Fair Haven Low Impact Hydro

Feasibility Study – Phase 2

Prepared for the

Town of Fair Haven, Vermont

February 18, 2014

The Upper Falls

Prepared by

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Fair Haven Low Impact Hydropower Feasibility Study (Phase 2)

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Looking Down the Falls from the Depot St. Bridge

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Fair Haven, Vermont Low Impact Hydropower Feasibility Study (Phase 2)

I. Introduction

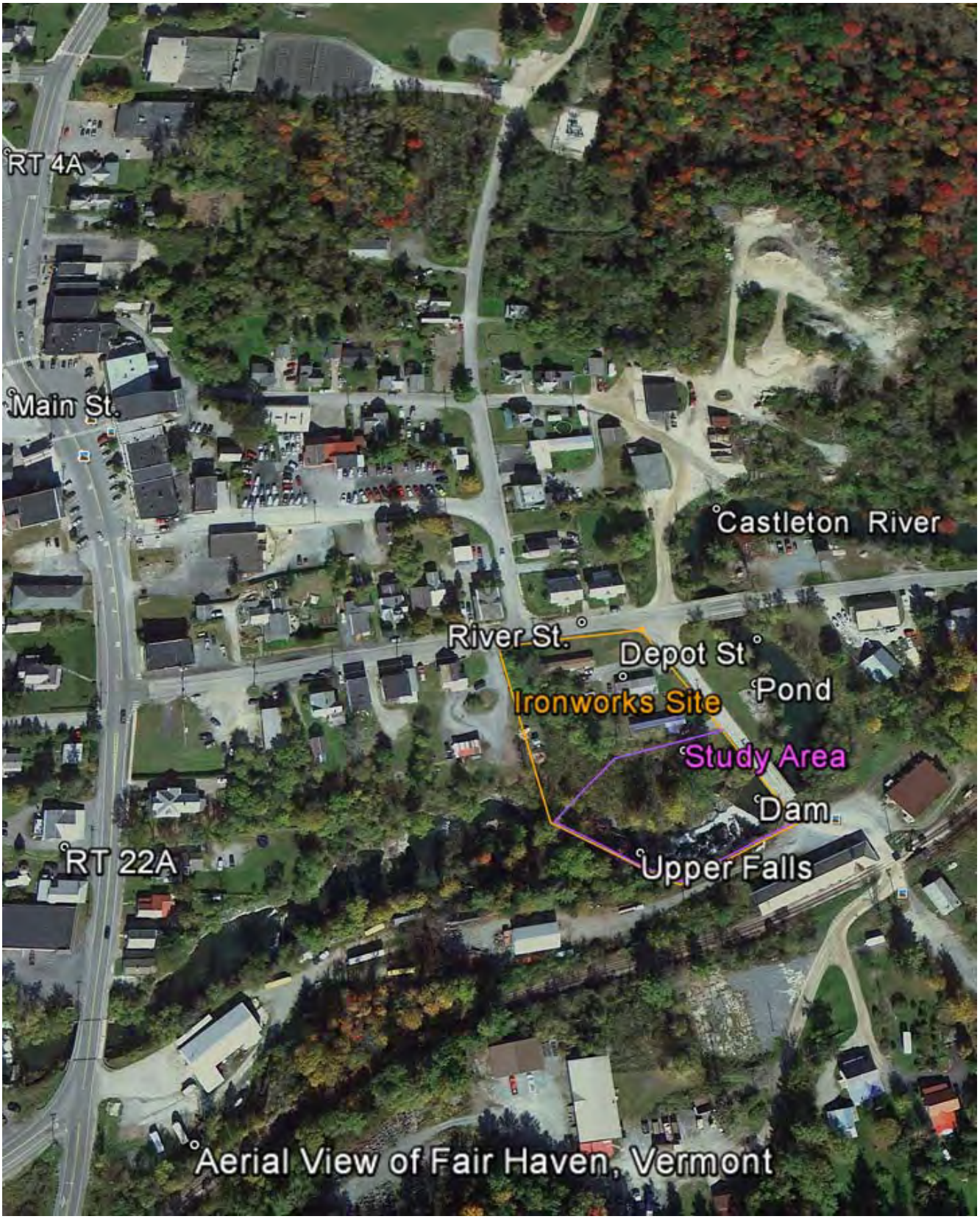
The Town of Fair Haven cast a broad net when it proposed a second and more detailed study for low impact hydroelectric development at town owned or controlled sites. Such energy development should be local, sustainable, renewable, and benefit town residents and businesses with stable and reduced cost electricity.

After a careful review of potential water power sites, I found only one site that might fit the above standards. I concluded this for a number of reasons, the most compelling being the Vermont Agency of Natural Resource's policy to oppose any project that doesn't have an existing dam. Other reasons were based on habitat issues raised in the Castleton River Corridor Plan that describes reaches of the river that need to be protected, and noting removal of one dam. It is likely that only run-of–river projects, ones that don't store and release water, could be permitted and deemed low impact, thus making them eligible for additional revenue from renewable energy credits.

The selected site, obvious and studied numerous times in the last 30 years, is at the Upper Falls. It lies just below the bridge on Depot Street (formerly Water Street) on the north side of the Castleton River, 2 miles upstream of its confluence with the Poultney River. The Falls area is shown on the Location Map (see page 3). Slightly to the right of center and enclosed by a yellow boundary is a four acre site labeled Ironworks Site, location of the Lyon Works, an 18th century water powered development associated with Fair Haven's important iron industry. The Study Area for this report is the southerly portion of the Ironworks Site and is marked by a purple boundary.

In general, all aspects of a water power site's history are important to a potential developer. Early developers knew what they were doing when locating mills and dams, deciding what type of waterwheel or turbine to use, estimating available water flow and power, and importantly, gauging how to stay above the inevitable flood. They did not have excavators and cranes, steel and concrete, or handy modern tools and materials. They were clever, and we literally build on their foundations. So one looks at a site's ruins to better understand why they did what they did over the course of many generations of ownership and change of business pursuits. Understanding historical and cultural resources early in the planning stages helps determine the design and the costs associated with permit requirements.

The study of old water powered sites is like the study of geology, where one peels back layers from past eras, each associated with a particular industry and its enabling technology. At the Upper Falls there seems to have been 3 distinct eras – Ironworks, Slateworks and Public Water Supply. Each one left behind clues as to how best build yet another phase - hydroelectricity.



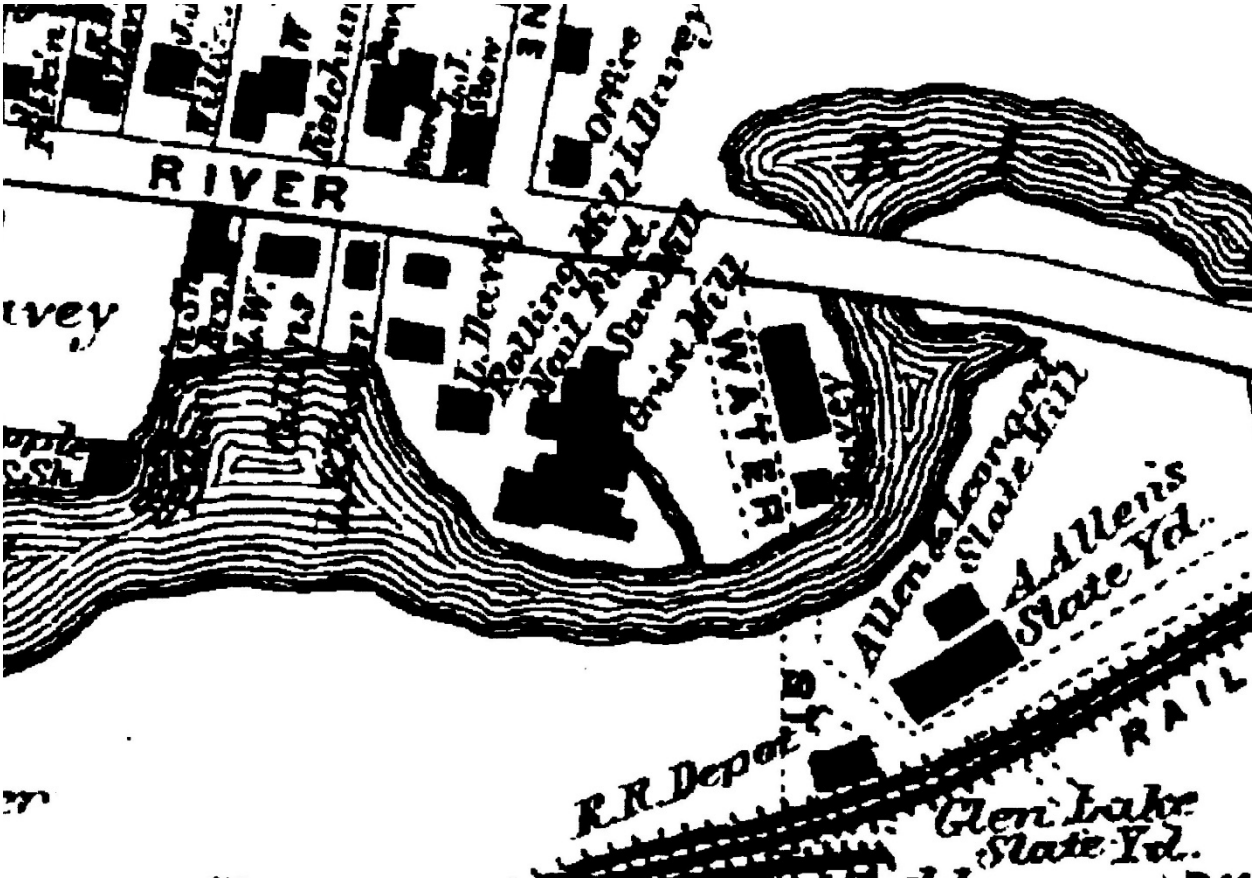
Aerial View of Fair Haven, Vermont

History of Development.

The history of water power at the Upper Falls is described in unusually good detail in Andrew Adam's 1869 History of Fair Haven Vermont. The first dam at the Upper Falls was erected in 1785 by Col. Mathew Lyons to support his ironworks. Here he produced iron from imported ore, using the iron to make nails rods from which came hand-made nails. He also manufactured anvils, axes, tools and agricultural equipment. The invention of machinery to cut nails from rolled plates resulted in a business expansion that included more forges, a rolling and slitting mill and a coal house Water power supplied the energy to run the bloomer hearths (furnaces), forge bellows (blowers), trip hammers, grinders and forming machinery. In an 1859 report entitled Iron Manufacturers Guide to Furnaces, Forges and Rolling Mills, the author J.P. Lesley stated the Fair Haven rolling mill makes "nail plates, marble saw blades, horse-shoe rods and a little merchant iron out of hammered bars which the bloomery forge .. makes out of St. Lawrence or Champlain ore. The small nail factory attached contains 3 furnaces…and makes 1000 kegs of nails a month, or about 500 tons per year."

This complex was known as the Israel Davey Ironworks. It also had an attached saw mill (for wooden nail kegs and more) and a grist mill, and is shown below on the 1869 Fair Haven Village map (from the Beers and Soule Atlas of Rutland County).

Another report by William G. Nielson entitled Charcoal Blast Furnaces, Rolling Mills, Forges, and Steel Mills of New England (1866) noted the site contained 4 Tyler wheels, a very early type of iron turbine (see page 8), and a breast wheel (13 feet long and about 8 feet in diameter) that operated a 1500 pound trip hammer. Please note in the map below that Water Street is today's Depot Street.

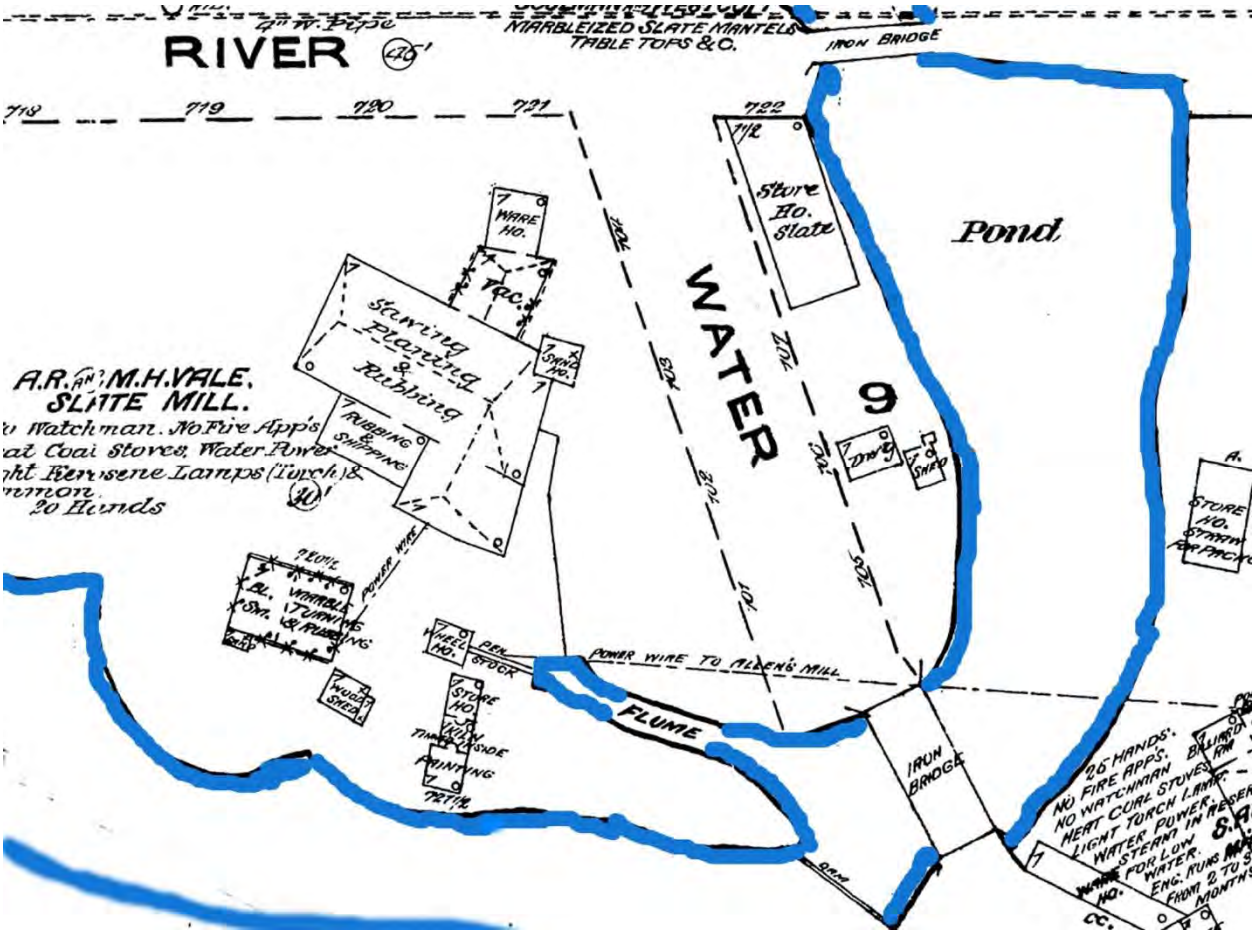


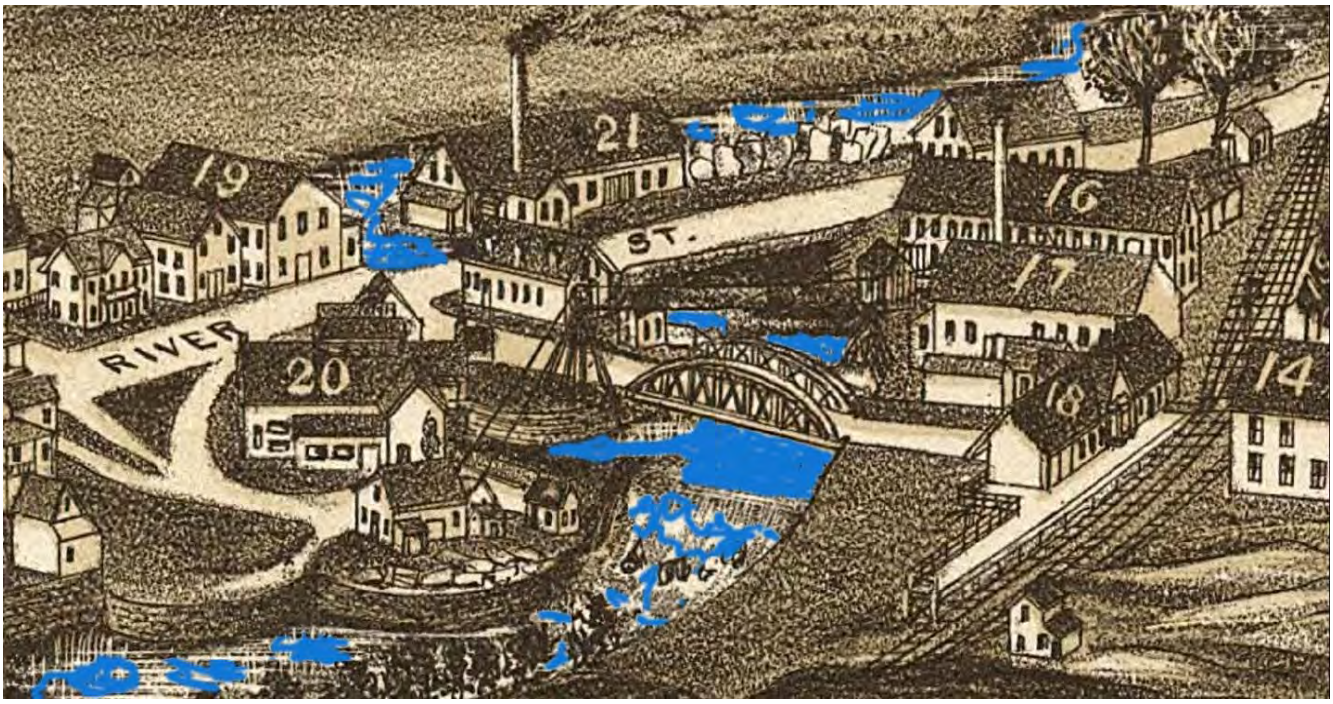
Victor Rolando, in his very comprehensive book 200 Years of Soot and Sweat - The History and Archeology of Vermont's Iron, Charcoal and Lime Industries, includes an excellent history of Fair Haven's ironworks (pages 110-112). During inspection trips in the late 1970's Mr. Rolando found forge slag near the base of the Falls (still there today) but no surface traces of the ironworks at what he said was an excellent mill site.

The Ironworks era ended in the 1870's after the death of Israel Davey during the post-Civil War depression. Its offspring was the slate industry evident in the 1885 Sanford Insurance Map shown below. Israel Davey's ironworks became the A.R. & M.H. Vale Slate Mill. The buildings, flume and dam seem much the same but there are new features near the end of the "flume" - a Wheel House, penstock and power line that runs to the slate mill across the river.

The Yankee tradition of "waste not, want not" is witnessed by adaptation of the water power. Whereas water power for the iron works was fully consumed on site, power for the slateworks was needed on both sides of Depot Street and the Castleton River. In pre-electric days one needed a way to transfer power between its source and the multiple end-users that didn't have access to the fall of water. The solution was an endless traveling cable running through pulleys mounted on towers – ski lift style – to the numerous buildings with slate saws and milling machines. The power source for all this was a turbine located in the Wheel House. Its running gear spun the large drive pulley (see page7).

Turning the page you will see a 3-dimensional view of this "business network" in the enlargement of a section of L.R. Burleigh's1886 "Birdseye View of Fair Haven"

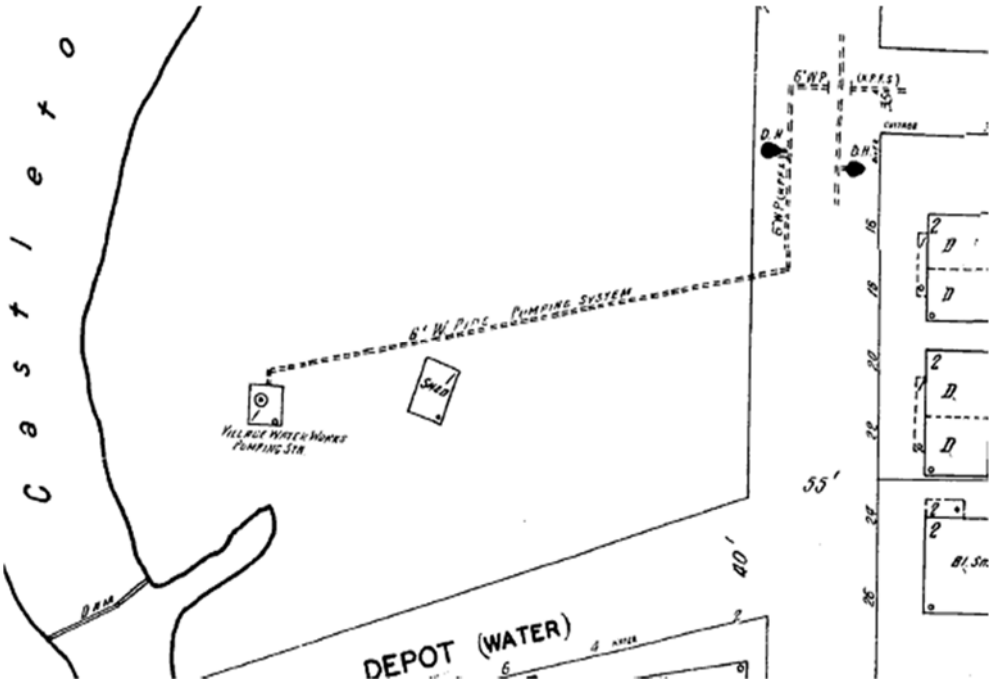




Key: (20) Union Slate Co. (16) Stewart Slate Mantel Co. (17) Allen Slate Co. (19) Marbleized Slate Co.

Below Building 20, near the base of the Falls, is the old Wheel House. Mostly buried in the wheel pit is a vertical Francis type turbine (late 19th century) with, running gear and cable drive wheel.

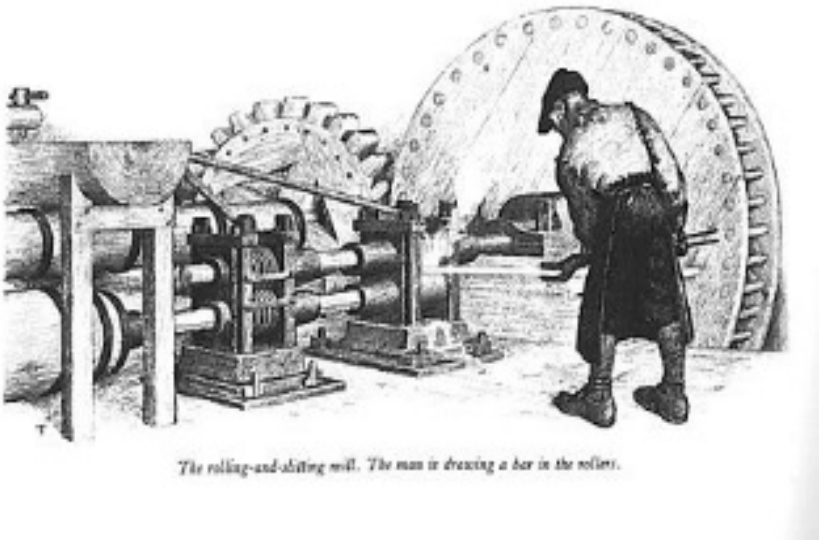
The third era of development, a public water works, is identified in the Sanford Maps published in 1922 and 1944 shown below. The slate mills at the Falls are not shown but a 6” water line runs from the Wheel House-Pump Station to the hydrants on River Street. Today, the pump station, still standing and immediately adjacent to the old wheel pit, contains the ruins of the mid twentieth century electric service and electrified high pressure water pump.



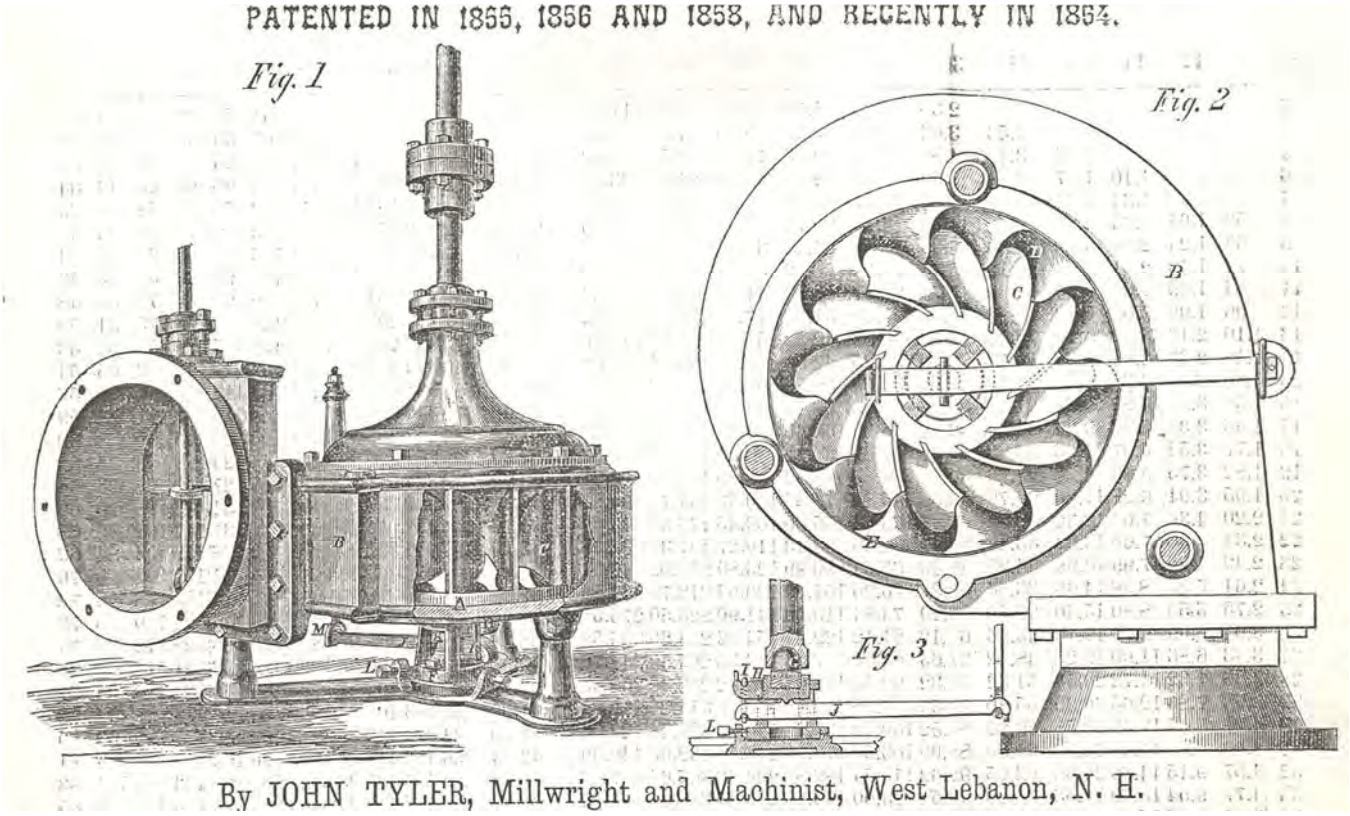
Over the past 30 years, the site has had a number of water power suitors but only one came close to constructing a project. In 1988 the Fair Haven Hydroelectric Company was issued a Federal Energy Regulatory Commission License (FERC-9541) and a Vermont Water Quality Certificate and obtained a power sales contract with Central Vermont Public Service Company. The company had all the fixings, but the timing was bad as the cost of money was excessive and bank loans were difficult to get. I know because I did a financial analysis for one of the developers. The importance of being poised to act when regulatory and financial factors are in alignment will be discussed later in this report.

The Sanford Insurance Company was ubiquitous throughout the United States, insuring nearly all the businesses in Fair Haven alone. Their agents mapped whole districts, citing details on building size, use, location, number of employees, watchmen and fire suppression equipment. The Vermont Historical Society has a large collection of these Vermont maps.

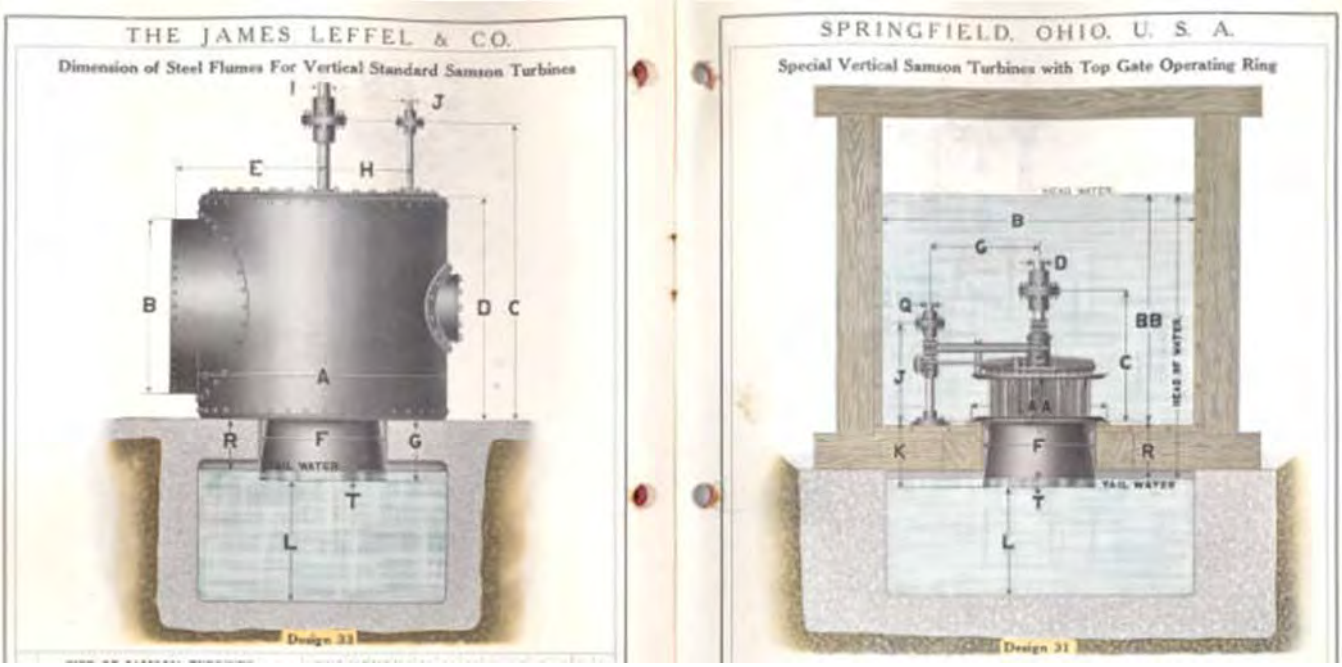
Large cable drive wheel and turbine running gear that sit above the turbine in the old wheel pit.



An eighteenth century rolling and slitting mill for making nail plates.



Most likely the same Tyler Wheel used at the Ironworks and mentioned in the 1866 report.



Later model Francis type turbine partly buried in the wheel pit and that would have powered the cable power line for the slate mills.

II. General Information about Developing Hydropower

The nature of modern hydro development has changed considerably since the passage of the Public Utilities Regulatory Power Act of 1978. This landmark legislation lets independently owned hydros (wind, solar and biomass too) use the electrical distribution grid (utility poles and wires) to carry electricity to a utility or other purchaser. Use of the distribution grid is considered interstate commerce, so before a hydro can be built, one needs a federal license from the Federal Energy Regulatory Commission (FERC). This process can be arduous, time consuming and costly. But today, for projects like a potential, low impact one at the Upper Falls, there may be a streamlined process.

News Release: September 14, 2011

Print this page

Docket No. P-14230

FERC Approves First Hydroelectric Project in Colorado under Small Hydro Agreement

The Federal Energy Regulatory Commission (FERC) today approved the construction of a hydroelectric project in Colorado, the first issued since FERC and the state of Colorado signed an agreement last year to simplify procedures for the development of small-scale hydropower projects. As a result of the streamlined procedures, the approval of today's project was completed in two months.

The Meeker Wenschhof hydroelectric project, to be located on an existing irrigation pipeline near the town of Meeker in Rio Blanco County, would consist of a powerhouse containing one generating unit with an installed capacity of 23 kilowatts and an average annual generation of 100,000 kilowatt hours. FERC approved the project in a two-month time span.

In signing the memorandum of understanding (MOU) with Colorado in August 2010, FERC said it had seen rising interest among entities seeking to develop small, low-impact hydropower projects. Federal surveys have identified several hundred potential small hydropower projects of smaller than 5 megawatts (MW) in Colorado with a combined capacity of more than 1,400 MW. These projects have the potential to make a significant contribution to meeting Colorado's energy needs while helping to satisfy Colorado's new Renewable Energy Standard and create related business opportunities.

"Small hydro is a renewable resource that has tremendous potential," FERC Chairman Jon Wellinghoff said. "FERC and Colorado have shown their commitment to moving these projects forward knowing that, ultimately, it will benefit consumers and help create jobs. It's a win-win for everyone."

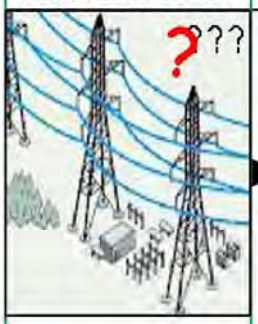
The MOU signed by FERC and Colorado agreed to the following:

- Colorado will develop a pilot program to test options for simplifying and streamlining procedures for authorizing conduit exemptions and small 5MW or less exemption projects while ensuring environmental safeguards;
- Colorado and FERC will identify a single point of contact for implementation of the pilot program;
- Both parties will hold quarterly teleconferences to discuss the development and implementation of the pilot program;
- Both parties will share and make publicly available all relevant economic, environmental, and technical data.
- FERC will waive certain consultation requirements when all relevant resources agencies agree to do so.

The design guide on the next page I created for a VT Agency of Natural Resource's Hydro Conference in 2010. It lists many of the considerations that need to be addressed when planning a hydro project.

III, ENGINEERING GUIDE FOR SMALL HYDRO DEVELOPMENT

WHAT ARE YOU DOING WITH YOUR POWER ?



SELL TO THE GRID
OFF GRID USE
NET METER
GROUP METER
MANAGE DEMAND
HYDRO-WIND-PV MIX
DISTRIBUTE GREEN PWR

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2. RESOURCE INVENTORY

HISTORIC INFO
EXISTING FEATURES
- DAM
- WATER CONVEYANCE
- TURBINE/GENERATOR
- SWITCHGEAR
- BUILDINGS
- UTILITY SERVICE

WATER
FLOWS & DURATIONS
POND STORAGE
FALL of WATER
TAILWATER
RIPARIAN OWNERSHIP

3. CONSIDERATIONS

THE ENVIRONMENT
- WATER QUALITY
- FISHERIES
- RIPARIAN HABITAT
- TERRESTRIAL HABITAT
- WETLANDS

HISTORIC PRESERVATION
INTERCONNECTION
CONSTRUCTION ISSUES
AESTHETICS
DAM HAZARD
LIABILITIES
NEIGHBORS
MONEY

4.DESIGN

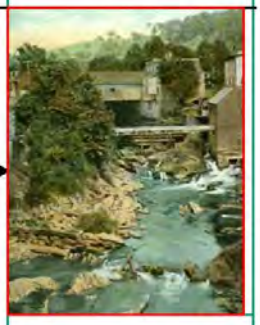
CAPACITY kW
GENERATION kWH
CIVIL WORKS DESIGN
- DAM & INTAKE
- GATES
- TRASHRACK
- FLUME OR PENSTOCK
- POWERHOUSE
- TAILRACE

TURBINE/GENERATOR
INTERCONNECTION
CONTROLS
REVENUE
RETURN ON INVESTMENT

5. CONSTRUCTION

PERMIT/LICENSE
THE CONTRACTOR
WORKING in the STREAM
SITE PREPARATION
DEMOLITION
CIVIL WORKS
SETTING EQUIPMENT
STARTUP
SHAKEDOWN
ADJUSTMENTS
RETROFITS

6. OPERATIONS



POND LEVEL CONTROL
TRASH and DEBRIS
GRAVEL, SILT and ROCK
FLOODS
FRAZZLE & ANCHOR ICE
RACK CLEANERS
SECURITY
INSPECTIONS
EQUIPMENT FAILURE
REMOTE CONTROL
ALARMS
TURNING IT OFF

A Few Energy and Engineering Facts.

Energy is the ability to do work and is measured in kilowatts per hour (kWh). A 100 watt light bulb uses 1/10 of a kW per hour. An average house might use 800 kWh per month. The Town of Fair Haven used about 975,000 kWh of electricity last year and paid Green Mountain Power about $160,000.
Power (kW) is the rate at which energy is made or expended. One kW equals about ¾ of a horsepower (HP). A household blender may have a 1/10 kW motor, a refrigerator a 1/3 kW motor, and a central air conditioner or heat pump might be 2 kW.
Flow of water is measured in cubic feet per second (cfs), where a cubic foot equals a little less than 7 and ½ gallons.
Hydropower is generated by capturing the potential energy of a volume of water falling through a vertical distance (the head).
If one skimmed an imperceptible ¼ inch thickness from the surface of Lake Bomoseen and spilled it at the Upper Falls Dam, it would provide for the monthly energy needs of about 40 households.

Fair Haven's Annual Energy Cost and Usage		
Locations with Electric Meters	**Annual Cost**	**Annual kWh**
Park Place - Office	$ 6,648	44,484
Main St - Alarm	$ 648	72
River St - Town Garage	$ 3,672	27,972
Airport Building	$ 252	0
Main St. Park	$ 384	756
Info Booth	$ 336	444
Carnival/Flagpole	$ 492	1,296
Cottage St. - Rec Dept	$ -	0
Dog Kennel	$ 588	1,776
Compactor	$ 1,488	3,600
Waste Water Treatment Plant	$ 57,528	374,652
Adams St	$ 3,876	23,580
River St.	$ 840	1,356
Sewer Pump Station	$ 684	348
Academy Pump Act	$ 372	588
Airport Rd. Pump Station	$ 684	348
Water Dept. -South Tank	$ 504	1,344
Water Treatment- Inman Pond	$ 10,752	71,448
Fair Haven Grade School	$ 69,816	421,380
Total	$ 159,564	975,444
Additional Meters Not Covered by Net Metering		
Main St. St. Street Lights	$ 44,628	
Main St. Security Lights	$ 8,016	
Total	$ 52,644	

III. Power Sales Options:

1. **Direct Sale with ISO-NE Rates** - Sell all your generation to the interconnecting utility Green Mountain Power (GMP).

2. **SPEED Program -** Sell all your generation to the state's electrical distribution utility as currently administered by the Vermont Electrical Power Producers Inc. (VEPP).

3. **Group Net Metering** – Create a group of customers located anywhere in Green Mountain Power's service territory. Since the town's energy needs shown on page 10 is slightly less than energy generation from an Upper Falls project, the town can be the sole customer.

4. **Stand Alone Generation -** Do not connect to the grid but use all the power generated on site for whatever your purpose. Since there is no grid connection, one needs state and local permits but not a federal FERC license.

1. Direct Sale with ISO-NE Rates.

Direct sale of energy to the local (interconnecting) utility is typically accomplished with a long term contract. Up until the late 1980's, the contract rates paid to an independent power producers (IPPs) were about 12 cents per kWh for a thirty year (30), levelized contract. The rate was based on the concept known as Avoided Cost, the cost a utility would incur if it had to build a new power plant. This rate was by the Vermont Public Service Board. Knowing the long term, guaranteed value of energy made for a reliable revenue stream and led to the construction of about 25 hydroelectric projects in Vermont.

Long term contracts still exist but the guaranteed values have expired, replaced by a bidding process regulated by FERC and known as the New England System Operator (ISO-NE). Every **5 minutes** – yes, 5 minutes – a new rate is published and its value can range from zero to several dollars per kWh. Over the past 10 months the average was about 5.2 cents per kWh, but with very high prices during the December and January cold snaps the annual average rose to 6.2 cents. The long term unpredictability of these ISO-NE based rates creates a planning problem.

The real-time 5 minute market price, energy demand, and energy imports for all of New England is available at the ISO-NE web site https://isoexpress.iso-ne.com/guest-hub.

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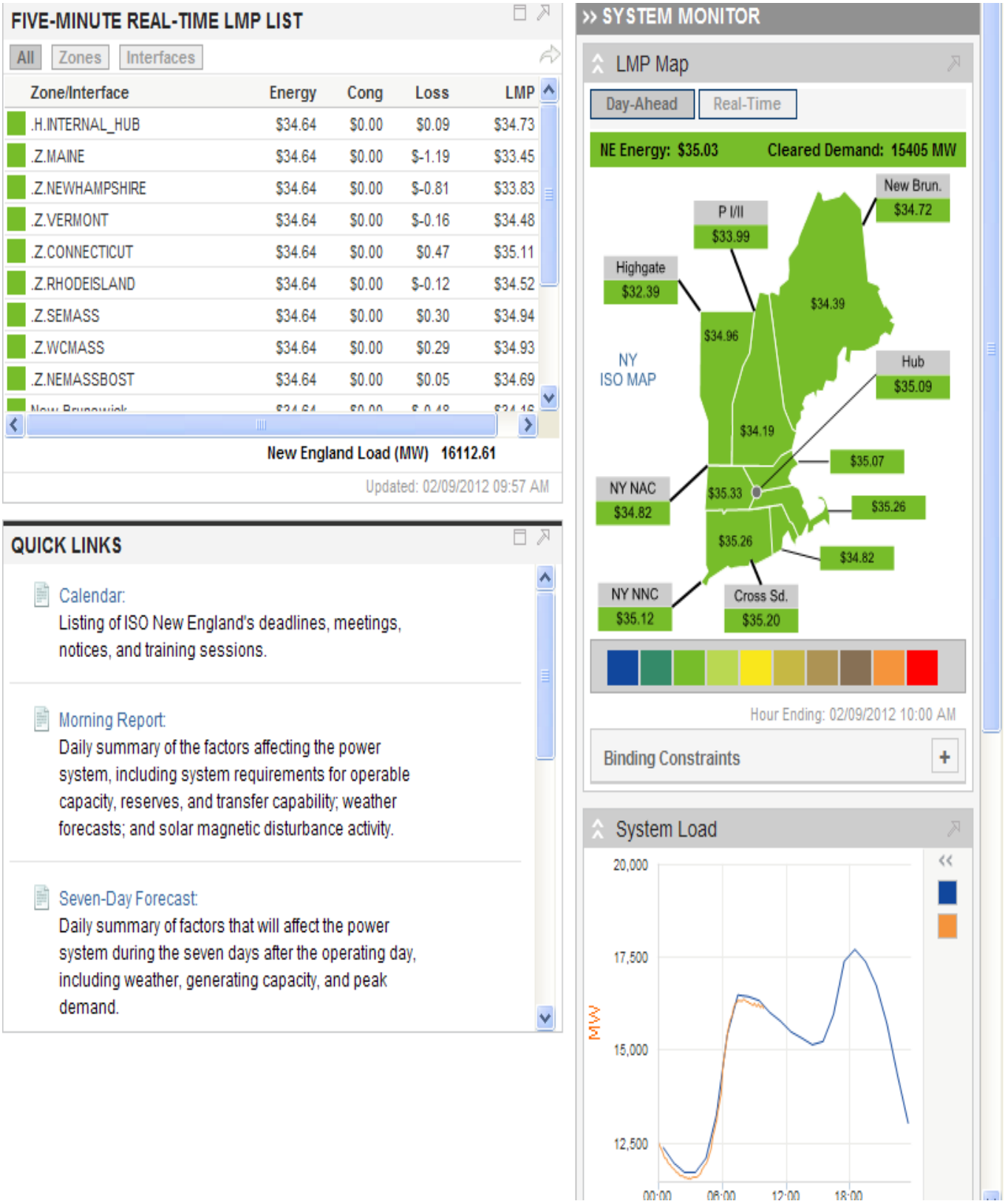
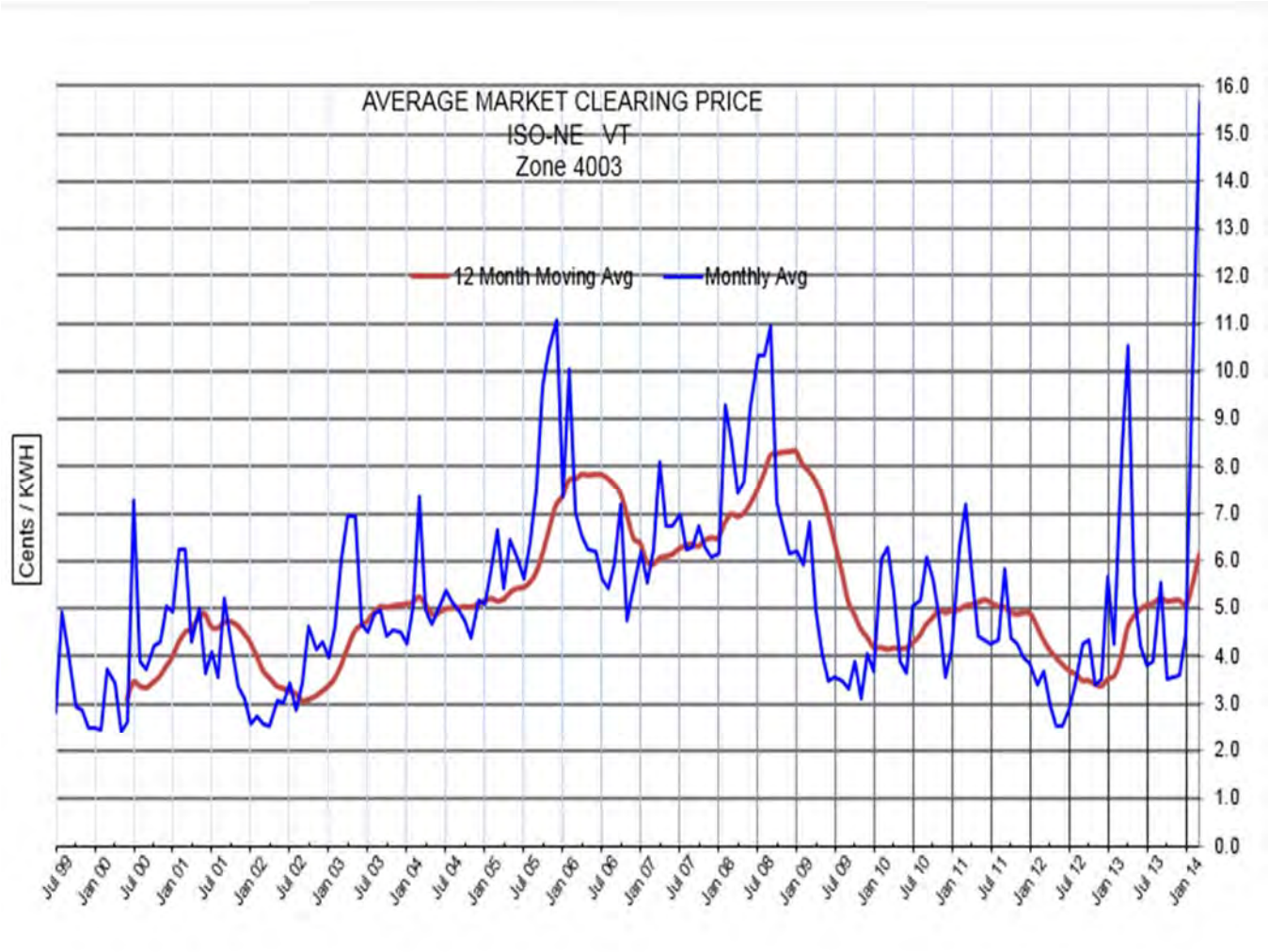
A typical snapshot of a 5 minute energy rate is shown on the following page. The energy price on the map is in units of dollars per megawatt hour (mWh), so just divide by 10 to get the price in cents per kWh. By way of example, the first energy value of $34.68 per mWh equals 3.468 cents per kWh.

ISO-NE LMP MAP



The chart below depicts the average ISO-NE clearing price since 1999 (courtesy of Mathew Rubin and VIPPA). It illustrates the difficulty of predicting ISO-NE revenues.



2. Vermont's Sustainably Priced Energy Development (SPEED).

By contrast with ISO-NE rates, the SPEED program offers a long term levelized rate.

In 2005, the Vermont General Assembly established the SPEED Program to encourage the development of renewable energy resources in Vermont as well as the purchase of renewable power by the state's electric distribution utilities. The SPEED Standard Offer Program is designed to encourage the development of SPEED resources by making long term contracts at fixed prices available to qualified renewable energy facilities.

On May 18, 2012, the Vermont Energy Act of 2012 (ACT 170) was signed into law. Act 170 expands the Standard Offer Program up to 127.5 MW over the next ten years. The new law also mandates use of a market-based mechanism to determine pricing for Standard Offer Projects. On April 1, 2013, the first Standard Offer Program Request for Proposals (RFP) was released. The rate was 12.5 cents per kWh.

New capacity for the Standard Offer Program will be solicited through yearly Request for Proposals. He latest RFP will be released on April 1, 2014

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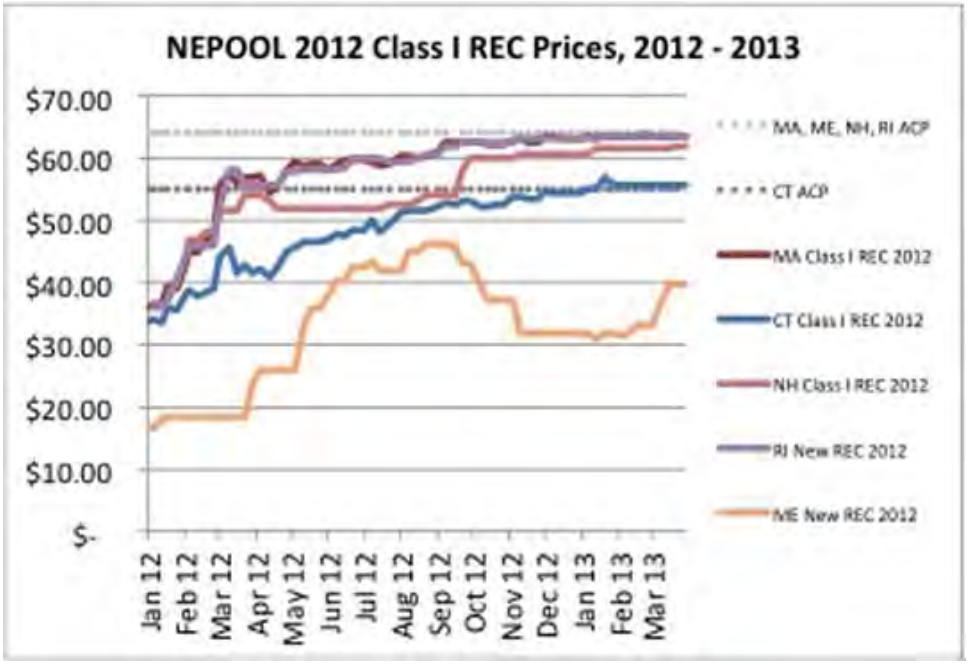
3. Group Net Metering.

In this program, the Fair Haven's (FH) renewable energy project can acquire a group of "retail" customers who are also interconnected to GMP. As mentioned before, FH does not need any outside customers because it can use all the projects generation itself. FH would allocate to each of the town's electric meters a portion of the monetized value of all the energy FH generated during a monthly period. GMP in turn would reduce the meter's monthly GMP bill by the allocated amount. Depending on FH's monthly production, sometimes the entire monthly GMP bill will be paid, sometimes only a portion. Any unused monthly allocation will be returned to the FH "holding account" for future use. It is important to understand Group Net Metering is not an energy "swap" between the production meter and usage meter. It is an ability to reduce or eliminate all components of a bill, including energy, demand, transmission, efficiency, and meter-reading charges. The monetized value for FH's generation is GMP Residential Rate 1, equal to 14.97 cents per kWh. This value will increase whenever the GMP rates rise.

B. Other Energy Value-Added Products.

1. Renewable Energy Credits (RECs)

Many states are trying to increase renewable energy generation by the development of a Renewable Portfolio Standard (RPS). This requires that a percentage of the state's total energy demand be from a renewable source. Massachusetts, for example, has set the standard at 15% by 2020, Vermont at 90% by 2050, and New Hampshire at 23.8% by 2025. To encourage the renewable market, states offer Renewable Energy Credits (RECs) to qualified renewable energy producers. For Fair Haven, the maximum REC price today is about 5.5 cents per kWH. Be aware that these values are volatile. Also, RECs are not available if one chooses the SPEED contract option.



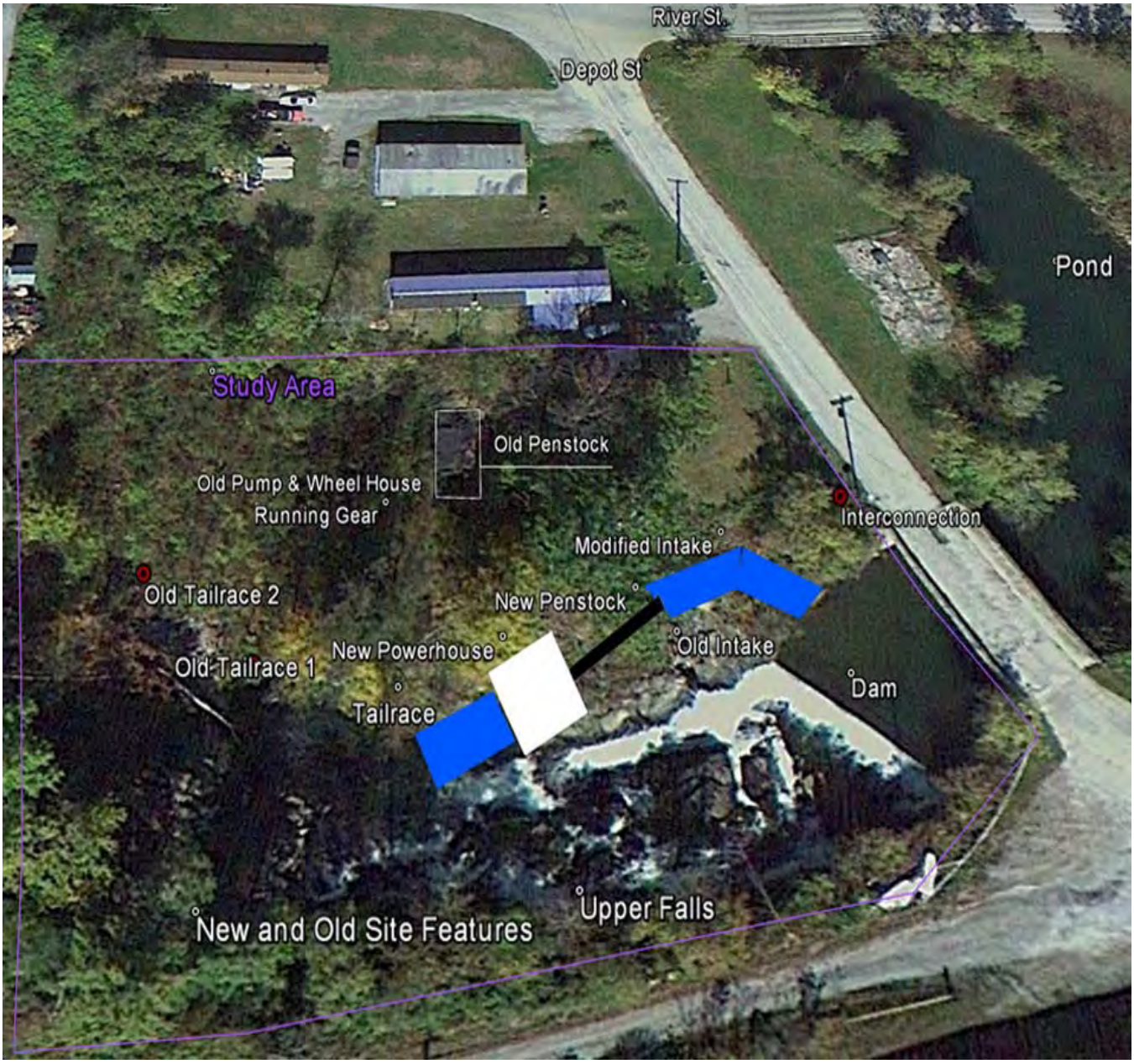
2. Capacity Payment.

The current capacity payment is at a rate of about 0.3 cents per kW of rated capacity.

V. Engineering Design.

Proposed Site Layout.

1. Rebuild the existing intake to support the site's appropriate hydraulic capacity.
2. Install a trash rack consistent with efficient turbine operation and fisheries requirements.
3. Install a trash rake or cleaner.
4. Install a 35 foot long penstock.
5. Construct a concrete powerhouse.
6. Enlarge the tailrace at the base of the Falls.
7. Provide a utility interconnection on Depot St. near the bridge.
8. Refurbish the existing dam and add a shear wall along the downstream face of the existing spillway.
9. Repair a portion of the retaining wall on the south end of the spillway.
10. Purchase and install all equipment.



The USGS map on the following page shows the drainage basin for the Upper Falls in Fair Haven. The area is 90.5 square miles. Flows for the project were derived from 85 years of daily flow data from USGS Gage 0428000 located on the Poultney River below Fair Haven. Available turbine flow and corresponding generation estimates for every day of the year are included in Appendix A.

Monthly and annual estimates of energy production, along with underlying engineering assumptions, are shown in the chart below.

The installed capacity of the plant is expected to be about 190 kW with an annual generation of 696,000 kWh. As will be discussed later, the monetized value of this generation, in one financial scenario, is only slightly less than the Fair Haven's Annual Energy Costs as shown on page 11.

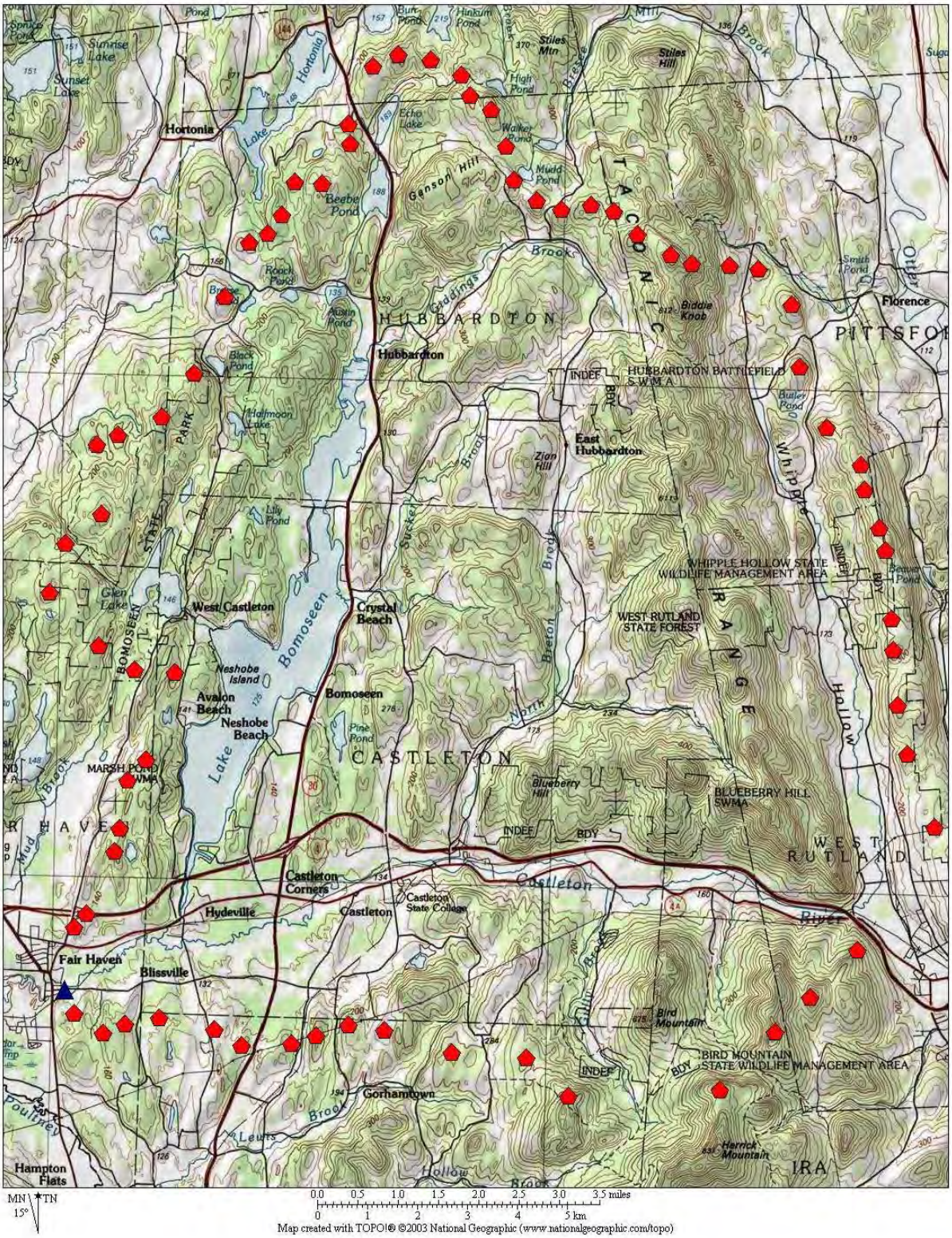
Fair Haven Hydro Feasibility Study - Estimates of Flow and Energy

Jay Boeri, PE - February 18, 2014

Flow Based on Daily 50 % Daily Exceedance Flow for USGS Gauge 04280000

Engineering Assumptions	
USGS Gauge Correction %	0.52
Turbine 1 Hyd Capacity cfs	180
Turbine 2 Hyd Capacity cfs	0
Total Hyd Capacity cfs	180
Min Hyd Capacity cfs	22
Minimum Bypass Flow cfs	10
Fish Passage Flow	0
Unit 1 Installed Capacity kW	190
Unit 2 Istalled Capacity kW	0
Total Installed Capacity kW	190
Gross Head (no flashboards) -FT	22
Flashboard Height - FT	0
Flashboard Availability	100.0%
Average Net Head - FT	21.5
Calculated Max Capacity	190
Efficiency @ 1/4	70%
Efficiency @ 1/2	75.0%
Efficiency @ 3/4	78.0%
Efficiency @ Full Gate	77.0%
Baseline Trash Rack Area SQFT	185
Days- No Net Flow	82
Days- Excess Flow	41

Results	
Month	Monthly kWH
Jan	76,226
Feb	70,711
March	109,102
April	121,944
May	97,745
June	40,187
July	2,252
Aug	0
Sept	5,483
Oct	31,725
Nov	63,889
Dec	77,193
Total	696,458



Drainage Basin Map for a Hydroelectric Project at the Upper Falls

V. Financial Analysis

The Financial Analysis includes the following items.

1. Construction Costs
2. Annual operating expenses.
3. Long term equipment repair and replacement.
4. Revenue from the sale of the energy – contract rate applied to generation.
5. Financing mechanism to borrow money to fund the project's development.

Construction Costs	**Dollars**
Site Mobilization-Access	25,000
Demolition (existing Forebay)	15,000
Stream Diversion-Dewatering	15,000
Rock Excavation - Intake & Penstock	39,111
Rock Excavation - Powerhouse & Tailrace	43,556
Powerhouse - concrete	177,778
Intake	55,556
Penstock	40,000
Retaining wall repairs	66,667
Dam Rehab	46,667
Powerhouse Superstructure	31,500
Subtotal - Construction	**555,833**
Equipment and Installation	
Gates-Rack	18,000
Flashboards	-
Turbine-Generator Units (1)	425,000
Controls-Switchgear	75,000
Transformers-Interconnection	35,000
Civil Electrical	30,000
Civil Mechanical	25,000
Misc. Civil works	15,000
Trash rack Cleaner	50,000
Subtotal - Equipment & Installation	**623,000**
Permitting and Startup	
FERC License (Expedited) and VT Permits	80,000
VT PSB Cert. of Public Good	12,000
Legal and Administration	20,000
Engineering and Design	80,000
Construction Supervision	15,000
Plant Startup	15,000
Subtotal - Permitting and Startup	**222,000**
Direct Cost	**1,400,833**
Contingency -10%	**140,083**
Total Cost	**1,540,917**

2. Operating Costs

Fair Haven Feasibility Study - Operational E															
Jay Boeri, PE February 18, 2014															
Item	Jan.	Feb.	Mar.	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.	Total Hr	Rate	Total $
Normal Maintenance	50	40	60	60	50	30	20	20	20	40	60	60	510	$18	$ 9,180
Unscheduled Repairs	8	8	8	8	8	8	8	8	8	8	8	8	96	$25	$ 2,400
Scheduled Maintenance								16	24	16			56	$25	$ 1,400
Outside Services	8	8	8	8	8	8	8	8	8	8	8	8	96	$60	$ 5,760
Project Administration	5	5	5	5	5	5	5	5	5	5	5	5	60	$25	$ 1,500
														Total	$20,240

3. Long term equipment repair and replacement.

The estimated annual cost of equipment repair and replacement is $5000, escalated at 2% per year.

4. Revenue from the sale of energy.

I will use Scenarios A, B, B-1 and C in the 30 year financial analysis.

Scenario A: Sale of Power through the Speed Program **See Page 20**
Energy at 12.5 cents per Kwh levelized for 15 years escalating at 2%
RECs are not available in the SPEED Program
Capacity 0.3 cents

Scenario B: Group Net Metering without REC's **See Page 23**
Energy production monetized at GMP Rate 1 = 15.3 cents/kWh escalated at 1.0%

Scenario B-1: Group Net Metering with 50% value of REC's **See Page 26**
Energy production monetized at GMP Rate 1 = 15.3 cents/kWh escalated at 1.0%

Scenario C: Group Net Metering with 100% value of REC's **See Page 29**
Energy production monetized at GMP Rate 1 = 15.3 cents/kWh escalated at 1.0%
RECs at 5.5 cents escalated at 1.0% .

5. Financing.

In its December 23, 2013 newsletter, the Vermont Municipal Bond Bank reported that the Northeast Regional coupon rate, with a maturity date of 2043, was 4.50%.
There is no RFP for CEDF Grants for hydroelectric projects in 2014 and
the Loan program has been closed indefinitely. For updates see:
http://publicservice.vermont.gov/topics/renewable_energy

Fair Haven Hydro Feasibility Study - 30 Year Cash Flow Projection
Jay Boeri, PE February 18, 2014
Scenario A: SPEED Contract (2015 - 2034) then ISO-NE (203-2044)

Assumptions

Project Cost	$ 1,540,917
Annual Generation - kwh	696,458

Rates for Period 1 (SPEED)		
Term	15	years
Energy (Levelized)	0.125	$/kWh
Capacity Value	0.000	$/kWh
REC value	0.000	$/kWh
Rates for Period 2 (ISO-NE)		
Term	10	years
Energy	0.145	$/kWh
Capacity	0.034	$/kWh
REC	0.064	$/kWh
Escalator	1.00%	

Financing	Amount	Interest Rate	Term	Debt Service
Grant	$ -			
CEDF Loan	$ -			
Bond	$ 1,540,917	4.50%	25	$ 103,918
Total Financed	$ 1,540,917			
Total Debt Service	$ 103,918			

Results

NPV rate	4.50%
NPV - Cash Flow	($339,833)
NPV Salvage Value	$161,488
Net NPV	($178,344)

Year		2015	2016	2017	2018	2019	2020	2021	2022
Gross Revenue		$ 87,057	$ 87,057	$ 87,057	$ 87,057	$ 87,057	$ 87,057	$ 87,057	$ 87,057
Expenses:	**Growth Rate**								
Property Taxes	2%	-	-	-	-	-	-	-	-
Insurance	2%	-	-	-	-	-	-	-	-
Utilities	1%	1,500	1,515	1,530	1,545	1,561	1,577	1,592	1,608
Daily Operations	2%	20,240	20,645	21,058	21,479	21,908	22,347	22,794	23,249
Equipment Repair	2%	5,000	5,100	5,202	5,306	5,412	5,520	5,631	5,743
Operating Expenses:		26,740	27,260	27,790	28,330	28,881	29,444	30,017	30,601
Debt Service		103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918
Net Cash Flow		$ (43,601)	$ (44,120)	$ (44,651)	$ (45,191)	$ (45,742)	$ (46,304)	$ (46,877)	$ (47,462)

Scenario A: SPEED Contract (2015 - 2034) then ISO-NE (203-2044) Continued **Scenario**

2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
$ 87,057	**$ 87,057**	**$ 87,057**	**$ 87,057**	**$ 87,057**	**$ 87,057**	**$ 87,057**	**$146,997**	**$148,453**	**$149,908**	**$151,364**	**$152,819**
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
1,624	1,641	1,657	1,674	1,690	1,707	1,724	1,741	1,759	1,776	1,794	1,812
23,714	24,189	24,672	25,166	25,669	26,183	26,706	27,240	27,785	28,341	28,908	29,486
5,858	5,975	6,095	6,217	6,341	6,468	6,597	6,729	6,864	7,001	7,141	7,284
31,197	**31,805**	**32,424**	**33,056**	**33,701**	**34,358**	**35,028**	**35,711**	**36,408**	**37,119**	**37,843**	**38,582**
103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918
$ (48,058)	**$ (48,665)**	**$ (49,285)**	**$ (49,917)**	**$ (50,561)**	**$ (51,218)**	**$ (51,889)**	**$ 7,368**	**$ 8,127**	**$ 8,872**	**$ 9,602**	**$ 10,319**

A: SPEED Contract (2015 - 2034) then ISO-NE (203-2044) Continue

2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
$139,373	**$140,688**	**$142,002**	**$143,317**	**$144,632**	**$145,947**	**$147,262**	**$148,577**	**$149,891**	**$151,206**
-	-	-	-	-					
-	-	-	-	-	-	-	-	-	-
1,830	1,849	1,867	1,886	1,905	1,924	1,943	1,962	1,982	2,002
30,076	30,677	31,291	31,916	32,555	33,206	33,870	34,547	35,238	35,943
7,430	7,578	7,730	7,884	8,042	8,203	8,367	8,534	8,705	8,879
39,336	**40,104**	**40,888**	**41,687**	42,502	**43,333**	**44,180**	**45,044**	**45,925**	**46,824**
103,918	103,918	103,918	103,918	103,918	0	0	0	0	0
$ (3,881)	**$ (3,334)**	**$ (2,803)**	**$ (2,287)**	**$ (1,787)**	**$ 102,614**	**$ 103,082**	**$ 103,533**	**$ 103,966**	**$ 104,382**

Fair Haven Hydro Feasibility Study - 30 Year Cash Flow Projection
Jay Boeri, PE February 18, 2014

Scenario B: Group Net Meter without RECs

Assumptions

Project Cost	$ 1,540,917
Annual Generation - kwh	696,458

Rates for 2015- 2044		
Term	30	years
Energy (GMP Rate 1)	0.153	$/kWh
Capacity	0.000	$/kWh
REC	0.000	$/kWh
Escalator	1.00%	

Financing	Amount	Interest Rate	Term	Debt Service
Grant	$ -			
CEDF Loan	$ -			
Bond	$ 1,540,917	4.50%	25	$ 103,918
Total Financed	$ 1,540,917			
Total Debt Service	$ 103,918			

Results

NPV rate	4.50%
NPV-Cash Flow	########
NPV Salvage Value	$151,583
Net NPV	$7,071

Year		2015	2016	2017	2018	2019	2020	2021	2022
Gross Revenue		**$106,355**	**$107,419**	**$108,493**	**$109,578**	**$ 110,674**	**$ 111,781**	**$112,898**	**$114,027**
Expenses:									
	Growth								
Property Taxes	2%	-	-	-	-	-	-	-	-
Insurance	2%	-	-	-	-	-	-	-	-
Utilities	1%	1,500	1,515	1,530	1,545	1,561	1,577	1,592	1,608
Daily Operations	2%	20,240	20,645	21,058	21,479	21,908	22,347	22,794	23,249
Equipment Repair	2%	5,000	5,100	5,202	5,306	5,412	5,520	5,631	5,743
Operating Expenses:		**26,740**	**27,260**	**27,790**	**28,330**	**28,881**	**29,444**	**30,017**	**30,601**
Debt Service		103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918
Net Cash Flow		**$ (24,303)**	**$ (23,759)**	**$ (23,215)**	**$ (22,670)**	**$ (22,126)**	**$ (21,581)**	**$ (21,036)**	**$ (20,492)**

Scenario B: Group Net Meter without RECs Continued

Scenario

2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
$115,168	**$116,319**	**$117,482**	**$118,657**	**$119,844**	**$121,042**	**$122,253**	**$123,475**	**$124,710**	**$125,957**	**$127,217**	**$128,489**
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
1,624	1,641	1,657	1,674	1,690	1,707	1,724	1,741	1,759	1,776	1,794	1,812
23,714	24,189	24,672	25,166	25,669	26,183	26,706	27,240	27,785	28,341	28,908	29,486
5,858	5,975	6,095	6,217	6,341	6,468	6,597	6,729	6,864	7,001	7,141	7,284
31,197	**31,805**	**32,424**	**33,056**	**33,701**	**34,358**	**35,028**	**35,711**	**36,408**	**37,119**	**37,843**	**38,582**
103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918
$ (19,947)	**$ (19,403)**	**$ (18,860)**	**$ (18,317)**	**$ (17,775)**	**$ (17,233)**	**$ (16,693)**	**$ (16,154)**	**$ (15,616)**	**$ (15,079)**	**$ (14,544)**	**$ (14,011)**

B: Group Net Meter without RECs Continued

2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
$129,774	**$131,072**	**$132,382**	**$133,706**	**$135,043**	**$136,394**	**$137,757**	**$139,135**	**$140,526**	**$141,932**
-	-	-	-	-					
-	-	-	-	-	-	-	-	-	-
1,830	1,849	1,867	1,886	1,905	1,924	1,943	1,962	1,982	2,002
30,076	30,677	31,291	31,916	32,555	33,206	33,870	34,547	35,238	35,943
7,430	7,578	7,730	7,884	8,042	8,203	8,367	8,534	8,705	8,879
39,336	**40,104**	**40,888**	**41,687**	**42,502**	**43,333**	**44,180**	**45,044**	**45,925**	**46,824**
103,918	103,918	103,918	103,918	103,918	0	0	0	0	0
$ (13,480)	**$ (12,950)**	**$ (12,423)**	**$ (11,899)**	**$ (11,376)**	**$ 93,061**	**$ 93,578**	**$ 94,091**	**$ 94,601**	**$ 95,108**

Fair Haven Hydro Feasibility Study - 30 Year Cash Flow Projection
Jay Boeri, PE February 18, 2014

Scenario B: Group Net Meter Plus 50% RECs

Assumptions

Project Cost	$ 1,540,917
Annual Generation - kwh	696,458

Rates for 2015- 2044		
Term	30	years
Energy (GMP Rate 1)	0.153	$/kWh
Capacity	0.000	$/kWh
REC	0.028	$/kWh
Escalator	1.00%	

Financing	Amount	Interest Rate	Term	Debt Service
Grant	$ -			
CEDF Loan	$ -			
Bond	$ 1,540,917	4.50%	25	$ 103,918
Total Financed	$ 1,540,917			
Total Debt Service	$ 103,918			

Results

NPV rate	4.50%
NPV-Cash Flow	$205,774
NPV Salvage Value	$178,880
Net NPV	$384,655

Year		2015	2016	2017	2018	2019	2020	2021	2022
Gross Revenue		**$125,508**	**$126,763**	**$128,031**	**$129,311**	**$ 130,604**	**$ 131,910**	**$133,229**	**$134,562**
Expenses:									
	Growth								
Property Taxes	2%	-	-	-	-	-	-	-	-
Insurance	2%	-	-	-	-	-	-	-	-
Utilities	1%	1,500	1,515	1,530	1,545	1,561	1,577	1,592	1,608
Daily Operations	2%	20,240	20,645	21,058	21,479	21,908	22,347	22,794	23,249
Equipment Repair	2%	5,000	5,100	5,202	5,306	5,412	5,520	5,631	5,743
Operating Expenses:		**26,740**	**27,260**	**27,790**	**28,330**	**28,881**	**29,444**	**30,017**	**30,601**
Debt Service		103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918
Net Cash Flow		**$ (5,150)**	**$ (4,415)**	**$ (3,677)**	**$ (2,937)**	**$ (2,195)**	**$ (1,451)**	**$ (705)**	**$ 43**

Scenario B: Group Net Meter without RECs Continued

Scenario

2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
$135,907	**$137,266**	**$138,639**	**$140,025**	**$141,426**	**$142,840**	**$144,268**	**$145,711**	**$147,168**	**$148,640**	**$150,126**	**$151,627**
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
1,624	1,641	1,657	1,674	1,690	1,707	1,724	1,741	1,759	1,776	1,794	1,812
23,714	24,189	24,672	25,166	25,669	26,183	26,706	27,240	27,785	28,341	28,908	29,486
5,858	5,975	6,095	6,217	6,341	6,468	6,597	6,729	6,864	7,001	7,141	7,284
31,197	**31,805**	**32,424**	**33,056**	**33,701**	**34,358**	**35,028**	**35,711**	**36,408**	**37,119**	**37,843**	**38,582**
103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918
$ 792	**$ 1,544**	**$ 2,297**	**$ 3,051**	**$ 3,807**	**$ 4,564**	**$ 5,322**	**$ 6,082**	**$ 6,842**	**$ 7,603**	**$ 8,365**	**$ 9,127**

B: Group Net Meter without RECs Continued

2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
$153,144	**$154,675**	**$156,222**	**$157,784**	**$159,362**	**$160,955**	**$162,565**	**$164,191**	**$165,833**	**$167,491**
-	-	-	-	-					
-	-	-	-	-	-	-	-	-	-
1,830	1,849	1,867	1,886	1,905	1,924	1,943	1,962	1,982	2,002
30,076	30,677	31,291	31,916	32,555	33,206	33,870	34,547	35,238	35,943
7,430	7,578	7,730	7,884	8,042	8,203	8,367	8,534	8,705	8,879
39,336	**40,104**	**40,888**	**41,687**	**42,502**	**43,333**	**44,180**	**45,044**	**45,925**	**46,824**
103,918	103,918	103,918	103,918	103,918	0	0	0	0	0
$ 9,890	**$ 10,653**	**$ 11,416**	**$ 12,179**	**$ 12,942**	**$ 117,623**	**$ 118,385**	**$ 119,147**	**$ 119,907**	**$ 120,667**

Fair Haven Hydro Feasibility Study - 30 Year Cash Flow Projection
Jay Boeri, PE February 18, 2014

Scenario C: Group Net Meter Plus 100% RECs

Assumptions

Project Cost	$ 1,540,917
Annual Generation kwh	696,458

Rates for 2015- 2044		
Term	30	years
Energy (GMP Rate 1)	0.153	$/kWh
Capacity	0.000	$/kWh
REC	0.056	$/kWh
Escalator	1.00%	

Financing	Amount	Interest Rate	Term	Debt Service
Grant	$ -			
CEDF Loan	$ -			
Bond	$ 1,540,917	4.50%	25	$103,918
Total Financed	$ 1,540,917			
Total Debt Service	$ 103,918			

Results

NPV rate	4.50%
NPV-Cash Flow	$570,143
NPV Salvage Value	$207,275
Net NPV	$777,418

Year		2015	2016	2017	2018	2019	2020	2021	2022
Gross Revenue		**$145,430**	**$146,885**	**$148,354**	**$149,837**	**$151,336**	**$ 152,849**	**$154,377**	**$155,921**
Expenses:									
	Growth								
Property Taxes	2%	-	-	-	-	-	-	-	-
Insurance	2%	-	-	-	-	-	-	-	-
Utilities	1%	1,500	1,515	1,530	1,545	1,561	1,577	1,592	1,608
Daily Operations	2%	20,240	20,645	21,058	21,479	21,908	22,347	22,794	23,249
Equipment Repair	2%	5,000	5,100	5,202	5,306	5,412	5,520	5,631	5,743
Operating Expenses:		**26,740**	**27,260**	**27,790**	**28,330**	**28,881**	**29,444**	**30,017**	**30,601**
Debt Service		103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918
Net Cash Flow		**$ 14,773**	**$ 15,707**	**$ 16,646**	**$ 17,589**	**$ 18,536**	**$ 19,487**	**$ 20,443**	**$ 21,402**

Scenario C: Group Net Meter With RECs Continued

Scenario

2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
$157,480	**$159,055**	**$160,646**	**$162,252**	**$163,875**	**$165,513**	**$167,169**	**$168,840**	**$170,529**	**$172,234**	**$173,956**	**$175,696**
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
1,624	1,641	1,657	1,674	1,690	1,707	1,724	1,741	1,759	1,776	1,794	1,812
23,714	24,189	24,672	25,166	25,669	26,183	26,706	27,240	27,785	28,341	28,908	29,486
5,858	5,975	6,095	6,217	6,341	6,468	6,597	6,729	6,864	7,001	7,141	7,284
31,197	**31,805**	**32,424**	**33,056**	**33,701**	**34,358**	**35,028**	**35,711**	**36,408**	**37,119**	**37,843**	**38,582**
103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918	103,918
$ 22,365	**$ 23,333**	**$ 24,303**	**$ 25,278**	**$ 26,256**	**$ 27,238**	**$ 28,223**	**$ 29,211**	**$ 30,203**	**$ 31,198**	**$ 32,195**	**$ 33,196**

C: Group Net Meter With RECs Continuec

2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
$177,453	**$179,227**	**$181,020**	**$182,830**	**$184,658**	**$186,505**	**$188,370**	**$190,253**	**$192,156**	**$194,078**
-	-	-	-	-					
-	-	-	-	-	-	-	-	-	-
1,830	1,849	1,867	1,886	1,905	1,924	1,943	1,962	1,982	2,002
30,076	30,677	31,291	31,916	32,555	33,206	33,870	34,547	35,238	35,943
7,430	7,578	7,730	7,884	8,042	8,203	8,367	8,534	8,705	8,879
39,336	**40,104**	**40,888**	**41,687**	**42,502**	**43,333**	**44,180**	**45,044**	**45,925**	**46,824**
103,918	103,918	103,918	103,918	103,918	0	0	0	0	0
$ 34,199	**$ 35,205**	**$ 36,214**	**$ 37,225**	**$ 38,239**	**$ 143,172**	**$ 144,190**	**$ 145,209**	**$ 146,231**	**$ 147,253**

VI. Conclusions.

Comparison of the 4 Different Contracts.

		Net Present Value @ 4.5%		
No.	Contract	Cash Flow	Salvage Value	Total NPV
A	SPEED Contract	($339,833)	$161,488	($178,344)
B	Group Net Metering - No RECs	($144,512)	$151,583	$7,071
B-1	Group Net Metering + 50% RECs	$205,774	$178,880	$384,655
C	Group Net Metering + 100% RECs	$570,143	$207,275	$777,418

It is obvious that Case C gives by far the best return. From day one of operation, there is always a positive cash flow. The project would group net meter with all of Fair Haven's town operated facilities and apply for Class 1 RECs to the New England state with the greatest value. Openings still exist for group net metering in Green Mountain Power's service territory, and the Vermont Public Service Board Vermont currently allows projects to keep their RECs - but this may change this year. The legislature may alter current net metering rules such that the RECs go to either the state or the utility. Should this happen, Case B becomes the next best choice, but it has a negative cash flow until the debt service obligation ends. It is not a particularly good option.

Should the legislature hold hearings or the PSB open a docket to modify net metering – to eliminate project REC ownership - there will certainly be an outcry by stakeholders. Time will tell so I created a middle-ground Case B-1: Group net metering with 50% of REC value. This gives good results, and there is only a relatively small, negative cash flow in the first seven years of operation.

As I mentioned earlier, good opportunities are ephemeral, driven by a complex mix of economics, federal regulation, and state energy policy. Today, in Vermont, for new projects with less than 500kW of capacity, prospects for a successful project are as good as they have been in the last 25 years. But forces are in play. The immediate downside one is the possible loss of Group Net Metering RECs but towns like Fair Haven as well as private developers have a forum during legislative proceedings. This also applies to a possible Vermont Renewable Portfolio Standards that could establish in-state RECs, especially if Vermont wants to meet its stated goal of 90% renewable energy by 2050. Beyond the control of Fair Haven, but affecting its decision, is the price of natural gas, ISO-NE demand and capacity and global warming legislation.

VII. Recommendations.

I would recommend that Fair Haven clarify any property ownership issues before it does anything else. After this, if there is still hydro interest, a formal dialog should be started with Vermont's ANR's hydro review group. This is also a first step in pursuit of a 401Water Quality Certificate that can lead to a streamlined FERC application, a PSB Certificate of Public Good d for Group Net Metering and a possible REC placeholder

Appendix A.

Fair Haven Hydro Feasibility Study - Daily Flow and Energy

Jay Boeri, PE February 18, 2014

Month	Day	Day of Year	Gross Avg Flow @ Site	Gross Med. Flow @ Site	Min flow Spill cfs	Available Flow	Flow thru Turbines	Power kW	Net KWH
1	1	1	133	76	10	66	66	90	1966
1	2	2	146	90	10	80	80	109	2373
1	3	3	144	101	10	91	91	123	2685
1	4	4	138	102	10	92	92	124	2715
1	5	5	125	102	10	92	92	125	2731
1	6	6	126	101	10	91	91	123	2685
1	7	7	128	103	10	93	93	127	2761
1	8	8	137	94	10	84	84	114	2480
1	9	9	149	96	10	86	86	117	2557
1	10	10	145	97	10	87	87	119	2588
1	11	11	132	94	10	84	84	114	2480
1	12	12	131	94	10	84	84	114	2480
1	13	13	116	93	10	83	83	112	2449
1	14	14	122	88	10	78	78	106	2311
1	15	15	126	79	10	69	69	93	2035
1	16	16	123	83	10	73	73	99	2158
1	17	17	110	80	10	70	70	95	2081
1	18	18	125	83	10	73	73	99	2158
1	19	19	146	79	10	69	69	93	2035
1	20	20	166	88	10	78	78	106	2311
1	21	21	144	87	10	77	77	104	2281
1	22	22	142	93	10	83	83	113	2465
1	23	23	147	97	10	87	87	119	2588
1	24	24	156	102	10	92	92	125	2731
1	25	25	198	107	10	97	97	131	2868
1	26	26	180	98	10	88	88	120	2618
1	27	27	173	103	10	93	93	127	2761
1	28	28	167	96	10	86	86	117	2557
1	29	29	141	94	10	84	84	114	2495
1	30	30	132	96	10	86	86	116	2541
1	31	31	125	87	10	77	77	104	2281

Month	Day	Day of Year	Gross Avg Flow @ Site	Gross Med. Flow @ Site	Min flow Spill cfs	Available Flow	Flow thru Turbines	Power kW	Net KWH
2	1	32	126	93	10	83	83	113	2465
2	2	33	127	99	10	89	89	121	2649
2	3	34	135	91	10	81	81	109	2388
2	4	35	132	92	10	82	82	112	2434

2	5	36	124	93	10	83	83	113	2465
2	6	37	121	85	10	75	75	102	2235
2	7	38	123	88	10	78	78	106	2311
2	8	39	122	91	10	81	81	109	2388
2	9	40	112	91	10	81	81	109	2388
2	10	41	103	86	10	76	76	103	2250
2	11	42	111	87	10	77	77	105	2296
2	12	43	119	87	10	77	77	105	2296
2	13	44	116	83	10	73	73	99	2158
2	14	45	125	88	10	78	78	106	2311
2	15	46	127	94	10	84	84	114	2495
2	16	47	135	107	10	97	97	131	2853
2	17	48	128	107	10	97	97	131	2853
2	18	49	126	102	10	92	92	124	2715
2	19	50	127	91	10	81	81	110	2403
2	20	51	126	94	10	84	84	114	2495
2	21	52	136	98	10	88	88	120	2618
2	22	53	158	94	10	84	84	114	2480
2	23	54	166	88	10	78	78	106	2311
2	24	55	162	94	10	84	84	114	2495
2	25	56	168	93	10	83	83	112	2449
2	26	57	169	94	10	84	84	114	2495
2	27	58	164	96	10	86	86	116	2541
2	28	59	173	93	10	83	83	113	2465
2	29	60	170	78	10	68	68	92	2005

Month	Day	Day of Year	Gross Avg Flow @ Site	Gross Med. Flow @ Site	Min flow Spill cfs	Available Flow	Flow thru Turbines	Power kW	Net KWH
3	1	61	146	96	10	86	86	116	2541
3	2	62	146	94	10	84	84	114	2480
3	3	63	146	103	10	93	93	127	2761
3	4	64	154	105	10	95	95	129	2807
3	5	65	168	120	10	110	110	156	3396
3	6	66	202	125	10	115	115	161	3523
3	7	67	205	114	10	104	104	146	3190
3	8	68	203	121	10	111	111	156	3412
3	9	69	232	140	10	130	130	190	4161
3	10	70	208	145	10	135	135	190	4147
3	11	71	205	140	10	130	130	190	4161
3	12	72	248	142	10	132	132	190	4156
3	13	73	236	143	10	133	133	190	4153
3	14	74	250	154	10	144	144	190	4128
3	15	75	272	165	10	155	155	190	4105
3	16	76	281	159	10	149	149	190	4560
3	17	77	290	176	10	166	166	190	4076
3	18	78	330	186	10	176	176	190	4049
3	19	79	314	184	10	174	174	190	4056
3	20	80	332	198	10	188	180	190	4039
3	21	81	308	219	10	209	180	190	2139
3	22	82	335	215	10	205	180	190	2139

3	23	83	318	228	10	218	180	190	2139
3	24	84	316	259	10	249	180	190	2173
3	25	85	323	268	10	258	180	190	2173
3	26	86	343	266	10	256	180	190	4073
3	27	87	381	314	10	304	180	190	4073
3	28	88	389	321	10	311	180	190	4073
3	29	89	399	310	10	300	180	190	4073
3	30	90	412	314	10	304	180	190	4073
3	31	91	446	318	10	308	180	190	4073

Month	Day	Day of Year	Gross Avg Flow @ Site	Gross Med. Flow @ Site	Min flow Spill cfs	Available Flow	Flow thru Turbines	Power kW	Net KWH
4	1	92	476	350	10	340	180	190	4073
4	2	93	448	348	10	338	180	190	4073
4	3	94	444	350	10	340	180	190	4073
4	4	95	448	363	10	353	180	190	4073
4	5	96	447	369	10	359	180	190	4073
4	6	97	449	391	10	381	180	190	4073
4	7	98	447	374	10	364	180	190	4073
4	8	99	401	378	10	368	180	190	4073
4	9	100	353	328	10	318	180	190	4073
4	10	101	350	303	10	293	180	190	4073
4	11	102	355	290	10	280	180	190	4073
4	12	103	363	292	10	282	180	190	4073
4	13	104	363	289	10	279	180	190	4073
4	14	105	364	286	10	276	180	190	4073
4	15	106	344	284	10	274	180	190	4073
4	16	107	338	282	10	272	180	190	4073
4	17	108	356	307	10	297	180	190	4073
4	18	109	345	277	10	267	180	190	4073
4	19	110	325	265	10	255	180	190	4073
4	20	111	319	250	10	240	180	190	4073
4	21	112	292	245	10	235	180	190	4039
4	22	113	279	224	10	214	180	190	4039
4	23	114	275	212	10	202	180	190	4039
4	24	115	264	198	10	188	180	190	4039
4	25	116	267	199	10	189	180	190	4039
4	26	117	260	212	10	202	180	190	4039
4	27	118	238	189	10	179	179	190	4042
4	28	119	224	176	10	166	166	190	4075
4	29	120	218	177	10	167	167	190	4072
4	30	121	207	179	10	169	169	190	4067

Month	Day	Day of Year	Gross Avg Flow @ Site	Gross Med. Flow @ Site	Min flow Spill cfs	Available Flow	Flow thru Turbines	Power kW	Net KWH
5	1	122	198	179	10	169	169	190	4068
5	2	123	191	170	10	160	160	190	4093

5	3	124	206	164	10	154	154	190	4107
5	4	125	208	157	10	147	147	190	4122
5	5	126	197	156	10	146	146	190	4123
5	6	127	180	135	10	125	125	176	3841
5	7	128	173	129	10	119	119	167	3651
5	8	129	170	124	10	114	114	161	3508
5	9	130	169	122	10	112	112	158	3444
5	10	131	161	130	10	120	120	169	3682
5	11	132	167	124	10	114	114	161	3508
5	12	133	173	136	10	126	126	177	3873
5	13	134	182	123	10	113	113	159	3476
5	14	135	187	120	10	110	110	156	3396
5	15	136	191	115	10	105	105	148	3221
5	16	137	182	120	10	110	110	156	3396
5	17	138	175	112	10	102	102	144	3142
5	18	139	168	101	10	91	91	123	2685
5	19	140	161	107	10	97	97	131	2868
5	20	141	171	111	10	101	101	142	3094
5	21	142	194	111	10	101	101	142	3110
5	22	143	173	107	10	97	97	131	2868
5	23	144	154	108	10	98	98	133	2899
5	24	145	150	94	10	84	84	114	2480
5	25	146	149	100	10	90	90	122	2664
5	26	147	138	85	10	75	75	102	2219
5	27	148	128	94	10	84	84	114	2495
5	28	149	120	83	10	73	73	100	2173
5	29	150	118	74	10	64	64	87	1897
5	30	151	124	76	10	66	66	89	1943
5	31	152	118	67	10	57	57	78	1698

Month	Day	Day of Year	Gross Avg Flow @ Site	Gross Med. Flow @ Site	Min flow Spill cfs	Available Flow	Flow thru Turbines	Power kW	Net KWH
6	1	153	119	76	10	66	66	89	1943
6	2	154	132	73	10	63	63	86	1882
6	3	155	135	73	10	63	63	86	1866
6	4	156	123	70	10	60	60	82	1790
6	5	157	104	72	10	62	62	85	1851
6	6	158	92	78	10	68	68	93	2020
6	7	159	91	66	10	56	56	76	1652
6	8	160	86	67	10	57	57	77	1682
6	9	161	80	60	10	50	50	63	1506
6	10	162	82	62	10	52	52	70	1529
6	11	163	81	61	10	51	51	69	1498
6	12	164	79	60	10	50	50	63	1506
6	13	165	81	54	10	44	44	56	1335
6	14	166	86	57	10	47	47	59	1413
6	15	167	90	53	10	43	43	54	1288
6	16	168	78	52	10	42	42	54	1272
6	17	169	90	57	10	47	47	60	1428
6	18	170	93	60	10	50	50	63	1506

6	19	171	83	48	10	38	38	49	1152
6	20	172	77	43	10	33	33	42	996
6	21	173	69	41	10	31	31	39	933
6	22	174	70	45	10	35	35	45	1058
6	23	175	86	42	10	32	32	41	964
6	24	176	73	41	10	31	31	40	949
6	25	177	70	40	10	30	30	38	902
6	26	178	71	44	10	34	34	44	1043
6	27	179	71	36	10	26	26	33	777
6	28	180	68	37	10	27	27	35	824
6	29	181	70	38	10	28	28	36	855
6	30	182	65	35	10	25	25	32	769

Month	Day	Day of Year	Gross Avg Flow @ Site	Gross Med. Flow @ Site	Min flow Spill cfs	Available Flow	Flow thru Turbines	Power kW	Net KWH
7	1	183	70	36	10	26	26	33	792
7	2	184	64	31	10	0	0	0	0
7	3	185	57	36	10	26	26	33	792
7	4	186	53	31	10	0	0	0	0
7	5	187	58	32	10	22	22	28	667
7	6	188	55	32	10	0	0	0	0
7	7	189	53	32	10	0	0	0	0
7	8	190	79	29	10	0	0	0	0
7	9	191	55	29	10	0	0	0	0
7	10	192	50	31	10	0	0	0	0
7	11	193	51	29	10	0	0	0	0
7	12	194	70	28	10	0	0	0	0
7	13	195	68	26	10	0	0	0	0
7	14	196	59	27	10	0	0	0	0
7	15	197	51	29	10	0	0	0	0
7	16	198	59	27	10	0	0	0	0
7	17	199	57	26	10	0	0	0	0
7	18	200	47	26	10	0	0	0	0
7	19	201	45	27	10	0	0	0	0
7	20	202	75	27	10	0	0	0	0
7	21	203	65	25	10	0	0	0	0
7	22	204	61	26	10	0	0	0	0
7	23	205	62	28	10	0	0	0	0
7	24	206	62	28	10	0	0	0	0
7	25	207	59	25	10	0	0	0	0
7	26	208	52	27	10	0	0	0	0
7	27	209	46	25	10	0	0	0	0
7	28	210	44	23	10	0	0	0	0
7	29	211	49	26	10	0	0	0	0
7	30	212	56	25	10	0	0	0	0
7	31	213	54	24	10	0	0	0	0

Month	Day	Day of Year	Gross Avg Flow @	Gross Med. Flow @	Min flow Spill cfs	Available Flow	Flow thru Turbines	Power kW	Net KWH

			Site	Site					
8	1	214	69	24	10	0	0	0	0
8	2	215	61	24	10	0	0	0	0
8	3	216	58	21	10	0	0	0	0
8	4	217	65	24	10	0	0	0	0
8	5	218	62	21	10	0	0	0	0
8	6	219	56	21	10	0	0	0	0
8	7	220	56	21	10	0	0	0	0
8	8	221	54	22	10	0	0	0	0
8	9	222	47	20	10	0	0	0	0
8	10	223	51	21	10	0	0	0	0
8	11	224	58	24	10	0	0	0	0
8	12	225	54	25	10	0	0	0	0
8	13	226	60	22	10	0	0	0	0
8	14	227	56	24	10	0	0	0	0
8	15	228	47	22	10	0	0	0	0
8	16	229	48	25	10	0	0	0	0
8	17	230	47	22	10	0	0	0	0
8	18	231	44	20	10	0	0	0	0
8	19	232	46	20	10	0	0	0	0
8	20	233	38	19	10	0	0	0	0
8	21	234	37	20	10	0	0	0	0
8	22	235	46	19	10	0	0	0	0
8	23	236	39	19	10	0	0	0	0
8	24	237	36	19	10	0	0	0	0
8	25	238	36	22	10	0	0	0	0
8	26	239	33	18	10	0	0	0	0
8	27	240	29	18	10	0	0	0	0
8	28	241	44	22	10	0	0	0	0
8	29	242	101	21	10	0	0	0	0
8	30	243	58	23	10	0	0	0	0
8	31	244	47	24	10	0	0	0	0

Month	Day	Day of Year	Gross Avg Flow @ Site	Gross Med. Flow @ Site	Min flow Spill cfs	Available Flow	Flow thru Turbines	Power kW	Net KWH
9	1	245	43	21	10	0	0	0	0
9	2	246	38	24	10	0	0	0	0
9	3	247	35	21	10	0	0	0	0
9	4	248	37	23	10	0	0	0	0
9	5	249	33	21	10	0	0	0	0
9	6	250	35	18	10	0	0	0	0
9	7	251	39	21	10	0	0	0	0
9	8	252	39	22	10	0	0	0	0
9	9	253	38	21	10	0	0	0	0
9	10	254	38	24	10	0	0	0	0
9	11	255	40	24	10	0	0	0	0
9	12	256	35	27	10	0	0	0	0
9	13	257	39	22	10	0	0	0	0
9	14	258	40	22	10	0	0	0	0

9	15	259	44	26	10	0	0	0	0
9	16	260	40	24	10	0	0	0	0
9	17	261	41	25	10	0	0	0	0
9	18	262	44	24	10	0	0	0	0
9	19	263	46	25	10	0	0	0	0
9	20	264	45	26	10	0	0	0	0
9	21	265	57	31	10	0	0	0	0
9	22	266	92	29	10	0	0	0	0
9	23	267	76	32	10	22	22	28	667
9	24	268	71	32	10	0	0	0	0
9	25	269	60	35	10	25	25	32	761
9	26	270	52	36	10	26	26	33	792
9	27	271	55	35	10	25	25	32	761
9	28	272	57	41	10	31	31	40	949
9	29	273	57	36	10	26	26	33	777
9	30	274	60	36	10	26	26	33	777

Month	Day	Day of Year	Gross Avg Flow @ Site	Gross Med. Flow @ Site	Min flow Spill cfs	Available Flow	Flow thru Turbines	Power kW	Net KWH
10	1	275	66	35	10	25	25	32	761
10	2	276	80	39	10	29	29	37	886
10	3	277	69	41	10	31	31	39	933
10	4	278	65	40	10	30	30	38	902
10	5	279	62	38	10	28	28	36	855
10	6	280	65	39	10	29	29	37	870
10	7	281	65	37	10	27	27	35	824
10	8	282	67	40	10	30	30	38	902
10	9	283	70	42	10	32	32	41	980
10	10	284	78	46	10	36	36	45	1074
10	11	285	65	42	10	32	32	41	980
10	12	286	62	38	10	28	28	35	839
10	13	287	62	43	10	33	33	42	996
10	14	288	61	37	10	27	27	35	824
10	15	289	67	43	10	33	33	42	996
10	16	290	81	42	10	32	32	41	980
10	17	291	79	47	10	37	37	47	1105
10	18	292	83	43	10	33	33	42	996
10	19	293	76	41	10	31	31	39	933
10	20	294	85	40	10	30	30	39	917
10	21	295	87	41	10	31	31	39	933
10	22	296	79	42	10	32	32	41	980
10	23	297	78	44	10	34	34	44	1043
10	24	298	96	49	10	39	39	49	1168
10	25	299	103	51	10	41	41	52	1226
10	26	300	101	43	10	33	33	43	1011
10	27	301	98	53	10	43	43	54	1288
10	28	302	124	56	10	46	46	59	1397
10	29	303	127	52	10	42	42	54	1272
10	30	304	110	57	10	47	47	60	1428
10	31	305	92	57	10	47	47	60	1428

Month	Day	Day of Year	Gross Avg Flow @ Site	Gross Med. Flow @ Site	Min flow Spill cfs	Available Flow	Flow thru Turbines	Power kW	Net KWH
11	1	306	92	56	10	46	46	58	1381
11	2	307	95	62	10	52	52	71	1544
11	3	308	100	67	10	57	57	78	1698
11	4	309	100	68	10	58	58	79	1728
11	5	310	101	73	10	63	63	86	1866
11	6	311	105	72	10	62	62	84	1836
11	7	312	104	70	10	60	60	82	1790
11	8	313	98	72	10	62	62	84	1836
11	9	314	116	71	10	61	61	83	1820
11	10	315	121	71	10	61	61	83	1820
11	11	316	117	73	10	63	63	86	1866
11	12	317	108	74	10	64	64	87	1897
11	13	318	107	74	10	64	64	87	1897
11	14	319	108	73	10	63	63	86	1866
11	15	320	113	85	10	75	75	102	2219
11	16	321	111	82	10	72	72	97	2127
11	17	322	118	84	10	74	74	100	2189
11	18	323	116	83	10	73	73	99	2158
11	19	324	116	82	10	72	72	97	2127
11	20	325	149	85	10	75	75	102	2219
11	21	326	140	85	10	75	75	102	2219
11	22	327	133	84	10	74	74	100	2189
11	23	328	138	84	10	74	74	101	2204
11	24	329	127	87	10	77	77	105	2296
11	25	330	128	88	10	78	78	106	2311
11	26	331	140	94	10	84	84	114	2495
11	27	332	160	107	10	97	97	131	2853
11	28	333	182	105	10	95	95	129	2807
11	29	334	180	114	10	104	104	146	3190
11	30	335	163	112	10	102	102	143	3437

Month	Day	Day of Year	Gross Avg Flow @ Site	Gross Med. Flow @ Site	Min flow Spill cfs	Available Flow	Flow thru Turbines	Power kW	Net KWH
12	1	336	154	122	10	112	112	157	1857
12	2	337	166	104	10	94	94	128	1513
12	3	338	159	91	10	81	81	109	1294
12	4	339	150	122	10	112	112	158	1866
12	5	340	154	110	10	100	100	141	1668
12	6	341	151	104	10	94	94	127	2777
12	7	342	170	107	10	97	97	131	2853
12	8	343	151	107	10	97	97	131	2853
12	9	344	134	105	10	95	95	129	2822
12	10	345	133	103	10	93	93	127	2761
12	11	346	143	107	10	97	97	131	2853

12	12	347	148	100	10	90	90	122	2670
12	13	348	159	111	10	101	101	142	3094
12	14	349	172	112	10	102	102	143	3126
12	15	350	150	112	10	102	102	144	3142
12	16	351	136	100	10	90	90	122	2670
12	17	352	135	104	10	94	94	127	2777
12	18	353	159	107	10	97	97	131	2853
12	19	354	134	92	10	82	82	112	2434
12	20	355	129	96	10	86	86	117	2557
12	21	356	150	107	10	97	97	131	2868
12	22	357	151	103	10	93	93	126	2746
12	23	358	132	95	10	85	85	116	2526
12	24	359	137	91	10	81	81	110	2403
12	25	360	140	86	10	76	76	103	2250
12	26	361	134	93	10	83	83	113	2465
12	27	362	142	91	10	81	81	110	2403
12	28	363	135	88	10	78	78	107	2327
12	29	364	138	83	10	73	73	100	2173
12	30	365	146	91	10	81	81	109	2388
12	31	366	159	84	10	74	74	101	2204