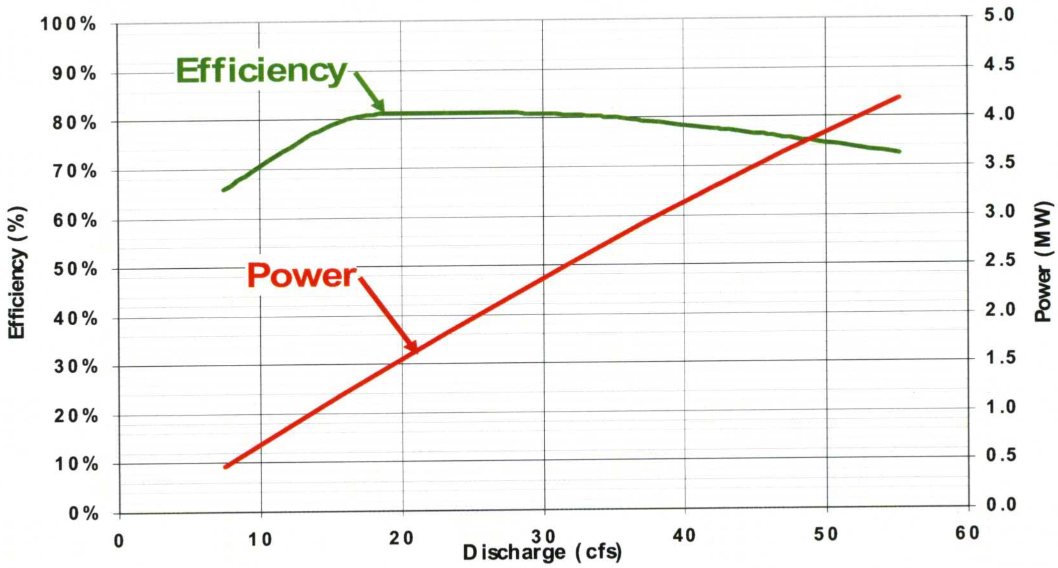
Figure 3.5
Allison Lake Reservoir Storage



3.5 Hydro Equipment Characteristics

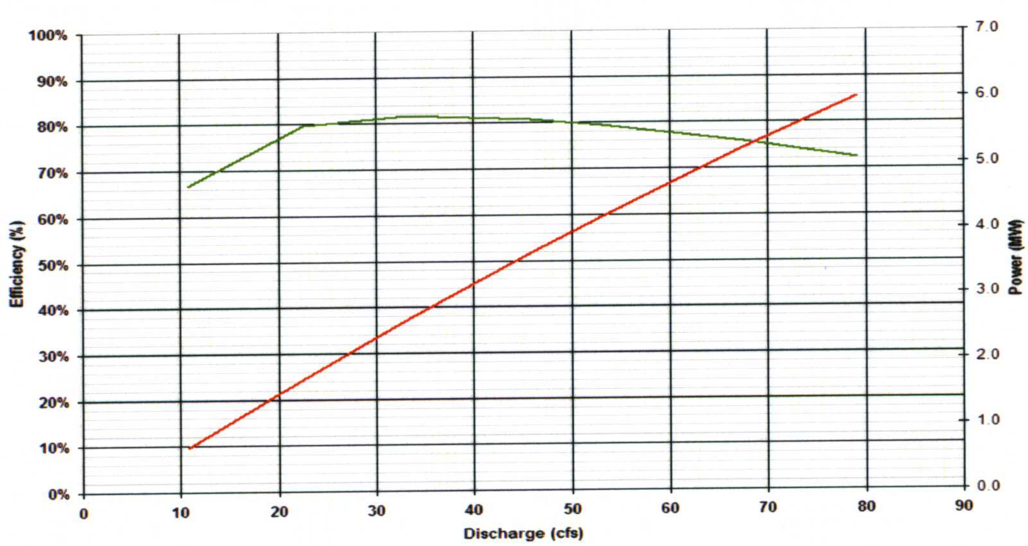
The performance curves for the Solomon Gulch Powerhouse have been included as provided by the CVEA. The new units at the proposed Allison Lake Powerhouse for **Alt 3c** and **3d** are based on Hatch Acres in-house generic data for Pelton units. Alt 3c comprises a 4 MW generating station and Alt 3d comprises a 6 MW generating station. A plot of the characteristics used in this analysis is shown in **Figure 3.6**.

Figure 3.6
Allison Powerhouse Unit Characteristics – 4 MW Installed Capacity



All elements of the conduit system components for each alternative have been assumed to perform in accordance with published engineering data.

Figure 3.7
Allison Powerhouse Unit Characteristics – 6 MW Installed Capacity



3.6 AUTO Vista Results

Representative plots of the annual operation of the Solomon Lake and Allison Lake Reservoirs are included in **Appendix D.1**. The two primary observations from these plots for **Alt 1** are that this alternative attempts to conserve the storage in the Solomon Gulch Reservoir as long as possible and that the Solomon Gulch Powerhouse is slightly undersized. In the case of **Alt 2** and **Alt 3**, the plots suggest a parallel operation of the two basins and demonstrate a reasonable balance between reservoir storage and powerhouse capacity.

In addition, stacked bar charts indicating the most efficient dispatch of system resources as required to meet the system load are included in **Appendix D.2** for the existing condition, **Alt 1b**, **Alt 3c** and **Alt 3d**. The first charts compare the existing condition to the development alternatives for the 1961 water year, which is the 50% year as indicated in **Table 3.2**. Also included for comparative purposes are the charts for 1954 and 1977 water years which represent 25% and 75% water years respectively. Finally, a chart is included that expands the scale to show a typical weekly dispatch from 1961.

The annual generation for each of the 7 years included in the analysis for the existing condition and the **Alt 1b, Alt 3c and Alt 3d** cases are shown in **Table 3.3 through Table 3.6** below.

Table 3.3
Annual Generation – Existing Condition

	Generation (MWh)					
Year	SG 1	SG 2	Allison	Diesel	Cogen	Total
1969	32,500	19,700	NA	11,200	22,900	86,400
1984	34,100	22,000	NA	7,500	22,800	86,400
1954	31,400	22,700	NA	9,300	23,000	86,400
1961	34,800	23,500	NA	6,800	21,300	86,400
1957	35,200	24,800	NA	6,200	20,200	86,400
1977	36,500	25,300	NA	3,400	21,100	86,400
1989	35,200	26,700	NA	4,800	19,700	86,400
Average	34,200	23,500	NA	7,000	21,600	86,400

Table 3.4
Annual Generation – Alt 1b

Year	Generation (MWh)					
	SG1	SG2	Allison	Diesel	Cogen	Total
1969	40,700	22,400	N/A	3,300	19,900	86,400
1984	41,000	25,400	N/A	1,100	18,900	86,400
1954	39,900	22,600	N/A	3,600	20,300	86,400
1961	40,900	24,800	N/A	800	19,800	86,400
1957	40,100	23,300	N/A	3,000	20,100	86,400
1977	41,500	26,300	N/A	100	18,500	86,400
1989	39,100	27,600	N/A	2,800	16,900	86,400
Average	40,500	24,600	N/A	2,100	19,200	86,400

Table 3.5
Annual Generation – Alt 3c

Year	Generation (MWh)					
	SG1	SG2	Allison	Diesel	Cogen	Total
1969	35,200	19,000	25,900	1,200	5,000	86,400
1984	35,900	19,600	25,800	800	4,300	86,400
1954	33,400	17,100	25,800	600	9,500	86,400
1961	35,700	16,200	28,400	500	5,600	86,400
1957	35,100	16,100	26,800	2,800	5,600	86,400
1977	36,800	16,200	29,700	300	3,400	86,400
1989	35,600	17,400	27,900	500	4,900	86,400
Average	35,400	17,400	27,200	1,000	5,500	86,400

Table 3.6
Annual Generation – Alt 3d

Year	Generation (MWh)					
	SG1	SG2	Allison	Diesel	Cogen	Total
1969	35,100	11,100	26,900	1,400	11,900	86,500
1984	36,300	10,800	27,300	900	11,100	86,400
1954	35,600	8,500	24,900	600	16,700	86,400
1961	36,600	8,700	28,200	300	12,700	86,500
1957	35,600	8,200	28,200	1,600	12,800	86,400
1977	35,100	11,500	29,200	400	10,300	86,400
1989	35,800	8,200	30,000	400	12,000	86,400
Average	35,700	9,600	27,800	800	12,500	86,400

The annual general benefits from the AUTO *Vista* Analyses for **Alt 1b**, **Alt 3c** and **Alt 3d** can then be summarized as shown in **Table 3.7** in terms of the incremental hydropower generation and associated reduction on thermal power as required to satisfy the system load for each of the alternatives under consideration. Please note that the minor differences between the hydro and thermal generation values for each alternative are due to rounding within the AUTO *Vista* modeling.

Table 3.7
Annual Generation Benefits

	Generation (MWh)			
	Existing	Alt 1b	Alt 3c	Alt 3d
Hydro	57,700	65,100	80,000	73,100
Fossil	28,600	21,300	6,500	13,300
Total	86,300	86,400	86,500	86,500
Benefit	N/A	7,300	22,100	15,200

4. Project Construction Cost and Construction Schedule

Construction costs and schedules were prepared and reported for the various upgrade configurations under consideration for the Project during the Pre-Feasibility Study and the Interim Feasibility Review. As stated at the close of Section 1, the focus of this Final Feasibility Report includes **Alt 1b**, **Alt 3c** and **Alt 3d** as discussed below.

4.1 Construction Cost Estimates

All cost estimates are based on January 2010 bid price levels. The Direct Construction cost for each alternative is the total of all costs directly chargeable to the construction of the project and in essence represents a contractor's bid. Indirect costs are defined as those which are added to the Direct Construction Cost to result in the Total Construction Cost.

The cost estimates for the heavy civil elements of the project are based on a bottoms up approach that consider crew sizes, equipment requirements and production rates. Details for these estimates are included in **Appendix E**. The costs for the major equipment within the powerhouse are based on preliminary quotations from equipment suppliers while the cost for other lower cost items were obtained from in-house cost data and from recently obtained bid prices on similar construction.

Indirect costs include an allowance for contingencies, engineering and owner administration. The contingency used for all alternatives was 25%. Engineering and Owner Administration assumed for all alternatives was 15% of construction cost, inclusive of contingencies.

The period of time required to complete the process for obtaining a FERC License can be expected to be approximately 3 years. Adding another 2^+ years to construct the project over three construction seasons suggests that a realistic on-line date of the project to be in the range of 2015. Accordingly, it is appropriate to include escalation to the above costs to determine a realistic on-line cost for the project. However, for the purposes of the present economic analyses, 2010 dollars are used herein to avoid the need to hypothesize what the cost of thermal generation may be that far into the future. The resulting construction cost estimates for **Alt 1b**, **Alt 3c** and **Alt 3d** are summarized in **Tables 4.1.1** and **4.1.2**.

Table 4.1.1
Alternative 1b
Total Construction Cost (Bid 1/2010)

Item	Alt 1b Diversion to Solomon Gulch
1. Mobilization & Access Road	$7,500,000
2. Intake Structure/ Lake Tap / Dike	$1,275,000
3. Tunnel	$20,000,000
4. Energy Dissipater	$500,000
Direct Construction Cost (Bid 1/08)	**$29,275,000**
Escalation	$1,183,000
Direct Construction Cost (Bid 1/10)	**$30,458,000**
Contingencies	$7,615,000
Engineering & Owner Admin.	$5,711,000
Total Construction Cost (Bid 1/10)	**$42,601,000**

Table 4.1.2
Alternatives 3c and 3d
Total Construction Cost (Bid 1/2010)

Item	Alt 3c Allison Dam @ El 1420		Alt 3d Allison Dam @ El 1395	
1. Mobilization		**$1,573,000**		**$1,573,000**
2. Construction Access Road		**$4,860,000**		**$4,860,000**
3. Dam, Intake & SpillwayIntake				
a. Embankment & Intake	$19,569,000		$11,844,000	
b. Spillway	$2,299,000		$2,299,000	
		$21,868,000		**$14,143,000**
4. Surface Penstock / Pipeline				
a. HDPE Pipeline	$668,000		$888,000	
b. Steel Pipeline	$4,201,000		$4,591,000	
		$4,869,000		**$5,479,000**
5. Powerhouse				
a. Civil Works	$1,611,000		$1,779,000	
b. Turbine & Generator	$2,804,000		$3,095,000	
c. Misc. Mech. Equip.	$414,000		$447,000	
d. Accessory Elec. Equip.	$630,000		$696,000	
e. Bridge Crane	$187,000		$219,000	
		$5,646,000		**$6,236,000**
6. Switchyard		**$525,000**		**$525,000**
7. Transm. & Interconnection		**$310,000**		**$310,000**
Direct Construction Cost (Bid 1/09)		**$39,651,000**		**$33,126,000**
Escalation		**-$1,577,000**		**-$1,247,000**
Direct Construction Cost (Bid 1/10)		**$38,074,000**		**$31,879,000**
Contingencies		**$10,234,000**		**$8,635,000**
Engineering & Owner Admin.		**$7,250,000**		**$6,080,000**
Total Construction Cost (Bid 1/10)		**$57,135,000**		**$47,841,000**

4.2 Construction Schedule

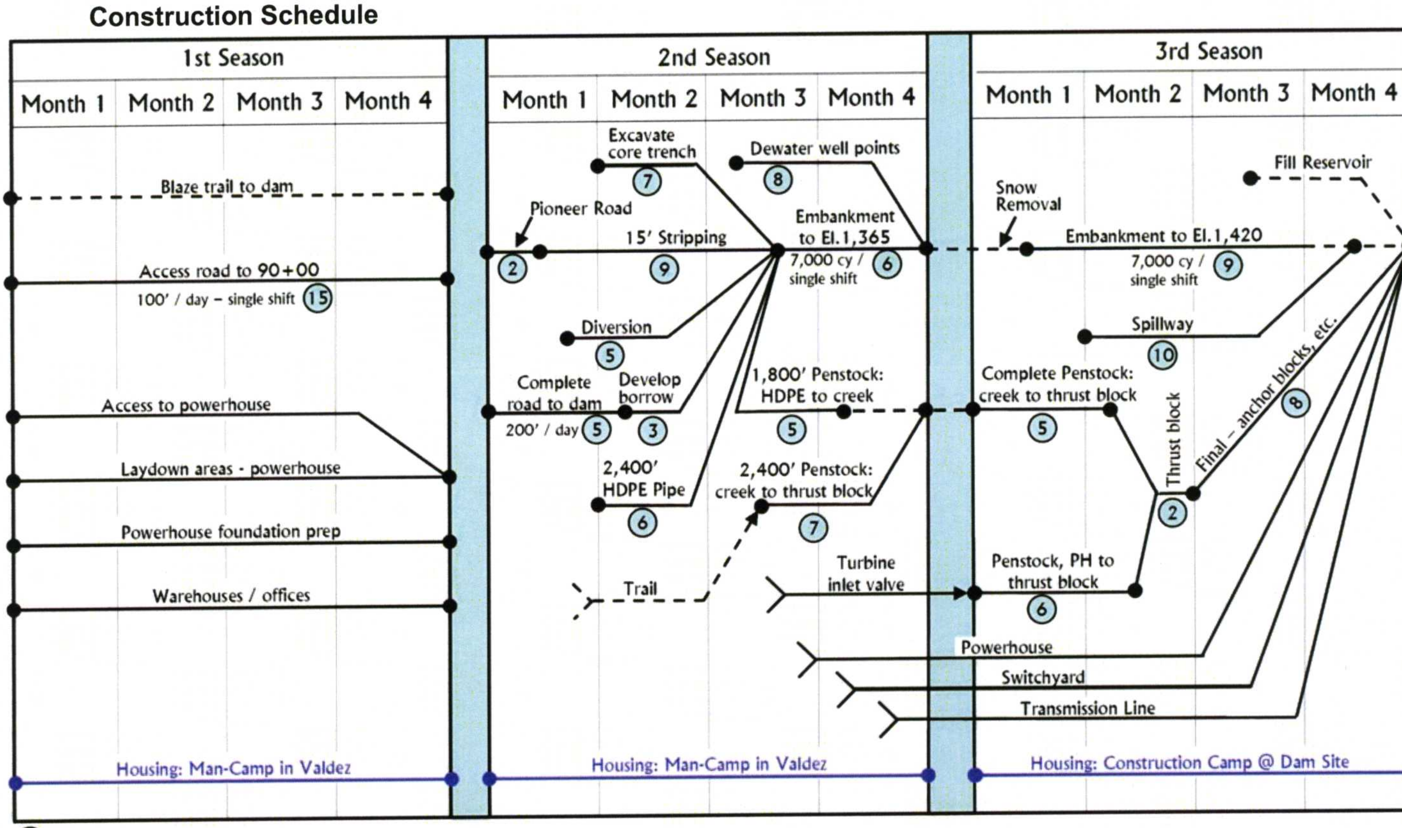
The construction of the project is controlled by the following major factors:

- Delivery time for major powerhouse equipment
- Construction quantities for the primary civil features
- Access to Allison Lake for construction activity
- Four month window for construction activity at Allison Lake

Taking these factors into consideration, the overall schedule for **Alt 1b** would be controlled by the time to mine the tunnel, whereas the construction of the dam would control the schedule for either **Alt 3c** or **Alt 3d**.

A similar approach has been used to develop a schedule for each alterative relative to the purposes of the cost estimates presented above and the annual costs presented below for each alternative. The schedule for **Alt 3c** is presented in **Figure 4.1** as an example thereof.

Figure 4.1
Alternative 3c
Construction Schedule



(n) Activity Duration (weeks)

4.3 Economic Analysis

The Total Investment cost includes interest during construction (IDC) over an assumed 28-month construction period. As outlined above, we have assumed that construction at the project site would come to a stop during the winter months, with the exception of equipment installation within the powerhouse structure.

Annual costs of the Project can be apportioned into fixed and variable costs. For this analysis, the fixed amount, amortization of the Total Capital Requirements less earnings on Reserves, is based on 7% interest rate financing over a 30-year term. Variable annual costs escalate each year and include operation and maintenance (O&M) costs, administrative and general expenses, interim replacements and insurance. The basic assumptions for determining the annual fixed and variable costs of the Project are shown in **Table 4.2**. The development of the annual cost as well as the resulting unit cost of power for each of the alternative development schemes considered herein are shown in 2010 dollars on **Table 4.3**.

Table 4.2
Basic Assumptions for Economic Analyses

Item	Value
Construction Period	28 months
Financing Term	30 years
Financing Interest Rate	7%
Reinvestment Rate	Same as financing
Escalation of Project Costs	3% annually
Financing Reserve	1 year of debt service
Financing Expenses	3% of Total Investment Cost
Variable Annual Costs	$500,000

Table 4.3
First Year Cost of Power (2010 dollars)

Item	Alt 1b Diversion to SG	Alt 3c Allison Dam @ El. 1420	Alt 3d Allison Dam @ El. 1395
Total Construction Cost (Bid 1/10)	**$42,601,000**	**$57,135,000**	**$47,841,000**
Interest During Construction	3,280,000	5,166,000	4,316,000
Total Investment Cost	**$45,881,000**	**$62,301,000**	**$52,157,000**
Reserve Fund	4,151,000	5,633,000	4,717,000
Financing & Legal	1,380,000	1,870,000	1,560,000
Working Capital	100,000	100,000	100,000
Total Capital Requirements (1/10)	**$51,512,000**	**$69,904,000**	**$58,534,000**
Annual Cost			
Debt Service	$4,151,000	$5,633,000	$4,717,000
Earnings on Reserve Fund	(291,000)	(394,000)	(330,000)
Variable Annual Costs	500,000	500,000	500,000
Total First-Year Annual Cost	**$4,360,000**	**$5,739,000**	**$4,887,000**
Added Hydro Generation (kWh)	7,235,000	22,137,000	15,277,000
First-Year Cost of Power ($/kWh)	**$0.60**	**$0.26**	**$0.32**

5. Regulatory Considerations and Environmental Field Investigations

CVEA filed an Application for Preliminary Permit on March 3, 2008, for FERC Project No. 13124. That Application included a detailed study plan based on consultations that began in 2007. There was a competing application filed by Green Power LLC; however, CVEA's application was deemed to be first filed. FERC issued the Permit to CVEA on September 4, 2008, effective September 1, 2008 and expiring on August 31, 2011. Prior to award of the Preliminary Permit, in May 2008 CVEA commenced consultations with the resource agencies to discuss the study plan presented in the Application for Preliminary Permit and began its initial engineering and environmental field investigations.

As provided by the FERC regulation, *"the purpose of the preliminary permit is to provide a three-year period during which time CVEA maintains priority to file an application for license while studies are conducted and an application for license is prepared."*

The FERC pre-filing process, including the environmental and engineering studies and investigations, has been conducted with the goal in mind that CVEA intends to file an application for license with the FERC in January 2011. To date field and office studies have been performed by CVEA's Project Team including: Hatch Acres Corporation, R&M Consultants, Alaska Biological Resources, Inc. (ABR), and Northern Land Use Resources, Inc. (NLUR). Field and office reports prepared by CVEA's Project Team have been prepared to document the 2008 & 2009 effort. These studies and reports support this Final Feasibility Report as well as the Application for License. A summary of CVEA's regulatory and environmental framework is presented below.

5.1 Regulatory Considerations

Early in the pre-filing process CVEA considered the three potential pre-filing options:

- The Integrated Licensing Process (ILP), the default process at the FERC. This process essentially puts FERC in the "driver's seat" and establishes hard deadlines at the outset of the pre-filing process. These deadlines do not address the difficulties with developing projects in Alaska, for example (1) unforgiving deadlines that do not take into consideration difficulties with accessing the site to perform studies; (2) the need to use helicopter access to conduct studies and the problems with weather interruptions; and (3) the fact that resource agencies are in the field much of the summer and early fall and therefore unavailable to work with an applicant under the strict deadlines regarding consultation.
- The Alternative Licensing Procedure (ALP), the preferred option elected by CVEA and an application to use the ALP is pending before the FERC. The ALP enables an Applicant to design a pre-filing process in consultation with the federal and state agencies to address the above noted problems with the ILP. Under the ALP, CVEA can prepare the Environmental Exhibit in the format of a document that addresses the requirements of the National Environmental Policy Act (NEPA) in the form of a Preliminary Draft Environmental Assessment (PDEA) as discussed below.
- The Traditional Licensing Process (TLP). This pre-filing process would not enable CVEA to prepare its draft NEPA document in the form of the PDEA and would expose CVEA to a longer process, providing resource agencies with essentially "two bites at the apple" to recommend conditions in the License and resulting in a higher cost to CVEA with no positive results to CVEA.

As noted above, CVEA at the outset of the process elected to use the ALP and met with FERC in June 2009 to discuss the path forward. CVEA is now awaiting FERC approval of its request.

Throughout the pre-filing process, CVEA has diligently consulted with FERC Staff and representatives from Federal and State agencies regarding the proposed project and has completed two years of field and office studies. Some of these studies are currently ongoing.

The regulatory accomplishments and milestones are listed below:

- Application for Preliminary Permit to study the Allison Lake Project was filed March 3, 2008. This was a competitive proceeding and CVEA prevailed by being first in line to file as Rural Electric Cooperatives do not enjoy municipal preference[1].
- FERC initiated consultations with federal and state agencies on May 14, 2008, and these consultations will continue throughout the term of the Preliminary Permit. The purpose of these consultations is three fold: to discuss CVEA's proposed project; to discuss and receive approval regarding necessary field studies; and to discuss potential project related effects and potential Protection, Mitigation, and Enhancement (PM&E) measures that may be included in the FERC License.
- Consultation held with Alaska Department of Natural Resources regarding water rights held in May 2008; ADNR provided documentation of the permit issued to Alyeska Pipeline Service Company (ADNR file LAS 11813)
- CVEA's consultants met with FERC Staff in April 2008 to discuss on a generic basis the issues associated with conducting studies and preparing Applications for License for projects located in Alaska.
- CVEA received access licenses from Alyeska to enable the Project Team to enter Alyeska lands to conduct studies beginning in June 2008
- Alaska Department of Fish & Game (ADF&G) issued Fish Sampling Permit #08-198 in August 2008
- FERC issued Order Issuing Preliminary Permit on September 4, 2008; the Permit will expire on August 31, 2011
- CVEA prepared a Literature Review and Gap Analysis regarding Allison Lake in 2008 to assist in identifying required studies.
- CVEA prepared study plans in consultation with the Federal and State resource agencies beginning in May 2008 and has completed two years of field and office studies as noted in this Final Feasibility Report.
- CVEA met with FERC Staff in Washington, DC, in June 2009 to discuss the Project and its interest in using the ALP. FERC Staff agreed that CVEA's proposal made sense and in light of the fact that CVEA would have two years of studies completed that the required Pre-Application Document (PAD) could be presented to include: Draft Exhibit A describing the Project layout and operation and other information required by the regulation (18 CFR 4.61); a Preliminary Draft Environmental Assessment; and supporting data including copies of field reports.
- CVEA prepared an initial Contact List in 2008 and issued its Contact List and Regulatory Schedule for the FERC Proceeding on January 15, 2010 for review and comment.
- CVEA provided its Notice of Intent to File an Original License Application (NOI) and its Request to the FERC to use the Alternative Licensing Procedure (ALP), including the Communications Protocol, to the entities included in the Contact List on January 15, 2010.
- CVEA filed its request to be designated as the Non-Federal Representative to conduct informal consultation with the Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) to engage in consultation regarding Section 7 of the Endangered Species Act (ESA); to engage in consultation with NMFS regarding Section 305 of the

[1] Rural Electric Cooperatives, Investor Owned Utilities and Independent Power Producers are all grouped into one category. Only municipal and state applicants enjoy preference under Section 7(a) of the Federal Power Act.

Magnuson Stevens Act; and the Alaska State Historic Preservation Officer (SHPO) pursuant to Section 106 of the National Historic Preservation Act (NHPA) on January 26, 2010.

- CVEA filed its NOI and Request to Use the ALP with the FERC on April 7, 2010
- CVEA prepared and filed its Preliminary Application Document (PAD) comprised of: Exhibit A – Project Description; the Preliminary Draft Environmental Assessment (PDEA); and copies of Field Studies Reports with the FERC and provided to entities included in the Contact List on April 13, 2010
- FERC approved of the request to consult with the SHPO on April 19, 2010; and, on April 22, 2010, FERC approved of the request to consult with the FWS and NMFS regarding Section 7 of the ESA and NMFS regarding Section 305 of the Magnuson Stevens Act.
- CVEA prepared and filed Scoping Document with FERC and resources agencies on April 22, 2010
- CVEA will conduct NEPA scoping meetings on May 10, 2010, in Anchorage and May 12, 2010 in Valdez.
- CVEA proposes to provide its Draft Application for License for review and comment to entities listed on the Contact List on July 30, 2010.
- CVEA proposes to file its Final Application for License with the FERC and provide copies to the entities listed on the Contact List in January 2011.
- The Preliminary Permit expires on August 31, 2011.

5.2 Environmental Field Investigations

In support of the preliminary permit, environmental field investigations began in 2008 for the Project. These field investigations and desk-top reviews are summarized in the following sections and the complete reports can be found in **Appendix F**. The major studies conducted are listed in **Table 5.1**.

Table 5.1
Summary of Major Environmental Studies Conducted

Type of Field Investigation	Conducted By	Timeline
Geological Resources (As described in Section 2)	R&M Consultants	Began: 2008 Completed: 2009
Water Use and Quality	R&M Consultants	Began: 2008 Completed: on-going
Biological Resources - Fish and Aquatic Resources - Vegetation - Wetlands - Birds and Mammals - Wildlife Habitats	ABR, Inc.	Began: 2008 Completed: on-going
Archaeological/Historical	NLUR, Inc.	Began: 2008 Completed: on-going

5.2.1 Water Quality Study

5.2.2 Description

A Water Quality Study was undertaken by R&M Consultants, Inc. (R&M) as a subconsultant to Hatch Acres to describe the hydrologic setting of the Allison Lake Watershed. This study, included herein as **Appendix F.1**, sought to describe and quantify the flow variations in Allison Creek and to characterize the Allison Lake/Allison Creek water quality. To that end, studies of the Allison Lake Watershed began in summer of 2008 and will proceed throughout the 36-month life of the Preliminary Permit, as required to help determine the feasibility of this project. The following three objectives were pursued:

- Perform monthly, opportunistic in-situ monitoring of pH, temperature, specific conductivity, and turbidity in two locations of Allison Creek,
- Continuously monitor stream temperature in two locations of Allison Creek, and
- Annually model the thermal profile of Allison Lake

As Allison Lake hydropower development continues to be studied, its potential impacts to water quality may be assessed against environmental baseline data. The rationale for this effort comes from the fact that FERC and State agencies require at least two consecutive years of water quality data to support a Development Application. The two-year data set is stipulated to illustrate variations from season to season and year to year. As such, water quality monitoring has continued through 2009 on a regular basis, the results of which are included in the full report.

Physical and chemical parameters such as dissolved oxygen (DO), total dissolved gas, total hardness, chlorophyll, total nitrogen, total phosphorus and fecal coliform concentrations have not been acquired. Based on agency consultation, DO has been specifically excluded as a parameter of concern.

5.2.3 *Findings*

Indications to date are that water quality is relatively consistent between upper and lower Allison Creek. Stream temperatures have followed generally expected trends of peaking in July, then beginning a cooling trend in August that continues through the fall months to bottom out in November. Daily temperature variations in Allison Creek tend to decrease markedly beginning in early September, likely coinciding with shorter, cooler days. Daily variations begin to increase noticeably in June when the snow melt becomes prevalent during daytime hours.

Available data indicate that specific conductivity is either equivalent between the upper and lower reaches of Allison Creek or ranges slightly higher in lower Allison Creek. The higher readings in the lower creek could be a result of the increased sediment load in the lower reaches of the stream after traversing a mountainside and receiving side input from multiple drainages. Ongoing data collection continues to more clearly define this trend.

Turbidity levels in lower Allison Creek tend to range slightly lower than those measured in the upper reach of the stream. This trend contradicts the indications described in the previous edition of this report (R&M, 2009). At the time that the previous report was published as a final version in April 2009, insufficient data had been collected to illustrate the inconsistency of turbidity readings collected in September and October of 2008. When viewed against the backdrop of subsequent turbidity readings, the September/October 2008 readings appear anomalously high. Based on this fact and on the obvious turbidity sensor malfunction experienced by the field personnel on 8 October 2008, the September/October 2008 turbidity readings are considered suspect. As such, they should only be used for modeling and/or regulatory purposes with caution, if at all. Excluding these readings from analysis leaves a clear trend to date of slightly higher measured turbidity in upper Allison Creek than in lower Allison Creek.

Seasonally, turbidity measurements to date in the creek tend to range highest in August; this is expected, and is likely due to peak flows during that month (R&M, 2010). Turbidity is not an inherent property of water as is pH or temperature (Davies-Colley and Smith, 2001), and so it can be a useful indicator of the environmental health of a water body. Within the context of this study, it will be important to compare the potential effects of hydropower development at Allison Lake on turbidity within Allison Creek. Significant changes in this water characteristic as a result of development could be detrimental to the ecology of Allison Creek and its ability to support aquatic life. Additional study of the turbidity levels within Allison Creek will help to establish an adequate environmental baseline against which the potential effects of future hydropower development can be measured.

5.3 Biological Resources

5.3.1 Literature Review and Gap Analysis

In support of the permitting process for the Allison Lake Hydroelectric project the Hatch Acres team jointly conducted a review of the published literature and unpublished research reports on biological resources in the project area and subsequently prepared a gap analysis thereof. The goal of the analysis was to identify biological resources for which additional field studies may be required. The report that was prepared includes basic background information on life histories of fish and wildlife, a brief listing and summary of studies directly applicable to resources in the project area, and an assessment of gaps in current knowledge of resources in the project area. The analysis addressed fish and macro invertebrates, mammals, birds, vegetation, wetlands, and wildlife habitats. Field studies conducted in 2009 were pursued to help fill the identified data gaps. The results of the field studies are outlined in the section below.

5.3.2 Description of Study

Following the above described gap analysis, Alaska Biological Resources, Inc. (ABR) prepared a report, *Biological Resources in the Allison Lake Hydroelectric Project Area: 2009 Studies and Impact Analysis,* as a subconsultant to Hatch Acres in support of the FERC permitting process. This report, which is included herein as **Appendix F.2**, discusses the field studies conducted in 2009 to address the data gaps as identified in the above Literature Review and Gap Analysis section and report issued in 2008. The report summarizes available relevant information, including results of 2009 studies, for terrestrial mammal, bird, and fish species in the impact assessment area and, for those species identified as conservation priorities, presents a semi-quantitative, habitat-based assessment of potential impacts of the Allison Lake project. The report also addresses potentially affected vegetation, wetlands and wildlife habitats. The impact assessment area boundaries were defined as the assumed maximal distance of potential impact for any wildlife or fish species, resulting in inclusion of the entire upper and lower Allison Creek basin within about 1 mile of Allison Lake and the coastal portion of the Solomon Gulch drainage west of Solomon Gulch Creek. Marine habitats were excluded as not affected by the Allison Lake project.

5.3.3 Findings

Nearly all of Alaska's birds are protected under provisions of the Migratory Bird Treaty Act (MBTA). The only species exempt from the 'no-take' provisions of the MBTA are introduced and invasive species, such as Starlings in Alaska. Bald and Golden eagles and their nests are further protected by the Bald and Golden Eagle Protection Act. The Endangered Species Act (ESA) protects all listed and candidate threatened or endangered species, as defined by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS). In Alaska, Kittlitz's Murrelet is a candidate species for listing under the ESA (USFWS 2007a) and, on 2 October 2008, the USFWS announced that the Marbled Murrelet also is under review for listing. Eight additional bird species that are confirmed in the project area are considered high-priority species for conservation in Alaska.

Although not federally listed or candidate threatened or endangered, these species are of increasing concern because of low and/or declining populations or other population threats. These species of conservation concern are likely to occur in terrestrial and freshwater habitats in the project area during the breeding, migration, and/or wintering seasons.

Although few of the fish or mammal species likely to occur in the Allison Lake project area are considered priority species for conservation because of population declines or threats, most fish and many mammal species are of considerable conservation interest, largely because of their use in subsistence and/or recreational activities. The mountain goat, however, is considered a management indicator species by the U.S. Forest Service (USFS) and mountain goat habitats on USFS lands can be removed from logging plans. Other mammals also are of conservation interest to management agencies, largely due to the regulation of human harvest activities, such as sport hunting, trapping, and subsistence activities, which are managed by the Alaska Department of Fish and Game (ADFG). Similarly, freshwater habitats for fish are protected by many state and federal water-quality and fisheries-habitat regulations. Because of their importance in commercial, sport, and subsistence harvest, anadromous fish (salmon and some trout populations) are of particular conservation interest and development activities that could potentially affect anadromous fish streams are highly regulated by ADFG and NMFS. For a full discussion of the field studies results please reference the attached appendix.

5.4 Recreation and Land Use

Situated near Prince William Sound, the Project site is located on the opposite side of the sound due south of Valdez, Alaska. Valdez's proximity to the sound and Chugach Mountains provides many recreational opportunities. Recreational use near Valdez and the surrounding areas include: fishing, kayaking, canoeing, rafting, motor boating, sailing, hiking, skiing and cross-country skiing, snowshoeing, dog sledding, ice climbing, snow mobiling, biking, camping, and hunting. There are no water recreational facilities such as a boat dock at Allison Lake. The Project area is undeveloped. The closest facilities to the Project site include the Alyeska Pipeline Service Company (northeast of the Project site) and the Solomon Gulch Hydroelectric Project (due east of the Project site).

There are no current and future recreation needs near the Project site as identified in Alaska's State Comprehensive Outdoor Recreation Plan (2009, Irwin). There will be no future recreation constructed at the Project site. The access road to the Project site will remain restricted to CVEA personnel use only. These measures have been taken due to the Project site's proximity to the Alyeska Pipeline Service Company and Trans-Alaskan Pipeline. Signs will direct readers east to the Solomon Gulch Trail and Solomon Gulch Hydroelectric Project. Enhancement measures at the Solomon Gulch viewing area may be implemented to supplement additional activity to the area.

5.5 Archaeological / Historical Study

5.5.1 Description of Study

In order to assess the cultural, archaeological and historical character of the Project site, an extensive research program was undertaken by Northern Land Use Research, Inc. (NLUR) as a subconsultant Hatch Acres. The results of this study, included herein as **Appendix F.3,** are summarized below.

Cultural resources information available for Alaska resides in numerous sources, varies in quality and availability, and presents a sometimes daunting challenge for researchers to identify, locate, and summarize during the preparation of literature reviews such as the present report. Several articles in the Alaska Journal of Anthropology recently reviewed cultural resources research and anthropology research in Alaska over the last 30 years. All of these articles provided excellent reviews of several decades of recent research within particular sub-fields of anthropology. None of these sources identify research in Valdez Arm in general, or the Allison Lake vicinity specifically.

Cultural resource investigation reports from every community in Alaska are stored at the Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation, Office of History and Archaeology (ADNR, DOPOR, OHA)– the State Historic Preservation Office (SHPO), in Anchorage.

Previous research is often in the unpublished literature for a particular community. To identify these sources, it is common practice to locate a recent report, and then to examine the bibliography for references to earlier works. This "data mining" research methodology is necessary when so many of the source materials are unpublished, narrowly circulated, and ephemeral reports.

Published and unpublished sources of information pertaining to the cultural resources were examined within and adjacent to the project area. NLUR's in-house files and reports were checked for information relevant to Allison Lake. NLUR also searched the electronic card catalogs of the Alaska Resources Library and Information Services (ARLIS), UAA/APU Consortium Library, Loussac Public Library, Anchorage Museum at Rasmuson Center (AMRC), and the University of Alaska Fairbanks Library electronic card catalog "GOLDMINE". In addition, NLUR reviewed the U.S. survey plats for homesteads and Fort Liscum located within and adjacent to the project area (website accessed various dates, 2009, http://landrecords.alaska.gov).

5.5.2 Findings

There are no sites in the vicinity of the project area listed on the National Register of Historic Places.

The cleanup efforts following the Exxon Valdez Oil Spill (EVOS) included numerous cultural resources research studies (Mobley et al. 1990; Restoration Planning Work Group 1990; L. Yarborough 1997 and references therein). Post-EVOS research on subsistence included reports on specific communities, specific species or species groups, and long-term studies of the EVOS effects on subsistence (for example Fall et al. 1996; Picou et al. 2009; Fogarty et al. 2000; Simeone 2008; Fall 2009 and references therein).

The research results show that a total of four sites are known in the vicinity of the Allison Lake Hydroelectric project. Two of them, VAL-00054, Midas Camp and VAL-00093 Solomon Dam are within the Solomon Gulch hydroelectric project area and should not be affected by the Allison Lake project, if the sites still even exist. VAL-00055, Fort Liscum (Dayville) reportedly was completely demolished during the construction of the Alyeska marine terminal facility in the 1970s. It is possible that some features relating to the Fort and subsequent homesteading and cannery operations exist in upland areas. VAL-00090 Granby Roadhouse is listed in the AHRS on the basis of its presence on a 1923 National Geographic map (Smith 1974:67). Granby Roadhouse has never been field verified as to its location or condition.

The Alyeska marine terminal and TAPS pipeline are not listed in the AHRS. The TAPS pipeline crosses Allison Creek.

6. Conclusions and Recommendations

6.1 Conclusions

6.1.1 Engineering Studies

The conclusion gained from the engineering studies performed as a part of the present evaluation include:

- The Project is technically feasible.
- Of those technically feasible arrangements considered, **Alt 3c** consisting of a buried / surface penstock with a dam constructed to El 1420 appears to provide the lowest cost of power.
- The Project will fit well into the existing CVEA power system and will substantially reduce the amount of thermal generation that is required to meet system load.
- The technical challenges of the Allison Lake site add considerable cost of the Project.
- The Project would benefit from state or federal financial support.

6.1.2 Regulatory and Environmental Studies

The conclusion gained from the regulatory and environment studies performed as a part of the present evaluation include:

- Allison Lake does not support fish; there were no fish found during field studies
- The powerhouse would be located above the identified anadromous fish barrier in Allison Creek.
- Salmonids observed at the mouth of Allison Creek were determined to be strays from the hatchery located at the Solomon Gulch Project. No wild fish were observed during the two years of studies.
- Water quality is relatively consistent between upper and lower Allison Creek. CVEA will develop plans to protect water quality during construction.
- No habitats used by murrelets would be directly affected by the Project. The limited activities in the upper basin near the dam and upper penstock during project operation are anticipated to have no impacts on nesting murrelets.
- With appropriate restrictions of helicopter traffic, impacts related to behavioral disturbance of mountain goats should be minor or moderate during project construction.
- Access to lower Allison Creek is restricted by Alyeska. Informal use of the upper areas of Allison Creek for purposes of recreation does occur, however, due to the proximity to the Marine Terminal of the TAPS, no formal recreational facilities are proposed.
- The Project does not include any federal lands.
- The Project is not located within or adjacent to a National Wild and Scenic River, State-protected river segment, or designated Wilderness Area.

6.2 Recommendations

Based on the conclusions outlined above, CVEA would be well served to undertake the following:

- Proceed with the development of a FERC License Application for the Project based on **Alt 3c** to be submitted at the earliest possible date, but not later than, August 31, 2011 as follows:
  - As the designated non-federal representative to conduct informal endangered species consultation and Magnuson-Stevens Fishery Conservation and Management Act consultation, enter into consultation with the U.S. Fish and Wildlife Service and National Marine Fisheries Service to verify that the project would not affect protected species and identify any recommended measures to avoid any future effects
  - As the designated non-federal representative to conduct informal consultation with the State Historic Preservation Officer (SHPO) regarding Section 106 of the National Historic Preservation Act., conduct the survey recommended by the SHPO in the second quarter of 2010
  - Hold NEPA Scoping Meetings in May 2010 for purposes of discussing the Project and engaging the resource agencies and public in discussion of any potential project-effects
  - Develop any required protection, mitigation, and enhancement measures following the Scoping Meetings
- Include the following mitigation / enhancement measures in the FERC License Application:
  - A return flow outlet at the proposed dam to provide an ecological release to Allison Creek
  - A kiosk along Dayville Road to explain the Allison Lake Project and direct people to the Solomon Gulch Project for recreational activities
  - Proposed recreation facilities consistent with the needs of the area and practicable opportunities as provided by the Project.
- Support efforts to reclassify hydropower as "renewable" with reference to Federal grants and CREB financing
- Pursue other sources of funding at State level

7. References

1. HDR Engineering, Inc., Allison Lake Reconnaissance Study, prepared for Alaska Energy Authority, September 1992.

2. US Army Corps of Engineers, Electric Power for Valdez and the Copper River Basin, Interim Feasibility Report and Final Environmental Impact Statement, March 1981.

3. Schiff, Caleb. Thesis: "Late-Holocene temperature of Prince William Sound, Southern Alaska." 2006. Northern Arizona University. <http://oak.ucc.nau.edu/cjs235/AlaskaClimate/allison.html>