Hydro Electric Feasibility Study Report for Murray (Weimer's) Dam, Price County, Wisconsin

Price County Dams Committee
August, 2008

Contractor:
ENVIRONMENTAL / HEALTH PRODUCTS & SERVICE

Subcontractor:
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Date: August 1st, 2008

To: Price County Dams Committee
Mr. Bob Lepke, Dams Keeper

From: Rich Hackner, P.E.

RE: Hydro Electric Feasibility Study Report for Murray (Weimer's) Dam, Price County, Wisconsin

Committee members and Mr. Lepke, I have reviewed the above report and based on the available information and subsequent analysis agree with the conclusions and recommendation as they are presented.

If you have any questions or concerns please don't hesitate to contact me.

Sincerely,

Rich Hackner, Wisconsin P.E. License E-25012
GDS Associates

WISCONSIN
RICHARD J.
HACKNER
E-25012
WEST BEND
WIS.
PROFESSIONAL ENGINEER

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Executive Summary

Site Summary--Description of the Site

The Weimer Dam is located on the Elk River in Price County, Wisconsin. The dam has a head of approximately eight feet and is used to manage lake levels on Lac Sault Dore (Soo Lake). Weimer Dam Road provides access to the dam from the south, with the nearest major road being County Road W. The dam is approximately 750 feet from County Road W.

The dam is a concrete weir, approximately 100 feet across. The dam is manually operated by the Dams Keeper. A service light is supplied by the local electricity cooperative, Price Electric. The existing dam facilities have no electrical service.

The Price County Dams Committee and Dams Keeper Bob Lepke applied for and was awarded in mid 2007 a 50/50 cost shared grant by the State of Wisconsin, Department of Administration, Office of Energy Independence, Madison, Wisconsin ($ 7,500 maximum from the state, $ 15,000 total if fully matched by County funds). The purpose of the grant was to conduct a hydroelectric feasibility study on the Weimer's Dam, about 12 miles west of the City of Phillips, Price County, Wisconsin.

This study of the hydro electric generative capacity of the Elk River at Weimer's Dam was conducted to determine the estimated harvest potential of an otherwise unused energy resource. This feasibility study tried to determine the optimum size range of a hydroelectric installation, whether it is for continuous or intermittent generative capacity, whether it is sized for low flow generative capacity only or for multiple generators to accommodate generative capacity at low, medium and higher flows. Potential construction funding sources for such a project were explored together with potential payback period scenarios.

Primary Contractor: Represented by Mr. Kenneth E. Neu, MS

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EHPS Subcontractor: Represented by Mr. Richard Hasselman, Mr. Richard Hackner, PE

GDS Associates, Suite 212, 437 S. Yellowstone Dr., Madison, WI 53719 Ph: (608) 273-0182
GDS Associates is a professional energy engineering firm with at least eight (8) offices and over 100 engineers and employees across the United States. Their main focus is energy project engineering.

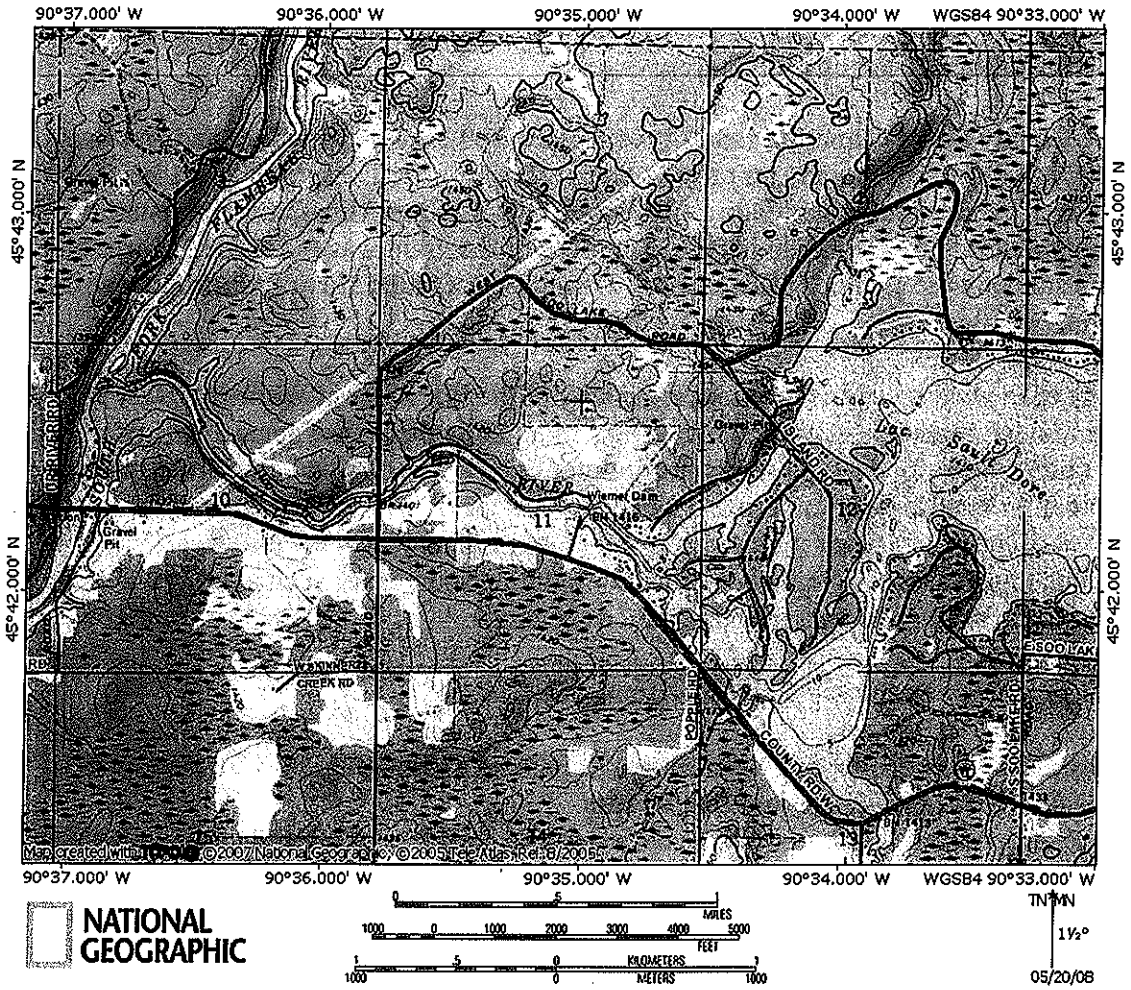
Hydro Electric Feasibility Study Report for
Murray (Weimer's) Dam, Price County, Wisconsin

The work product of this feasibility study is in a booklet format, entitled:

"Hydro Electric Feasibility Study Report for
Murray (Weimer's) Dam, Price County, Wisconsin"

Seven (7) final copies will be delivered to the Price County Dams Committee. After final approval of the Price County Dams committee, the committee will send at least three copies of the final report to the State of Wisconsin (Division of Energy, Office of Energy Independence). Delivery to the State will complete the grant agreement.

Map of Project Location



Overview of Market for Electricity

The Weimer Dam is located in the Price Electric service territory. Price Electric purchases wholesale electricity from the Dairyland Power Cooperative and distributes that electricity to its members. Price Electric is responsible for ensuring high quality, safe, reliable and reasonably priced electricity is provided to its members. Price Electric must comply with state law requiring minimum purchases of renewable electricity (the Renewable Portfolio Standard, or RPS), though the Dairyland Power Cooperative is currently responsible for providing that renewable electricity.

State law allows for customers of electric utilities to sell power to their local utility at retail rates. The term of "net billing" is typically used to describe that transaction. For systems up to 20 kW in capacity, utilities reimburse customers for electricity delivered to the utility distribution system at retail rates. In the case of Price Electric, these rates are 9.9 cents for the first 500 kWh each month and 9.4 cents for all kWh in excess of 500 kWh.

Price Electric has informed us that they are willing to offer Price County the opportunity to participate in net billing up to 40 kW in capacity. This generous offer allows for a larger renewable energy system to receive a very favorable price for electricity being produced. Most utilities in Wisconsin do not offer this opportunity.

If the customer of an electric utility wishes to provide power in excess of net billing amounts, the local utility can purchase that power at "avoided cost." Avoided cost is typically the wholesale rate for electricity and is much lower than the retail rate. Although less predictable than retail rates, Price Electric estimates that the wholesale price of electricity is approximately 5.7 cents per kWh. Thus, for the Weimer Dam site, a system in excess of 40 kW will suffer a significant economic penalty—meaning that Price Electric with only offer "wholesale" price for electricity above 40kW projects, versus offering "retail" price for electricity for 40kW or under projects.

Other options for selling electricity do exist. Technically, power can be sold across utility territories. However, in that case, the host utility and any utilities in-between, can charge a fee for the privilege of using the capacity of their electricity lines. The option to sell power across utility territories is only realistic for very large electrical generators able to produce power cheaply enough to overcome the costs of selling power to utilities other than the host utility. Typically, the developers of such projects engage utilities in a negotiated Power Purchase Agreement (PPA). There is no obligation for a utility to accept electricity at a rate that makes a project profitable for the developer. Examples of electricity developments that could engage in PPA negotiations could include a large natural gas powered electricity plant or a large wind farm. This option will be infeasible for a facility at the Weimer Dam.

For the Weimer Dam and Price County, the best pricing option with the lowest transaction costs is likely to be with Price Electric at the net billing rate. If a system larger that 40 kW is developed, the development effort will require extensive negotiations with Price Electric and Dairyland Power Cooperative, significantly increasing the costs and economic uncertainties of the project.

Other than the sale of electricity, renewable energy projects can create value through the development of "green tags" or some other measure of the environmental benefit created by the generation of renewable energy. In Wisconsin, utilities trade Renewable Energy Credits (RECs) to ensure compliance with the RPS. Green tags and RECs are methods of separating the physical electricity product from the environmental benefit, potentially allowing for greater value for the electricity than would be available if the electricity and green tags are combined. The current market for green tags is fairly flat. For small renewable energy projects, they are competing with large wind projects and other large generators of renewable electricity. Further, the cost of certifying green tags can be relatively expensive for small renewable energy projects when compared to larger projects. The value of these green tags has been low, with a *retail* value of 2.0 cents per kWh as typical, which means the price offered a seller will be substantially less.

An additional issue with green tags that *could* impact a potential hydroelectric project at Weimer Dam is whether or not Price Electric intends to use the electricity for compliance with the RPS. Since Price Electric is offering a very favorable rate in excess of the required net billing level (40 kW vs 20 kW), Price Electric may be expecting to retain any RECs or green tags for the electricity. In that case, Price County would not have additional green tags to sell. Determining Price Electric's plans is beyond the scope of this study, but is a factor that could impact the sale of potential green tags. That said, the cost of certifying and marketing the green tags will undercut the ultimate value of the tags. We estimate that green tags will have little impact on project economics, whatever the outcome.

Overview of Economic Feasibility

A hydroelectric project provides economic value by either providing power to an electric utility or by meeting the internal power needs of a host facility. In the case of the Weimer Dam, there is little or no electricity load. Thus, the vast majority of electricity will be exported to Price Electric. Based on the price per kWh offered by Price Electric and the various options for system sizing and performance (explained in detail, below), a hydroelectric project at the Weimer Dam is economically feasible. If bank loan financing is utilized to fund the project, it may seem as though the project is only marginally economically feasible. As will be explained in text and tables, a brighter outlook could be taken if the project avoided bank financing charges and utilized the counties general tax fund to pay for the project.

The chief limiting factor for electricity production is the very low head behind the dam. For calculation purposes throughout this report, an eight (8) foot head was used. It is estimated that the head can vary from approximately 6 feet at high flows, high tailwater to 10 feet at low flows. Despite a significant flow of water, the ultimate kWh's being produced does not overwhelmingly overcome the significant capital costs required to build the project. A second challenge related to the low head of the dam is that large systems quickly become infeasible due to very large pipe diameters required to capture the water flow.

The outcome is that a system of 40 kW is optimal, with two 20 kW turbine/generators providing the power. Even with the optimal system, the system can achieve positive cash flow only if the Dams Keeper's labor time is counted as an additional expense (about 1 hour per day, 365 days per year). *If the Dams Keeper's time is counted as an additional expense (NOT included in annual operating costs), AND there are NO financing charges, the system can produce income*

for the county. If no loan was taken and the project was funded entirely from the general county tax fund, financing charges would be eliminated, and an annual income to Price County of over $ 14,000/yr could be realized for the 40kW system.

However, if a loan was taken out for the entire project cost for a 40kW system, the system may be able to cash flow between $2,000 and $5,000 per year during the loan period, depending on the financing arrangements. This is based on the assumption that a loan is taken for the entire project amount and loan duration. After the loan was paid off, the County would have income of over $ 14,000/yr for the 40 kW hydroelectric system. (Higher amount if Price Electric increased future net metering rate)

If Price County were to take a loan for this project for an investment of $160,000 for the Weimer Dam hydroelectric project, the annual return on investment amounts to about 1 to 3 percent. A bank's certificate of deposit offers similar or better returns at much lower risk.

A final consideration for the economic feasibility of developing a hydroelectric project at the Weimer Dam facility is the market for the system components. The demand for hydroelectric components has increased substantially in the last few years. The manufacturers we spoke with expressed substantial skepticism at developing a project with an eight foot head, despite the water flow. Most indicated they had "moved out of" the micro hydro market (the Elk River at Weimer Dam is considered, for hydroelectric development purposes, "micro-hydro" in size) and were concentrating on small scale or even large scale hydroelectric projects. We were able to locate only one vendor who offered to supply a turbine/generator package in the size ranges appropriate for the Weimer Dam.

It is possible that the market environment for developing a hydroelectric project at the Weimer Dam will improve in the future. In order to prepare for that potential, we recommend beginning to develop a dataset of actual stream gauge measurements at the Weimer Dam. If the market improves, the dataset can be used to "true-up" this feasibility study and provide new information to inform development decisions.

An engineering firm specializing in micro-hydro projects and equipment was asked to provide an equipment breakdown of costs for a potential 40 kW project using a single turbine. Although using two 20 kW units may provide an increased utilization of available flow at low flow periods of the year, and may be simpler to control, the costs for two turbine sets will be higher.
As of August 5, 2008 we have not received this detailed equipment cost projection. We anticipate the cost information will arrive and we will provide an addendum to this report when the projected cost breakdown is received from the firm requested to provide this information.

We recommend the next steps to continue on with the Weimer Dam Hydroelectric Project:

1) Install a gauge station; begin to monitor actual flow based on "industry best practice".
2) Begin the process of FERC licensing or permit waiver
3) Conduct a brief feasibility study using the collected stream gauge and/or flow data
4) Update Price Electric power prices and project revenue
5) Request quotes or go out to bid to project developers if the updated feasibility study with actual stream gauge or actual flow measurements supports a project

A separate memo details "next steps" options to accomplish the above goals, projected costs & grant funding options that might be available to reduce cost of continued work on the project.

Description of project area

Price County and the area surrounding the Elk River Watershed

Price County is located in the northwestern portion of North Central Wisconsin. The County is roughly 31 miles wide (east to west) and roughly 41 miles long (north to south) or about 1275 sq miles. The Elk River is fully contained within the boundaries of Price County & lies entirely within the Northern Highland physiographic province of Wisconsin in Hydrologic Unit 0705003-020. The Elk River is within the Upper Chippewa River Basin, within the Mississippi River watershed.

The topographic landscape is irregular, shaped from past glaciations. The Elk River Watershed is primarily wooded with many swamps; pitted outwash plains predominate. Many of the swamps, marshes, and lakes within the watershed have poorly developed drainage patterns.

The climate is typically continental. The 1989 Floodplain study references data from 1974 National Oceanic and Atmospheric Administration records as January average temperature of 11 degrees F, with 68 degrees F as average July temperature (80 F max). Average annual precipitation is listed at 34 inches per year. (During the past 34 years average temperatures and precipitation may have changed somewhat).

The undeveloped floodplains of the watershed exhibit bottomland tree and scrub species such as willow, aspen, red maple, white birch, tamarack, black ash, and tag alder. There are also open sedge areas. The upper lands within the watershed contain a diverse population of both deciduous trees and conifers of all age categories, as most of the government lands and much of the private lands are managed for their forest content. The watershed area contains a diverse population of wildlife and bird species as a result.

A large area of Price County (20.2 % of the county's land area, or nearly 170,000 acres) encompasses the Elk River drainage basin or watershed. The concentration of developed shoreline is moderate to high on over half of the lakes within the watershed. There is an ever-increasing water-related resource use pattern, and pressure to develop river segments and lake and flowage shorelands that are not already developed. Many seasonal cottages around lakes have been converted to year-round residences. The year-round population of the county is around 16,000 people. It is estimated that about 1/3 of that population lives within the Elk River watershed. It is estimated that at times during the peak summer recreation season, the watershed estimated summer population could be from 8,000 to near 10,000 people.

About the Elk River Watershed

The Elk River watershed is part of the South Fork of the Flambeau River Watershed. The South Fork Flambeau watershed is about 615 sq miles. According to data listed in the 1989 Elk River flood study, the watershed drainage area is 257 sq miles, or about 41.8 % of the area of the South Fork Flambeau watershed. Weimer dam is only about one mile from where the watershed ends. Therefore, the "effective watershed" upstream of Weimer dam is about 255 square miles, as listed in the 1989 floodplain study. The Elk River is the largest tributary of the South Fork of the Flambeau River.

The main channel of the Elk River is about 42 miles long in total. It is composed of several branches that feed the main stem. The river headwaters are formed from a series of springs and wetlands drainage in the eastern portion of Price County. It stretches from near the eastern border of the county (27 miles northeast of Phillips) to 12 miles west of Phillips. The shoreline of the river is predominantly in its natural state, with the exception of the shores of the lakes and impoundments along its length. Water flow is from the northeast toward the southwest. The end of the Elk River watershed is the confluence of the Elk into the South Fork of the Flambeau. The North and South forks of the Flambeau join in Sawyer County; the Flambeau joins the Chippewa, the Chippewa flows into the Mississippi.

Elk River Watershed Background

The Elk River Watershed is in the middle of Price County and accounts for about 20.2% of the area of Price County. The City of Phillips (population 1600) is located close to the center of the county; it is the county seat and the third largest community in the Upper Chippewa Basin. Phillips borders the main stem of the river and is situated just west of the center of the watershed. The City wastewater treatment plant is designed to discharge about 254,000 gallons per day of highly treated water into the Elk River. In addition, two industries discharge about 44,000 gpd of cooling water into Elk River. (Upper Chippewa River Basin report, 1980)

In the mid to late 19th century, the City of Phillips was nearly twice its current population. Phillips was a major lumber town on the edge of the cool and majestic virgin pine forests. The Flambeau and Elk River system served as the major transportation artery to float pine and other species to mills in and near Phillips. Near the close of the 19th century, a fire destroyed much of the City of Phillips. Lumber mills rebuilt, but the virgin pine resource was severely depleted by that time. Logging of virgin timber forests in Price County ended in the late 19th and early 20th century.

Since the forests had been cut over, and other modes of transport became available to move second growth logs from woods to mills, the river was no longer needed as a transportation artery. A very distinctive and interesting feature of the Elk River Watershed is that most of the larger water bodies in the watershed are not lakes at all, but wide spots in the contiguous river system. These wide spots were further enhanced with a series of dams built in the 1930's as public works projects during the depression years. The county owns the dams that form wider flowage-type bodies of water on the river. These bodies of water are identified on maps as lakes, and are contiguous with the Elk River and its tributaries. Most of the larger impoundments have moderate to high development densities.

The main branch of the Elk River (known as the Big Elk River east of Phillips, WI) and the Little Elk River (w/ North & South Branches), both originate in or near the Chequamegon National Forest in the eastern part of Price County. The Little Elk River has the most open area for drainage, with about 40% in farmland and private homes. The remainder of the watershed has a ratio of about 80% wooded to 20%

open land. The rivers join just east of downtown Phillips. East of the City of Phillips, both rivers are classified as first and second-class trout streams- the entire length of the Little Elk and the portion of the Big Elk east of County Hwy H.

River Impoundments Created by WPA Dams

There are at least 25 lakes and impoundments and several ponds and wetlands included in the watershed. A tributary to the Elk, Squaw Creek, has a dam on it that forms the impoundment known as Solberg Lake (859 ac, 16' max depth); Solberg Lake has an active lake association. There is a shallow impoundment in the Chequomegan National Forest on a tributary to the Elk River before it flows into Musser Flowage, know as Wilson Flowage (289 ac, 6' max depth). This flowage was mainly developed for wildlife habitat.

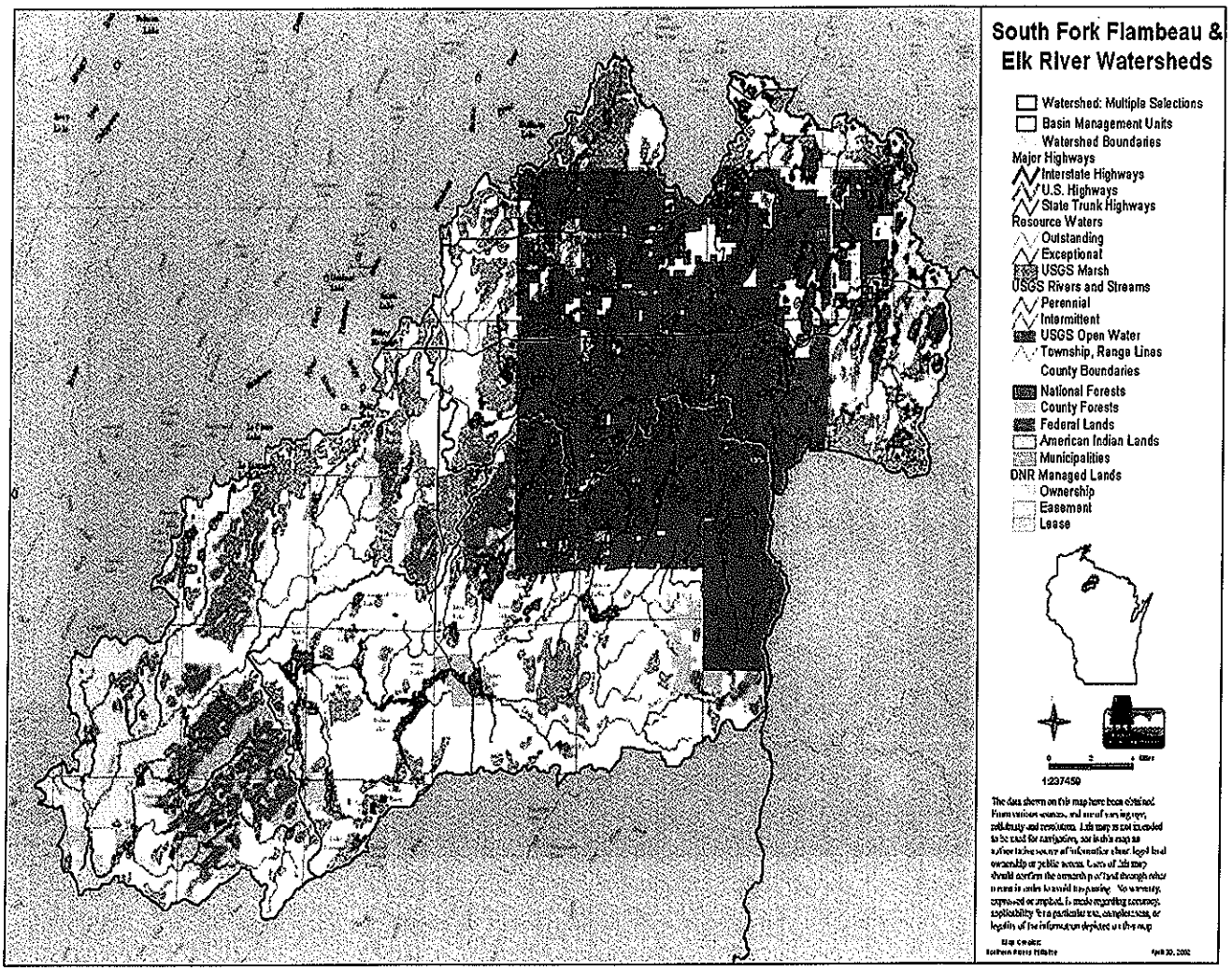
There are three dams on the main stem of the Elk River, with a total head of 31 feet. (Upper Chippewa Basin report, 1980) West of Hwy H, the Big Elk has an impoundment within it (Musser Flowage, 563 acres, max depth 15'), with an active lake association. Jobe's Dam three miles downstream from downtown Phillips forms a large impoundment of the river called the Phillips Chain of Lakes (Duroy; 379 ac, 18' max depth, Elk; 88 ac, 25'max depth, Long; 418 ac, 54' max depth, Wilson; 351 ac, 11'max depth). A portion of this water body is visible while driving through the City of Phillips. Two lake associations have formed there. The river then passes a few more miles downstream where a final impoundment is formed by Weimer's dam. Soo Lake (561 ac, 21' max depth) is formed by the water backed up due to the fourth major impoundment on the Elk River watershed. Weimer's dam is about 11 miles West of Phillips. Two lake associations are active on this body of water. About a mile from Weimer's dam the Elk River flows into the South Fork of the Flambeau River.

Elk River main stem tributaries:

- Spring Creek, near main stem headwaters
- Little Elk River, No. Branch & other tributaries, such as: Murphy creek from Murphy (spring) Lake, the Little Elk flows into Duroy Lake SE of Phillips
- Musser Creek, which flows north into Musser Flowage
- Popple Creek & Chase Creek, flows south into Musser Flowage
- Big & Little Dartis lake outlets to Musser Flowage
- Squaw Creek northwest of Phillips, with a dam on it to form Solberg Flowage. This tributary also joins the Elk main stem east of downtown Phillips.
- Deer Creek, outlet to the Elk River West of the Phillips Chain of Lakes
- Crane/Chase Creek from Crane/Chase Lake into the Elk River at Soo Lake
- Nine Mile and Carpenter Creek, into the Elk River at Soo Lake
- A number of other smaller permanent and seasonal/intermittent drainage ways

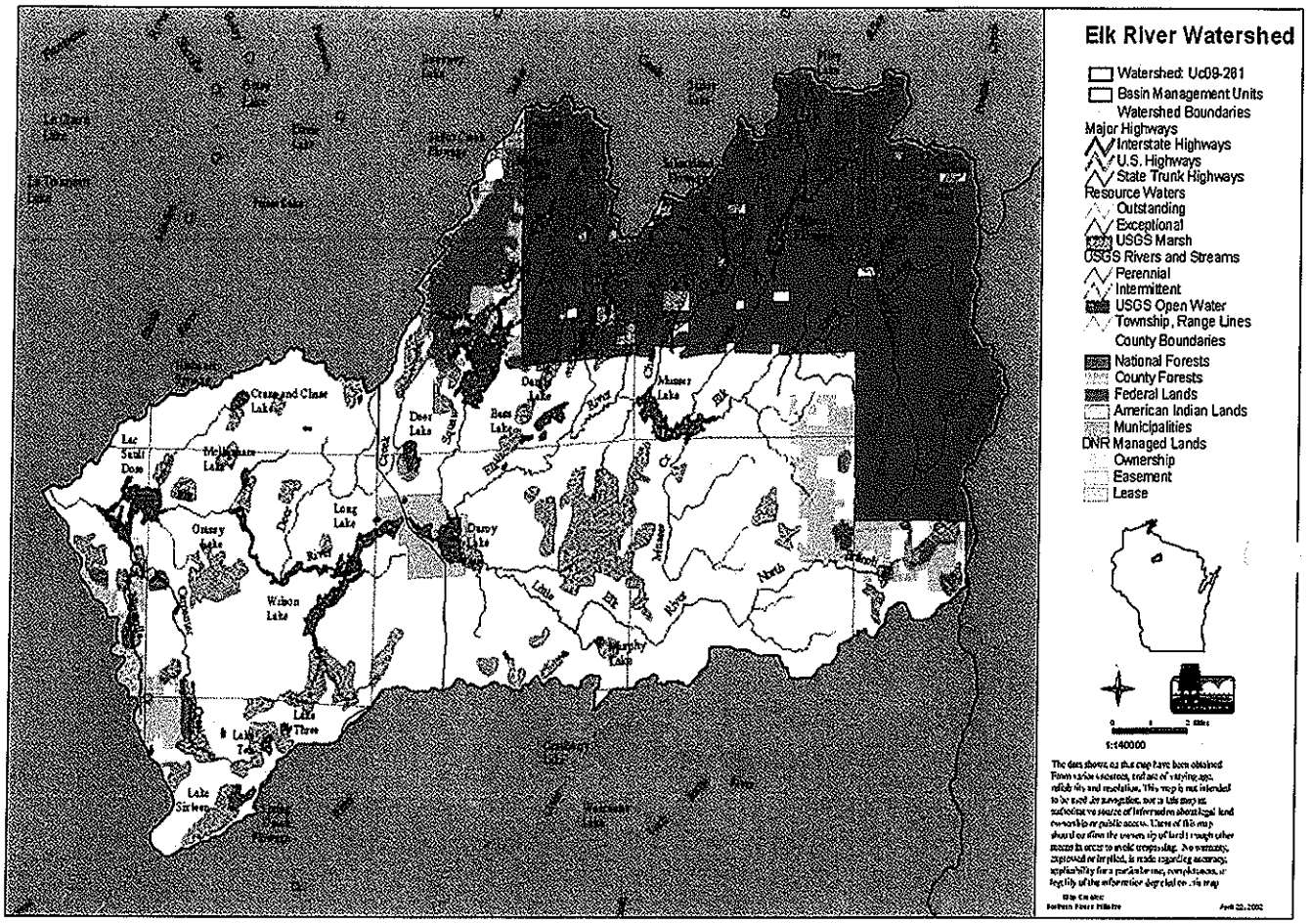
The Elk River supports a good warm water sports fishery and is heavily used. The Elk River Watershed has a diverse mixture of uses (some uses conflict or affect others, at least seasonally), which include forestry, agriculture, tourism and recreation, domestic and industrial discharges, and residential/industrial shoreland development, and the introduction of exotics. The recreational and fishery aspects of the river and flowage system are very important to the economy of the area. Walleye, muskellunge, northern pike, small mouth and largemouth bass, perch, crappie and a variety of pan fish populate the lake waters. Trout are found in colder sections of the streams that feed the main river stem. Various other species (suckers, red horse, chubs, minnows, etc) inhabit the waters as well. The lakes are utilized in all seasons, as major snowmobile routes traverse the larger frozen bodies during the winter season.

Watershed of the South Fork of the Flambeau River
(The Elk River Watershed is included as part of this Watershed)

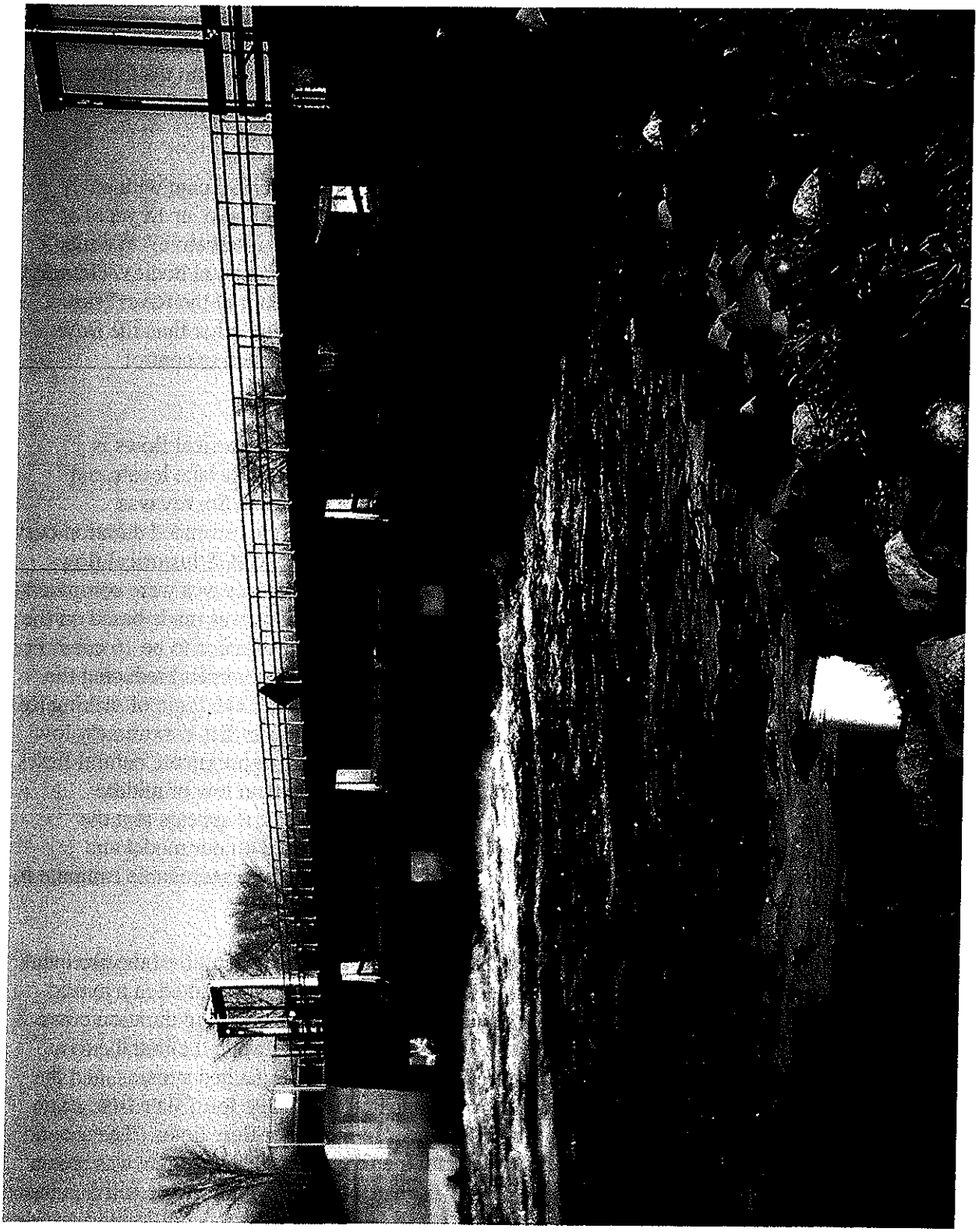


Elk River Watershed

(Weimer's Dam is located about 1 mile east of the junction of the Elk River with the South Fork of the Flambeau River. Weimer's Dam holds the water for Soo Lake)



Weimer's Dam---October, 2007



I. Flow Study

The first step was to estimate and define low and high ranges of water flow (cubic feet per second) at the Weimer dam site, within the realm of normal permitted operating water levels. In the contract agreement, all parties acknowledged that there is no historic direct flow data available from the Client on the Elk River Watershed that is usable for this hydroelectric feasibility study. Therefore, this study is based on **estimated** water flow and duration at the Weimer Dam.

At the start of the study, the Price County Dams Keeper provided the EHS Team with an estimated water flow and duration table. This duration curve was based on over 15 years of experience operating the Weimer Dam, though was estimated to be "conservative." Weimer's dam is operated to control lake level to a prescribed level set by governmental bodies. Therefore, any potential hydroelectric project would be allowed to utilize only "Run of the River" flows. The dam could not be controlled to provide water for electric generation other than the flow available as a result of managing the dams within the Elk River Watershed to control impoundment or lake levels.

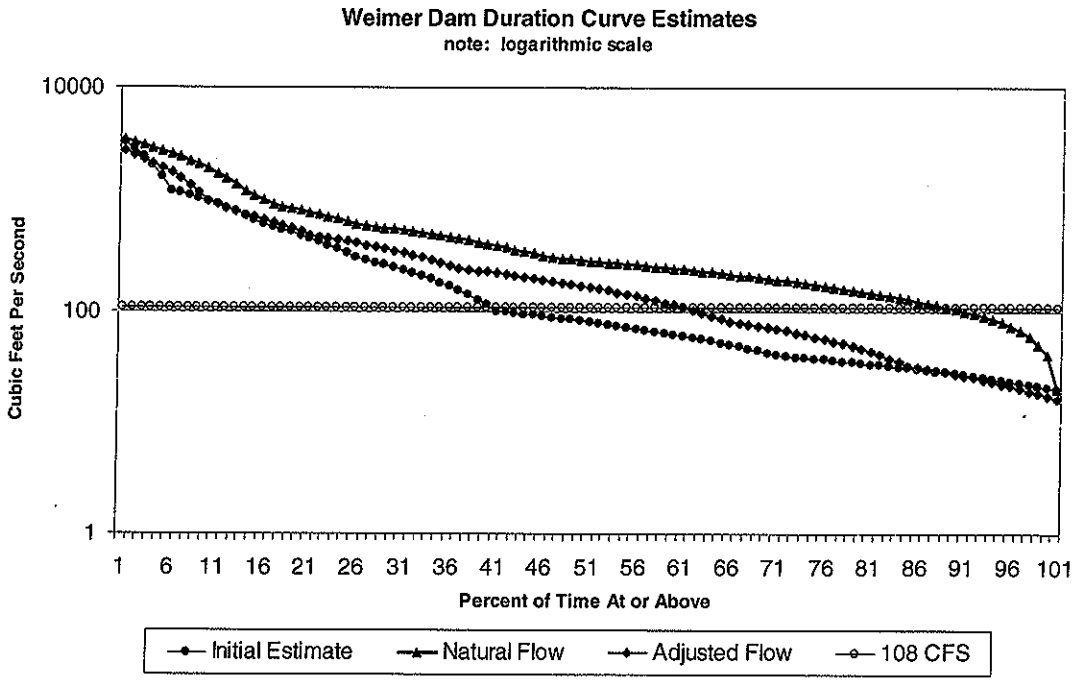
Analysis: Weimer Dam flow has not been measured, and no record of historical flows is available. Price County Dams Keeper records only record impoundment or lake levels, not amounts of water over the dam. Therefore, data from the U.S. Geological Survey was investigated, comparing USGS data of gauged streams in the area to the estimated duration curve from the County. The EHS Team reviewed several area streams with USGS historical flows (Table A), and created duration curves. These USGS historical duration curves were compared to the curve provided by the Price County Dams Keeper. The comparison was made based on the frequency of multiples of the minimum flow, which was ultimately estimated to be 16 cubic Feet per Second (CFS), or about 7181 gallons per minute. Thus, we also recommend reducing the minimum flow provided by the Dams Keeper from 20 CFS to 16 CFS. The logic of making this adjustment is based on analyzing the natural stream flows. We estimate that at extremely low flow periods and extremely high flow periods, the Weimer Dam will approximate natural flows. Further, we expect that the high flow frequency is better understood than low or middle frequency flows. Thus, based on the frequency of high flow estimates, it appears that the Weimer Dam would expect a minimum flow less than 20 CFS. Based on our model and subsequent conversations with the Dams Keeper, 16 CFS appears to be a reasonable estimate for minimum flows.

Based on USGS data, and subsequent conversations with the Dams Keeper, all of the pertinent data was used, statistical correlations were made, and the combined data resulted in a hybrid flow and duration curve which features data of each data source. The resulting duration curve is presented in table form below. To better illustrate the comparison between the initial curve provided by the County, the averages of natural flows of three USGS gauged streams, and the compromise or hybrid curve, the curve features are compared in graphic form. The first graph uses a logarithmic scale to better illustrate the differences in the lower flow times. The second graph uses a linear scale to illustrate the classic duration curve shape. The estimate was begun with the data points provided by the initial Weimer Dam estimate. The gaps were filled in based on linear interpolation between the given points. It is recommended to use the following duration curve, which combines features of each data source:

CHART 1
Flow Study-Weimer Dam Hybrid Flow & Duration Chart

Percent of Time at or Above	Cubic Feet Per Second	Percent of Time at or Above	Cubic Feet Per Second
0%	2688	55%	135
5%	1728	60%	108
10%	900	65%	80
15%	651	70%	69
20%	480	75%	56
25%	405	80%	43
30%	330	85%	31
35%	255	90%	26
40%	218	95%	21
45%	190	100%	16
50%	163		

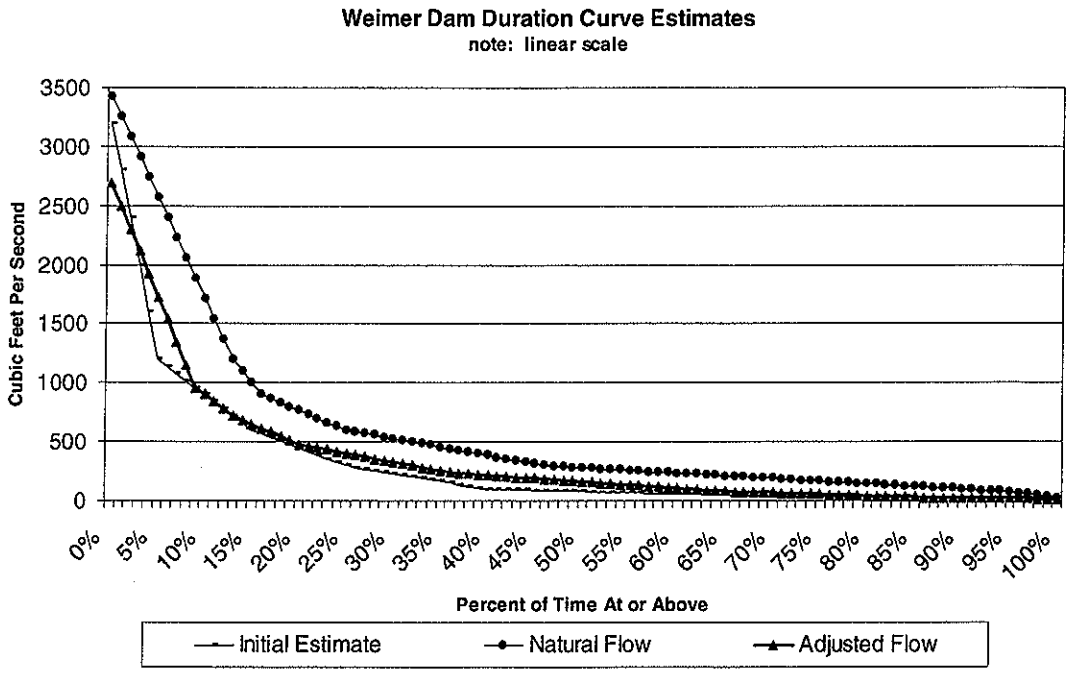
Flow Duration Curve 1A— Weimer Dam---Logarithmic Scale



The EHS Team conducted a spot test of actual CFS flow on February 26, 2008. The measured flow was 108 CFS. This line is included in the logarithmic table, above, with a line just above the 100 CFS line. Depending on which curve is used, the 108 CFS recorded flow occurs at varying percentages of time. For the Initial Estimate, 108 CFS occurs roughly 40 percent of the time or more. For the natural flow model, 108 CFS would occur about 72 percent of the time or more. In the adjusted flow duration curve, this flow rate occurs 60 percent of the time or more.

The 108 CFS line is not included on the traditional duration curve, following, as it is difficult to visually represent the data, with multiple lines overlapping at the lower end of the flow scale.

Flow Duration Curve 1B—Weimer Dam--- Linear Scale



We believe the adjusted curve to be a reasonable estimate. Given the characteristics of wintertime flow, the EHS Team feels that the modeled duration curve has captured a reasonable estimate of expected wintertime flows.

Conclusion

Water flow and duration data was collected from various sources. Several actual flow data sets from various gauged streams in the area were used. This data was correlated with an initial flow and duration estimate provided by the Price County Dams Keeper and a winter flow actual measurement at Weimer Dam. All pertinent data was used to establish a "hybrid" adjusted flow and duration curve that is usable to estimate potential power generation. Engineering and statistical methods were used to derive the resultant flow and duration curve. It is a reasonably accurate ***estimate*** of the actual flows at the Weimer dam.

Although this curve is more aggressive than the original estimate provided by Price County, it is less aggressive than the averages of the USGS gauged stream data. It should be reasonable to estimate equipment sizing, performance and cost using the adjusted curve.

Table A
Data sources used for correlation of Elk River flow and duration at the Weimer Dam

Creek or River Location-County	Data Source	Flow Measurement Timeframe
Spirit-Price, Lincoln	USGS	Feb. 1988 to Feb. 2008
Butternut-Price, Ashland	USGS	Oct. 2002 to Nov. 2004
Black-Taylor	USGS	Sept. 1984 to Mar. 1988
Elk-Price	Estimate-Price County Dams Keeper	Estimate- from + 15 years of experience
Note: South Fork Flambeau River flow monitoring station data not used in the final duration and flow estimates due to possible influence of Elk River controlled flow at the Weimer Dam		

Several other regional streams with USGS gauge stations were considered, but rejected by the subcontractor due to limited data in more recent times (1980s to the present). These include: Prairie River, Pine Creek River, and Price Creek. The three streams were rejected due to data that only tracked flows up to the 1960s (the 1970s for Pine Creek River). As water flows and duration curves can be influenced by precipitation patterns, as well as human development of the landscape, we felt that using the older and limited data was not advisable.

II <u>Power Generation Capacity, projected on an annual basis</u>

- Determine correlation between potential water flow & duration and power source / generative capacity best suited for the estimated flow and structure
    - Size, type, style of structure to add (power house, turbine and generator sets)
    - Watts, Kilowatts and/or Mega-watts production chart.

Project Generator Sizing and System Energy Production

Weimer Dam water flow estimates and estimated durations of various flows were used to estimate possible system sizing options. The EHS Team has developed a preliminary analysis for the purposes of sizing hydroelectric facilities at the Weimer Dam. The EHS team used the "Adjusted Duration Curve" for Weimer Dam as the basis for system sizing and production estimates in conjunction with RETScreen software. RETScreen is a validated software analysis tool published by Natural Resources Canada and used for a wide variety of renewable energy investigations.

Table B
Initial Hydroelectric Analysis --Key Assumptions:

Factor	Assumption	Notes
Head—a standard of 8' was used throughout report for power generation calculation	8 feet-(2.4 meters) (8' -for calculation Variable from approx 6'-10')	Provided by Price County. An assumption is that a head of 9 feet will have a minor impact, and not significantly affect overall power prediction estimates.
Maximum tail water effect	1 foot (0.31 meters)	Tail water is the rise in lower steam levels during periods of high flows
Residual flow	16 CFS (0.45 m^3/s)	We assume that at least 16 CFS must flow over the dam and cannot be diverted. This assumption can be changed as needed.
Turbine type	Propeller	Appropriate for kW size range
Turbine efficiency	RETScreen standard	Varies based on turbine type, water flow, and kW size. Based on industry or manufacturer averages
Hydraulic losses	5 percent	Losses in penstock
Miscellaneous losses	2 percent	Other unknown factors that can impact water flow
Generator efficiency	95 percent	Typical efficiency
Availability	95 percent	Availability is the time the system is able to operate vs. downtime.

These factors combine to create the estimated system output of a turbine at a given size. The estimated sizing and annual electricity production for turbines sized to meet several different design flows is described in the table presented below. We base the design flows on the Weimer Dam adjusted duration curve.

CHART 2
Estimated Hydroelectric System Electrical Power Output

Flow duration percentage	Design Flow (CFS)	Generator sizing	Annual production	Capacity Factor*
100 percent	16	6 kW	45,000 kWh	85.6%
90	26	10 kW	72,000 kWh	82.2%
75	56	23 kW	143,000 kWh	70.0%
60	108	45 kW	241,000 kWh	61.1%
50	163	69 kW	325,000 kWh	53.8%
40	218	94 kW	385,000 kWh	46.8%
30	330	144 kW	466,000 kWh	36.9%
20	480	212 kW	529,000 kWh	28.5%
10	900	571 kW	571,000 kWh	11.4%

**The capacity factor is the ratio of a power plant's output compared to the output the plant would have had if it had operated at full capacity over a period of time. So if a 100 kW generator ran at full output for all 8,760 hours of a year, it would produce 876,000 kWh in the year. However, if it has a capacity factor of 10%, this means it only produced 87,600 kWh during the year. In the case of the hydroelectric plant at the Weimer Dam, we can see that a very large generator would be utilized much less than a smaller generator by comparing the capacity factors.*

As we worked with our production model, we made a minor adjustment to the maximum tailwater effect in our production model, increasing the tailwater to three feet, instead of one foot based on input from Price County. The impact of increasing the maximum tailwater effect resulted in a few percentage points reduction of capacity factor. No change was needed for overall system kW capacity, except for the largest system. The change in overall electricity production is a slight decrease. In order to ensure a more conservative analysis, the three foot tail water effect will be retained.

Generators sized for flows will also produce electricity at other flow rates, but the efficiencies drop. Thus, a generator sized for a flow of 218 CFS will still produce electricity at a flow of 108 CFS, but will produce less electricity per unit of flow than at 218 CFS. Many hydroelectric projects are sized for flows ranging from 40 to 80 percent of the duration curve.

III. Hydroelectric Power Project Costs; Project Development Models; Potential Project Funding Sources, Potential Environmental Impacts

- Project cost alternatives; hydroelectric power generation system at Weimer Dam
  - Total project cost estimates include general retrofit of inlet (penstock) and tail water structures at Weimer Dam.
- Operation and maintenance projected costs
- Explore Alternative Project Development Models
- Explore Federal, State and other agency funding incentives available for NEW hydro-electric projects on existing dams
- Explore Potential Environmental Impacts

This project is classified as "micro hydro". As such it is a fairly small power generation source due to the amount of water available for power generation and the duration of the flow. Therefore, sizing of equipment is critical to the feasibility and viability of this project. At low flow times, if the turbine is sized too large, the turbine may need to be shut down. Another issue is that the vertical head of eight feet (8') will be reduced during high water (snow melt, wet and high rainfall events) as the tail water rises, causing reduction of electric generation capacity.

Technology Options and System Sizing

The production of electricity from a hydroelectric plant is dependent on two key variables. These two variables are:

1) The volume of water passing through the system,
2) The head or vertical distance the water falls.

In the case of the Weimer Dam, the head is fixed at approximately eight feet. However, the capacity of the generator can be based on varying levels of water flow. The possible range of water flows is determined by the duration curve, described in the previous section. At the size range of the possible systems for the Weimer Dam, a single or dual turbine system will be used to manage costs. A hydroelectric turbine is designed to maximize efficiency for a particular flow of water, with reduced efficiencies for water below the optimum. Typically, a micro-hydro project is sized to take advantage of between 40 and 80 percent of the duration curve, though other system sizes to use more of the duration curve are possible. The issue of system sizing is one of tradeoffs – a larger generator will be able to use higher volumes of water, but will cost more, and have proportionally less time generating at the designed water flow conditions. Alternatively, a smaller project may produce at capacity over much of the year, but with a relatively small amount of electricity generation.

Turbine Types

There are two main turbine categories used in micro-hydro projects: *impulse* turbines and *reaction* turbines. An impulse turbine uses an incoming stream of water directed through a nozzle at blades. Most impulse turbines require high head pressures, as the water flow is relatively small through the nozzles. One exception is the Banki-Mitchell style, or cross flow turbine. These turbines can run at lower head pressures due to a design that captures the water flow twice, though at reduced efficiency.

The other main category of turbines is *reaction* turbines. Reaction turbines develop rotational forces by reacting to the water's pressure. As water moves through a reaction turbine, it reduces the water pressure. The pressure reduction is converted into mechanical motion, which can turn a generator. Of reaction turbines used in micro-hydro facilities, there are two major types, the propeller turbine and the Francis turbine. In general, the Francis turbine is appropriate for higher head sites. Propeller turbines have one variant called a Kaplan turbine. The Kaplan turbine allows for variable pitch blades, which optimizes efficiency for varying water flow rates. Kaplan turbines can be used in low head micro hydro projects.

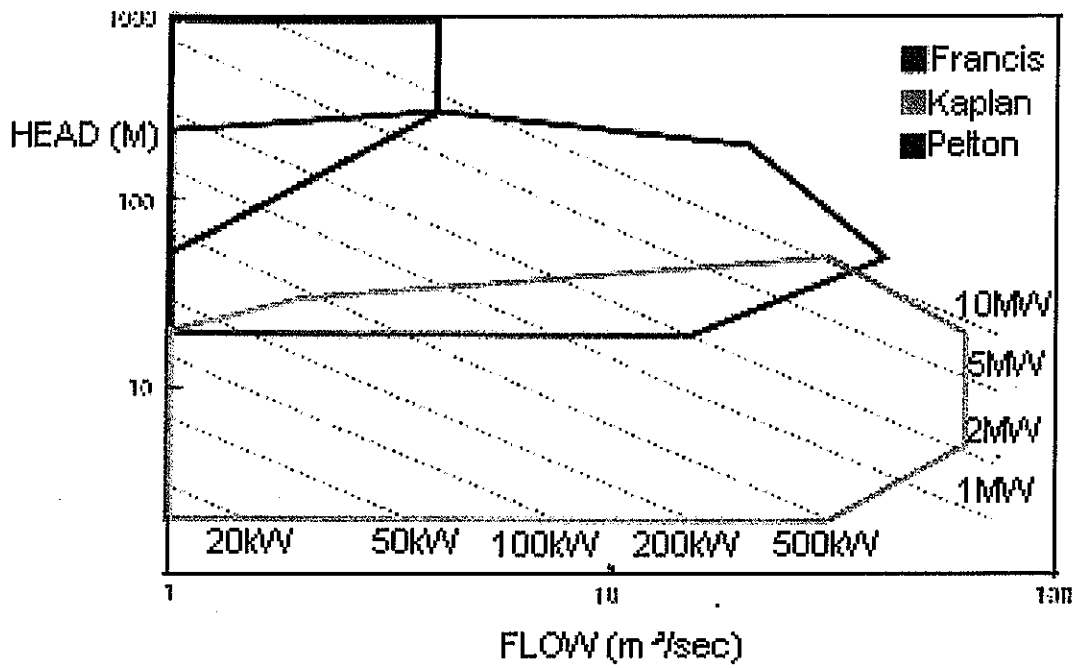
Kinetic turbines are a third type of turbine, but are not typically available for micro-hydro projects, except at the "toy" level. Larger kinetic turbines are being tested, but these turbines are too large for the Elk River and have not proven themselves in the marketplace. Kinetic turbines use the flow of the water as the sole source of energy production. Some kinetic turbines sit in the water and allow water to flow over them, much like a wind turbine. One small kinetic turbine operates by floating on the water and allowing the water to turn a wheel, much like a paddle wheel boat. In all cases, at the micro hydro scale, prototype models have been developed, but actual projects appear rare. Kinetic turbines are not a viable option for Weimer Dam unless much more detailed information is developed about the water flow and rate of water flow over specific cross sectional areas. The data would need to consider the *rate* of flow through a given cross section of water. This data is different from flow volumes, as is typically captured by stream gauges.

Thus, of the turbine types to consider for a low head micro hydro site, such as the Weimer Dam, a propeller/Kaplan turbine or cross flow turbine are the most likely candidates. The lower efficiency of a cross flow turbine plus low head makes a cross flow turbine an unattractive option. Of turbines available in the marketplace, Kaplan turbines are far more common than cross flow turbines and is the focus of the feasibility study.

Description of Several Turbine Types and the Appropriate Ranges of Head and Flow

Turbine Sizing and Production

In selecting an appropriate size turbine for a project, many factors come into play. The cost of a system increases with turbine sizing. The efficiency of the system will be optimized over a range of water flows. In some cases, using more than one turbine can allow for an improvement of system efficiency or overcome a design barrier, though may result in higher costs. There is a temptation to invest in a system to capture water flows during peak runoff periods. This temptation should be avoided as the cost of equipment frequently outweighs the potential value of energy sales. Further, for a low head site, to capture significant flow during high flow periods will require very large civil works, which are likely to prove impractical.



Courtesy: University of Strathcylde in Glasgow

RETScreen is a software tool used to analyze and model a variety of renewable energy projects. In the case of a micro-hydro project, RETScreen allows the user to input a flow duration curve, head, and other factors, to test the impact of various options on system sizing and annual energy production. RETScreen was used to compare system sizing and annual energy production for two scenarios:

1) A single turbine project
2) A multiple turbine project

The single turbine project offers the lowest cost option, though with some penalty on system efficiency. The multiple turbine project offers higher annual production (to a point), though at higher system cost. We described the Base Modeling Assumptions in Table B in a prior section of this report.

The residual flow is the major assumption that impacts annual kWh output and system sizing. We assume that at least 16 CFS will be maintained to flow over the dam. Thus, only at times that water flow is above 16 CFS will the hydroelectric project be producing power. As 16 CFS is considered the base flow level from the duration curve, most of the time, flow rate will be above 16 CFS. Other efficiency factors are industry averages recommended by RETScreen. Specific project designs may have other factors, though the differences from typical industry values will be minor.

Single Turbine Output Estimates

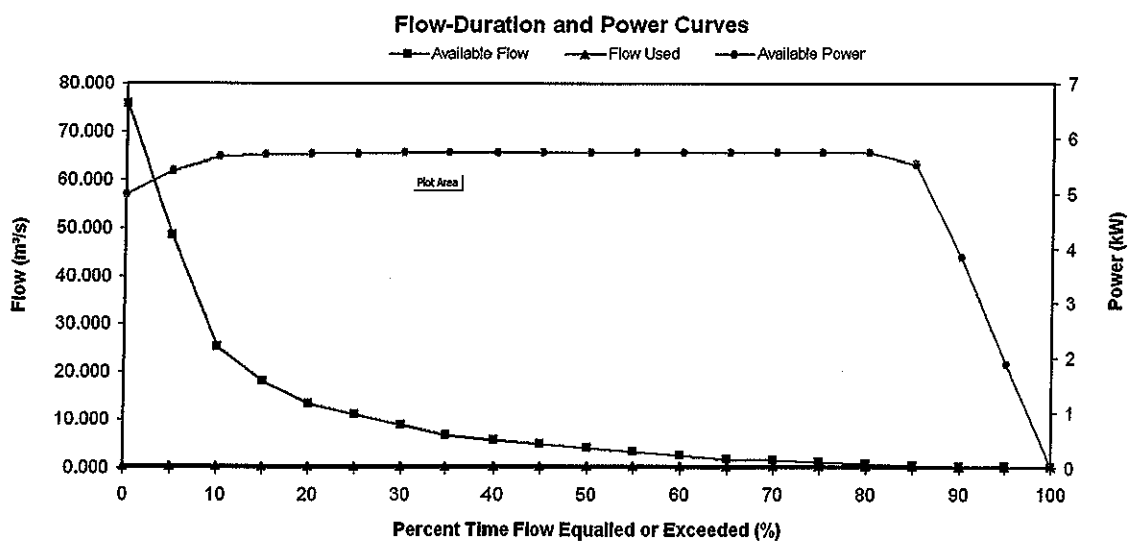
For a single turbine project, RETScreen developed a series of recommended generator sizes based on conditions at various points on the duration curve. The turbine being modeled is a Kaplan design system.

CHART 4-A
Single Turbine System Sizing and Energy Production

Flow duration percentage	Design Flow (CFS)	Design Flow (m^3/sec)	Generator sizing (kW)	Annual production (kWh)	Capacity Factor
100 percent	16	0.45	6	44,000	83.7%
90	26	0.74	10	70,000	79.9%
75	56	1.59	22	142,000	73.7%
63	102	2.9	40	237,000	67.6%
60	108	3.06	43	248,000	65.8%
50	163	4.62	66	342,000	59.2%
40	218	6.17	88	417,000	54.1%
30	330	9.34	136	534,000	44.8%
20	480	13.59	200	644,000	36.8%
10	900	25.49	381	775,000	23.2%

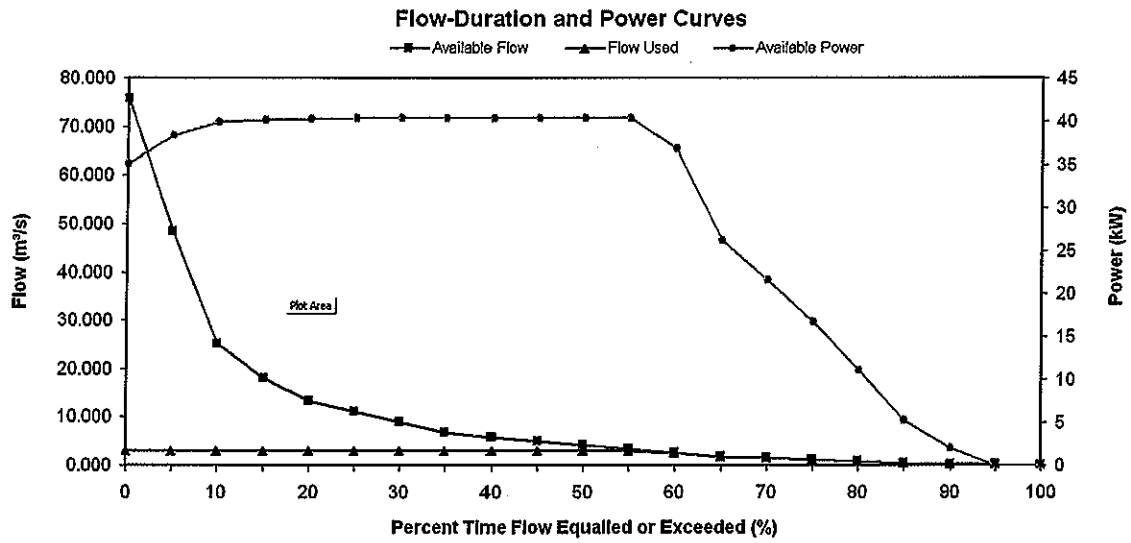
The following charts illustrate the flow being utilized by several sizes of system, their relationship to the flow duration curve, and the percent of time the generators would be operating in relation to the duration curve. We selected three sizes to illustrate the concepts – a system sized at 6 kW, 40 kW, and 136 kW, corresponding to points on the duration curve at 100 percent, 63 percent, and 30 percent of the duration curve, respectively.

Characteristics of a 6 kW system at Weimar Dam



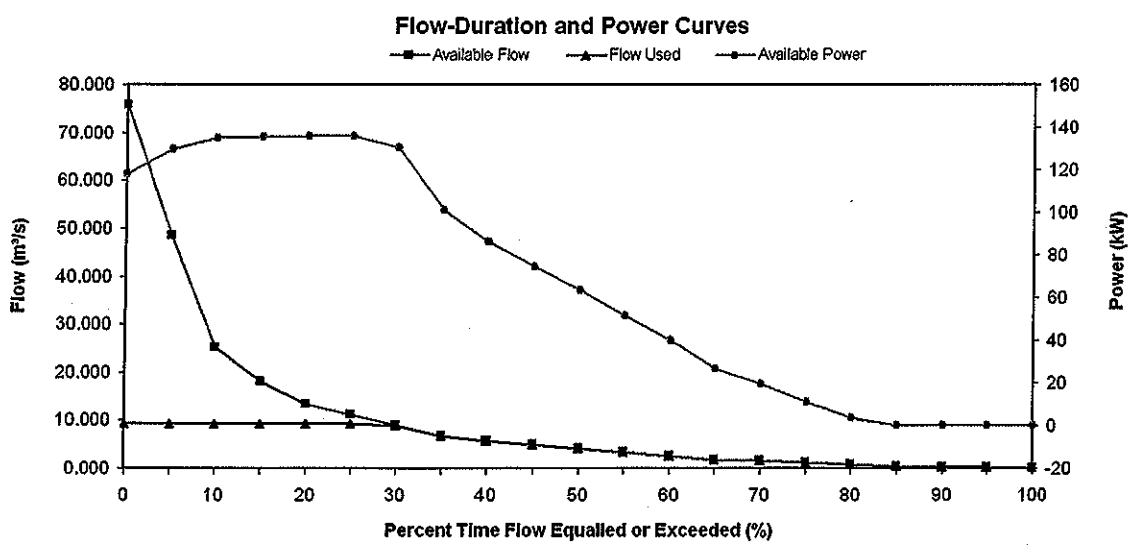
Note that for this system, the generator reaches full capacity at approximately 80 percent of the flow duration curve. Capacity trails off during times above 10 percent of the duration curve due to the tailwater effect. However, between about 80 and 10 percent of the duration curve, the system would produce at full output, reflecting a high capacity factor.

Characteristics of a 40 kW system at Weimar Dam



The 40 kW system reaches peak generating capacity at 55 percent of the flow duration curve. This capacity is maintained until the tailwater effect dampens power production at 10 percent of the duration curve. In comparing the generator production of the 40 kW system to the 6 kW system, one can see that peak production capacity is achieved for much less time.

Characteristics of a 136 kW system at Weimar Dam



The 136 kW system is sized to achieve optimal efficiency at 30 percent of the duration curve. One can see that peak generator output is only achieved between 25 percent and 10 percent of the duration curve. The narrow band of time when there is sufficient flow and minimal tailwater effect amounts to 15 percent of the hours in the year, or about 1,314 hours, when the system can

achieve full electricity output. Note that the generator will produce no output another 15 percent of the year – only when the flow reaches less than 85 percent of the duration curve or higher.

Multiple Turbine Output Estimates

A multiple turbine project offers the potential for higher annual production based on a water flow range that is closer to the optimal efficiency for each individual turbine. The tradeoff with multiple turbine projects is the increased cost associated with purchasing and maintaining two or more units.

RETScreen allows for modeling multiple turbine projects. The method used is to size the project based on total kW capacity for a design flow (as above), but model the impact of greater turbine efficiency. Generators come in multiple size possibilities. For modeling the impact of multiple turbines, we assume that two turbines will be used and total kW capacity can be split evenly between the turbines. The project could have two differently sized turbines. However, the impact on overall system production will be fairly close to two equally sized systems. The lowest flow rate (16 CFS) is not modeled as an option for a two-turbine project due to very small system sizing at that flow rate.

CHART 4-B
Two Turbine System Sizing and Energy Production

Flow duration percentage	Design Flow (CFS)	Design Flow (m^3/sec)	Total Generator sizing (kW)	Annual production (kWh)	Capacity Factor
90 percent	26	0.74	10	71,000	81.1%
75	56	1.59	22	144,000	74.7%
63	102	2.9	40	241,000	68.8%
60	108	3.06	43	252,000	66.9%
50	163	4.62	66	350,000	60.5%
40	218	6.17	88	430,000	55.8%
30	330	9.34	136	558,000	46.8%
20	480	13.59	200	682,000	38.9%
10	900	25.49	381	870,000	26.1%

In the case of the two-turbine project, total annual production increases, but only by a small amount. For the 10 kW system, using two smaller generators only nets 1,000 extra kWh per year, or about 1.4 percent. At the larger system sizes, using two generators has a greater percentage increase, but likely not enough to justify the cost of purchasing and operating a large two-turbine/generator system.

It is possible that a two-turbine system that uses turbines of significantly different sizes could increase production somewhat beyond the simple two-turbine system described above. However, gains would be expected to be minimal. The larger turbine would not be used during lower flow times and the total available flow to the larger turbine would be reduced as flow is diverted to the smaller turbine. The net economic effect is to reduce the number of hours the larger turbine would be able to earn revenue to offset costs.

Considerations for Capturing Flow

Hydroelectric systems are limited in size by two factors – available head and the duration curve. Most micro hydro projects are sized in the range of 40 to 80 percent of the duration curve. In developing nations, the economic question is typically based on "what is the cost of not having the electricity." In developed countries, the economic question is more often "what is the market value of the electricity." Thus, in the United States, the economic consideration is the value of hydroelectric power compared to commodity-based power from the utility system, rather than the value of the electricity product itself. Furthermore, the issue of the size of required civil engineering structures (piping, trenching, etc.) may place limits on the practical size of potential structures.

The following table presents the flow duration curve at Weimer Dam and the pipe diameter required capturing the flow for the turbine/generator.

Penstock Diameter for System Sizing

Flow duration percentage	Design Flow (CFS)	Generator sizing (kW)	Required Penstock Pipe Diameter (m)	Required Penstock Pipe Diameter (ft)
100 percent	16	6	0.71	2.3
90	26	10	0.86	2.8
75	56	22	1.15	3.8
63	95	40	1.45	4.8
60	108	43	1.48	4.9
50	163	66	1.73	5.7
40	218	88	1.93	6.3
30	330	136	2.26	7.4
20	480	200	2.61	8.6
10	900	381	3.32	10.9

The key conclusion from the table is that a system sized to capture very high flows would require extremely large penstock pipe diameters. Note that at flows between 20 and 30 percent of the duration curve, the penstock diameter would need be nearly as tall as or taller than the entire head of the dam. As the penstock must be buried in order to prevent frosting, the civil works required to install large systems would be expensive and extend far into the ground. In theory, the hydraulic pressure of the eight foot head would be maintained, however, the decreasing capacity factors by designing the system for high flow rates creates diminishing returns for the investment. In the case of capturing large flows, a two-turbine project would be more practical due to smaller individual penstock sizing, though the cost would be much higher.

A final issue with the largest systems is that during times of high flow, the tailwater level at the dam will rise. As the tailwater level rises, the head of water pressure decreases. We assumed a conservative rise of one foot at the highest flow. Some observations at the dam indicated a two to three foot tailwater effect may be appropriate for the Weimar Dam. Thus, the estimates of production in this report are likely higher than may be the case for systems that rely on times of high water flow. The rise in tailwater levels for smaller systems is minor, as a smaller system would produce more of its electricity at times with lower tailwater effects.

Hydroelectric Project Development Models

Based on discussions with two hydroelectric project developers, micro-hydro projects are developed in three ways. Each has advantages and disadvantages. We outline each below.

Method One: Experienced Hobbyist

The Experience Hobbyist development method relies on a highly knowledgeable individual who can take the time to design and system and procure parts. The advantages of this approach are that direct financial outlays are minimized, while still maintaining a high quality project. However, the underlying assumption is that the "hobbyist's" time is of little value. The developer is able to provide their substantial knowledge to the project with no cost impact, and take the time to procure used equipment. The chief disadvantages are that this method of development is highly individualized, outcomes are uncertain, and timelines are flexible.

Method Two: Turn-Key Development

The turn-key method of development relies on a professional company to design and construct a project from start to finish. The chief advantages of this method is that specific timelines can be maintained, permitting will be handled by an experienced company, equipment will be new, performance parameters can be built into the contract, and the budget will be known. The main disadvantage is that the turn-key method is likely the highest cost development method. For micro-hydro projects, estimates range from $4,000 to $5,000 per kW of generating capacity, or higher.

Method Three: General Contractor

The third method is something of a hybrid between the Experienced Hobbyist and Turn-Key Development Methods. In this approach, a general contractor with hydroelectric experience is brought on board to develop the project. The general contractor is responsible for designing the system and procuring equipment as cheaply as possible, often with used, but serviceable equipment. The main advantages in this approach are that an experienced contractor is overseeing the project, while costs are reduced via the use of used equipment. Further, the general contractor will be responsible for permitting the project. The main disadvantages of this approach are uncertain outcomes and system parameters, coupled with risks associated with relying on used equipment. Further, the process of identifying and working with the general contractor could pose a challenge. For micro-hydro projects, cost estimates range from $2,500 to $3,500 per kW of generating capacity using this approach, though could easily be more expensive. The savings come at some level of increased risk, while project funders will still be expected to cover general contractor expenses, regardless of the outcome
(Contract language may be used to manage risk; risks may be higher with the G. C. approach).

In summarizing the three micro-hydro development methods, the Turn-Key and General Contractor methods are likely the most useful for Price County to consider. The General Contractor method should only be used if Price County is prepared to risk variable outcomes, while providing significant time and flexibility to work with the general contractor.

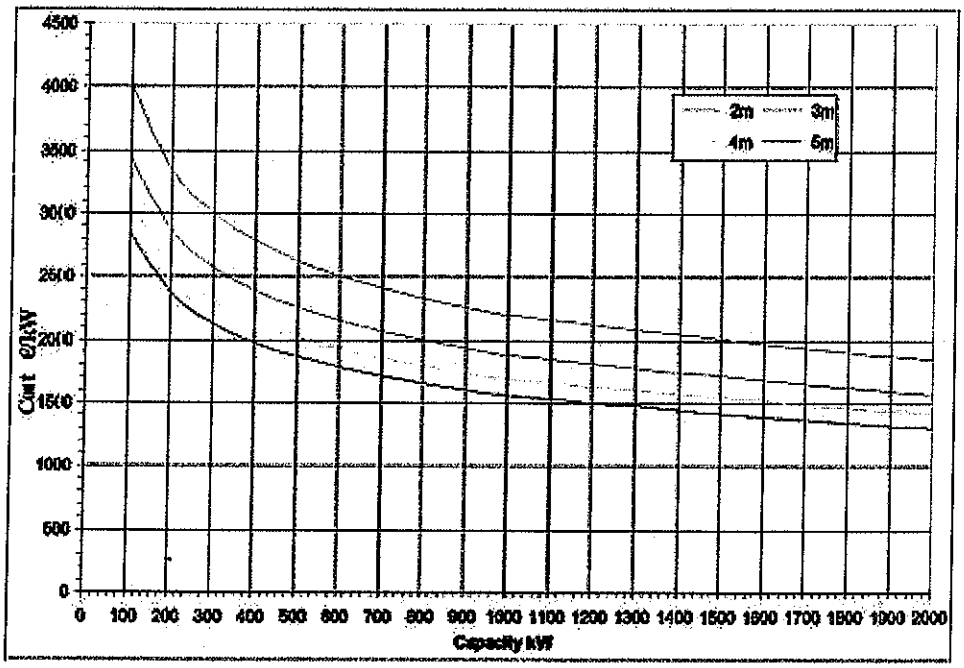
Economics- Project Financial Performance

The economics of any energy project are driven by the factors of gross energy production, the value of that energy, the financing options that may be available, and the cost to purchase, install, and operate the project. In the case of micro-hydro, costs are somewhat dependent on the method of project development. As described above, the costs can vary based on the development model. At the high end, turn-key projects done by experienced contractors are the highest cost, but offer the most control over outcomes. At the low cost end, hobbyists have successfully built projects very cheaply, though this method of development is unpredictable in terms of technology availability, takes a significant time investment, and has highly uncertain outcomes.

As the Weimer Dam project would be a publicly owned project and significant time is not available for managing an uncertain project, we focus on the turn key method of development for estimating project financial performance. The turn key method of project development has the highest cost, ensuring the most conservative financial analysis.

Based on conversations with developers, turn-key project development for micro-hydroelectric projects ranges from $4,000 to $5,000 per kW of installed generator capacity. Projects in the hundred kW and higher range can drop to $3,500. These estimates are supported by a study commissioned by the European Small Hydropower Association (2004). Two charts from the study are presented, below:

Price per kW of installed capacity by system head, 1997 Euros



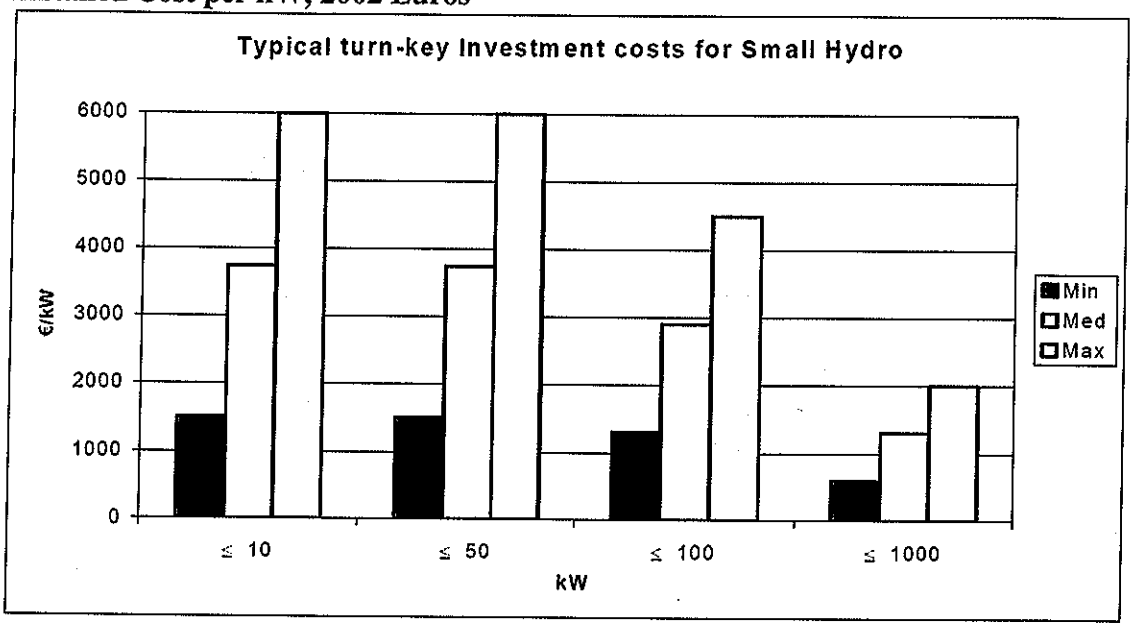
Courtesy: European Small Hydropower Association (2004)

1997 Euros, the cost of a 100 kW hydroelectric system between two and three meters of head cost between $3,500 and $4,000 Euros. The dollar/euro exchange rate in 1997 was about 0.85 dollars per Euro, making the range approximately $3,000 to $3,500 per kW of installed capacity. The higher expense for lower head sites for a given generator capacity is driven by the need for

larger infrastructure. Quite simple, high head sites can use smaller penstocks, civil works, and turbines while achieving the same generator capacity compared to lower head sites.

A 2002 study found that for small hydroelectric projects, the price of an installed kW can vary significantly. The chart below illustrates the installed cost of various sized systems.

Installed Cost per kW, 2002 Euros



In 2002, the dollar and the euro were approximately equal in value (1:1), making the price in euros the same as the price in dollars. The chart, above, does not describe the difference in price based on head. However, based on the chart for 1997 costs, one would expect that low head sites would be in the more expensive range of costs. Based on inflation since 2002, we would expect a cost of between $4,000 and $6,000 per kW of installed capacity for a low head site up to 50 kW in generator size. For units in the 100 kW range, a cost estimate of $3,000 to $5,000 may be reasonable for installation cost expectations.

In general, the larger the system, the lower the cost will be per kW of capacity. The reason for the economy of scale is that much of a project's costs are similar regardless of system sizing. For example, the trenching required for a penstock for a smaller system will take nearly the same amount of time and equipment as the trenching for a larger system. We summarize the expected cost of a system based on the cost ranges for generators sized for the flow conditions we analyzed above.

Hydro project developers we spoke with echoed these ranges of costs. Two emphasized the higher end of the cost range, while the third suggested lower costs were possible with the right development model.

For conducting the financial analysis, below, we suggest using the lower end of the cost range. The Weimar Dam facility has an existing road and Price Electric will install the new electric

service (though with a monthly service fee). As a result, using the lower end of the range may be reasonable for modeling purposes.

Summary of Installed System Costs

Generator Size	Low Cost (per kW)	Higher Cost (per kW)	Midpoint (per kW)	Installed Cost Using Low End of Range
6	$4,000	$6,000	$5,000	$24,000[1]
10	$4,000	$6,000	$5,000	$40,000
22	$4,000	$6,000	$5,000	$88,000
40	$4,000	$6,000	$5,000	$160,000
43	$4,000	$6,000	$5,000	$172,000
66	$3,000	$5,000	$4,000	$198,000
88	$3,000	$5,000	$4,000	$264,000
136	$3,000	$5,000	$4,000	$408,000
200	$2,500	$3,500	$3,000	$500,000
381	$2,500	$3,500	$3,000	$952,500

Operations and maintenance are critical aspects to ensuring a successful project. Project developers estimate that one-hour of work per day is reasonable to budget for routine tasks, such as clearing the trash rack and checking system operations. Although hydroelectric equipment is very durable, annual maintenance by an experienced contractor will be necessary to ensure reliable operations over time. We summarize estimates for various operations and maintenance costs in the table, below. Some standard costs will not be relevant for the project if owned by Price County and noted as such.

Operating costs were developed from several sources. When possible we used direct information, such as for labor costs related to daily operations and maintenance, or the cost of the electrical service. For other costs, we used RETScreen's costing estimates. RETScreen provides ranges of costs for many O&M expenses, expressed as a percentage of initial cost. The RETScreen cost information is used by North American Hydro. North American Hydro uses RETScreen for production estimates for feasibility studies and considers the cost estimates reasonable.

Summary of Operations and Maintenance Cost Factors

O&M Expense Item	Estimated Cost or Range	Notes/Considerations
Land Lease	NA	Price County Owns the Facilities
Property Taxes	NA	No property tax assessment
Water Rental	NA	Public waters
Insurance Premium	0.25 to 1 percent	Percent of initial installed cost. Use 0.5

[1] One equipment supplier quoted a price of $20,750 for a 6 kW turbine/generator/controller package. This suggests that the $24,000 installed cost may be low for this size unit as the balance of system costs could easily be double the price of the unit. Although a price for a 10 kW unit was unavailable, we have similar concerns with the installed cost estimate being too low. In either case, the project financials are not favorable with the low installed cost, making a project in this size range financially unattractive

		percent
Transmission line	$336	$28 per month for service fee per Price Electric
Spare parts	0.5 to 1 percent	Percent of initial installed cost. Use 0.75 percent
Annual cost for daily labor	$10,950	$30 per hour, 1 hour per day, 365 days per year. Cost per Price County Personnel Dept.
Contracted maintenance	$2,500	Cost per year for annual maintenance
Utilities	$1,000	Cost to operated lights and heat the powerhouse during very cold weather.
Contingencies	10 to 20 percent	Based on other O&M expenses. Use 10 percent

The O&M costs are likely to increase by the general rate of inflation. The cost of labor for daily maintenance is a significant cost factor. We assume that the additional time to conduct daily maintenance and inspections is over and above the current Dams Keeper's duties. Thus, the added hour per day should be included in O&M costs. If Price County chooses to view the one-hour per day as a core part of the Dams Keeper's duties that would not change the existing Dams Keeper's labor costs, then this cost should not be considered in the O&M costs. We provide a financial analysis for either scenario, below.

Project Financing

Any capital project can be funded in one of three ways: 100 percent cash, a mix of debt and cash, or all debt. The financial analysis assumes that Price County will prefer an all debt financial structure in order to minimize the initial outlay of capital and to manage cash flow over time. Three sources of debt financing may be available to Price County. Local banks offer a typical source of debt financing. The State of Wisconsin operates the State Trust Fund Loan Program. Finally, the federal government operates a program called Clean Renewable Energy Bonds (CREBs) to provide interest free financing for renewable energy projects. Below we summarize the parameters of each financing source:

Table C-1 Summary of Primary Financing Options

Source	*Interest Rate*	*Notes*
Local Banks	Varies	Banks will bid on the loan product
State Trust Fund Loan Program	Currently 4.75 percent (20 year term)	Requires approval by the Attorney Generals Office. http://bcpl.state.wi.us/asx/
CREBs	0 percent (15 year term)	Funded annually; competitive; application window limits access (timing dependent); 15 year financing is typical. http://www.elpc.org/energy/farm/crebs.php

Other potential funding sources may be available to impact project finances or offer support for development efforts / next steps. For example the Office of Energy Independence can provide loans that cover a portion of project costs at a low interest rate. The Focus on Energy program has a Renewable Energy Program. However, at this time, hydroelectric projects are not being funded by Focus on Energy. Although program policy could change in the future; at this point any possible change would be highly speculative.

Table C-2 Other Potential Funding Sources

Source	*Type*	*Contact*	*Phone*
WI Dept of Commerce	Wisconsin Energy Independence Fund, Loan up to 25% of project cost, 4% interest.	Ms. Amy Cumblad, Interim coordinator	Madison, WI 608-266-2688
Wisconsin DNR	Dam management grant program	Terry Cummings	715-365-8938

Depending on the exact mix of financing, the interest rate could be higher or lower and loan terms may vary. However, as in most ventures, the revenue generated by the hydroelectric project must offset the costs associated with the project (financing, O&M, etc.). Based on the various size options and assumed costs to install the system, a comparison of different system options can be compared to optimize the system sizing and gauge whether the project offers sufficient financial return to justify the project risk.

The financial analysis considers the impact of two loan products – CREBs and the State Trust Fund Loan Program. Bank financing would be similar to the State Trust Fund Loan Program, though the exact interest rate is less certain. The analysis uses the estimated production presented in the previous section and the assumed revenue provided by power sales. The price of the system is assumed to be conservatively estimated at $5,000 per kW for the 6 through 45 kW systems, with $4,000 per kW up to 136kW and $3,500 per kW for any larger systems. Financing is assumed to be for 20 years using a loan, and 15 years using the CREBs. We assume costs and production are for a single turbine system. (A dual turbine system may ultimately be more practical to develop, though would cost more)

For systems at 40 kW or under, Price Electric has forwarded a value of $0.099 cents per kWh for the first 500 kWh produced each month and $0.094 per kWh for any electricity production after 500 kWh. For a system above 40kW, Price Electric estimates the value for electricity at $0.057 per kWh. Thus, the market value for electricity drops steeply for a system over 40 kW*. The

impact on project financials is significant. Thus, the market value for electricity drops steeply for a system over 40 kW. The impact on project financials is significant.

CHART 5-A

Weimer Dam Hydroelectric Potential, Projected Financial Performance, Including Daily Labor Expense counted in Operating Costs

Total Generator Sizing (kW)	Annual Production (kWh)	Installation Cost	Operating Costs (Year One)	Revenues (Year One)	Operating Margin	Simple Payback (years)
6	44,000	$24,000	$16,677	$4,166	-$12,429	NA
10	70,000	$40,000	$16,952	$6,610	-$10,205	NA
22	142,000	$88,000	$17,777	$13,378	-$4,097	NA
40	**237,000**	**$160,000**	**$19,015**	**$22,308**	**$3,843**	**41.6**
43*	248,000	$172,000	$19,221	$14,136*	-$4,494	NA
66	342,000	$198,000	$19,895	$19,494	$507	391
88	417,000	$264,000	$21,105	$23,769	$3,874	68.1
136	534,000	$408,000	$23,745	$30,438	$8,563	47.6
200	644,000	$500,000	$24,515	$36,708	$13,568	36.9
381	775,000	$952,500	$31,981	$44,175	$14,814	64.3

*Note that above 40 kW the price for electricity drops to $0.057 per kWh

Simple payback is calculated by subtracting revenues from operating costs to determine the operating margin. Then the installation cost is divided by the operating margin to determine the number of years for simple payback to occur. From a simple payback perspective, the 40 kW system at the smaller end and the 200 kW system at the larger end are the most financially attractive. Sizes smaller than 40 kW do not pay for themselves as operating expenses exceed revenues, while larger systems have longer paybacks due to the lower value of electricity produced by the system. A major assumption driving the poor financial performance is the inclusion of labor costs for daily maintenance. If the labor cost is considered a "sunk cost" by Price County, then one of the most significant operating expenses should not be included in the analysis. We present the same financial information with the assumption that the daily maintenance cost is a sunk cost, below:

CHART 5-B

Project Installation Cost, Annual Expenses and Revenues, No Daily Labor Expense

Total Generator Sizing (kW)	Annual Production (kWh	Installation Cost	Operating Costs (Year One)	Revenues (Year One)	Operating Margin	Simple Payback (years)
6	44,000	$24,000	$5,645	$4,166	-$1,479	NA
10	70,000	$40,000	$5,865	$6,610	$745	53.7
22	142,000	$88,000	$6,525	$13,378	$6,853	12.8
40	**237,000**	**$160,000**	**$7,515**	**$22,308**	**$14,793**	**10.8**
43*	248,000	$172,000	$7,680	$14,136*	$6,456	26.6
66	342,000	$198,000	$8,037	$19,494	$11,457	17.3
88	417,000	$264,000	$8,945	$23,769	$14,824	17.8
136	534,000	$408,000	$10,925	$30,438	$19,513	20.9
200	644,000	$500,000	$12,190	$36,708	$24,518	20.4
381	775,000	$952,500	$18,411	$44,175	$25,764	37.0

*Note that above 40 kW the price for electricity drops to $0.057 per kWh

By removing the cost of the daily maintenance labor expense, the project simple paybacks improve substantially. Due to the higher price for electricity for units below 40 kW, 22 to 40 kW is the most attractive size range. Above 40 kW, the lower price of power and lower capacity factors combine to reduce the financial attractiveness of larger projects, despite not including daily labor costs. Charts 5A and 5B show the project financials without loan financing. Note that the payback is over 10 years without considering labor costs for maintenance (Chart 5B) and somewhere over 40 years with labor costs (Chart 5A).

The simple payback analysis illustrates where project sizing may provide the best return. However, the operating margin only represents the cash remaining to pay down any debt. Thus, the financing arrangements have an overall impact on annual project cash flow.

<u>If the project was funded with Price County general fund tax revenue, there would be no debt to pay down.</u> Thus, for a 40 kW system, the simple payback on investment would be 10.8 years [$ 160,000 investment in installation of the Weimer dam hydroelectric project divided by $ 14,793/yr annual cash flow income after expenses (not counting Dams Keeper maintenance labor) = 10.81 years to pay back the investment -after which $ 14,793 annual cash flow income would be available to for Price County—however, at least one year's worth of income must be set aside for approx. year 20 turbine rebuild].

If the project were financed with a loan, two financial scenarios are analyzed – a 20-year loan using funds from the State Trust Loan Program and a 15-year loan using Clean Renewable Energy Bonds (CREBs). The financial payment is assumed to be on an annual basis in both cases. For the analysis on cash flows we assume that the daily maintenance expense is considered a sunk cost and not factored into the financial analysis. If the daily maintenance costs are not considered sunk costs, no project will cash flow once financing costs are considered.

CHART 6-A
Project Financial Results Using the State Trust Fund Loan Program (20 years)

Total Generator Sizing (kW)	Installation Cost	Operating Margin	Financing Costs (Annual)	Net Cash Flow During Loan Period*	Net Cash Flow If No Loan Used*
6	$24,000	-$1,479	$1,885	-$3,364	$ -1,479
10	$40,000	$745	$3,142	-$2,397	$ 745
22	$88,000	$6,853	$6,912	-$59	$ 6,853
40	**$160,000**	**$14,793**	**$12,568**	**$2,225**	**$ 14,793**
43	$172,000	$6,456	$13,511	-$7,054	$ 6,456
66	$198,000	$11,457	$15,553	-$4,096	$ 11,457
88	$264,000	$14,824	$20,737	-$5,913	$ 14,824
136	$408,000	$19,513	$32,049	-$12,535	$ 19,513
200	$500,000	$24,518	$39,275	-$14,757	$ 24,518
381	$952,500	$25,764	$74,819	-$49,056	$ 25,764

*Based on the year one operating margin

In the case of the 20 year financing at an annual rate of 4.75 percent, the 40 kW generator is the optimum size on a cash flow basis. Generator sizes below 40 kW can cash flow, but only down to a size above 22 kW. Above 40 kW, the project does not cash flow. Due to the effect of inflation on expenses and revenues, the operating margin will increase on an absolute basis each year; however, the impact on cash flow will be minimal. After the loan is paid off (year 21), cash flow will improve substantially as the cost of debt will no longer be a factor.

The next financial analysis assumes a project using Clean Renewable Energy Bonds, CREBs, with zero percent interest financing over a 15-year term.

CHART 6-B
Project Financial Results Using CREBs (15 years)

Total Generator Sizing (kW)	Installation Cost	Operating Margin	Financing Costs (Annual)	Net Cash Flow During Loan Period*	Net Cash Flow If No Loan Used*
6	$24,000	-$1,479	$1,600	-$3,079	-$1,479
10	$40,000	$745	$2,667	-$1,921	$745
22	$88,000	$6,853	$5,867	$987	$6,853
40	**$160,000**	**$14,793**	**$10,667**	**$4,127**	**$14,793**
43	$172,000	$6,456	$11,467	-$5,010	$6,456
66	$198,000	$11,457	$13,200	-$1,743	$11,457
88	$264,000	$14,824	$17,600	-$2,776	$14,824
136	$408,000	$19,513	$27,200	-$7,687	$19,513
200	$500,000	$24,518	$33,333	-$8,815	$24,518
381	$952,500	$25,764	$63,500	-$37,736	$25,764

*Based on the year one operating margin

Using CREBs and the zero interest financing, the cash flows are better than with the State Trust Fund Loan Program. However, the conclusion is not substantially different. Positive cash flow is strongest for a 40 kW sized system. However, given the shorter debt period, the upturn in cash flow will begin in year 16, creating a stronger cash flow position earlier than with the 20 year debt.

In both financing scenarios, systems larger than 40 kW build up substantial negative cash balances during the financing period. Although not considered in the tables above, most small hydroelectric facilities will require a major overhaul of the system some time after 20 years. Even for the optimal 40 kW sized system, this overhaul cost could eat away any positive cash flow balances accrued over the financing period—if financed. If loan financing is utilized, in all cases, a hydroelectric project appears either not financially feasible or only marginally financially feasible during the period of the loan.

As an example, let's project that the 40 kW system was selected by Price County to be installed. Also, let's project that the system was not loan financed, but rather funded from the county's general tax revenue fund. A positive cash flow from day one of over $ 14,000/yr could be realized with the 40 kW system, and after 10.8 years the investment would be paid back. The charts above predict annual electricity production of 237,000 kW for this size of a system. If a typical home uses on average 600 to 700 kW/ month, this size system would produce enough electricity per year to supply electrical power for 28-33 homes.

A portion of this income must be put away and accumulated for eventual turbine overhaul costs, and other operation maintenance. Although not listed directly in a breakdown of costs for a hydroelectric project, there will need to be money budgeted for long-term system maintenance, particularly on the moving parts of the system. For example, a typical propeller turbine needs to be refurbished at about 20 year intervals. Current projected cost is about half the cost of a new unit. Associated costs would include turbine removal and repositioning, loss of revenue during refurbishment, and the refurbishment itself. Costs 20 yrs from now are unknown, but if a unit costs $ 24,000 today, refurbishment cost could be $ 12,000 plus an unknown inflation factor.

An engineering firm specializing in micro-hydro projects and equipment was asked to provide an equipment breakdown of costs for a potential 40 kW project using a single turbine. Although using two 20 kW units may simpler to control, the costs will be higher. To date (August 1) we have not received this detailed equipment cost projection. We anticipate it will arrive and will provide an addendum to this report when the projected cost breakdown is received from the firm requested to provide this information.

Potential Environmental Impacts of a Developed Hydroelectric Project at Weimer Dam

The environmental impact of the installation of a small hydroelectric generating facility on County owned property at the existing Weimer's dam site would be minimal, if any. One of the environmental questions that will arise is: Since the water flow is so low at some times of the season, especially in dry years, can all of the water be used at low flow, so that the maximum benefit can be derived from this resource?

Typically, with a traditional hydropower setup, some flow is diverted over dams with hydroelectric works, to keep sufficient Dissolved Oxygen (DO) in the water to protect the fishery. If Soo Lake has sufficient DO to maintain DO in the mile or so before the Elk River meets and mixes with S Fork Flambeau, we may be able to USE ALL of the water through the turbine--even in low flow. The argument for doing so would be the residual lake water DO, the fact that there are rocks and ripple beds in the stream, and due to slight gradient to the Flambeau from the Weimer dam, the water would be naturally aerated. [In other words, the relatively short distance of stream length before confluence with the South Fork of the Flambeau and turbulence and gradient should argue for no need for DO supplementation after turbine(s). The river downstream of the dam is not a quiet, lazy lake; the gradient would provide natural aeration capability.

If the main concern is DO and if all of the flow is used through the turbine (assume all water through the turbine in low flow), then if low DO occurs, there may be a need for some mechanism to re-aerate to take the place of oxygen input downstream of the dam. The tradeoff would be cost to re-aerate if we used all water through turbine, and low DO resulted. If we needed all water, and low DO resulted, is supplemental aeration an answer? And, if so, how much would that cost? Least cost would be to allow a residual over dam, reducing power output, or shutting down the generator during periods of insufficient flow.

Further conversation with the Jeff Scheirer, DNR fisheries biologist, suggested that initially—for sizing purposes, it could be assumed that all water could be utilized to operate the turbine at low flow without adversely affecting the fishery downstream of the dam. Modifications and adjustments could be made if monitoring suggested a stressed fishery due to low DO. His extensive experience with other FERC projects and other dam sites suggests his knowledge is valid. He also pointed out that "right-sizing" the equipment to gain the maximum benefit and cost/benefit ratio would be advisable on such a small project.
There may be alternative methods and devices available that may not need the water diverted to a turbine outside the main flow of the dam. A turbine assembly placed within the dam structure or in the tailrace may still provide turbulence and some dissolved oxygen for the fishery. Further exploration of these alternatives is recommended.

IV. Federal Energy Regulatory Commission (FERC) Issues, Local Utility Issues

- License requirements, permits, & timetable of a new hydroelectric projects
- Explore local utilities to determine:
  - Project interest, Other Issues
  - Potential cost of connection to the electrical distribution grid
  - Potential revenues from local utilities on an annual or seasonal basis
  - Annual revenue production potential in the form of a pay chart
- Explore dam lease options
- Explore ownership options

FERC License Requirements

The Federal Energy Regulatory Commission, under the authority of the Federal Power Act, may issue licenses for up to 30 to 50 years for the construction, operation, and maintenance of non-federal hydroelectric developments. A proposed hydroelectric project at Weimer Dam, Price County would need FERC licensing. In other words, according to phone conversations with FERC personnel in March 2008, this project cannot be EXEMPT from FERC licensure per Federal guidelines. At least two (2) triggers are positive that would place this project under FERC license requirements:

1) There is no one user or specific group of users of the potential electric power generated. In other words, no factory or public or private entity would use the generated power without going through or bypassing the electric utility grid. (In that event, a FERC license exception may be granted) Therefore, the electric power generated by a new structure needs to be directed to the electrical distribution grid, which requires a FERC license.
2) Price County is the owner of Weimer's dam. The dam creates the vertical head of water necessary for electric power generation and also creates a reservoir of water upstream of the dam. The county does not own all of the land that surrounds and borders the reservoir. Therefore, a FERC license is needed. (In cases where the same entity owns the dam and all land around the reservoir or impoundment that the dam creates, a FERC license may not be needed)

FERC License Exemption Potential

There are instances when hydroelectric projects below 5 Megawatts may be EXEMPT from obtaining a FERC license. In these instances, the exemption may be issued in perpetuity (for ever). In the Weimer Dam/Price County case, a few items would need to be reviewed with interested stakeholders such as the US Fish and Wildlife Service, the Wisconsin Department of Natural Resources, and Federal Energy Regulatory Commission. After a brief general description of the Weimer Dam potential project in Price County, sources at FERC in Washington DC explained that the decision as to whether an exception from a FERC license requirement may be granted rests on at least two (2) variables.

1) The powerhouse should be as close as possible to the dam, with short penstock and tailrace. According to the FERC representative, the ideal scenario is when the

powerhouse is integral with the dam. In Price County's case at the Weimer Dam, this may not be possible due to dam structural limitations (this feasibility study has never been designed as defining structural integrity or limitations of the dam). However, since there is adequate land area owned by the county at either end of the dam, a small powerhouse could be designed and built in close proximity to the dam. The general idea, according to the FERC representative, is to have minimal impact on the surrounding area.

2) Since the dam is owned by the county, but not the reservoir and shoreline created as a result of the dam backwater, according to the FERC representative, the county would need to obtain a recorded perpetual lease or easement from each landowner for the land that could be covered with water during a 100 year flood. That elevation on each property around the reservoir should have been determined and recorded in the 1989 Elk River Flood study document. It would then be a matter of getting each landowner within the 100-year floodplain to grant an easement to the county for that portion of their property that is delineated as in the 100-year flood plain. The purpose of this easement requirement, according to the FERC representative, is for liability concerns connected to the dam and the hydroelectric project.
3) The above discussion involved limited phone conversations with various FERC officials. Additional definition of FERC licensing exemption requirements are needed from FERC and from the Wisconsin DNR as it relates to legal ownership up to and including 100-year flood delineation. If Price County determines that it is going to move forward with a hydroelectric project on Weimer Dam, the best way to approach the licensing exemption question may be to start the process with as detailed a description as possible of the project (this feasibility study could be a part of that) in a Letter of Intent to the FERC national and regional offices and to the Wisconsin Department of Natural Resources. Notice of Intent and Pre-Application documents would accompany the letter of intent, providing information about the project, and requesting exemption from FERC licensing. Prior to Letter of Intent submission, further define, through additional research, the 100-year flood easement concern, and include with that initial documentation any additional information on why this project could be qualified for FERC license exemption. Upon review of this document package by FERC and WI-DNR, a clearer definition of FERC license exemption may be forthcoming. According to at least one FERC representative, it may be possible that for the Weimer dam case, a FERC license exemption may be granted, especially for a relatively small input into the electrical grid. However, a determination as to FERC license exemption needs to be made AFTER further information and description of the project is submitted to interested stakeholders. After review of documentation, the above stakeholders would issue an opinion as to license exemption status.

FERC License Requirements

A traditional FERC license is the preferred license to obtain. Contrasted to an integrated FERC license and procedures to obtain the license, the traditional license procedure requires somewhat less documentation and usually has a shorter timeframe to obtain. The local DNR representative (Jeff Scheier) had worked with FERC regulations for several years in the Northwest Wisconsin area. He also indicated that his first thought was that a FERC license would be required.

The typical timeframe for a traditional FERC license to produce hydroelectric power is 2-4 years. It was reported by one FERC representative during a phone conversation in March of 2008 that there is no cost for the FERC license itself. The cost results from the studies, consulting and design work that is required before the license can be issued by FERC. It is very difficult to estimate cost of studies, consulting and design work until more of the "unknowns" of the Weimer Dam hydroelectric project are defined. These unknowns hinge on the regional FERC authorities, who may or may not require licensure---AFTER they review an initial project description and proposal for a hydroelectric facility at Weimer Dam. This includes a letter of Intent and a notice of intent to file for a FERC license, and should accompany a Pre-Application Document.

For the Weimer dam project to become licensed and construction completed, the process could take 3-5 years from the time that the county gave the approval to proceed with licensing. The FERC Handbook for Hydroelectric Project Licensing lists steps to be taken toward licensing a proposed hydroelectric project. Initial documents needed would include:

--A) Letter of Intent to file for a FERC license, which includes project description, and which requests a preliminary permit number to be issued to the licensee, and a request to file a Traditional license as opposed to the more complicated and cumbersome Integrated license

--B) Notice of Intent (NOI) to file a License, which should clearly specify:
- -The licensee's intent to file for a license
- -Licensee's name and address
- -Preliminary permit number
- -Type of principle project features licensed
- -Location of the project
- -Plant installed capacity
- -Locations where information under 18 CFR 16.6 is available to the public
- -Names and mailing addresses of every county, city, town or similar gov't jurisdiction in which any part of the project is located or has a population of 5000 or more and is within 15 miles of the dam.

-C) Concurrent with the Filing of the NOI, an applicant must also file a Pre-Application Document (PAD), which makes known all existing engineering, economic, and environmental information relevant to licensing the project that is reasonably available, or can reasonably be obtained with due diligence when the NOI is filed. The PAD serves as the foundation for issue identification, study plan development, and the Commission's environmental analysis. It will also set forth the applicant's proposed schedule for completing application preparation and filing the formal application for the hydroelectric license with the FERC.

Several entities should be contacted and consulted during the application preparation process. The process usually involves several meetings with a variety of stakeholders, where matters pertinent to the license and the project will be discussed. An outcome of these meetings is that areas of concern will be identified for further study and investigation. This is termed project scoping. The purpose of the scoping process is to identify and evaluate engineering, economics, and environmental issues, and to propose alternative solutions to significant issues related to the development of the project in the areas of: Geology and Soils, Water Resources, Wildlife and

Fisheries, Terrestrial Resources, Aesthetic Resources, Recreation and Land Use, Socioeconomics, the Need for Power by hydroelectric generation, and Other issues.

The Need for Power Evaluation should specify the following:

- Load requirements and forecasted generating capacity, and
- How the project will:
  - Stimulate economic growth
  - Support necessary reserve margins
  - Provide less expensive power
  - Displace depletable and foreign supplied oil
  - Provide a reliable power source that is owned and controlled by the applicant and will be used to meet increasing load requirements and reduce reliance on an external power supplier

The scoping process involves participation by numerous agencies, non-governmental organizations and individuals. One of the outcomes will identify what studies need to be conducted to address stakeholders concerns. The scoping studies will contain a brief description of the proposed action and alternatives, environmental issues, and an environmental impact statement outline and schedule. The scoping studies, once completed, will be circulated to appropriate Federal, state, and local resource agencies, developers, non-governmental organizations, and other interested parties and stakeholders to help them participate in the scoping process. Who should be consulted during the application preparation process?

- US Fish and Wildlife Service
- US Environmental Protection Agency
- Any state agency with responsibility for fish, wildlife, and botanical resources, water quality management, plan consistency certification, shoreline management, water resources
- Local, state, and regional recreation agencies and planning commissions
- Local and state zoning agencies
- Any potentially affected landowners

State Department of Natural Resources Permit:

- A permit from the Wisconsin Department of Natural Resources would be required under:
- Chapter 31.12 or 31.18 If a typical or traditional design layout for a powerhouse is selected, the dam spillway would be altered when a powerhouse is built at the south end of the dam, and water is diverted from the normal spillway, flow through an inlet structure to the powerhouse, through turbine(s), to a modified tail race structure. The local DNR dam's coordinator would be the primary contact regarding application of this permit. Among the permitting steps to be taken would be the submittal of an engineering plans and specifications document set, showing detailed drawings of the proposed changes to the spillway structure (more-or-less the entire plan set for new construction), even though the dam itself may not need modification.

Local Utility Participation

- Project interest, Other Issues
- Potential cost of connection to the electrical distribution grid
- Potential revenues from local utility on an annual or seasonal basis

Utility Interconnection with Price Electric Cooperative

The Weimer Dam is located in the Price Electric Cooperative service territory. Price Electric follows the State of Wisconsin Rules for Interconnecting Distributed Generation Facilities (PSC 119). The requirements for meeting PSC 119 are spelled out in a guidebook available on the Price Electric website: www.price-electric.com

The guidelines explain the process for interconnecting with the utility, technical requirements for specific systems, and other rights and responsibilities for owners of distributed generation systems. For the Weimar Dam project, the likely generator sizing will place the project into Category 1 or Category 2. Category 1 refers to systems 20 kW and under. Category 2 refers to systems greater than 20 kW and up to 200 kW. The key financial implications are:

Liability Insurance: Category 1: $300,000 Category 2: $1,000,000

Fees:

Item	Max Fee Category 1	Max Fee Category 2
Application Review	None	$250
Engineering Review	None	$500
Distribution System Study	None	$500

The fees for Category 2 are fairly modest and should not impact project financials significantly.

Net Metering

Wisconsin state law allows for customers to "net meter" with their utility. Net metering offers a customer the opportunity to sell power back to the utility at the same rate they purchase power. Current state law requires utilities to offer net metering at no greater than 20 kW in total system generator size. Price Electric indicated that net metering would be honored for a system at the Weimar Dam with a generating capacity of 40 kW. The higher level for net metering is an economic boon to the project.

For Price Electric, the net metering prices are:
$0.099cents per kWh for the first 500 kWh per month
$0.094 cents per kWh for any production beyond 500 kWh

If the generator is sized beyond 40 kW, Price Electric is obligated to only offer "avoided cost," or the price of power *they* pay for electricity. Price Electric estimated this value at $0.057 / kWh.

No one knows what utility rates will be in the future. However, projected trends seem to indicate at least a 5-7 % increase annually, at least for the next several years. Rates could double in the next 10 years. Net billing rates will increase with the increase in electricity rates as net billing rates are tied to general electricity costs. Therefore, in several years, the net billing rate may be

substantially higher than today, making a project in the future more financially attractive. It is also possible that hydroelectric system components will increase in price, too, which could undermine a future project. The County should be aware that net billing is done on a meter by meter basis. Therefore a net billing project at the Weimar Dam would still allow for a net billing project at some other County facility.

Other potential liabilities that the county might look into and be aware of regarding this or other future hydroelectric projects:

Liability Insurance rate increases
Weather pattern changes: Drought
DNR and FERC policy changes that might negatively impact hydroelectric projects
Equipment, labor, or construction pricing changes
Utility or Public Service Commission policy changes that could alter financial aspects of projects
Environmental factors: flooding, etc
Vandalism
Maintenance worker harm

Explore Dam Lease and Ownership Options

From data gathered during this hydroelectric feasibility study, it is summarized that the electrical output and consequent revenues are on the small end of the spectrum of developed hydroelectric projects. If the project were developed to a larger scale than the shortest few payback period sizes, the longer payback period may become an obstacle for any potential interested owners or leasers of the dam. Companies that manage lease or own dams are usually "for profit" companies. They need profit to stay in business. North American Hydro, here in Wisconsin, may be the most likely candidate for interest in owning or leasing Weimer dam with a developed hydroelectric project.

We spoke candidly to NA Hydro representatives about the hydroelectric potential at Weimer dam from an engineering standpoint. The NA Hydro representative indicated that based on the parameters of the project, it would be unlikely to move ahead with anything. NA Hydro indicated that they could help with equipment, but that a turbine of the size that would most economically fit into Weimer dam is of no interest in terms of owning or leasing the dam.

From a sales perspective, a NA Hydro salesperson may have been making calls, but their sales staff are not engineers. They may be interested in selling equipment or of keeping tabs on any other companies who may try to develop something. Typically a turbine/generator set would be purchased from one company. NA Hydro would be able to handle the control equipment after the generator. Other companies that handle micro hydro equipment were contacted and have provided pricing and other information on turbine/generator sets.

Conclusion and Next Steps

The Weimer Dam can support a small hydroelectric power plant. The optimal system size is in the range of 40 kW. If the system is over 40 kW, the price for electricity drops substantially. The project can cash flow based on the expected power production modeled using the estimated duration curve and RETScreen modeling software. Although the project *can* cash flow, the positive financial results are based on the assumption that the daily labor expense of maintaining the system (one hour per day) is not considered in the analysis. If the daily labor expense is considered, no project will cash flow using the financing scenarios presented in the analysis.

The performance of the system is based on a flow duration curve that combines the estimate of the Price County Dams Keeper and natural stream flows. No gauge station exists near the Weimer Dam to measure actual flows. Absent nearby gauge station readings it would be imprudent to move ahead with a project. If the project showed strong financial performance, the uncertainty of the water flow can be mitigated by the apparent "easy win." However, in this case there is no apparent "easy win." As a result we strongly recommend developing an accurate history of measured water flows at the Weimer Dam.

As a result, we recommend the following next steps:

6) Commission a gauge station to begin collecting data.
7) Begin the process of FERC licensing or permit waiver
8) Conduct a brief feasibility study using the collected stream gauge data
9) Update Price Electric power prices and project revenue
10) Request quotes or go out to bid to project developers if the updated feasibility study with actual stream gauge measurements supports a project

Hydroelectric Feasibility Study Acknowledgements:

Our thanks to Mr. Robert Lepke, Price County Dams Keeper, for his guidance through this project, and to the Price County Dams Committee members ('06-'08): Richard Schneider, Robert Rogalla, Joe Rasmussen, Russell Kapitz, Paula Houdek. Thanks also to the Price County Land Conservation Department, the local Department of Natural Resources watershed manager and fisheries biologist, representatives of Price Electric Cooperative, Wisconsin Energy Independence Office, the regional and national offices of the Federal Energy Regulatory Commission and others for their assistance and contributions.

V. Reference List

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Interview with David Blecker, Seventh Generation Energy Systems (developer)

Interviews with Dan Purzycki at North American Hydro

21st Century Complete Guide to Hydropower, Progressive Management. Compilation of U.S. Government documents on hydroelectric power.

RETScreen International (software)

Figure 1
Potential to locate turbine/generator sets on either side of Weimer Dam

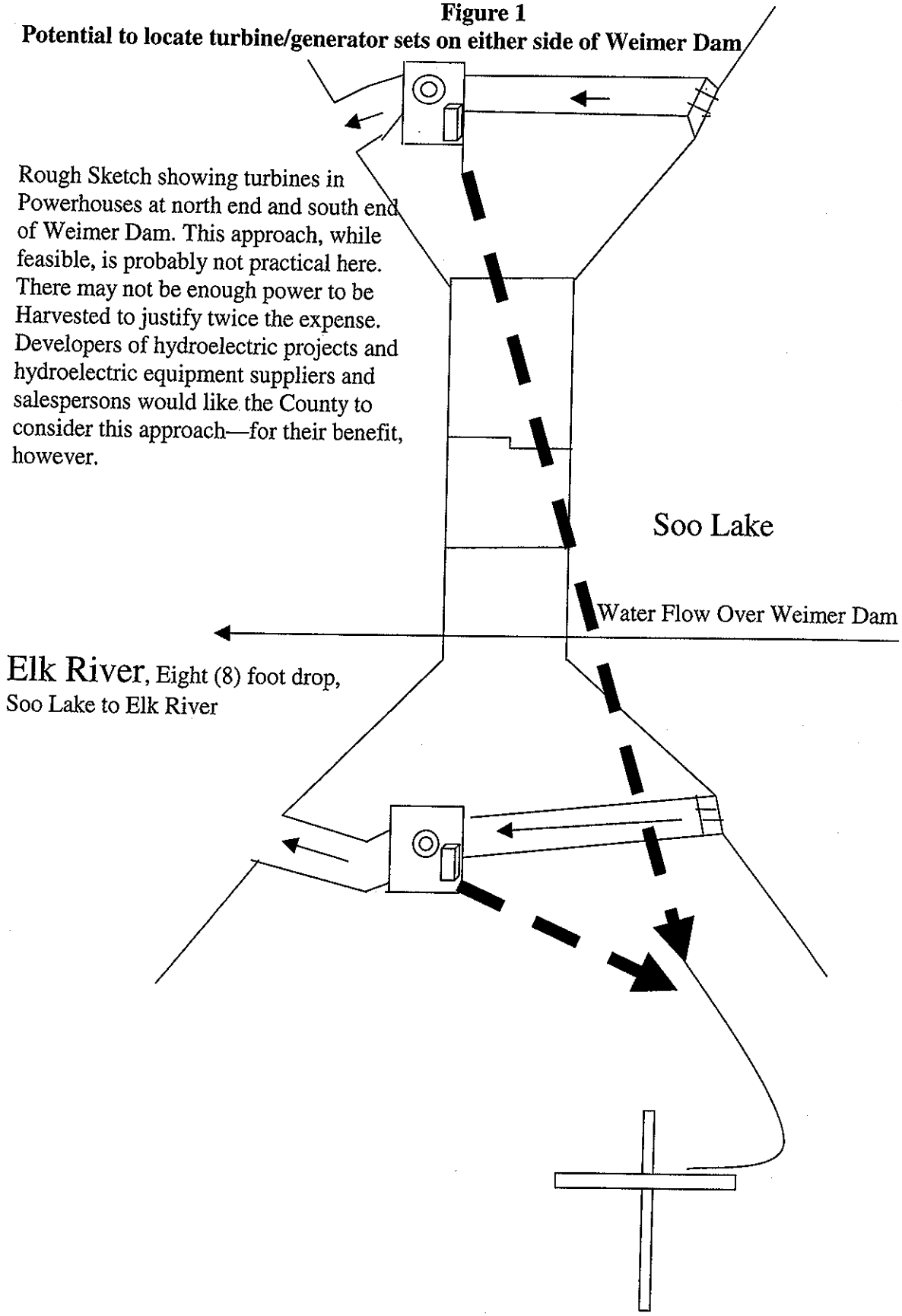


Figure 2-Conceptual Structure—Powerhouse & turbine/generator on top of dam

Figure 2 depicts a top view of a conceptual pre-fabricated structure that could be custom-built to fit the dimensions of the dam. The unit's main weight bearing load would be supported by the dam base structure. The unit could conceptually be inserted in the stop log grooves from the top with a crane. Very little weight would be supported by the walk above the dam. The powerhouse could be an integral part of this modular insert, or could be built separately on the insert base. It could be compact, an 8-foot cube, housing horizontal propeller-style turbine on vertical shaft, direct drive to top-mounted generator, and electrical controls. The material could be non-corrosive metal or other materials, with valved opening and structure insert rails for turbine, so once in place, there would be a relatively tight seal (turbine box). There could be a roof-opening hatch to pull turbine, since low head would require only about a 12' shaft. Screen upstream of turbine could be heavy-duty and automated for self-cleaning.

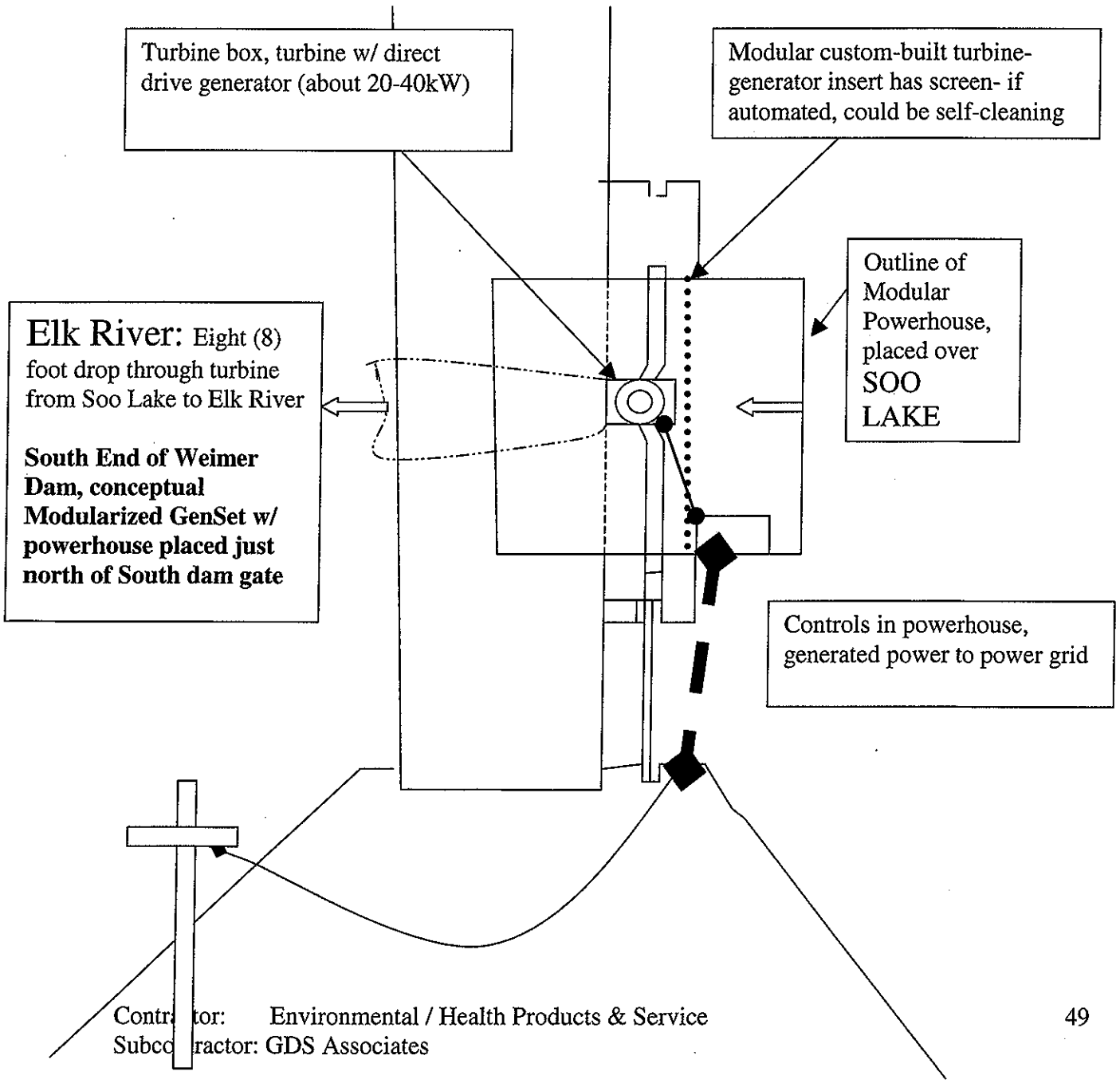
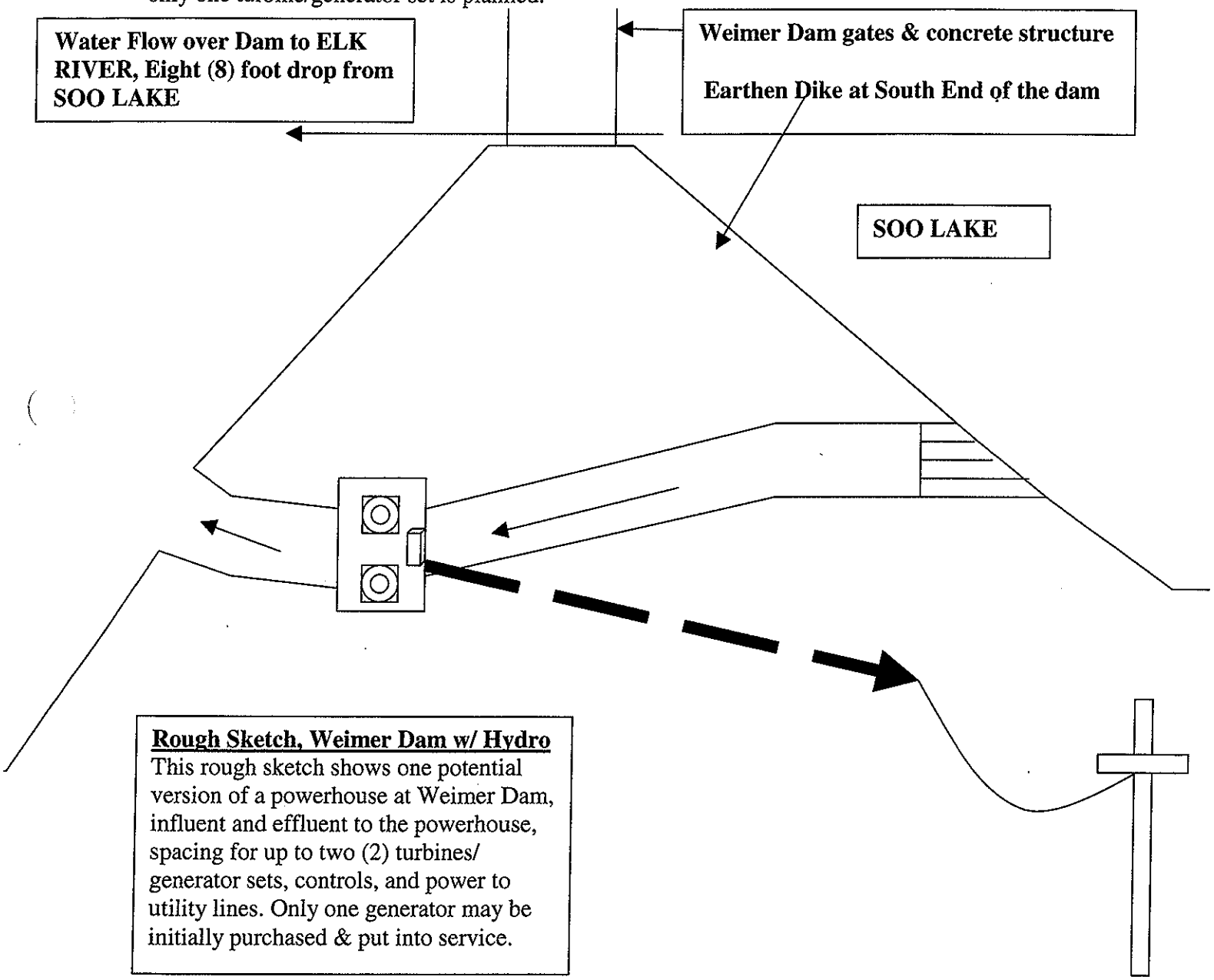


Figure 3

Typical hydroelectric project layout----One-dimensional very rough not to scale sketch of Powerhouse (top view) at the south end of the dam. Inlet screen and tube to get water to turbine (penstock), tail water structure, and rough shape of turbine/generator locations. This layout could assume initial installation of one turbine/generator set, with space allocated for an additional unit in the future. Entire structure (and associated project costs) could be downsized significantly if only one turbine/generator set is planned.



Rough Sketch, Weimer Dam w/ Hydro
This rough sketch shows one potential version of a powerhouse at Weimer Dam, influent and effluent to the powerhouse, spacing for up to two (2) turbines/ generator sets, controls, and power to utility lines. Only one generator may be initially purchased & put into service.

Addendum to the

Hydro Electric Feasibility Study Report for Murray (Weimer's) Dam, Price County, Wisconsin

Price County Dams Committee
August, 2008

Contractor:
ENVIRONMENTAL / HEALTH PRODUCTS & SERVICE

Subcontractor:
GDS Associates, Inc

Detailed Costs for 40 kW Weimer Dam

Cost Category	Cost Estimate
MOBILIZATION	$2,500
SITE PREPARATION	$1,000
DEWATERING	$6,900
EROSION CONTROL	$1,000
INTAKE	$13,300
INTAKE ACCESSORIES	$8,925
PENSTOCK	$20,000
POWERHOUSE SUBSTRUCTURE	$34,100
POWERHOUSE SUPERSTRUCTURE	$21,400
TAILRACE CHANNEL	$4,400
TURBINE & GENERATOR PACKAGE	$60,000
LOW VOLTAGE ELECTRICAL EQUIPMENT	$8,500
CONTROL SYSTEM	$6,750
SUBSTATION & INTERCONNECT	$26,400
SITE CLEAN UP	$1,800
INDIRECT COSTS	$50,000
Total	**$266,975**

Financial Analysis

Based on the detailed cost estimate, we updated the financial analysis for the hydroelectric project. A major factor that remains uncertain is how to handle the Dams Keeper's labor costs. One hour per day, 365days per year, will be needed to handle basic maintenance. It is unclear whether this labor should considered additional and act as an operating cost, or whether this labor can be managed within the existing Dams Keeper's labor budget. For the purposes of the financial analysis, we assume that the Dams Keeper's labor is not an additional cost and can be ignored.

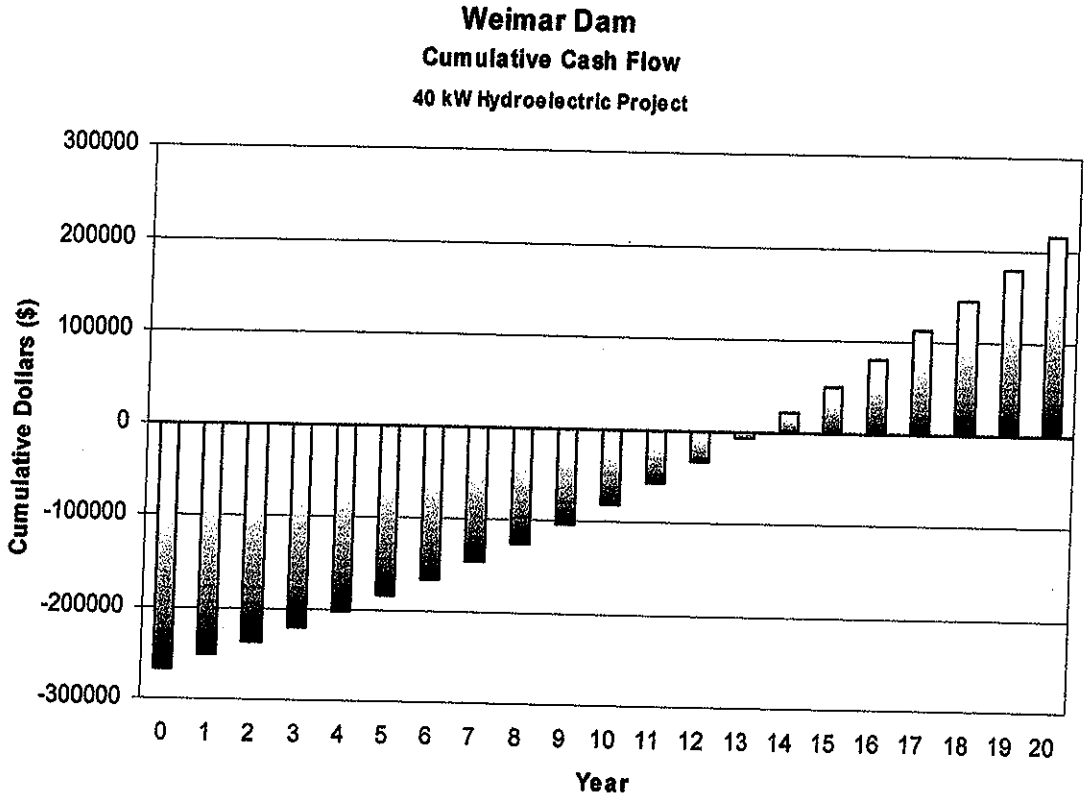
Other financial assumptions:

Annual rate of O&M inflation – two percent
Annual rate of revenue inflation – four percent
Year One O&M costs - $7,515 (from feasibility study)
Year One Revenue - $22,308 (from feasibility study)

Below, we present two financial scenarios. The first is a simple payback scenario in which Price County uses available funding to pay for the hydroelectric project outright. The simple payback uses the above assumptions to determine the point at which the project pays for itself. We also include an internal rate of return estimate over a 20 year period to provide a comparison to other investment options, such as a savings account.

Simple Payback and IRR Scenario

Following is a chart presenting the net cash flow from the proposed 40 kW project using tax general fund revenue with no debt financing. Between years 13 and 14, cumulative net cash flow equals the initial cost, illustrating that the simple payback occurs between years 13 and 14.



Based on the net cash flows for a 20 year period, the internal rate of return on the project is about 5.4 percent. The question is--given the risk of the project, is this rate of return sufficient to justify the expenditure? As mentioned above, this return is equivalent to a CD or similar investment vehicle, at a lower risk. However, does the increased risk outweigh the rewards mentioned earlier?

- not be a drain on taxes in the long run,
- will generate a small revenue stream,
- will promote renewable and green technologies on a LOCAL basis,
- will help the people of the county [all of the revenue (energy = electricity) generated will be used in the county],

mentioned earlier. CREB's offer effective zero-interest due to government incentive to invest in clean renewable energy, and the county may not need local taxpayer funding of the project. This scenario could potentially be the winning compromise funding mechanism with even a higher cumulative rate of return than the tax-funded or bank-funded scenarios.

Financial Summary

We do urge caution in assuming that the project offers a guaranteed rate of return. The project finances are highly dependent on increasing revenue from electricity sales and on the ability of Price County to successfully operate the project. In either financial scenario, positive cash flow cannot occur from the start of the project (unless for the general tax revenue funding scenario the county totally discounted the future value of money). However, in later years—taking the long view-- positive cumulative cash flows do occur for both scenarios, and would be a small income source to the county—in later years. A hydroelectric project is not risk free and consideration could be made for alternative projects with similar financial returns, but different risk profiles. However, without taking the risk of investing in locally available energy, the listed rewards would not be possible. Another factor to consider is that the financial returns are dependent on NOT including the labor cost of day to day maintenance by the Dams Keeper. If this labor cost is factored into either of the defined financing scenarios, the project revenue will be sharply negative. CREB's financing may ease this a bit.

Detailed Financial Assumptions

The following table was provided by Blackbrook Environmental to support the detailed cost analysis. The analysis explains a breakdown of the major cost categories and factors in the costing. Note that indirect costs are not detailed. In discussion, these costs were estimated at $50,000 to $100,000, depending on project specifics. In the table, below, these costs are not factored into the total cost or cost per kW of capacity.

Addendum to the Weimer's Dam
Hydro Electric Feasibility Study Report

10	CONTROL SYSTEM						$6,750
10.1	Cabinet & Wiring	wall hung cabinet	1	LS	$750	$750	
10.2	PLC Based HWL Control System	basic HWL control & automation	1	LS	$4,000	$4,000	
10.3	Pickups and Transducers	4-20ma HWL, rack level & RPM	1	LS	$1,500	$1,500	
10.4	cell modem or similar for monitoring & alarm	details to be determined	1	LS	$500	$500	
11	SUBSTATION & INTERCONNECT						$31,400
11.1	Utility Interconnection Study	included in "Indirect Costs"	0	LS	$0	$0	
11.2	Cabinet and Wiring		1	LS	$1,400	$1,400	
11.3	MCCBs	per code over current protection	2	Each	$500	$1,000	
11.4	contactors	for auto start/stop	2	Each	$750	$1,500	
11.5	Metering	utility supplied	1	LS	$5,000	$5,000	
11.6	Pad Mounted	details to be determined	1	LS	$15,000	$15,000	
11.7	Disconnect	utility supplied - pole mount	1	LS	$5,000	$5,000	
11.8	Grounding	details to be determined	1	LS	$2,500	$2,500	
12	SITE CLEAN UP						$1,800
12.1	Debris Removal & Disposal		1	LS	$1,000	$1,000	
12.2	General Grading, Seed & Mulch		8	Hours	$100	$800	
13	INDIRECT COSTS						$0
13.1	FERC permitting	Costs to be determined separately	1	LS	$0	$0	
13.2	Construction Permits	"	1	LS	$0	$0	
13.3	Structural Engineering	"	0	Hours	$0	$0	
13.4	Systems Design and Engineering	"	0	Hours	$0	$0	
13.5	Drafting and Blue Printing	"	1	LS	$0	$0	
13.6	Engineering Inspections & Reports	"	1	LS	$0	$0	
13.7	Construction Management	"	1	LS	$0	$0	
13.8	Transmission Line - upgrade	"	0	Mile	$0	$0	
13.9	Interconnection	"	1	LS	$0	$0	

CONSTRUCTION COST SUB-TOTAL:	$221,975
INDIRECT COST TOTAL:	$0
TOTALPROJECT COST	**$221,975**
INSTALLED CAPACITY:	40
$ / KW kw of INSTALLED CAPACITY:	$5,649

Contractor:
ENVIRONMENTAL / HEALTH PRODUCTS & SERVICE

Subcontractor:
GDS Associates, Inc

Addendum to the

Hydro Electric Feasibility Study Report for Murray (Weimer's) Dam, Price County, Wisconsin

Price County Dams Committee
August, 2008

Contractor:
ENVIRONMENTAL / HEALTH PRODUCTS & SERVICE

Subcontractor:
GDS Associates, Inc

Addendum to the Weimer's Dam
Hydro Electric Feasibility Study Report

This document is an addendum to the final report of the Weimar Dam hydroelectric feasibility study conducted by EHS, and GDS Associates, Inc. The purpose of this document is to provide a detailed pricing estimate on a two turbine 40 kW hydroelectric system, the most cost effective and practicable hydroelectric development option.

Overview

Jason Hines, the principal of Blackbrook Environmental, a hydroelectric developer, provided the detailed pricing information. The information is based on Blackbrook's considerable past experience developing smaller hydroelectric systems, but should not be considered an endorsement of a development effort at Weimar Dam or a formal price quote from Blackbrook Environmental.

The detailed pricing estimate is broken down into two sections – direct costs and indirect costs. Direct costs are related to physically constructing the facility – labor and materials. Indirect costs are related to activities that support the development. These include permitting, construction documents, and related activities. The indirect costs are much less certain than direct costs and some cost savings may be possible by Price County providing some of these services directly. Indirect costs are presented as a range based on Blackbrook Environmental's experience and can have considerable impact on overall project costs.

Summary of costs:
Direct costs - $216,975
Indirect costs - $50,000 to $100,000

Indirect costs are likely to be at the lower end of the range as costs related to power line upgrades or extension are covered by Price Electric, but paid for in the monthly service charge. We assume the lower end of the range ($50,000) is reasonable. The total cost is estimated at $266,975, or $6,674 per kW. The cost per kW is at the high end of the range estimated in the feasibility study report. The financial analysis presented in the feasibility study report assumes the low end of the cost range, or $4,000 per kW. That detailed costs are estimated in the high end of the range is not surprising given the rise in labor and material costs from just the last few years.

We present the detailed cost breakdown by category and a financial analysis using the detailed values.

Detailed Costs for 40 kW Weimer Dam

Cost Category	Cost Estimate
MOBILIZATION	$2,500
SITE PREPARATION	$1,000
DEWATERING	$6,900
EROSION CONTROL	$1,000
INTAKE	$13,300
INTAKE ACCESSORIES	$8,925
PENSTOCK	$20,000
POWERHOUSE SUBSTRUCTURE	$34,100
POWERHOUSE SUPERSTRUCTURE	$21,400
TAILRACE CHANNEL	$4,400
TURBINE & GENERATOR PACKAGE	$60,000
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Total	**$266,975**

Financial Analysis

Based on the detailed cost estimate, we updated the financial analysis for the hydroelectric project. A major factor that remains uncertain is how to handle the Dams Keeper's labor costs. One hour per day, 365days per year, will be needed to handle basic maintenance. It is unclear whether this labor should considered additional and act as an operating cost, or whether this labor can be managed within the existing Dams Keeper's labor budget. For the purposes of the financial analysis, we assume that the Dams Keeper's labor is not an additional cost and can be ignored.

Other financial assumptions:

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Below, we present two financial scenarios. The first is a simple payback scenario in which Price County uses available funding to pay for the hydroelectric project outright. The simple payback uses the above assumptions to determine the point at which the project pays for itself. We also include an internal rate of return estimate over a 20 year period to provide a comparison to other investment options, such as a savings account.

The second financial scenario assumes the project is 100 percent financed by debt at a local bank over a 20 year period at five percent interest. This scenario tests the ability of the project to cash flow with debt financing. It is also possible for the project to be financed with a mixture of cash and debt, however all the possibilities are beyond the scope of this project. However, a compromise financing position may be to in effect have zero interest from borrowed money in the form of Clean Renewable Energy Bonds (CREB's), referred to in the final report, to create a scenario in which general tax fund revenue would not be used, and borrowed money would be interest-free while the project paid back the interest-free money. This is the incentive to use CREB's.

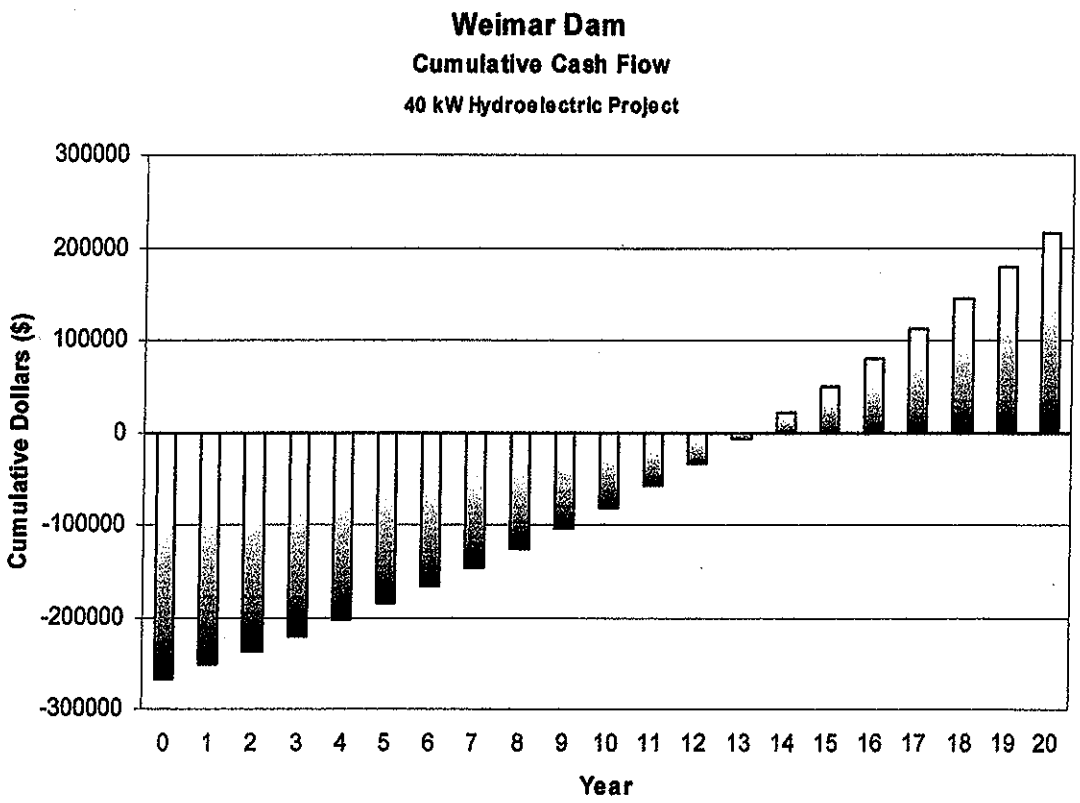
Investment Discussion-Risk versus Reward

While free market economy business investment decisions for capital equipment expenditures and projects are viewed in the 3-7 year payback scenario, government investments sometimes are not measured in monetary payback, but rather services provided. In Price County, as in many communities, examples of investments for the public good include transportation, health and safety, and education, provided with other than monetary return on investment as the goal. A combination of capital investment to provide for the public good, an ability to use local resources to sustain ourselves (an example might be the annual cash flow of the Forestry Department as a result of managing county forest land) and a longer view of investment monetary payback could combine to justify a business/service investment at the county level such as the Weimer Dam Hydroelectric Project. With a longer view in mind, eventually leading to a slight boost in increased income for the county and taking advantage of local unused energy resources in this high energy cost era, the Weimer Dam Hydroelectric Project is do-able--without undue burden on the taxpayers of Price County.

It is feasible that Price County may take some calculated risk on an investment that will not be a drain on taxes in the long run, will generate a small revenue stream, will promote renewable and green technologies on a LOCAL basis, and will help the people of the county [all of the revenue (electricity) generated will be used in the county]. In a pure business investment sense, there may be less risk putting money in a CD in a bank. However, the same could be said for expenditures for above-mentioned services, yet we as taxpayers need those services, so we make proper investments. In the near future, locally generated energy may become one of those essential services. The Weimer Dam Hydroelectric Project could be a leading edge into at least a portion of locally provided energy, putting the people of Price County in a more self-sustaining mode of survival, and providing a competitive edge for the people of Price County related to the global economy. This may be a model project for the "Think Globally, Act Locally" motto.

Simple Payback and IRR Scenario

Following is a chart presenting the net cash flow from the proposed 40 kW project using tax general fund revenue with no debt financing. Between years 13 and 14, cumulative net cash flow equals the initial cost, illustrating that the simple payback occurs between years 13 and 14.



Based on the net cash flows for a 20 year period, the internal rate of return on the project is about 5.4 percent. The question is--given the risk of the project, is this rate of return sufficient to justify the expenditure? As mentioned above, this return is equivalent to a CD or similar investment vehicle, at a lower risk. However, does the increased risk outweigh the rewards mentioned earlier?

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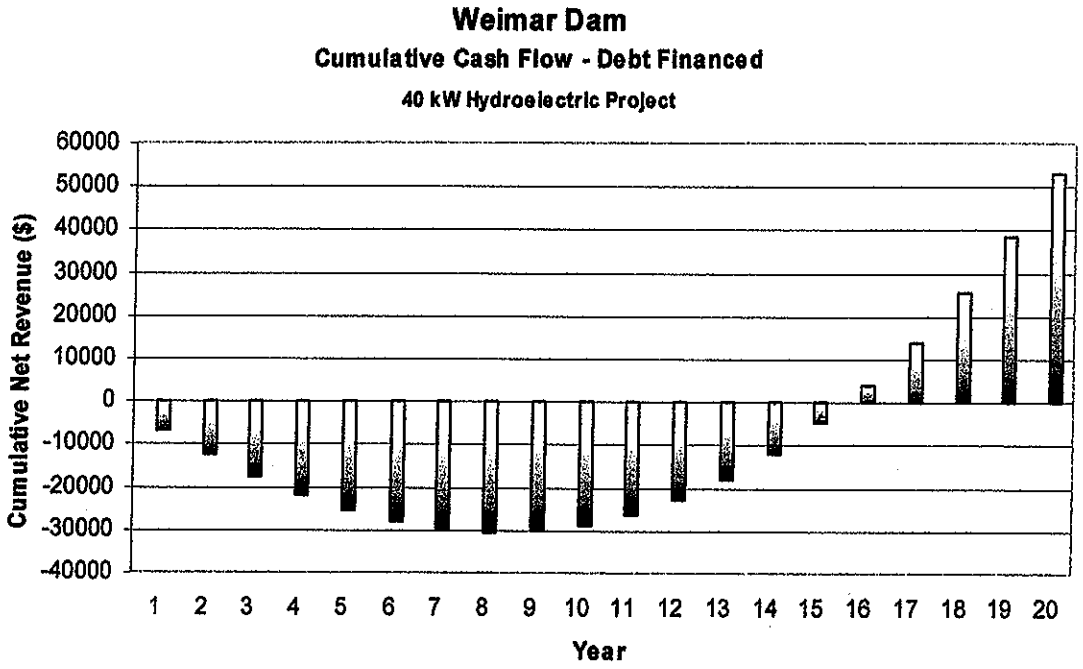
- may position the people of Price County in a more self-sustaining mode of survival,
- may provide a competitive edge for the people of Price County related to the global economy.

Financing Scenario

Another option for funding the project is to use a bank's money. In this case we model the finances assuming the project is financed with 100 percent debt for 20 years at five percent interest. Other financing options are noted in the full report. In this scenario, the annual total debt payment (principle + interest) equals about $21,423. Other financial factors (inflation rates, revenues, O&M) are the same as above.

The chart shows the cumulative net revenues of the project over the 20 year financing period. During the first 15 to 16 years, the project maintains a cumulative negative balance. This negative balance would have to be funded monthly or annually to make up for expected cash shortfalls. Net revenues grow as the revenue grows due to increasing electricity prices. However, the negative cash shortfall could be a political liability.



The net revenues from each year result in a total 20 year internal rate of return of eight percent, better than the cash financed scenario presented above. The reason for this improved rate of return is the avoidance of the initial outlay of cash at the start of the project. An alternative funding mechanism may be Clean Renewable Energy Bonds, as

mentioned earlier. CREB's offer effective zero-interest due to government incentive to invest in clean renewable energy, and the county may not need local taxpayer funding of the project. This scenario could potentially be the winning compromise funding mechanism with even a higher cumulative rate of return than the tax-funded or bank-funded scenarios.

Financial Summary

We do urge caution in assuming that the project offers a guaranteed rate of return. The project finances are highly dependent on increasing revenue from electricity sales and on the ability of Price County to successfully operate the project. In either financial scenario, positive cash flow cannot occur from the start of the project (unless for the general tax revenue funding scenario the county totally discounted the future value of money). However, in later years—taking the long view-- positive cumulative cash flows do occur for both scenarios, and would be a small income source to the county—in later years. A hydroelectric project is not risk free and consideration could be made for alternative projects with similar financial returns, but different risk profiles. However, without taking the risk of investing in locally available energy, the listed rewards would not be possible. Another factor to consider is that the financial returns are dependent on NOT including the labor cost of day to day maintenance by the Dams Keeper. If this labor cost is factored into either of the defined financing scenarios, the project revenue will be sharply negative. CREB's financing may ease this a bit.

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Addendum to the Weimer's Dam
Hydro Electric Feasibility Study Report

Wiemer Dam - Budgetary Development Estimate

ITEM NUMBER	DESCRIPTION		QUANTITY	UNIT	UNIT COST	AMOUNT	ACCOUNT TOTAL
1	MOBILIZATION		1	LS	$2,500	$2,500	$2,500
2	SITE PREPARATION						$1,000
2.1	Clearing and Grubbing	assumes basically open site	0	LS	$0	$0	
2.2	Construction Roads	assumes use of existing access	0	LS	$0	$0	
2.3	Public Safety	basic signage & fencing	1	LS	$1,000	$1,000	
3	DEWATERING						$6,900
3.1	Gravel Fill	reuse material from exc. on site	200	Cubic Yard	$8	$1,600	
3.2	Pumping		14	Days	$200	$2,800	
3.3	Cofferdam Placement and Removal		25	Hours	$100	$2,500	
4	EROSION CONTROL						$1,000
4.1	Temporary Erosion Control	silt fence & haybales incl. labor	1	LS	$1,000	$1,000	
5	INTAKE						$13,300
5.1.1	Excavation, Soil		100	Cubic Yard	$10	$1,000	
5.1.2	Excavation, Rock	assumes no bedrock	0	Cubic Yard	$75	$0	
5.2	Intake Structural Concrete	18W x 10L x 10D overall	20	Cubic Yard	$600	$12,000	
5.3	Backfill	reuse best material from on site	25	Cubic Yard	$12	$300	
6	INTAKE ACCESSORIES						$9,925
6.1	Trashrack	2 racks - 52 ft ea. 40 ft ea. slanted	104	Square Feet	$13	$1,300	
6.2	Intake Gate and Hoist	steel frame and chainfall	2	LS	$2,500	$5,000	
6.3	stop logs	safety railing at front by rack	1	LS	$500	$500	
6.4	Operator's Deck	steel grate -	150	Square Feet	$8	$1,125	
6.5	Railings and Ladders	safety railing at front by rack	1	LS	$500	$500	
6.6	Rack Rakes and Stoplog Pullers	2 hand rakes and 2 pullers	1	LS	$500	$500	
4	PENSTOCK						$20,000
4.1	steel pipe	two 36" dia. x 0.250" wall	200	LF	$75	$15,000	
4.2	installation	excavation, welding, backfill	1	LS	$5,000	$5,000	
5	POWERHOUSE SUBSTRUCTURE						$34,100
5.1.1	Excavation, Soil	approx - depends on final siting	250	Cubic Yard	$10	$2,500	
5.1.2	Excavation, Rock	assumes no bedrock	0	Cubic Yard	$75	$0	
5.2.1	Substructure Concrete	as shown in GD60 dwg	20	Cubic Yard	$650	$19,500	
5.2.2	powerhouse footing, frostwall, wall	4 ft frost wall - 4 ft knee wall x 8"	18	Cubic Yard	$400	$7,200	
5.2.3	Powerhouse Floor Concrete	16' x 20' x 6" slab	6	Cubic Yard	$400	$2,400	
5.3	Install Imbedded Parts	labor & misc small fabrications	1	LS	$2,500	$2,500	
6	POWERHOUSE SUPERSTRUCTURE						$21,400
6.2	manufactured metal building 16 ft x 20 ft	w/ 1 man door & 1 roll up door	1	LS	$15,000	$15,000	
6.3	Powerhouse Crane	steel rail and chainfall	1	LS	$3,000	$3,000	
6.3	Propane Fired Heating System	ceiling mounted propane fired	1	LS	$1,000	$1,000	
6.4	Ventilation Fans	two electric vent fans for summer	1	LS	$400	$400	
4.1	Entrance Panel, Conduit, Wiring & Lighting	100 amp service per code - basic	1	LS	$2,000	$2,000	
4.3	Telephone	NONE	0	LS	$0	$0	
7	TAILRACE CHANNEL						$3,400
7.1.1	Excavation, soil		200	Cubic Yard	$12	$2,400	
7.1.2	Excavation, Rock	assumes no bedrock	0	Cubic Yard	$75	$0	
7.2	Permanent Erosion Control	place rip rap armoring	1	LS	$2,000	$2,000	
8	TURBINE & GENERATOR PACKAGE						$60,000
8.1	Kaplan Turbine - St Onge GD60		2	LS	$30,000	$60,000	
8.1	Generator - 20 kw induction	included	1	LS	$0	$0	
8.1	Draft Tube	included	1	LS	$0	$0	
8.1	Basic Control Electronics	included	1	LS	$0	$0	
9	LOW VOLTAGE ELECTRICAL EQUIPMENT						$8,600
6.1	Cabinet and Wiring	NEMA 12 wall hung	1	LS	$2,500	$2,500	
6.2	Utility Relaying	Basler BE1 or similar	1	LS	$3,000	$3,000	
6.3	relay settings & programming		1	LS	$500	$500	
6.4	instrument transformers	ITT or equivalent	1	LS	$2,500	$2,500	

Contractor:
ENVIRONMENTAL / HEALTH PRODUCTS & SERVICE

Subcontractor:
GDS Associates, Inc

Addendum to the Weimer's Dam
Hydro Electric Feasibility Study Report

10	CONTROL SYSTEM						$6,750
10.1	Cabinet & Wiring	wall hung cabinet	1	LS	$750	$750	
10.2	PLC Based HWL Control System	basic HWL control & autostart	1	LS	$4,000	$4,000	
10.3	Pickups and Transducers	4-20ma HWL, rack level & RPM	1	LS	$1,500	$1,500	
10.4	cell modem or similar for monitoring & alarm	details to be determined	1	LS	$500	$500	
11	SUBSTATION & INTERCONNECT						$31,400
11.1	Utility Interconnection Study	included in "Indirect Costs"	0	LS	$0	$0	
11.2	Cabinet and Wiring		1	LS	$1,400	$1,400	
11.3	MCCBs	per code over current protection	2	Each	$500	$1,000	
11.4	contactors	for auto start/stop	2	Each	$750	$1,500	
11.5	Metering	utility supplied	1	LS	$5,000	$5,000	
11.6	Pad Mounted	details to be determined	1	LS	$15,000	$15,000	
11.7	Disconnect	utility supplied - pole mount	1	LS	$5,000	$5,000	
11.8	Grounding	details to be determined	1	LS	$2,500	$2,500	
12	SITE CLEAN UP						$1,800
12.1	Debris Removal & Disposal		1	LS	$1,000	$1,000	
12.2	General Grading, Seed & Mulch		8	Hours	$100	$800	
13	INDIRECT COSTS						$0
13.1	FERC permitting	Costs to be determined separately	1	LS	$0	$0	
13.2	Construction Permits	"	1	LS	$0	$0	
13.3	Structural Engineering	"	0	Hours	$0	$0	
13.4	Systems Design and Engineering	"	0	Hours	$0	$0	
13.5	Drafting and Blue Printing	"	1	LS	$0	$0	
13.6	Engineering Inspections & Reports	"	1	LS	$0	$0	
13.7	Construction Management	"	1	LS	$0	$0	
13.8	Transmission Line - upgrade	"	0	Mile	$0	$0	
13.9	Interconnection	"	1	LS	$0	$0	

CONSTRUCTION COST SUB-TOTAL:	$221,975
INDIRECT COST TOTAL:	$0
TOTALPROJECT COST	**$221,975**
INSTALLED CAPACITY:	40
$ / KW kw of INSTALLED CAPACITY:	$5,649

Contractor:
ENVIRONMENTAL / HEALTH PRODUCTS & SERVICE

Subcontractor:
GDS Associates, Inc

REVISED Addendum to the

Hydro Electric Feasibility Study Report for Murray (Weimer's) Dam, Price County, Wisconsin

Price County Dams Committee
August, 2008

Contractor:
ENVIRONMENTAL / HEALTH PRODUCTS & SERVICE

Subcontractor:
GDS Associates, Inc

REVISED Addendum to the Weimer's Dam Hydro Electric Feasibility Study Report

This document is an addendum to the final report of the Weimar Dam hydroelectric feasibility study conducted by EHS, Inc., and GDS Associates, Inc. The purpose of this document is to provide a detailed pricing estimate on a two turbine 40 kW hydroelectric system, the most cost effective and practicable hydroelectric development option.

Overview

Jason Hines, the principal of Blackbrook Environmental, a hydroelectric developer, provided the detailed pricing information. The information is based on Blackbrook's considerable past experience developing smaller hydroelectric systems, but should not be considered an endorsement of a development effort at Weimar Dam or a formal price quote from Blackbrook Environmental.

The detailed pricing estimate is broken down into two sections – direct costs and indirect costs. Direct costs are related to physically constructing the facility – labor and materials. Indirect costs are related to activities that support the development. These include permitting, construction documents, and related activities. The indirect costs are much less certain than direct costs and some cost savings may be possible by Price County providing some of these services directly. Indirect costs are presented as a range based on Blackbrook Environmental's experience and can have considerable impact on overall project costs.

Summary of costs:
Direct costs - $216,975
Indirect costs - $50,000 to $100,000

Indirect costs are likely to be at the lower end of the range as costs related to power line upgrades or extension are covered by Price Electric, but paid for in the monthly service charge. We assume the lower end of the range ($50,000) is reasonable. The total cost is estimated at $266,975, or $6,674 per kW. The cost per kW is at the high end of the range estimated in the feasibility study report. The financial analysis presented in the feasibility study report assumes the low end of the cost range, or $4,000 per kW. That detailed costs are estimated in the high end of the range is not surprising given the rise in labor and material costs from just the last few years.

Below we present the detailed cost breakdown by category and a financial analysis using the detailed values.

Detailed Costs for 40 kW Weimer Dam

Cost Category	Cost Estimate
MOBILIZATION	$2,500
SITE PREPARATION	$1,000
DEWATERING	$6,900
EROSION CONTROL	$1,000
INTAKE	$13,300
INTAKE ACCESSORIES	$8,925
PENSTOCK	$20,000
POWERHOUSE SUBSTRUCTURE	$34,100
POWERHOUSE SUPERSTRUCTURE	$21,400
TAILRACE CHANNEL	$4,400
TURBINE & GENERATOR PACKAGE	$60,000
LOW VOLTAGE ELECTRICAL EQUIPMENT	$8,500
CONTROL SYSTEM	$6,750
SUBSTATION & INTERCONNECT	$26,400
SITE CLEAN UP	$1,800
INDIRECT COSTS	$50,000
Total	**$266,975**

Financial Analysis

Based on the detailed cost estimate, we updated the financial analysis for the hydroelectric project. A major factor that remains uncertain is how to handle the Dams Keeper's labor costs. It is unclear whether this labor should considered additional and act as an operating cost, or whether this labor can be managed within the existing Dams Keeper's labor budget. For the purposes of the financial analysis, we provide two estimates – one that assumes that the Dams Keeper's labor is not an additional and can be ignored, and one that assumes the Dams Keeper's additional labor should be included.

Regarding the Dams Keeper's labor costs, we discussed this issue with Blackbrook Environmental. On average, one hour per day, 365 per year, will be needed to handle basic maintenance, though work may be concentrated more on some days and none on others. In the feasibility study report, we estimated the annual labor cost at $10,950. Blackbrook Environmental uses $10,000 as a standard initial estimate for smaller hydro projects for routine maintenance.

Routine maintenance will typically be focused on quick inspections of the powerhouse and intake, adjusting flow, and cleaning trash racks. Trash rack clearing will take the most time, potentially every few hours during high water flow, and during the autumn when leaves fall. In the winter, the intake must be kept clear of ice and snow must be removed to maintain access to the powerhouse and the general facility.

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Labor saving devices could include an automated trash rake, Internet cameras (web cams) for monitoring conditions, and other data monitoring equipment. The trash rake will save time and effort for clearing the trash rack, though the trash rake itself will still need clearing. The track rake brings debris up to the top of the trash rack where it can be accessed. The detailed cost estimate includes two manual trash rakes. Web cams will require a phone line to send information, but could be used to identify problems, or avoid the need to do quick checks on equipment – they will help identify the lack of a problem and avoid the need for unnecessary travel. Data monitoring equipment could be set up to monitor water levels or other factors and automatically record and transmit data via phone lines to a computer. This equipment will be relatively inexpensive, but will require some training and standard operating procedures to ensure the equipment is used effectively. The exact labor savings are difficult to estimate, though none of these systems will remove the need for standard maintenance. They help avoid unnecessary inspections and in the case of the trash rake, make life easier. Trash rakes will still need to be operated at the dam and cleared. Trash rakes can take the form of a rake and conveyor system or a device more similar to a small back-hoe mounted to the intake.

The exact cost of this equipment and the subsequent labor savings require a detailed bid. For the purposes of estimating the financial impact, we assume that by avoiding the need for unnecessary inspections and using a track rake with a conveyor system, the additional annual labor expense can be cut in half ($5,475). We assume the added equipment will increase the cost of the project by five percent ($13,348). With these assumptions, the labor saving equipment will be very cost effective, with a 2.4 year simple payback.

Other financial assumptions:

Annual rate of O&M inflation – two percent
Annual rate of revenue inflation – four percent
Year One O&M costs, excluding labor - $7,515 (from feasibility study)
Year One Revenue - $22,308 (from feasibility study)

Below, we present <u>three financial scenarios</u>:
The <u>first</u> is a simple payback scenario in which <u>Price County uses available funding</u> to pay for the hydroelectric project outright. The simple payback uses the above assumptions to determine the point at which the project pays for itself. We also include an internal rate of return estimate over a 20 year period to provide a comparison to other investment options, such as a savings account.

The <u>second</u> financial scenario assumes the project is <u>100 percent financed by debt at a local bank over a 20 year period at five percent interest</u>. This scenario tests the ability of the project to cash flow with debt financing. It is also possible for the project to be financed with a mixture of cash and debt, however all the possibilities are beyond the scope of this project.

The third financial scenario assumes the project is 100 percent financed with Clean Renewable Energy Bonds (CREBs). CREBs provide zero percent interest financing, typically over a 15 year period.

In all three cases we present the financial analysis with two considerations – one with the Dams Keeper labor costs **not included** and one with the Dams Keeper labor costs **included as an added expense**. In both cases we assume that the labor saving device mentioned above will be utilized, bringing total project cost to $280,325.

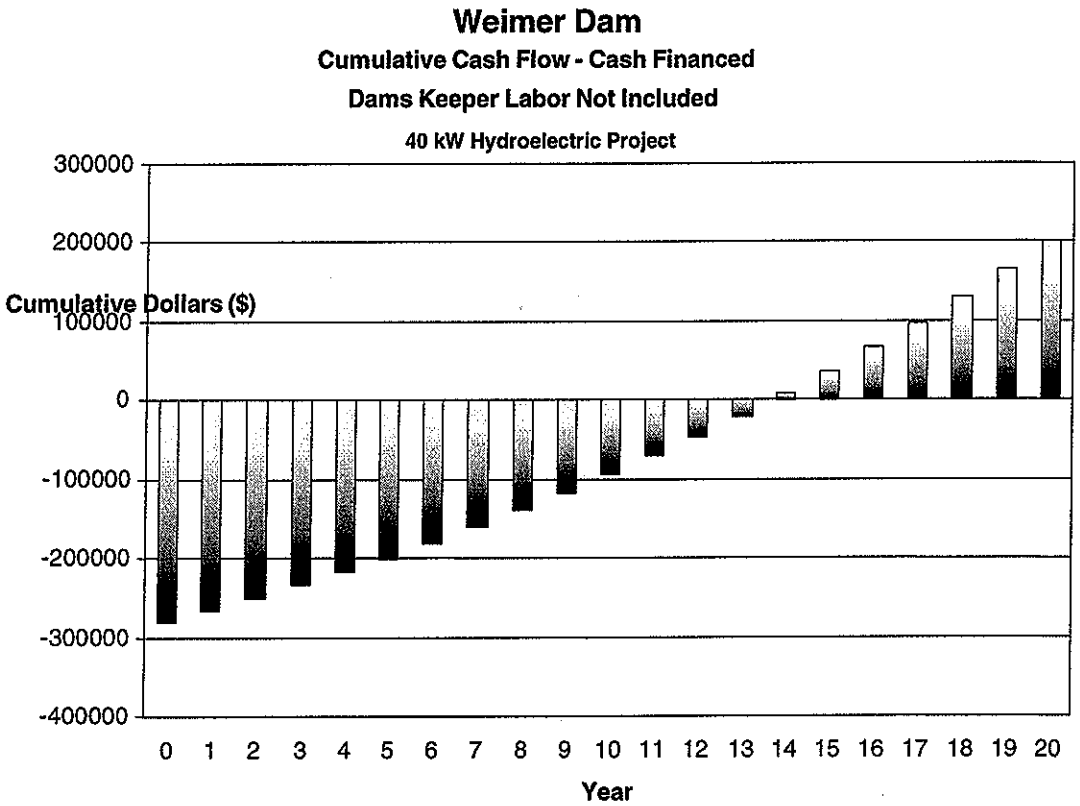
Investment Discussion-Risk versus Reward

While free market economy business investment decisions for capital equipment expenditures and projects are viewed in the 3-7 year payback scenario, government investments sometimes are not measured in monetary payback, but rather services provided. In Price County, as in many communities, examples of investments for the public good include transportation, health and safety, and education, provided with other than monetary return on investment as the goal. A combination of capital investment to provide for the public good, an ability to use local resources to sustain ourselves (an example might be the annual cash flow of the Forestry Department as a result of managing county forest land) and a longer view of investment monetary payback could combine to justify a business/service investment at the county level such as the Weimer Dam Hydroelectric Project. With a longer view in mind, eventually leading to a slight boost in increased income for the county and taking advantage of local unused energy resources in this high energy cost era, the Weimer Dam Hydroelectric Project is do-able---without undue burden on the taxpayers of Price County.

It is feasible that Price County may take some calculated risk on an investment that will not be a drain on taxes in the long run, will generate a small revenue stream, will promote renewable and green technologies on a LOCAL basis, and will help the people of the county [all of the revenue (electricity) generated will be used in the county]. In a pure business investment sense, there may be less risk putting money in a CD in a bank. However, the same could be said for expenditures for above-mentioned services, yet we as taxpayers need those services, so we make proper investments. In the near future, locally generated energy may become one of those essential services. The Weimer Dam Hydroelectric Project could be a leading edge into at least a portion of locally provided energy, putting the people of Price County in a more self-sustaining mode of survival, and providing a competitive edge for the people of Price County related to the global economy. This may be a model project for the "Think Globally, Act Locally" motto.

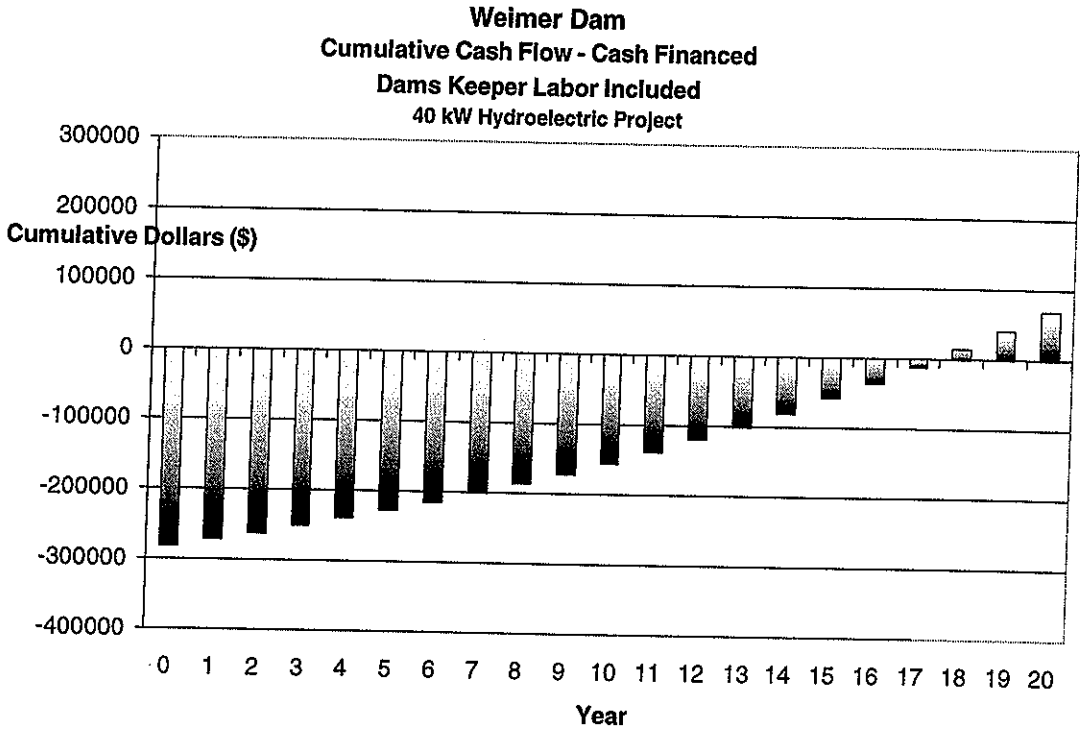
Financing Scenario # 1: Simple Payback and IRR Scenario

Below is a chart presenting the net cash flow from the proposed 40 kW project, without the Dams Keeper labor costs included. Between years 13 and 14, cumulative net cash flow equals the initial cost, illustrating that the simple payback occurs between years 13 and 14.



Based on the net cash flows for a 20 year period, the internal rate of return on the project is about 4.9 percent. Given the risk of the project, this rate of return may not be sufficient to justify the expenditure. This return is equivalent to a CD or similar investment vehicle, which can be had for much less risk.

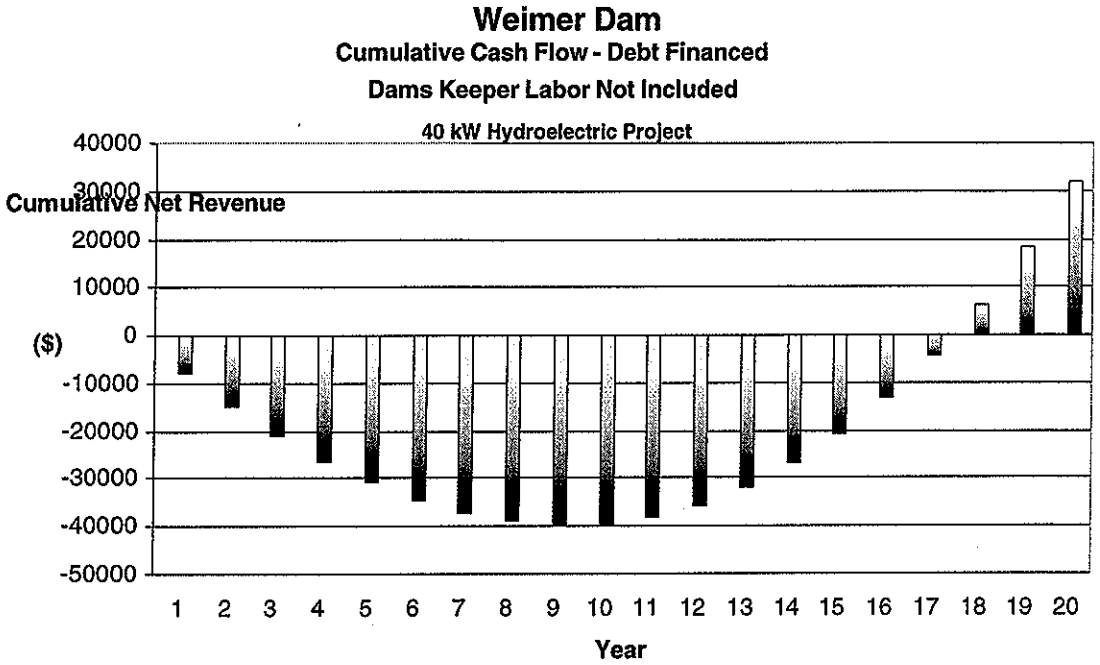
Below is a chart presenting the net cash flow from the proposed 40 kW project, with the Dams Keeper labor costs included. Between years 17 and 18, cumulative net cash flow equals the initial cost, illustrating that the simple payback occurs between years 17 and 18.



Financing Scenario # 2: Bank Financing Scenario

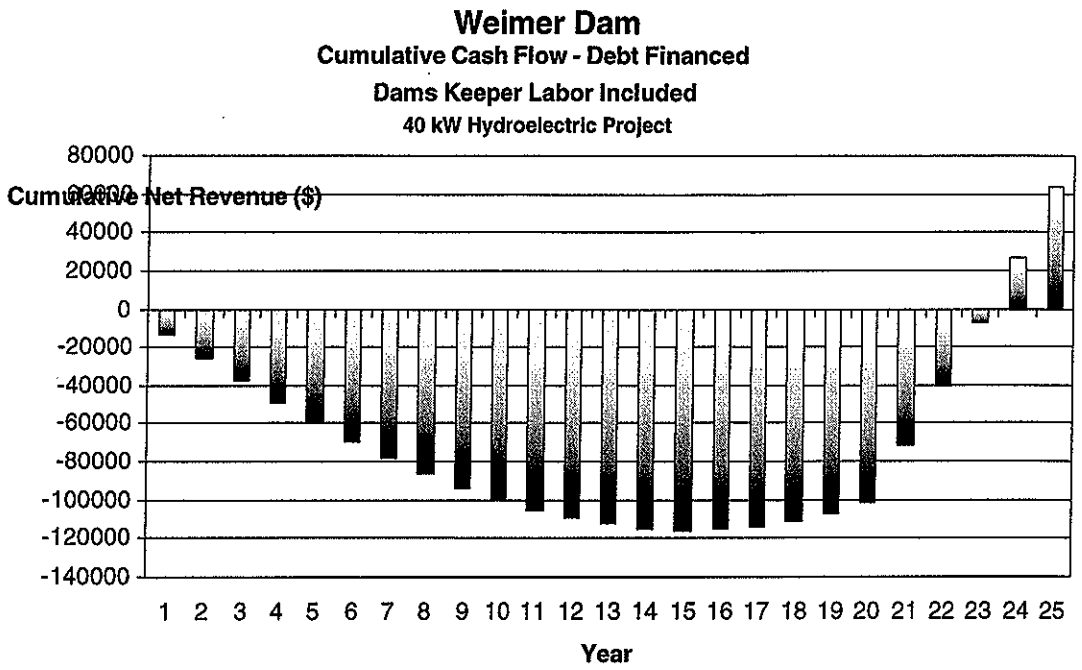
Another option for funding the project is to use a bank's money. In this case we model the finances assuming the project is financed with 100 percent debt for 20 years at five percent interest. In this scenario, the annual total debt payment (principle + interest) equals about $22,494. Other financial factors (inflation rates, revenues, O&M) are the same as above.

The chart shows the cumulative net revenues of the project over the 20 year financing period, assuming the Dams Keeper labor costs are not included. During the first 17 to 18 years, the project maintains a cumulative negative balance. This negative balance would have to be funded monthly or annually to make up for expected cash shortfalls.



The net revenues from each year result in a total 20 year internal rate of return of 4.5 percent, slightly worse than the cash financed scenario presented above.

In the chart below we present the same funding scenario, but include the Dams Keeper labor costs. The chart shows the cumulative net revenues of the project over the 20 year financing period, but adds five additional years to the analysis. During the first 23 to 24 years, the project maintains a cumulative negative balance. This negative balance would have to be funded monthly or annually to make up for expected cash shortfalls.

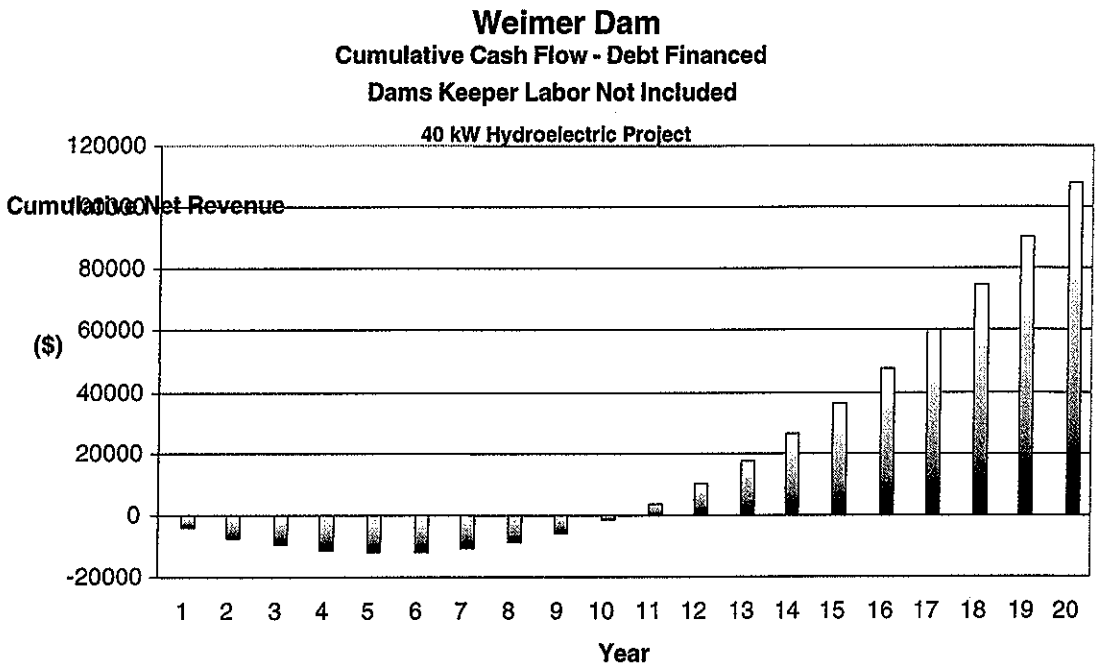


The net revenues from each year result in a total 25 year internal rate of return of 2.9 percent, a poor rate of return that requires substantial cash to maintain financing, while only offering positive cash flow far in the future.

Financing Scenario # 3: CREBs Financing Scenario

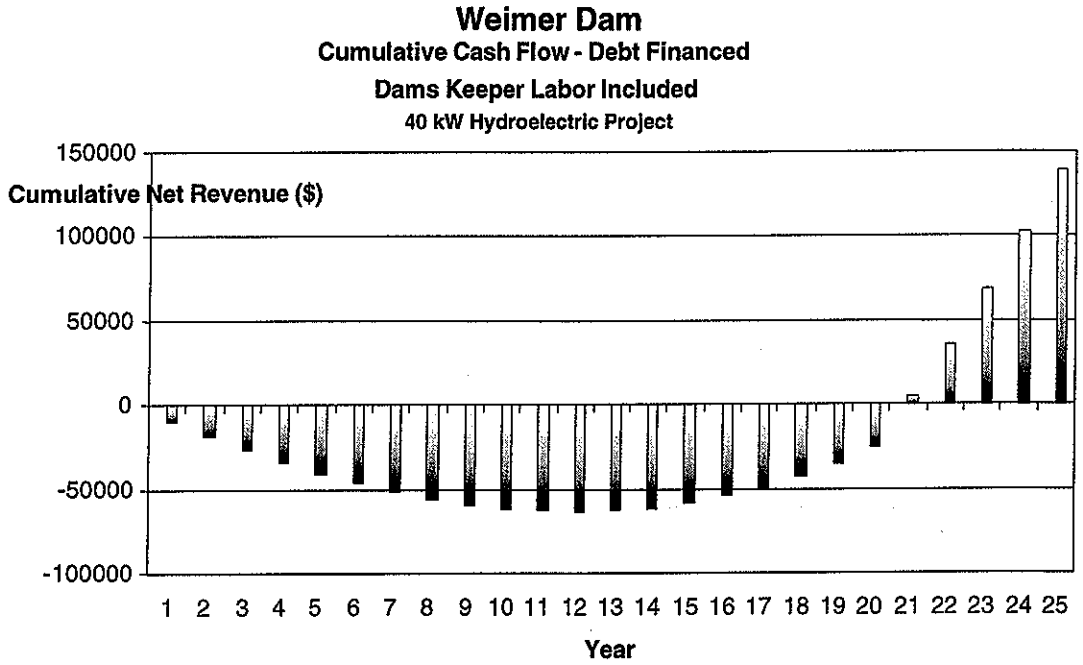
CREBs funding is available for publicly owned renewable energy projects. Applications are taken by the federal government and funding is awarded on a competitive basis. The funding is zero percent interest and typically occurs over a 15 year period. We present a cash flow analysis for CREBs, below, with consideration for the Dams Keeper labor costs.

The chart shows the cumulative net revenues of the project over 20 years, with financing costs ending in year 15. It assumes the Dams Keeper labor costs are not included. During the first 10 to 11 years, the project maintains a cumulative negative balance. This negative balance would have to be funded monthly or annually to make up for expected cash shortfalls.



The net revenues from each year result in a total 20 year internal rate of return of 20 percent, a substantially positive return. That this very positive return is dependent on not including Dams Keeper labor expenses should suggest caution at assuming this funding scenario is reasonable.

The next chart shows the cumulative net revenues of the project over 20 years, with financing costs ending in year 15. It assumes the Dams Keeper labor costs are included. During the first 20 years, the project maintains a cumulative negative balance. This negative balance would have to be funded monthly or annually to make up for expected cash shortfalls.



The net revenues from all years within the 25 year period with CREB's financing result in a total **25 year internal rate of return of 6.9 percent**. While it takes 25 years to achieve this rate of return while the project is paying for itself, the following years should provide a substantially higher rate of return.

Financial Summary

We do urge caution in assuming that the project offers a guaranteed rate of return. The project finances are highly dependent on increasing revenue from electricity sales (estimated at 5-7 % annually) and on the ability of Price County to successfully operate the project. In any of the financial scenarios, including Dams Keeper labor expenses puts a significant damper on project returns. The more conservative financial analysis would include this labor expense in order to ensure that project revenue is likely to cover project expenses. However, after the PROJECT PAYS FOR ITSELF, the rate of financial return for the county will increase substantially.

In none of the scenarios presented here is positive cash flow able to occur from the start of the project. In all cases, cumulative net cash flow only occurs at over a decade in the future (at best). Furthermore, the expenses that are modeled to occur far in the future are difficult to predict and many situations could arise that could increase expenses (higher labor costs, unexpected repairs, etc.). However, electrical rates could also increase more rapidly through future years, and the demand for energy and electricity rises. This effect may balance unknown cost increases, if any.

A hydroelectric project is not risk free. It is a matter of balancing risk and reward. Consideration may be made for alternative projects with similar financial returns, but different risk profiles. However, any other alternative project probably would not provide the County citizens with "green" technology and would probably not increase local energy supply. Furthermore, this project would be a long-term investment that could have a **25 year rate of return of nearly 7%** as the project pays for itself, and a rate of return on investment of nearly three times that figure after the investment pays for itself. Other potential advantages and rewards of the Weimer Dam Hydroelectric project include:

- not be a drain on taxes, with zero % interest Clean Renewable Energy Bonds
- will generate a revenue stream,
- will promote renewable and green technologies on a LOCAL basis,
- will help the people of the county [all of the revenue (energy = electricity) generated will be used in the county],
- may position the people of Price County in a more self-sustaining mode of survival,
- may provide a competitive edge for the people of Price County related to the global economy.

Potentially the Jobe's Dam could nearly equal the energy output of Weimer's Dam, if a hydroelectric project was installed at that location, as well.

Each of these projects could supply all electricity needs to an average of 30 homes on an average annual basis. Since many of the electrical services supplied by Price Electric are for seasonal service, the electricity supplied by potential hydroelectric facilities from these sources probably would service more homes than the above projections.

We recommend that the County consider the financial models that incorporate additional labor expenses for the Dams Keeper position, so that conservative planning is in effect, and may accommodate any additional labor above current availability, if there is any additional labor required to operate the hydroelectric facility.

Detailed Financial Assumptions

The following table was provided by Blackbrook Environmental to support the detailed cost analysis. The analysis explains a breakdown of the major cost categories and factors in the costing. Note that indirect costs are not detailed. In discussion, these costs were estimated at $50,000 to $100,000, depending on project specifics. In the table, below, these costs are not factored into the total cost or cost per kW of capacity.

Wiemer Dam - Budgetary Development Estimate

ITEM NUMBER	DESCRIPTION		QUANTITY	UNIT	UNIT COST	AMOUNT	ACCOUNT TOTAL
1	MOBILIZATION		1	LS	$2,500	$2,500	$2,500
2	SITE PREPARATION						$1,000
2.1	Clearing and Grubbing	assumes basically open site	0	LS	$0	$0	
2.2	Construction Roads	assumes use of existing access	0	LS	$0	$0	
2.3	Public Safety	basic signage & fencing	1	LS	$1,000	$1,000	
3	DEWATERING						$6,900
3.1	Gravel Fill	reuse material from exc. on site	200	Cubic Yard	$8	$1,600	
3.2	Pumping		14	Days	$200	$2,800	
3.3	Cofferdam Placement and Removal		25	Hours	$100	$2,500	
4	EROSION CONTROL						$1,000
4.1	Temporary Erosion Control	silt fence & haybales incl. labor	1	LS	$1,000	$1,000	
5	INTAKE						$13,300
5.1.1	Excavation, Soil		100	Cubic Yard	$10	$1,000	
5.1.2	Excavation, Rock	assumes no bedrock	0	Cubic Yard	$75	$0	
5.2	Intake Structural Concrete	18W x 10L x 10D overall	20	Cubic Yard	$600	$12,000	
5.3	Backfill	reuse best material from on site	25	Cubic Yard	$12	$300	
6	INTAKE ACCESSORIES						$8,925
6.1	Trashrack	2 racks - 52 ft ea. 40 ft ea. wetted	104	Square Feet	$13	$1,300	
6.2	Intake Gate and Hoist	steel frame and chainfall	2	LS	$2,500	$5,000	
6.3	stop logs	safety railing at front by rack	1	LS	$500	$500	
6.4	Operator's Deck	steel grate -	150	Square Feet	$8	$1,125	
6.5	Railings and Ladders	safety railing at front by rack	1	LS	$500	$500	
6.6	Rack Rakes and Stoplog Pullers	2 hand rakes and 2 pullers	1	LS	$500	$500	
4	PENSTOCK						$20,000
4.1	steel pipe	two 36" dia. x 0.250" wall	200	LF	$75	$15,000	
4.2	installation	excavation, welding, backfill	1	LS	$5,000	$5,000	
5	POWERHOUSE SUBSTRUCTURE						$54,100
5.1.1	Excavation, Soil	approx - depends on final siting	250	Cubic Yard	$10	$2,500	
5.1.2	Excavation, Rock	assumes no bedrock	0	Cubic Yard	$75	$0	
5.2.1	Substructure Concrete	as shown in GD60 dwg	30	Cubic Yard	$650	$19,500	
5.2.2	powerhouse footing, frostwall, wall	4 ft frost wall + 4 ft knee wall x 8"	18	Cubic Yard	$400	$7,200	
5.2.3	Powerhouse Floor Concrete	16' x 20' x 6" slab	6	Cubic Yard	$400	$2,400	
5.3	Install Imbedded Parts	labor & misc small fabrications	1	LS	$2,500	$2,500	
6	POWERHOUSE SUPERSTRUCTURE						$21,400
6.2	manufactured metal building 36 ft x 20 ft	w/ 1 man door & 1 roll up door	1	LS	$15,000	$15,000	
3.3	Powerhouse Crane	steel rail and chainfall	1	LS	$3,000	$3,000	
3.3	Propane Fired Heating System	ceiling mounted propane fired	1	LS	$1,000	$1,000	
3.4	Ventilation Fans	two electric vent fans for summer	1	LS	$400	$400	
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13	INDIRECT COSTS						$0
13.1	FERC permitting	Costs to be determined separately	1	LS	$0	$0	
13.2	Construction Permits	"	1	LS	$0	$0	
13.3	Structural Engineering	"	0	Hours	$0	$0	
13.4	Systems Design and Engineering	"	0	Hours	$0	$0	
13.5	Drafting and Blue Printing	"	1	LS	$0	$0	
13.6	Engineering Inspections & Reports	"	1	LS	$0	$0	
13.7	Construction Management	"	1	LS	$0	$0	
13.8	Transmission Line - upgrade	"	0	Mile	$0	$0	
13.9	Interconnection	"	1	LS	$0	$0	

CONSTRUCTION COST SUB-TOTAL:	$221,975
INDIRECT COST TOTAL:	$0
TOTALPROJECT COST	**$221,975**
INSTALLED CAPACITY:	40
$ / KW kw of INSTALLED CAPACITY:	$5,549

Contractor:
ENVIRONMENTAL / HEALTH PRODUCTS & SERVICE

Subcontractor:
GDS Associates, Inc