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Summit Street Dam

Hydropower Feasibility Study

Philmont, New York

Prepared for Elan Planning, Design, Landscape Architecture

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Saratoga Springs, NY 12866

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Table of Contents

1.0 BACKGROUND AND HISTORY 1
2.0 SITE EVALUATION 1
2.1 Head 2
2.2 Flow 3
2.3 Equipment and Efficiency 5
3.0 DEVELOPMENT OPTIONS 10
4.0 POWER AND ENERGY ESTIMATES 13
5.0 ENVIRONMENTAL AND PERMITTING 17
5.1 Environmental Impact and Regulatory Analysis 17
5.2 Permitting 18
6.0 FINANCIAL ANALYSIS 19
6.1 Cost Estimate 19
6.2 Value of Energy 20
6.3 Estimated Paybak Period and Return on Investment 21
7.0 DISCUSSION 29

Table of Figures

Figure 1. Overview of Net and Gross Head 2
Figure 2. Summit Dam Drainage Area (StreamStats) 3
Figure 3. Estimated Flow Duration Curves for Summit Street Dam. Data from Claverack Creek Gage and Moordender Gage; Normalized to Dam Location. 5
Figure 4 Overview of turbine types. 6
Figure 5. Crossflow turbine system. (www.water21.org/UK) 7
Figure 6. Francis Turbine (Lyndon 1916) 8
Figure 7. S-, Bulb, and Pit Turbines (with Kaplan runners), respectively (Voith 2015) 8
Figure 8. Turbine application chart. 9
Figure 9. Turbine Efficiency Chart (Johnson 2013) 10
Figure 10. Site overview. 11
Figure 11. Option 1 plan view. 12
Figure 12. Option 2 plan view 12
Figure 13. Option 3 plan view. 13

Figure 14. Annual Average Value of Energy Based on Review of RTLMP Historic Data. 21
Figure 15. Annual Net Revenue - Option 1, Wholesale Rates, No Grant Financing Proforma Results 25
Figure 16. Cumulative Net Profit - Option 1, Wholesale Rates, No Grant Financing Proforma Results 25
Figure 17. Annual Net Revenue - Option 1, Retail Rates, No Grant Financing Proforma Results 29
Figure 18. Cumulative Net Profit - Option 1, Retail Rates, No Grant Financing Proforma Results 29

Table of Tables

Table 1. Summary USGS Gages in Project Area 4
Table 2. Power Estimates by Development Option. 14
Table 3. Energy Estimates for Option 1 15
Table 4. Energy Estimates Option 2 and 3 16
Table 5. Summary Estimated Costs 20
Table 6. Option 1, Wholesale Rates, No Grant Financing Proforma Inputs 22
Table 7. Option 1, Wholesale Rates, No Grant Financing Proforma Results 23
Table 8. Option 1, Retail Rates, No Grant Financing Proforma Inputs 26
Table 9. Option 1, Retail Rates, No Grant Financing Proforma Results 27

1.0 BACKGROUND AND HISTORY

The Summit Street Dam is owned by the Village of Philmont and is located on the Agawamuck Creek. The Dam is constructed of dry laid stone with a concrete crest forming an overflow spillway section. The spillway is approximately 135 ft long and extends from a stone abutment at the left end of a rock outcrop. A sluice at the right end of the dam is controlled by stop logs and may act as a low level outlet. The stop log sluice entrance is constructed in the bedrock and water is controlled with stoplogs. The dam is approximately 21 ft high and has a maximum storage capacity of 264 acre-ft. [1]

The dam was constructed in approximately 1860 by the High Rock Knitting Company for industrial purposes. The Village of Philmont assumed ownership of the structure in 1975 and it is no longer used for industrial purposes. After the Village of Philmont acquired the dam, the impoundment was primarily used for recreational purposes; however, this is currently limited due to sedimentation issues.

There is a former mill building located downstream of the dam which appears to have formerly housed hydropower equipment. The building extends into the river and has a discharge arch which was likely acted as a tailrace, returning water from the turbine back to the river. The mill and former powerhouse are privately owned and not included in the Village's assets.

It is understood that the Village of Philmont is working on a project to develop a strategy for redevelopment of two potential brownfield sites that are located within the Summit Reservoir Revitalization Area. The primary community revitalization objectives include: creating a sustainable community in Philmont and the Summit Reservoir area, to minimize immediate and long-term impacts to the environment. The Village of Philmont is interested in investigating the micro-hydropower potential associated with the Summit Street Dam as one means of meeting their revitalization goals.

2.0 SITE EVALUATION

Hydropower generation is a function of head, flow available for generation and system efficiency. The site geometry and development option pursued will influence each of these variables and ultimately the power production.

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[1] Summit Street Lake Dam. USACE Phase I Inspection Report, National Dam Safety Program. New York District Corps of Engineers. March 1981.

A site visit of the project was completed on October 23, 2015. In addition to a general site walk, a limited survey was completed to better define the site geometry at the dam as well as downstream areas.

2.1 Head

The gross head available for power generation is typically a function of the difference in elevation between the upstream and downstream water surface elevations. Net head is what is available for generation and is broadly defined as the gross head minus the hydraulic losses throughout the system. The available head is both a function of the flow and hydraulic characteristics of the upstream and downstream channels, see Figure 1. If the tailwater level increases more in proportion to the headwater rise during high flow conditions, then the net head will decrease at these times. For the purposes of this preliminary estimate, the minor hydraulic losses through the system have been assumed to be 0.5 ft and net head has been assumed constant over all operational flow levels.

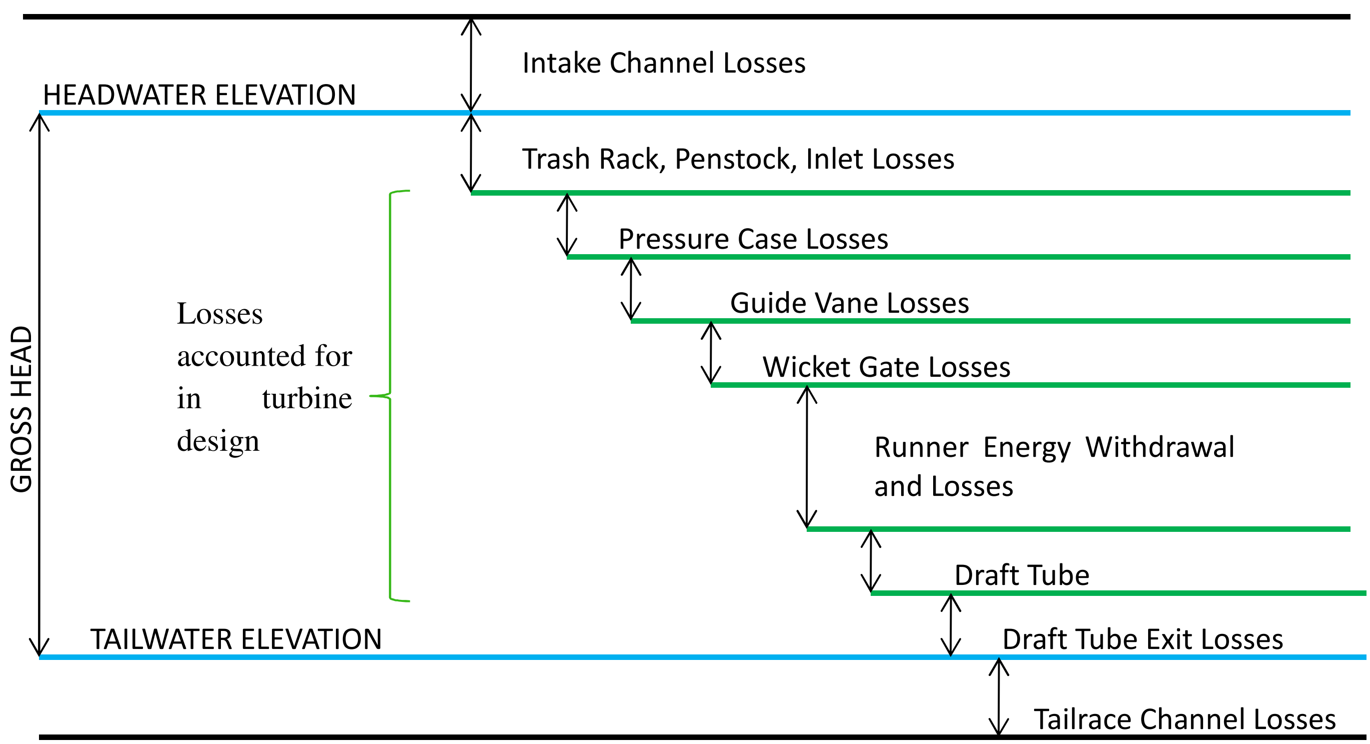

Figure 1. Overview of Net and Gross Head

The gross head at the Philmont project will be primarily dependent upon the location of the powerhouse. During the field visit, various water surface elevations were measured relative to the reservoir water surface elevation. Based on this, the elevation difference between the reservoir and the pool located at the toe of the dam was measured to be approximately 23 ft. The elevation difference between the reservoir and the pool located immediately downstream of the bridge was measured to be approximately 32 ft.

2.2 Flow

The available flow for hydropower generation is typically a function of the hydrologic characteristics of the drainage basin upstream of the hydroelectric project less any conservation flows that cannot be directed through the turbine. A drainage basin is the area of land that contributes water to a river. The basin can be characterized based on its land use (level of development), soil type and the slope of the terrain. The United States Geologic Service (USGS) StreamStats program was used to estimate the contributing drainage basin as 21.6 square miles see Figure 2.

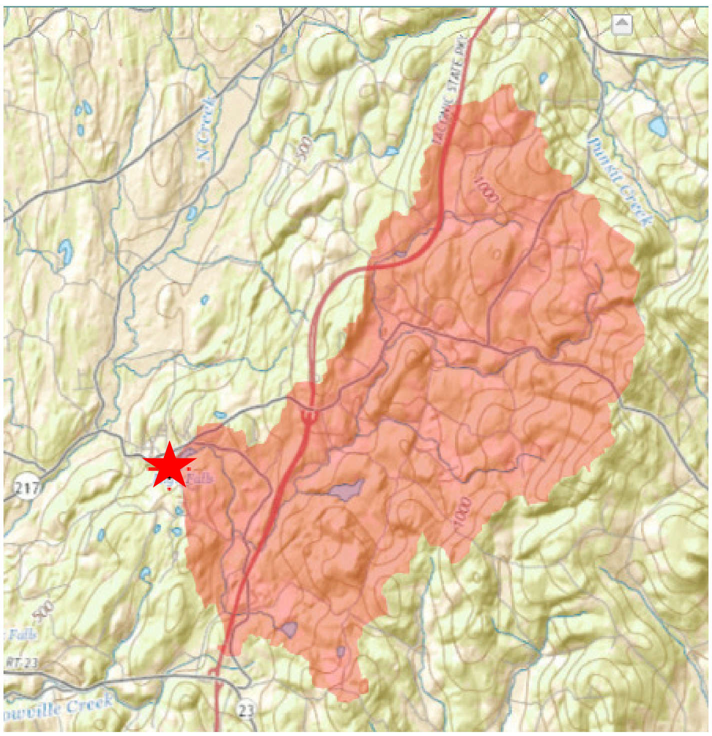

Figure 2. Summit Dam Drainage Area (StreamStats)

Historic flow data is typically available through USGS gaging stations. Ideally stations are located on the same river as the project and have a similar drainage area. This results in the same physical drainage basin characteristics and rainfall contributing to the USGS gage's flow estimates. When a gage is not located on the same river as a project or does not have a similar drainage area, other gages may be considered. In addition, an deal gage has a long period of record. A cursory review of the USGS gages indicated that there are none located on the Agawamuck Creek. The search was expanded to identify gaging stations within Columbia

County and the surrounding counties (similar terrain and land development) and gages with 10-35 square miles of contributing drainage area. The results are summarized in Table 1.

Table 1. Summary USGS Gages in Project Area

Gage No.	Location	Drainage Area (Square Miles)	Period of Record
01359133	Patroon Creek, Northern Blvd at Albany, NY	13.1	2002-2009
01359750	Moordender Kill at Castleton-On-Hudson, NY	32.6	1957-1995
01362100	Roeliff Jansen Kill Near Hillsdale, NY	27.5	1957- 1959
01364800	Saw Kill at Red Hook, NY	20.9	1959-1965
01372040	Crum Elbow Creek at Hyde Park, NY	17.3	1960-1962
01372051	Fall Kill at Poughkeepsie, NY	18.8	1993-1995
01372065	Casper Creek Near Wappingers Falls, NY	10.1	1969-1975
01372100	East Branch Wappingers Creek Near Clinton Corners, NY	33.6	1956-1963
01372300	Little Wappingers Creek at Salt Point, NY	32.9	1956-1975
01372400	Great Spring Creek at Pleasant Valley, NY	15.5	1960-1965

The majority of the gages located in Table 1 are of poor quality with a minimal period of record that does not reflect recent years. The Moordender Kill gage has 38 years of data but is not located within the same drainage basin as the project. The Claverack Creek at Claverack, NY has a USGS gaging station (No. 01361200) located downstream of the project that has a drainage area of 60.6 square miles and 35 years of data. This drainage area is considerably larger than the proposed project site; however, it is located within the same drainage basin.

A flow duration curve represents the relationship between the magnitude and duration of stream flows. Duration in this context refers to the overall percentage of time that a particular flow is exceeded. Flow duration curves were developed for the Claverack and Moordender gages and normalized to the project site using a drainage area ratio. The average of the two gages was used to estimate the flows at the Summit Dam as shown in Figure 3.

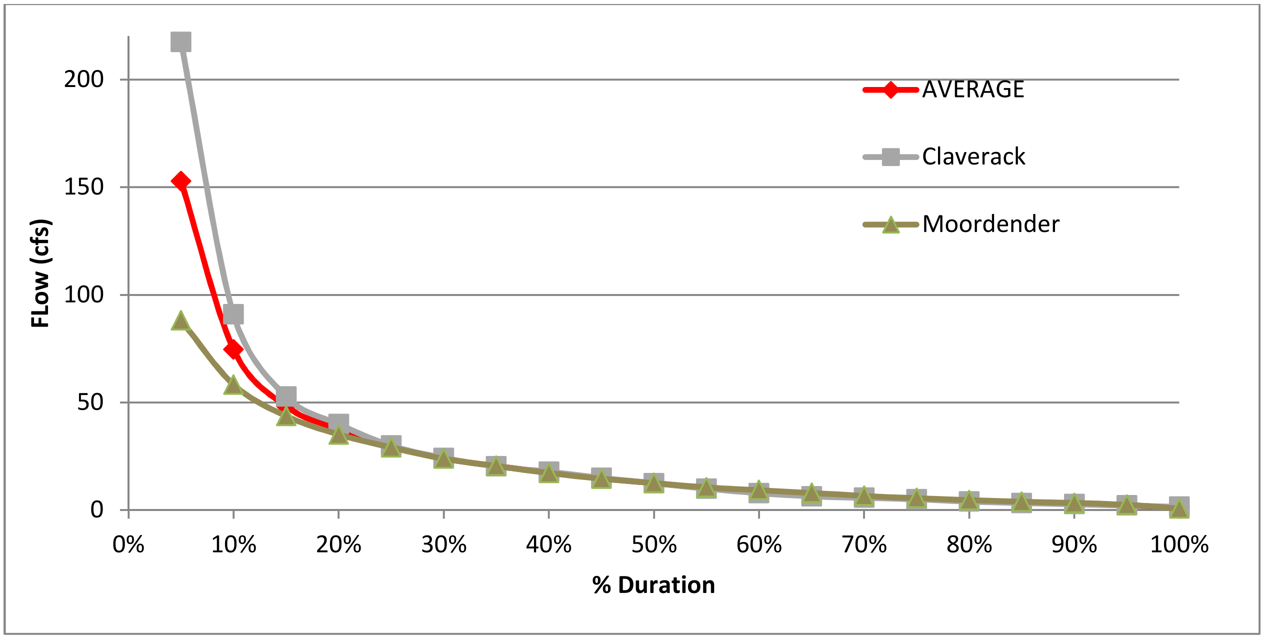

Figure 3. Estimated Flow Duration Curves for Summit Street Dam. Data from Claverack Creek Gage and Moordender Gage; Normalized to Dam Location.

Typically, the hydraulic capacity of a hydropower project is approximately the 25% duration flow. If the hydraulic capacity is increased, the project will produce more power but will operate less frequently throughout the year. Conversely, if the hydraulic capacity is decreased the power output will be reduced but the turbines will operate more frequently throughout the year. Ultimately, there is an ideal flow which will result in the maximum energy generation per year. At this evaluation stage, it will be assumed that the design flow at the project is 30 cfs which is the estimated average 25% duration flow.

There is a potential that during the permitting process, a minimum bypass flow will be required. This bypass flow will ensure that the bypassed section of river remains wetted during turbine operations. In some cases, a veil flow over the dam is required for aesthetic purposes as well. The need for bypass flows will be somewhat dependent upon the turbine installation location and feedback from resource agencies. At this time, bypass or conservation flows have not been considered.

2.3 Equipment and Efficiency

The efficiency of the system will primarily be dependent upon the type of turbine selected. Conventional hydroelectric turbines can be generally classified as impulse or reaction. There are fundamental differences between these types of turbines that define how water moves through the system and how energy is extracted. For a particular site, the turbine selection is typically dependent upon the net head, availability of flows, and physical requirements of the site. The general turbine types are summarized in in Figure 4.

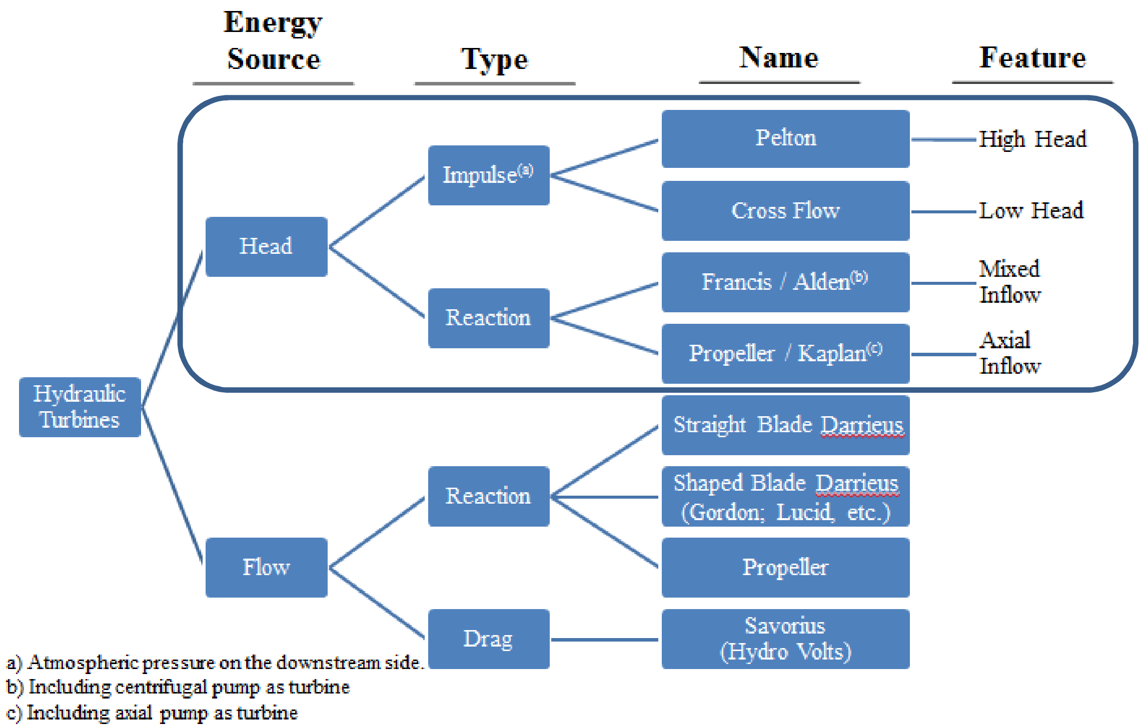

Figure 4 Overview of turbine types.

For each turbine type there is a flow and head range that it is best suited for operating in. Impulse turbines use the velocity of a jet of water to move a turbine runner and produce power. Typical impulse turbines include Pelton and Turgo and high head is required to form a suitable jet. The crossflow turbine (Figure 5) is an impulse variation which is suitable for low heads but tends to have low fish survival and will be challenging to permit in any environmentally sensitive areas.

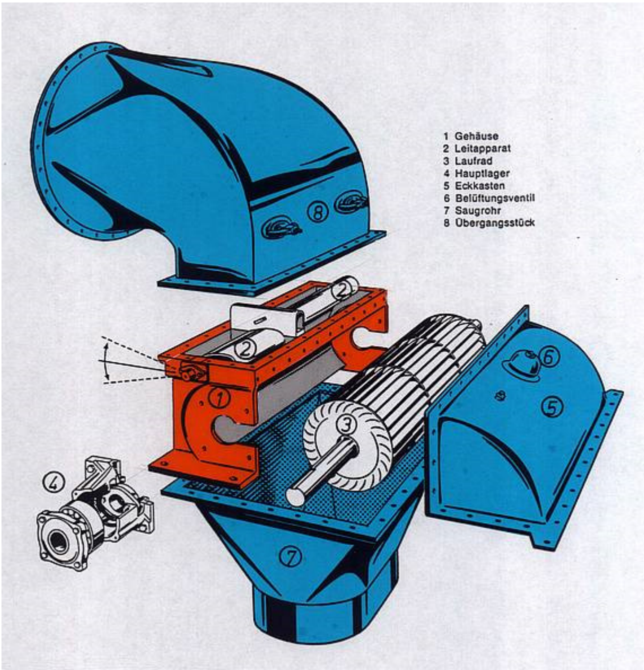

Figure 5. Crossflow turbine system. (www.water21.org/UK)

Any turbine where the water velocity accelerates relative to the runner is a reaction turbine. Typical reaction turbines include Francis, Kaplan, and Propellers. The Francis turbine is named after its original developer, James B. Francis; however, there have been numerous variations on the design since the 1800s. The turbine consists of a series of curved blades attached to a perpendicular top plate and skirt ring as shown in Figure 6. Due to the skirt ring reinforcement of the blades, they are firmly secured making the turbine capable of withstanding the pressures associated with high head. Francis turbines are suitable for lower head as well.

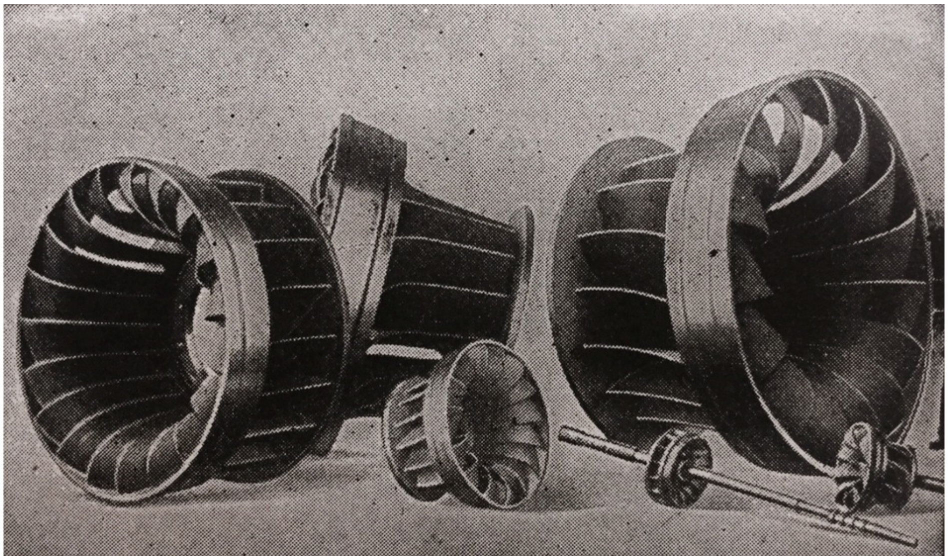

Figure 6. Francis Turbine (Lyndon 1916)

A Kaplan turbine resembles a ship's propeller albeit acting in reverse. The velocity of the water is relatively low as it enters into the scroll or pressure case and steadily increases as it approaches the turbine. Kaplan turbines are typically used when there is low head and high flow available.

There are numerous variations on the Kaplan turbine. A propeller turbine is similar in both geometry and theory of operation as a Kaplan turbine. However, a propeller turbine has fixed blades and will not operate over a wide range of flows. S-, bulb, and pit turbines are variations that all utilize a Kaplan turbine runner but with different installation and civil work approaches. See Figure 7. The S-turbine uses a curved tailrace to create space for the generator downstream of the turbine, while bulb and pit configurations encapsulate the generator upstream of the turbine. These variations are often used when space is limited and they can provide an overall cost effective means of project development.

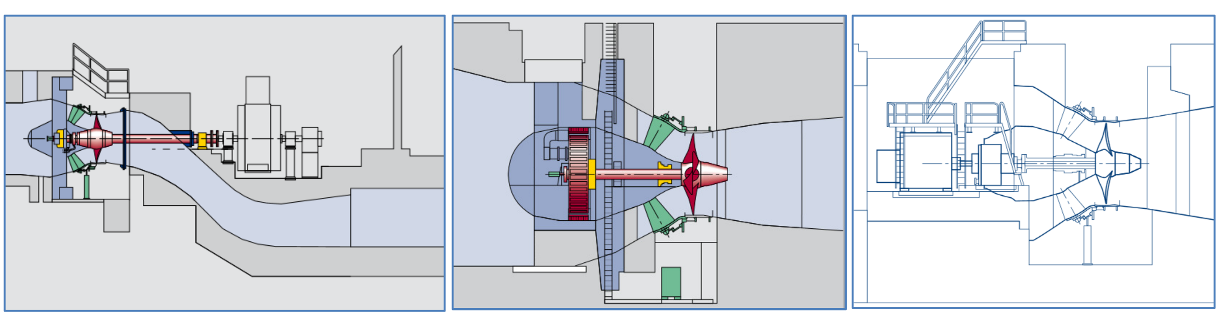

Figure 7. S-, Bulb, and Pit Turbines (with Kaplan runners), respectively (Voith 2015)

Figure 8 is a turbine application chart illustrating the head and flow ranges where each type of turbine is typically best suited. The chart is general in nature and the head/flow range of each turbine will ultimately be determined by the manufacturer.

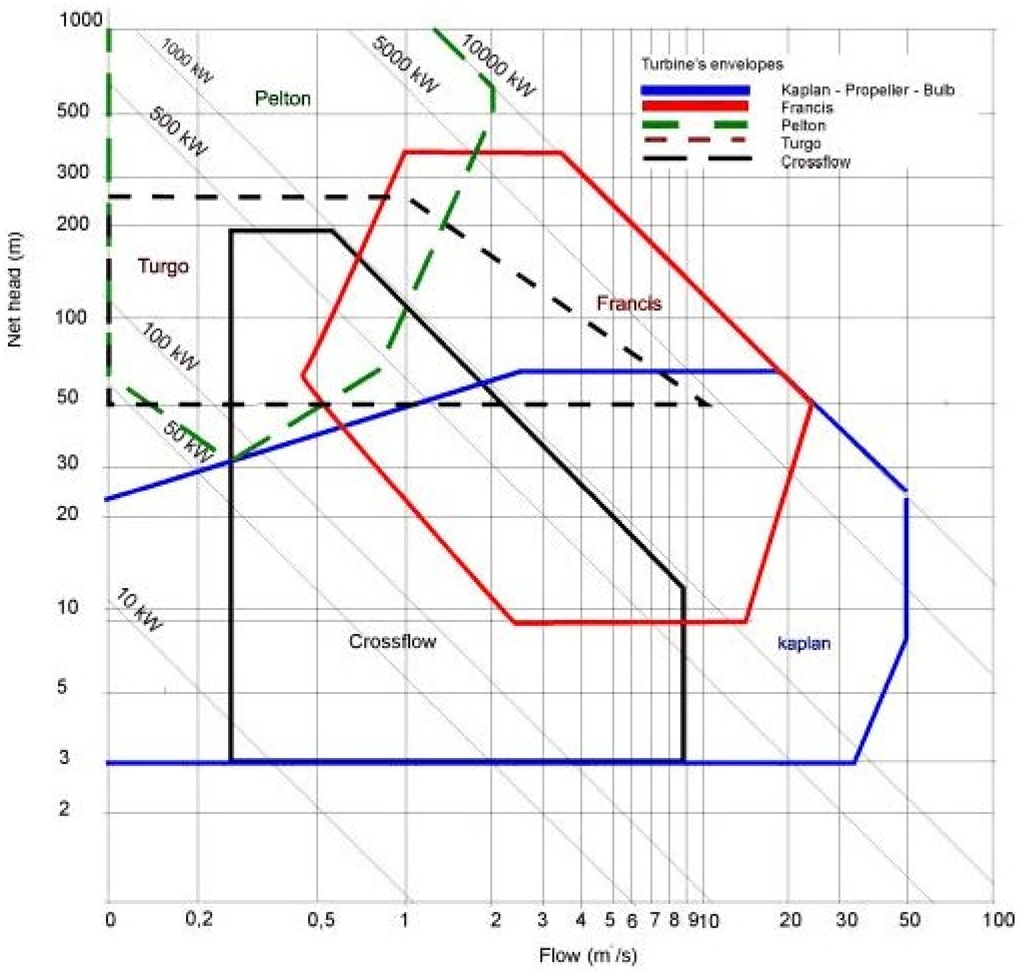

Figure 8. Turbine application chart.

Based on the head and flow characteristics at the site and the turbine application chart, the most suitable turbines would be a crossflow or Kaplan type. Although not indicated in Figure 8 a Francis unit may also be suitable.

When selecting a turbine, the efficiency and range of operations should be considered. A general turbine efficiency chart is presented in Figure 9. A hydropower turbine will operate over a range of flows from its peak hydraulic design flow to some fraction of that. Over the range of flows, the efficiency will vary as shown in Figure 9. Some turbines such as the full Kaplan and crossflow have a wide range of operations and maintain a relatively high efficiency while others such as the propeller have a very narrow range of operations and are best suited for sites which will have a steady flow throughout the year.

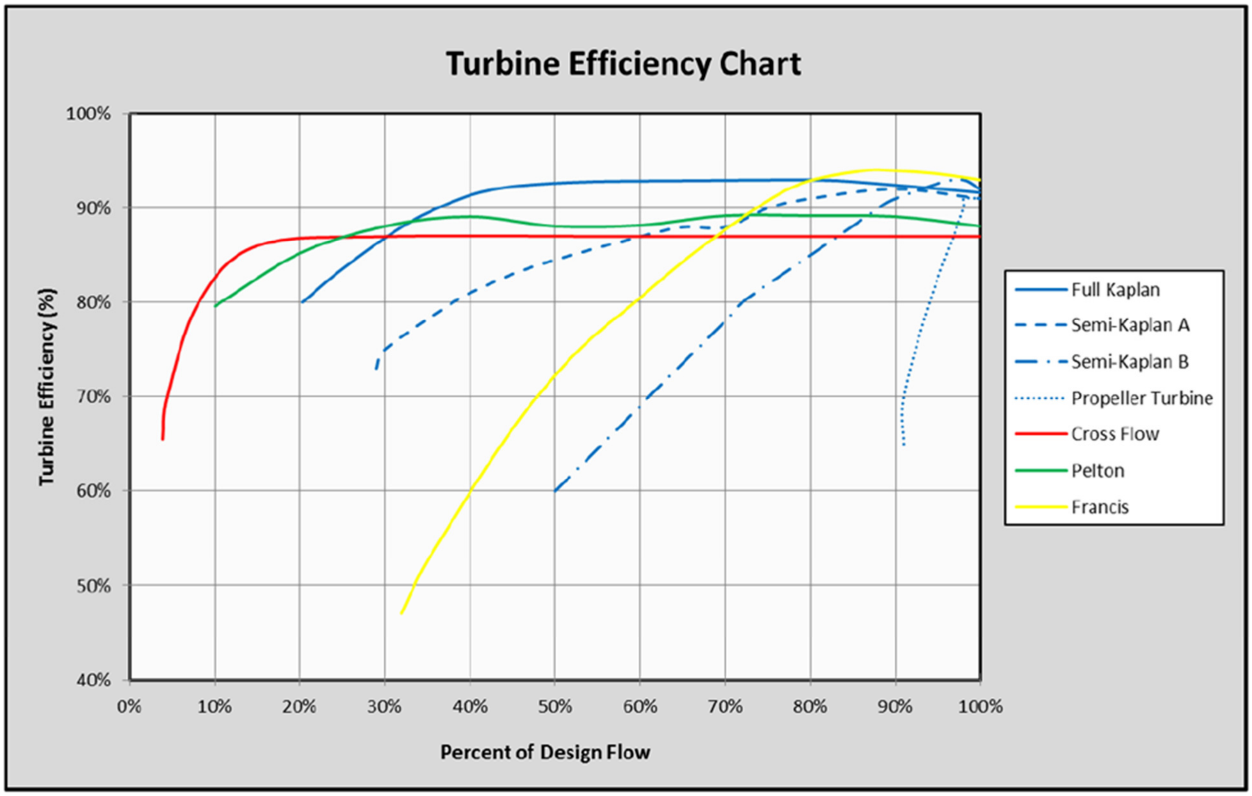

Figure 9. Turbine Efficiency Chart (Johnson 2013)

The peak efficiency of most conventional turbines is in the high 80% to low 90% range. However, there are additional efficiencies to consider such as the generator, transformers and other ancillary equipment. Overall, a reasonable overall efficiency to assume for the system is 85% at the design flow.

3.0 DEVELOPMENT OPTIONS

Based on a review of the project geometry, three potential development options were identified. The first options focuses on the installation of a turbine in the area immediately downstream of the dam. The second option focuses on rehabilitation and repowering of the former powerhouse and the third option consists of the construction of a new powerhouse in the area adjacent to the former powerhouse. Option 1 will have less head and produce less power and energy than options 2 and 3. Options 2 & 3 will have similar head, power and energy outputs. Option 1 will have the lowest cost while Options 2 and 3 will have higher costs since the penstock and transmission lines will be longer. It appears that Option 1 will be located on Town owned property while Option 2 and 3 are not, creating additional challenges. Options 2 and 3 will require the installation of a penstock approximately 100 ft in length to convey flow to the units. This penstock will either be routed under the bridge or tunneled through the right abutment. In either case, the long penstock will add significant cost to the project. Option 1 requires a penstock of approximately 15 ft. A site overview is presented in Figure 10 and the three options are presented in Figure 11, Figure 12, and Figure 13.

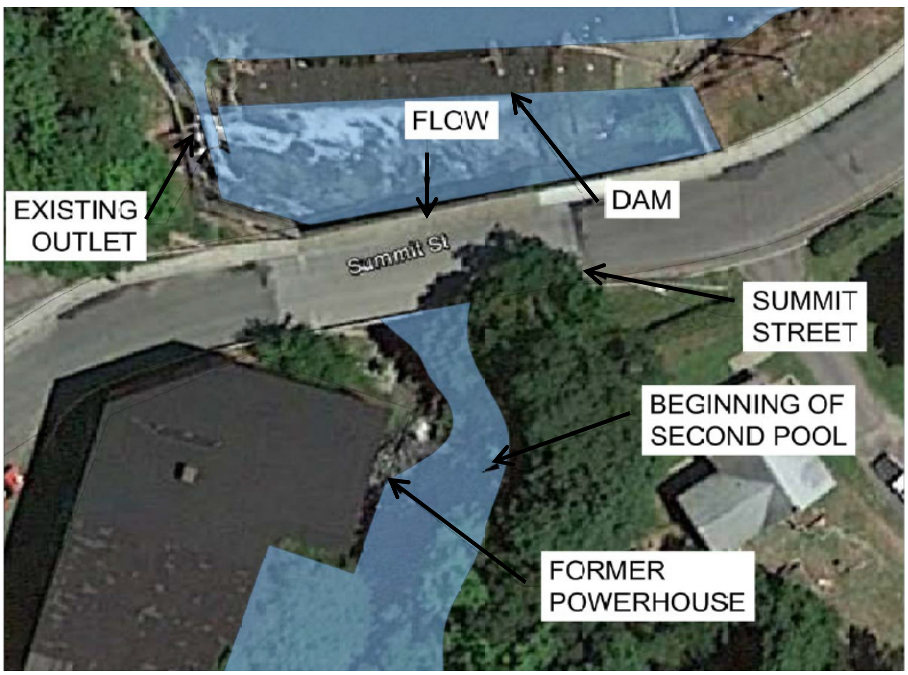

Figure 10. Site overview.

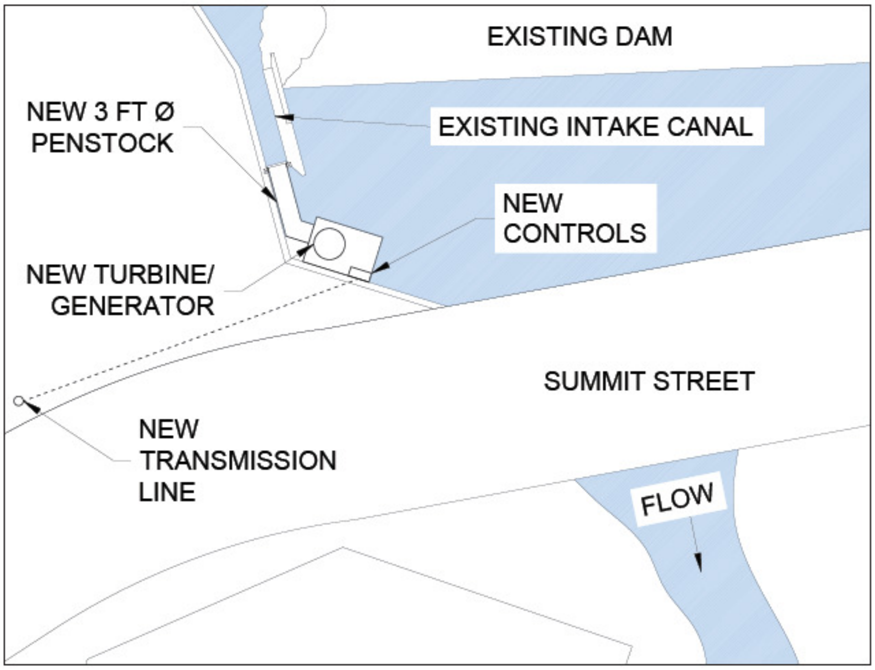

Figure 11. Option 1 plan view.

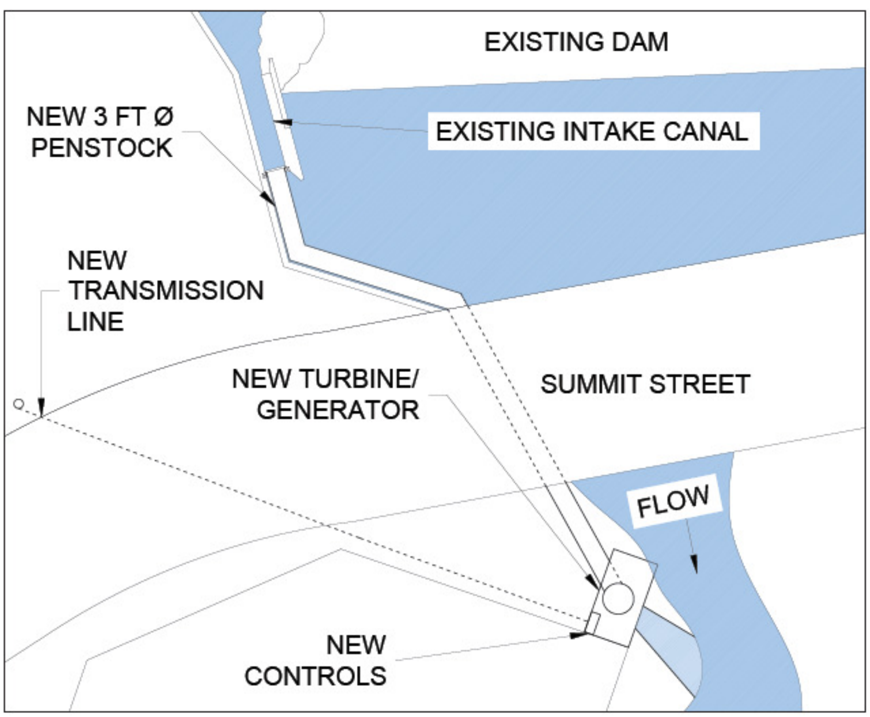

Figure 12. Option 2 plan view

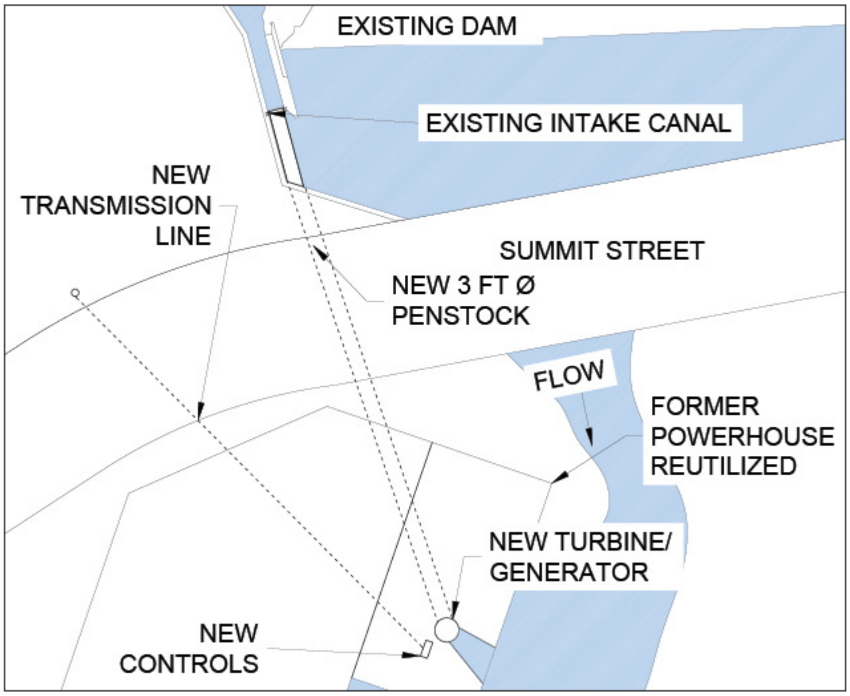

Figure 13. Option 3 plan view.

4.0 POWER AND ENERGY ESTIMATES

As mentioned, the power output of a hydroelectric project is a function of the design flow, head and system efficiency as described in Equation 1.

Equation 1:

$$P = \frac{QHe}{11.81}$$

Where:

P = power in kilowatts (kW)
Q = flow in cubic feet per second (cfs)
H = head in feet (ft)
e = efficiency (%)

Power is the instantaneous output from the turbines measured in Kilowatts (kW). Energy is the product of power over time and is measured in kilowatt-hours (kWh). Although power is important in that it contributes to the total energy, energy is the tangible product produced that has a financial value. Based on the head, flow and efficiency previously defined, power estimates have been estimated (Table 2). Options 2 and 3 have the same head while Option 1 has a different head. Therefore, Option 2 and 3 have been listed together since their power and energy estimates will be similar.

Table 2. Power Estimates by Development Option.

	Option 1	**Option 2 & 3**
Estimated 25% Duration Flow (cfs)	30	30
Estimated Net Head (ft)	22.75	32
Estimated Gross Head (ft)	22.25	31.5
Estimated Efficiency (%)	85	85
Estimated Power (kWh)	50	70

Based on the estimated head, flow, efficiency and power, the flow duration curve was broken into 20 discrete intervals and energy estimated. A summary of the estimated system performance during an average year is summarized in Table 3 for Option 1 and Table 4 for Option 2.

Table 3. Energy Estimates for Option 1

	Duration (%)	Site Flow (cfs)	Turbine Flow (cfs)	Head (ft)	System Efficiency (%)	Turbine Power (kW)	Energy (kWh)
1	5%	153	30	22.25	85%	48.0	21042
2	10%	75	30	22.25	85%	48.0	21042
3	15%	48	30	22.25	85%	48.0	21042
4	20%	38	30	22.25	85%	48.0	21042
5	25%	30	30	22.25	85%	48.0	21042
6	30%	24	24	22.25	85%	38.5	16866
7	35%	20	20	22.25	85%	32.7	14329
8	40%	18	18	22.25	85%	28.1	12292
9	45%	15	15	22.25	85%	23.7	10362
10	50%	13	13	22.25	85%	20.1	8790
11	55%	10	10	22.25	85%	16.5	7218
12	60%	9	9	22.25	85%	13.7	6003
13	65%	7	7	22.25	85%	11.5	5039
14	70%	6	0	22.25	85%	0.0	0
15	75%	5	0	22.25	85%	0.0	0
16	80%	4	0	22.25	85%	0.0	0
17	85%	4	0	22.25	85%	0.0	0
18	90%	3	0	22.25	85%	0.0	0
19	95%	2	0	22.25	85%	0.0	0
20	100%	1	0	22.25	85%	0.0	0
						Total	**186,100**

Table 4. Energy Estimates Option 2 and 3

	Duration (%)	Site Flow (cfs)	Turbine Flow (cfs)	Head (ft)	System Efficiency (%)	Turbine Power (kW)	Energy (kWh)
1	5%	153	30	31.5	85%	68.0	29790
2	10%	75	30	31.5	85%	68.0	29790
3	15%	48	30	31.5	85%	68.0	29790
4	20%	38	30	31.5	85%	68.0	29790
5	25%	30	30	31.5	85%	68.0	29790
6	30%	24	24	31.5	85%	54.5	23877
7	35%	20	20	31.5	85%	46.3	20286
8	40%	18	18	31.5	85%	39.7	17402
9	45%	15	15	31.5	85%	33.5	14670
10	50%	13	13	31.5	85%	28.4	12445
11	55%	10	10	31.5	85%	23.3	10219
12	60%	9	9	31.5	85%	19.4	8499
13	65%	7	7	31.5	85%	16.3	7133
14	70%	6	0	31.5	85%	0.0	0
15	75%	5	0	31.5	85%	0.0	0
16	80%	4	0	31.5	85%	0.0	0
17	85%	4	0	31.5	85%	0.0	0
18	90%	3	0	31.5	85%	0.0	0
19	95%	2	0	31.5	85%	0.0	0
20	100%	1	0	31.5	85%	0.0	0
						Total	**263,500**

5.0 ENVIRONMENTAL AND PERMITTING

5.1 Environmental Impact and Regulatory Analysis

A conventional hydropower project can have a variety of environmental resource including:

- Fish and Wildlife;
- Cultural;
- Recreation;
- Aesthetic; and
- Archaeological.

Section 4(e) of the Federal Power Act states that:

> "when deciding whether to issue a license, the Commission (FERC) must give equal consideration to development and environmental values. Environmental values include fish and wildlife resources, including their spawning grounds and habitat, visual resources, cultural resources, recreational opportunities, and other aspects of environmental quality. Development values include power generation, irrigation, flood control and water supply."

During the FERC licensing process (Section 5.2), consultation on the project must be completed with both the public and the relevant resource agencies. During the consultation environmental mitigations and studies will be requested. Anadromous and catadromous fish species require migration to complete their lifecycle and reproduce. Some hydropower dams can block or impede this passage and have significant impacts on fish populations. In addition, fish and other aquatic species may become impinged on the trash rack or entrained in the turbines resulting in injury or mortality. New construction can disrupt cultural and archaeological resources which are often found at or around riverbeds. Aesthetics, such as the visibility of a powerhouse or amount of spill flowing over a spillway may also be considered in conventional hydropower permitting. Rivers and waterways are often a location for recreational activities which can be impacted by the installation of a hydroelectric system. The installation and maintenance of recreational facilities (boat portage, maintenance of trails, picnic tables, etc) are required at some hydroelectric facilities.

The environmental impacts at the Summit Street Dam will likely be minimal since the dam and intake structure are already in service and a new dam will not be constructed. In addition, it appears that upstream migrating fish species (such as Atlantic salmon, shad, herring, etc) are not present at the dam as they are blocked by an approximately 200 ft high falls downstream of the project. Therefore, upstream fish passage will not likely be required by Agencies. It should be noted that sometimes fish passage is required for resident, non-migratory fish species. It is likely that some protection for downstream fish passage will be required to prevent impingement and entrainment of resident species in the turbines. Although no direct evidence was identified indicating that there are American eel in the waterway, it is likely that the species is present and will require protection. Downstream protection of eels can be incorporated into the fish protection system. However, there is a possibility that separate upstream eel passage will be required. Water quality must always be considered at hydroelectric projects. In some cases, water which flows through the turbines does not become as oxygenated as that which flows over the dam, impacting water quality. Typically the release of some water over the spillway will alleviate dissolved oxygen issues; however, spillway flow cannot be used for power generation. As part of the overall project underway in Philmont, a variety of improvements are being made to the reservoir and shoreline to improve recreation. It does not appear that safe boat portage could be installed; furthermore, it is not safe to encourage boating in the area downstream of the Summit Street Dam as it is over a high waterfall. There is potential that a minimum flow over the dam will be requested by stakeholders to create an aesthetically pleasing veil flow at the dam. Again, this water would not be available for power generation but serves as resource protection. There is always a possibility that Archaeological resources could be found during construction activities. However, the site has been previously disturbed numerous times (various bridge and dam projects) reducing the likelihood of disturbances.

5.2 Permitting

The permitting process to obtain authorization to construct and operate a hydropower project can be challenging and includes consultation with several Federal, State and local Agencies. Pursuant to Section 23(b)(1) of the Federal Power Act, 16 U.S.C. 817(1) (1982), a non-federal hydroelectric project must (unless it has a still-valid pre-1920 federal permit) be licensed by the US Federal government if it:

1. is located on a navigable water of the United States;
    - definition of navigable waters – nexus test
2. occupies lands of the United States;
    - if a project is built on federal land
3. uses surplus water or water power from a government dam; or
4. is located on a body of water over which Congress has Commerce Clause jurisdiction, project construction occurred on or after August 26, 1935, and the project affects the interests of interstate or foreign commerce.

- Fundamentally all projects, by virtue of either being connected to the electrical grid, or by offsetting electric consumption that would otherwise be purchased from a utility, are considered to affect interstate commerce.

The process of obtaining FERC authorization for a hydropower project is typically a multi-year process with numerous filings and meetings. FERC issues two types of authorization for conventional projects. A license is issued for a 30-50 year term while an exemption is issued in perpetuity. It should be noted that an "exemption" is a type of permitted authorization that includes some exemptions to parts of the Federal Power Act. During this process, stakeholders, including Federal and state agencies, are notified and can comment on the proposed project and/or request future studies. If the applicant chooses to proceed, FERC offers different licensing processes all of which include public meetings and consultation. Once filed in its final form, FERC will review the application and issue authorization for the project and provide the terms and conditions for the construction and operation of the project.

The FERC authorization cannot be issued until the state issues the Water Quality Certification (WQC) for the Project. A Section 401 WQC is required under the federal Clean Waters Act (CWA) for certain activities within wetlands and waters. A WQC is necessary to operate all hydroelectric projects and is a prerequisite for FERC approval.

Section 404 of the Clean Water Act - The USACE regulates the discharge of dredged or fill materials into Waters of the United States, including wetlands, under the jurisdiction of Section 404 of the CWA. Depending on the extent of thresholds triggered (i.e. volumes or areas of resource areas impacted) the permitting level can be higher or lower.

Some State permits may be required such as an inland waterways permit , historic properties review and interconnection applications.

6.0 FINANCIAL ANALYSIS

6.1 Cost Estimate

The itemized cost estimates for the hypothetical projects were made using costs from other projects, and best professional judgment. A high level cost estimate was completed for each of the three development Options. This is summarized in Table 5.

Table 5. Summary Estimated Costs

	Option 1	Option 2	Option 3
Mobilization	$ 5,000	$ 10,000	$ 10,000
Engineering	$ 30,000	$ 50,000	$ 70,000
Permitting	$ 40,000	$ 50,000	$ 60,000
Hydropower Equipment	$ 125,000	$ 175,000	$ 175,000
Penstock	$ 10,000	$ 25,000	$ 25,000
Powerhouse	$ 30,000	$ 30,000	$ 30,000
Excavation	$ 15,000	$ 15,000	$ 15,000
Tunneling	$ -	$ -	$ 15,000
Transmission Line	$ 15,000	$ 25,000	$ 25,000
Environmental Mitigations	$ 10,000	$ 10,000	$ 10,000
Contingency (25%)	$ 70,000	$ 97,500	$ 108,750
Estimated Total	**$ 350,000**	**$ 487,500**	**$ 543,750**

Based on the estimated costs and the additional challenges associated with Option 2 and 3 (property rights, proximity to bridge), only Option 1 shall be considered for pro-forma review.

6.2 Value of Energy

There are several ways to sell energy which will result in varying values. Power can be sold to the local utility based on real time locational marginal pricing (RTLMP) and considered wholesale rates. This RTLMP will vary regularly and the price re-calculated to reflect supply and demand. A review of the RTLMP values published by ISO NY was reviewed and the average annual value of energy calculated as illustrated in Figure 14. Between 2010 and 2015, the average RTLMP was $0.045/kWh.

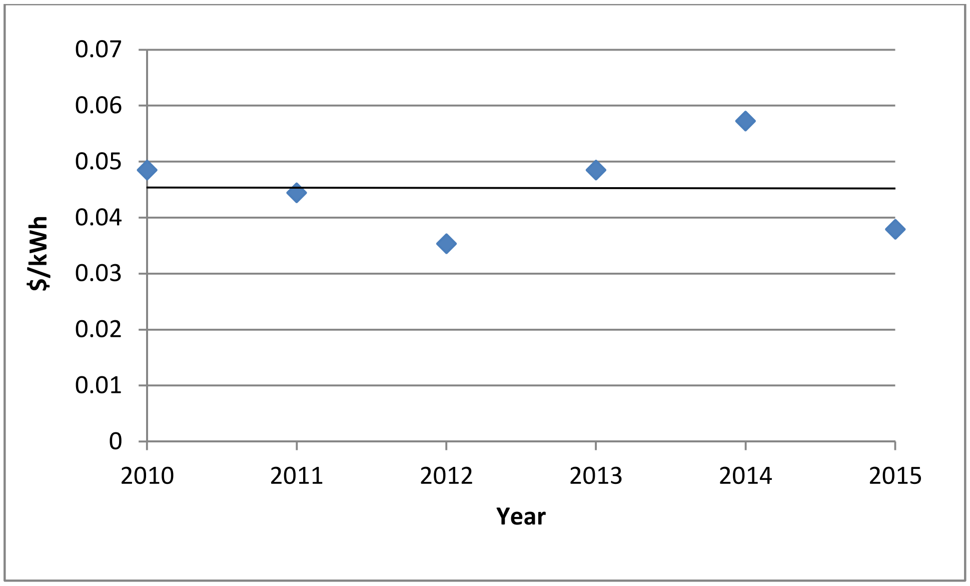

Figure 14. Annual Average Value of Energy Based on Review of RTLMP Historic Data.

New York permits the net metering of projects up to 2,000 kW. This means that the power can be generated at one location and the power utilized at a physically separate location. As such, the Town of Philmont could use the power generated to offset municipal demands. In this case, the value of the power is the equal to the cost of power which would have to otherwise be purchased and is known as retail rates. Retail rates are typically between $0.10/kWh and $0.20/kWh, which is significantly higher than wholesale rates.

In some cases, an additional value to the energy can be achieved by selling the renewable energy certificates (RECs) associated the energy generation. The value of these RECs varies by the market they are sold into (state) and whether the project has been certified as low impact. Due to market variations and the cost associated with RECs (difficult for small projects), RECs have not been included in the proforma at this time. The availability of REC markets for the project should be further investigated should the project move forward.

6.3 Estimated Paybak Period and Return on Investment

A high level financial review of Option 1 was completed. Preliminary proformas were developed and the analysis considered the power sales rate, power and cost escalation, and operations and maintenance costs, as well as finance rate and the financing term. The assumptions used are high level and the intention of the proforma analysis is to provide an order of magnitude understanding of the project potential prior to moving forward with any additional evaluations. It has been assumed that operations and maintenance of the project will not require new or dedicated staffing and that the Town's current municipal staff will be suitable. A proforma was completed assuming wholesale rates and separately retail rates. In the case of the wholesale rates, the financial performance is poor and the project not viable. The returns are negative and the simple payback period negative indicating that it will never make back its initial investment. With retail rates available (via net metering), the project finances significantly improve in that there is a positive net income each year; however, the payback period is still significant (46 years). Although the annual net revenue is not very large, it is consistently positive and the project gains value over time. Based on these two sets of results, alternative scenarios were run to understand the impact of both REC value and grant financing.

If with retail rates, RECs were available at ~$0.05/kWh, the payback period would change to 21 years. If with retail rates (no RECs), it would take grant funding of approximately $180,000 to reduce the simple payback period to less than 10 years. With retail rates and RECs, it would take grant funding of approximately $115,000 to reduce the simple payback period to less than 10 years. Table 6 through Table 9 and Figure 15 through Figure 18 summarize the primary financial analysis inputs and results.

Table 6. Option 1, Wholesale Rates, No Grant Financing Proforma Inputs

Proforma Inputs	
Draft	Option 1
Installed Capacity (kW)	50
Annual Power Generation (kWh/year)	181,000
Power Sales Rate ($/kWh)	$0.04
REC Sale Rate ($/kWh)	$0.00
Power Escalator (%/year)	2.0%
Operations and Maintenance Costs ($/year)	$3,000
General Costs ($/year)	$1,000
Costs Escalator (%/year)	0.035
Grant Financing ($)	$0
Total Borrowed Costs ($)	$350,000
Total Project Cost ($)	$350,000
Interest Rate (%)	2.00%
Financing Term (Years)	20

Table 7. Option 1, Wholesale Rates, No Grant Financing Proforma Results

YEAR	Initial Project Capitalization	1	2	3	4	5	6	7	8	9	10
Annual Power Generation (kWh/year)		181,000	181,000	181,000	181,000	181,000	181,000	181,000	181,000	181,000	181,000
Power Sales Rate ($/kWh)		$0.040	$0.041	$0.042	$0.042	$0.043	$0.044	$0.045	$0.046	$0.047	$0.048
REC Sales Rate ($/kWh)		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Gross Income		$7,000	$7,000	$8,000	$8,000	$8,000	$8,000	$8,000	$8,000	$8,000	$9,000
Operations and Maintenance Costs ($/year)		$3,000	$3,100	$3,200	$3,300	$3,400	$3,600	$3,700	$3,800	$4,000	$4,100
General Costs ($/year)		$1,000	$1,000	$1,100	$1,100	$1,100	$1,200	$1,200	$1,300	$1,300	$1,400
Total Escalated Costs ($/year)		$4,000	$4,100	$4,300	$4,400	$4,500	$4,800	$4,900	$5,100	$5,300	$5,500
	-$350,000										
Net Income (Without Annual Financing Costs-$/year)		$3,000	$2,900	$3,700	$3,600	$3,500	$3,200	$3,100	$2,900	$2,700	$3,500
Uniform Annual Financing Payment ($/year)		-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000
Final Net Income ($/year)		-$18,000	-$18,100	-$17,300	-$17,400	-$17,500	-$17,800	-$17,900	-$18,100	-$18,300	-$17,500
Cumulative Net Income ($)		-$18,000	-$36,100	-$53,400	-$70,800	-$88,300	- $106,100	- $124,000	- $142,100	- $160,400	- $177,900

YEAR	11	12	13	14	15	16	17	18	19	20	21
Annual Power Generation (kWh/year)	181,000	181,000	181,000	181,000	181,000	181,000	181,000	181,000	181,000	181,000	181,000
Power Sales Rate ($/kWh)	$0.049	$0.050	$0.051	$0.052	$0.053	$0.054	$0.055	$0.056	$0.057	$0.058	$0.059
REC Sales Rate ($/kWh)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Gross Income	$9,000	$9,000	$9,000	$9,000	$10,000	$10,000	$10,000	$10,000	$10,000	$11,000	$11,000
Operations and Maintenance Costs ($/year)	$4,200	$4,380	$4,500	$4,700	$4,900	$5,000	$5,200	$5,400	$5,600	$5,800	$6,000
General Costs ($/year)	$1,400	$1,500	$1,500	$1,600	$1,600	$1,700	$1,700	$1,800	$1,900	$1,900	$2,000
Total Escalated Costs ($/year)	$5,600	$5,880	$6,000	$6,300	$6,500	$6,700	$6,900	$7,200	$7,500	$7,700	$8,000
Net Income (Without Annual Financing Costs-$/year)	$3,400	$3,120	$3,000	$2,700	$3,500	$3,300	$3,100	$2,800	$2,500	$3,300	$3,000
Uniform Annual Financing Payment ($/year)	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	$0
Final Net income ($/year)	-$17,600	-$17,880	-$18,000	-$18,300	-$17,500	-$17,700	-$17,900	-$18,200	-$18,500	-$17,700	$3,000
Cumulative Net Income ($)	-$195,500	-$213,380	-$231,380	-$249,680	-$267,180	-$284,880	-$302,780	-$320,980	-$339,480	-$357,180	-$354,180

Levelized Power Rate ($/kWh)	$0.05
Present Value of the Net Cash Flow ($)	($350,000)
Uniform Annual payment	($21,000)
Simple Payback Period	-20.8

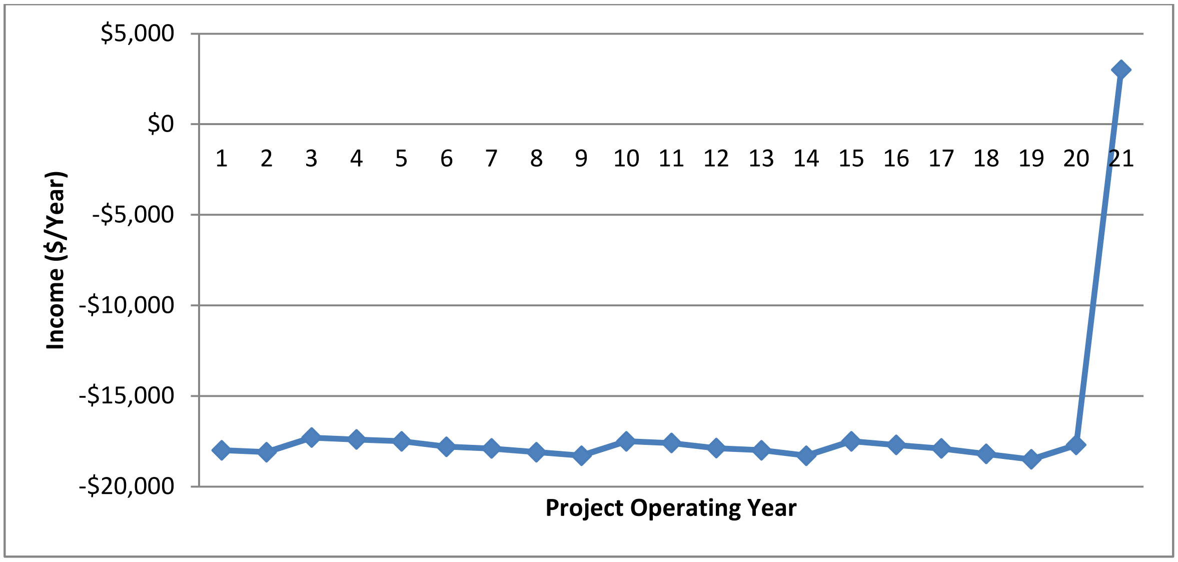

Figure 15. Annual Net Revenue - Option 1, Wholesale Rates, No Grant Financing Proforma Results

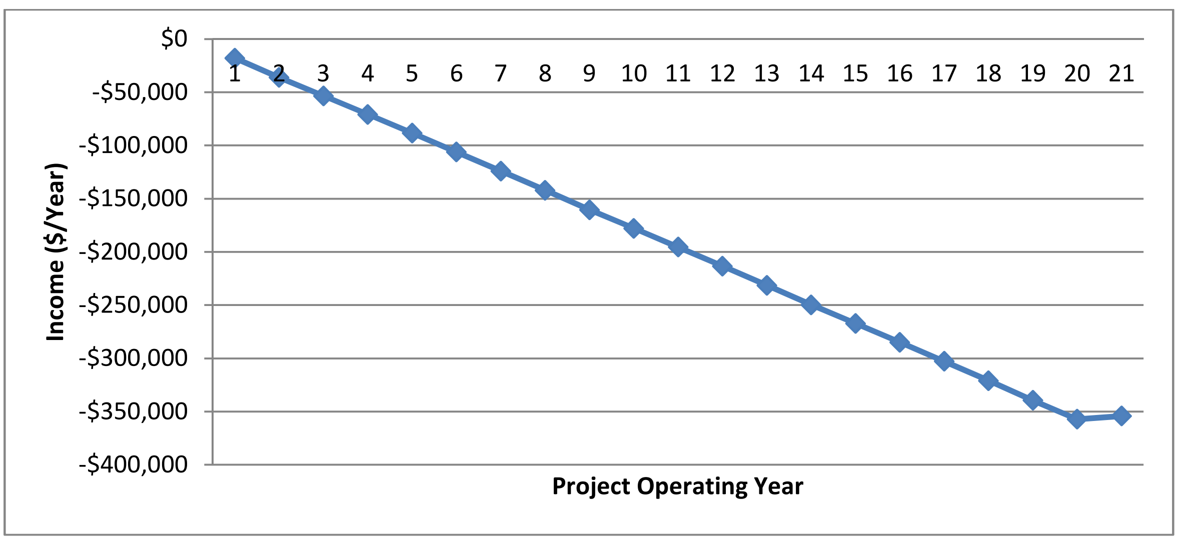

Figure 16. Cumulative Net Profit - Option 1, Wholesale Rates, No Grant Financing Proforma Results

Table 8. Option 1, Retail Rates, No Grant Financing Proforma Inputs

Proforma Inputs	
Draft	Option 1
Installed Capacity (kW)	50
Annual Power Generation (kWh/year)	181,000
Power Sales Rate ($/kWh)	$0.15
REC Sale Rate ($/kWh)	$0.00
Power Escalator (%/year)	2.0%
Operations and Maintenance Costs ($/year)	$3,000
General Costs ($/year)	$1,000
Costs Escalator (%/year)	0.035
Grant Financing ($)	$0
Total Borrowed Costs ($)	$350,000
Total Project Cost ($)	$350,000
Interest Rate (%)	2.00%
Financing Term (Years)	20

Table 9. Option 1, Retail Rates, No Grant Financing Proforma Results

YEAR	Initial Project Capitalization	1	2	3	4	5	6	7	8	9	10
Annual Power Generation (kWh/year)		181,000	181,000	181,000	181,000	181,000	181,000	181,000	181,000	181,000	181,000
Power Sales Rate ($/kWh)		$0.150	$0.153	$0.156	$0.159	$0.162	$0.166	$0.169	$0.172	$0.176	$0.179
REC Sales Rate ($/kWh)		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Gross Income		$27,000	$28,000	$28,000	$29,000	$29,000	$30,000	$31,000	$31,000	$32,000	$32,000
Operations and Maintenance Costs ($/year)		$3,000	$3,100	$3,200	$3,300	$3,400	$3,600	$3,700	$3,800	$4,000	$4,100
General Costs ($/year)		$1,000	$1,000	$1,100	$1,100	$1,100	$1,200	$1,200	$1,300	$1,300	$1,400
Total Escalated Costs ($/year)	-$350,000	$4,000	$4,100	$4,300	$4,400	$4,500	$4,800	$4,900	$5,100	$5,300	$5,500
Net Income (Without Annual Financing Costs-$/year)		$23,000	$23,900	$23,700	$24,600	$24,500	$25,200	$26,100	$25,900	$26,700	$26,500
Uniform Annual Financing Payment ($/year)		- $21,000	-$21,000	- $21,000	-$21,000	-$21,000	- $21,000	-$21,000	-$21,000	-$21,000	-$21,000
Final Net Income ($/year)		$2,000	$2,900	$2,700	$3,600	$3,500	$4,200	$5,100	$4,900	$5,700	$5,500
Cumulative Net Income ($)		$2,000	$4,900	$7,600	$11,200	$14,700	$18,900	$24,000	$28,900	$34,600	$40,100

YEAR	11	12	13	14	15	16	17	18	19	20	21
Annual Power Generation (kWh/year)	181,000	181,000	181,000	181,000	181,000	181,000	181,000	181,000	181,000	181,000	181,000
Power Sales Rate ($/kWh)	$0.183	$0.187	$0.190	$0.194	$0.198	$0.202	$0.206	$0.210	$0.214	$0.219	$0.223
REC Sales Rate ($/kWh)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Gross Income	$33,000	$34,000	$34,000	$35,000	$36,000	$37,000	$37,000	$38,000	$39,000	$40,000	$40,000
Operations and Maintenance Costs ($/year)	$4,200	$4,380	$4,500	$4,700	$4,900	$5,000	$5,200	$5,400	$5,600	$5,800	$6,000
General Costs ($/year)	$1,400	$1,500	$1,500	$1,600	$1,600	$1,700	$1,700	$1,800	$1,900	$1,900	$2,000
Total Escalated Costs ($/year)	$5,600	$5,880	$6,000	$6,300	$6,500	$6,700	$6,900	$7,200	$7,500	$7,700	$8,000
Net Income (Without Annual Financing Costs-$/year)	$27,400	$28,120	$28,000	$28,700	$29,500	$30,300	$30,100	$30,800	$31,500	$32,300	$32,000
Uniform Annual Financing Payment ($/year)	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	-$21,000	$0
Final Net income ($/year)	$6,400	$7,120	$7,000	$7,700	$8,500	$9,300	$9,100	$9,800	$10,500	$11,300	$32,000
Cumulative Net Income ($)	$46,500	$53,620	$60,620	$68,320	$76,820	$86,120	$95,220	$105,020	$115,520	$126,820	$158,820

Levelized Power Rate ($/kWh)	$0.18
Present Value of the Net Cash Flow ($)	$160,000
Uniform Annual payment	($21,000)
Simple Payback Period	46.3

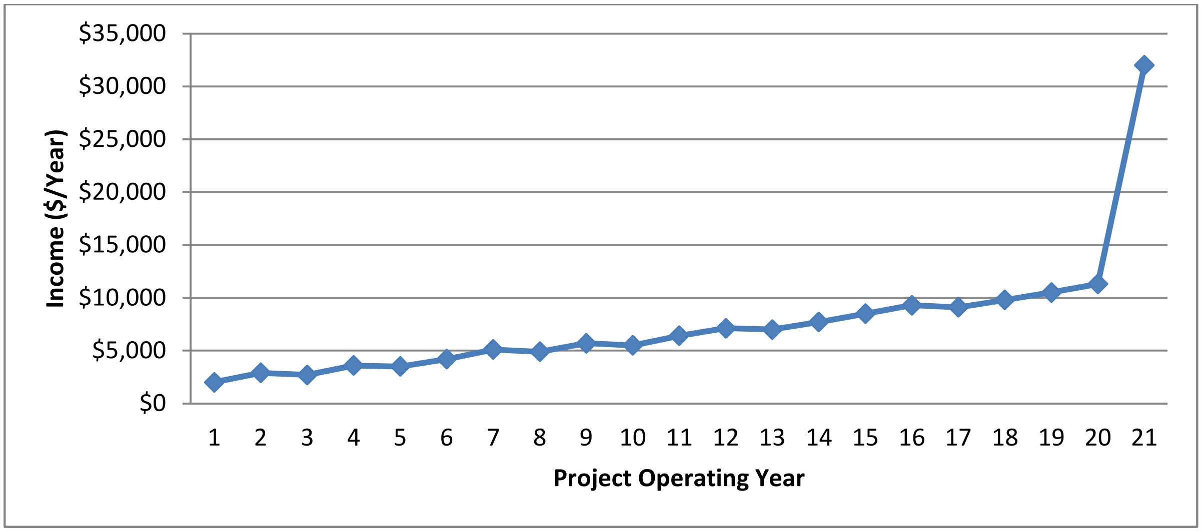

Figure 17. Annual Net Revenue - Option 1, Retail Rates, No Grant Financing Proforma Results

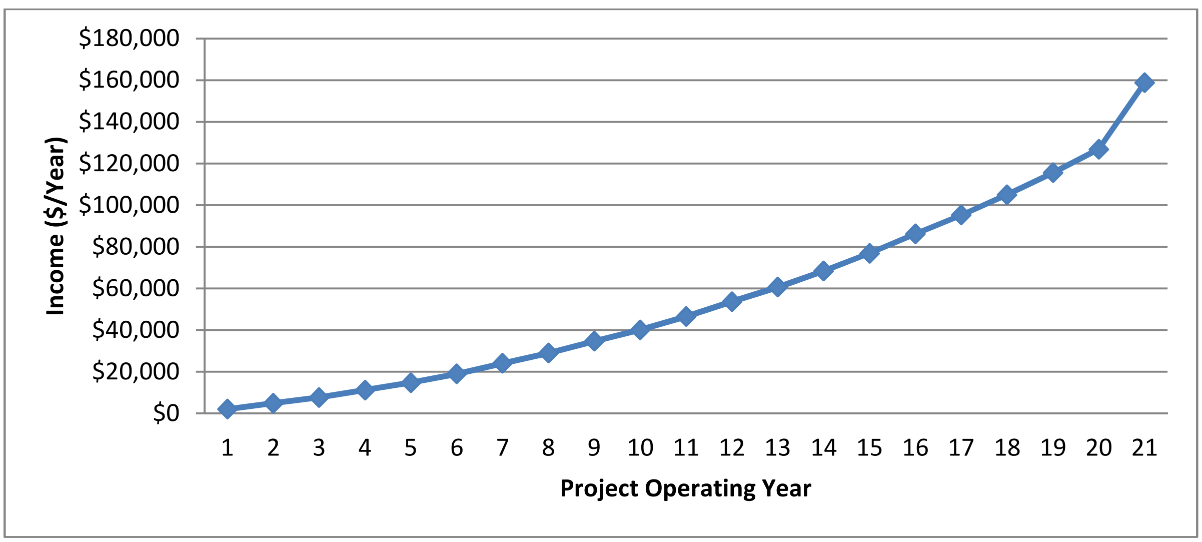

Figure 18. Cumulative Net Profit - Option 1, Retail Rates, No Grant Financing Proforma Results

7.0 DISCUSSION

The proposed hydroelectric project is technically feasible. There is evidence of historic hydropower generation and that it was the original purpose of the dam. The challenge with the project is making it financially viable. Under certain assumptions (wholesale power rates, no RECs, no grant funding) the financial return is poor and the project is not financially feasible.

With only retail rates (no RECs or grant funding), the project becomes financially positive. With RECs and/or grant funding combined with retail rates, the annual net benefit could be as high as $18,000-$25000/year during the finance period and $40,000 after the finance period. If the Town of Philmont is able to complete this hydropower project in conjunction with the other revitalization efforts, it is possible that the cost of the hydropower project could be reduced further benefiting the project economics. It is recommended that some additional design work is carried out on Option 1 to refine the layout and equipment. With that, a more detailed cost estimate can be developed. In addition, some additional research on the Town's municipal demands and the availability of retail would clarify the financial viability.