The Paran Creek Watershed Project

Feasibility Study Prepared for the Trustees of the Village of North Bennington
December 1st 2016

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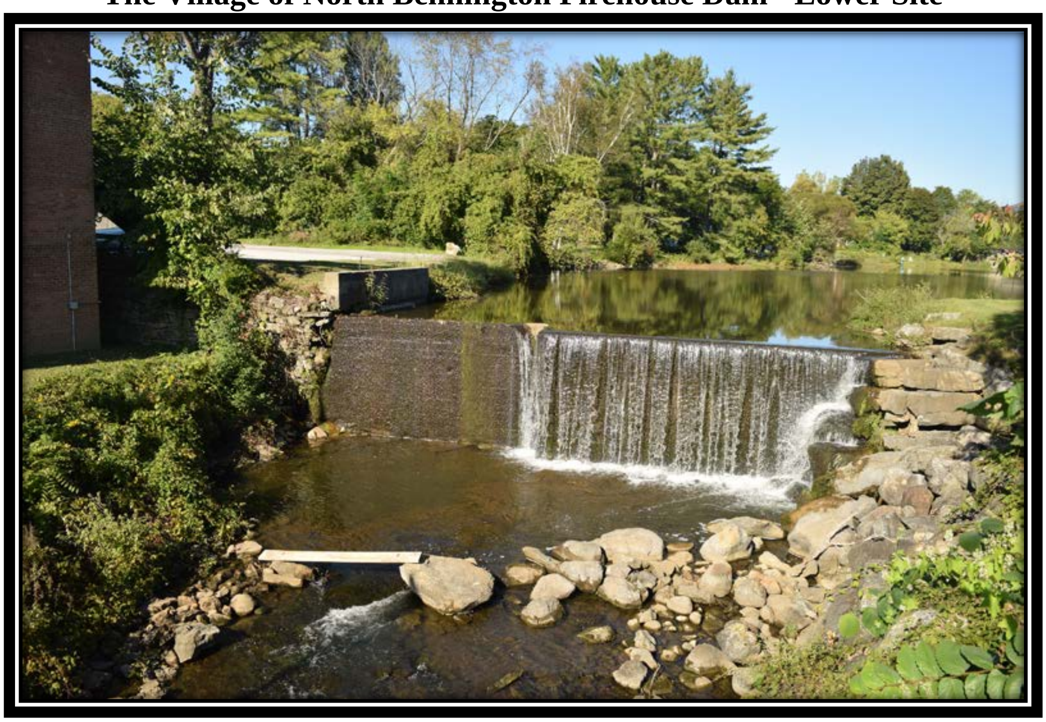


1. <u>Introduction</u>

a. Authority

The Paran Creek Watershed Project was developed by Bill Scully and Susan Sgorbati at Bennington College's Center for the Advancement of Public Action (CAPA), in collaboration with the students of the College's course the Village Privileges of North Bennington. Bill Scully is a leading Vermont expert on hydropower, entrepreneur, and developer of several hydroelectric redevelopments. Susan Sgorbati is the director of the Center for the Advancement of Public Action. The curriculum of CAPA is designed to engage students with confronting the challenges of today's world. Climate Change, being an issue tantamount to our survival as a species, is a challenge at the heart of CAPA's curriculum. Further, the February 2015 discovery of PFOA pollution in drinking water, an issue affecting the health and survival of the citizens of North Bennington, brought to the forefront the need for the Village to engage and address its watershed as a living entity, vital to our survival. Previous CAPA classes have worked with Green Mountain Power, Efficiency Vermont, and The Village Trustees of North Bennington, to convert the streetlamps in North Bennington to LED's. Students in the Village Privileges of North Bennington class of Fall 2016 represent a diverse range of locations both nationally and internationally, and a wide range of interests in their academic study, such as physics, architecture, mathematics, computer science, environmental studies, conflict resolution, design, and visual art.

b. Purpose

The purpose of the Paran Creek Watershed Project is to develop a preliminary feasibility study in an educational setting. If approved by the Village, this project would be followed with a more thorough feasibility study to begin the licensing process; which typically takes 3-5 years.

The mission of The Paran Creek Watershed Project is to support the Village's long term stewardship of renewable water resources, clean contaminants to improve the aquatic and riverine habitat, establish North Bennington as a model for energy independence and form a sustainable, long term watershed management plan by revitalizing existing infrastructure. The main goal of this project is to develop a means by which the water self-funds its own health and resilience without raising cost to the taxpayers.

In earlier years one had to obtain a Privilege to access public waterways. That term has since been changed to License which has altered perception and devalued our stewardship of our most precious resource. It is the purpose of the Paran Creek Watershed Project to create this feasibility study as the first step towards achieving this mission. The results of the redevelopment of either or both proposed sites would fund the implementation of the Watershed Management Plan, reduce energy costs, and limit the carbon footprint of the Village.

c. Benefits of Hydropower

Hydropower is fueled by water, so it's a clean fuel source, meaning it won't pollute the air like power plants that burn fossil fuels, such as coal or natural gas. Hydropower is a domestic source of energy, allowing each state to produce their own energy without being reliant on international fuel sources. The energy generated through hydropower relies on the water cycle, which is driven by the sun, making it a renewable power source and making it a more reliable and affordable source than fossil fuels that are rapidly being depleted. Impoundment hydropower creates reservoirs that offer a variety of recreational opportunities, notably fishing, swimming, and boating. Most water power installations are required to provide some public access to the reservoir to allow the public to take advantage of these opportunities. In addition to a sustainable energy source, hydropower efforts produce several benefits, such as flood control, irrigation, recreation, and water supply.[1]

d. Order of Operations

There are four student task forces within the class, one focused on public engagement, a second on the physical feasibility of the plants, a third on the history and ownership of the dams, and a fourth on finances and equipment.

Group 1 - responsible for overseeing all public interface, creating the mission statement, identifying stakeholders, understanding the work of each of the groups, and coordinating each of the groups work in the completion of the feasibility study.

Group 2 - responsible for designing and drawing the architectural plans for each hydropower plant, modeling the plant operations, measuring and collecting watershed data and United States Geological Survey data.

Group 3 - responsible for gathering all historical documentation related to each proposed site, researching the ownership of each proposed site, researching the history of the aquatic and riverine habitat, and researching potential habitat contamination.

Group 4 - responsible for determining what equipment would be most ideal for each proposed site, determining all financing and budgeting, and financial impacts to the Village.

2. Site Description

a. History of Site

The Lake Paran Dam - Upper Site:

The Lake Paran Dam was built in 1840 by the local railroad company. Stark Paper Company, owner of Haviland's Privilege, later acquired the water rights to the Lake Paran dam and controlled the flow to downstream companies. At one time in the early 19th century there were up to 13 Privileges claimed along the Creek. The Lake Paran Dam burst on February 11, 1852, and floodwaters destroyed all the existing factories and several residences along the creek and a 14-month-old boy perished. Following the flood, the dam was rebuilt and continued to be used as a rail route. Circa 1960, Lake Paran was developed as a recreation area. In 1978 Lake Paran was drained, as the dam had started to leak water, and Village members were scared the dam would burst again. A federal grant was obtained and the dam was rebuilt and reinforced with vertical

[1] Excerpts from US Department of Energy *see* http://energy.gov/eere/water/benefits-hydropower

sheets of steel. It was during this construction period that the fishing access point and parking lots that still exist today, were built.

Current Ownership:

In 1972 Stark Paper Company signed a deed giving Paran Recreations (now the Lake Paran Association) complete ownership of the land surrounding Lake Paran, the Lake and dam itself. (*see Appendix C*)

The Village of North Bennington Firehouse Dam - Lower Site:

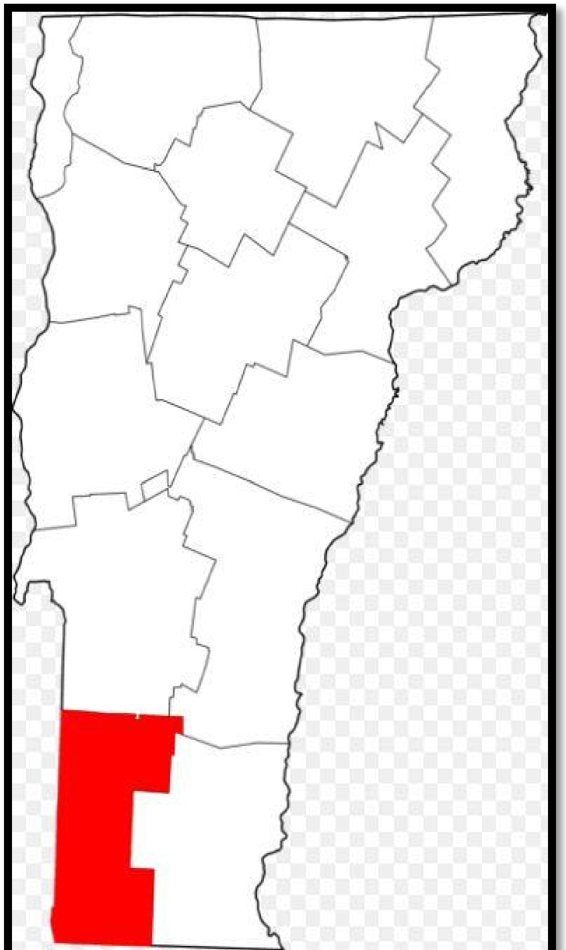
The North Bennington Firehouse dam is estimated to have been built during the 1700's when the first mills were constructed along Paran Creek. In 1960 the John G. McCullough Firehouse was built which overlooks the second millpond and the Firehouse dam of Haviland's Privilege. In 1975 the remains of the Stark Paper Company property below the Firehouse dam was replaced by several small condominiums. More recently a small public park was opened on the east side of the dam, which holds a view that attracts many fall tourists. Up until the early 2000's, most of the property on Lake Paran and Paran Creek was owned privately. In 2004, the Fund for North Bennington, Inc and the Vermont Land Trust worked together on a new Paran Conservation Project. There are currently 56 acres of protected land, which includes 2,976 feet of shoreline along Lake Paran and Paran Creek. The Walloomsac River, Lake Paran, Paran Creek and their related ponds make up the total surface water resources available to the Village of North Bennington.

Current Ownership:

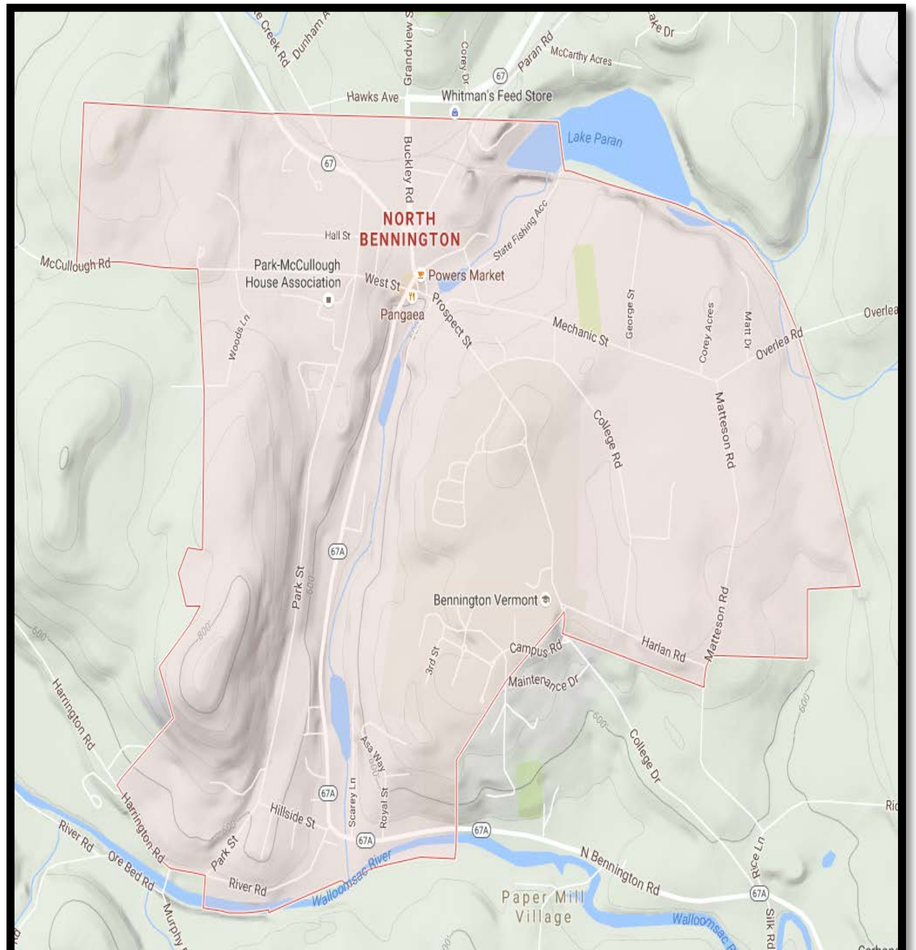
The Village of North Bennington owns the property adjoining the Firehouse Dam to the east and west. Because of said ownership and State Law, we can reasonably infer that the Village of North Bennington owns the dam and the water between the two pieces of property. This fact will require further vetting should the Village elect to proceed to the next stages of redevelopment.

b. Project Locus Maps

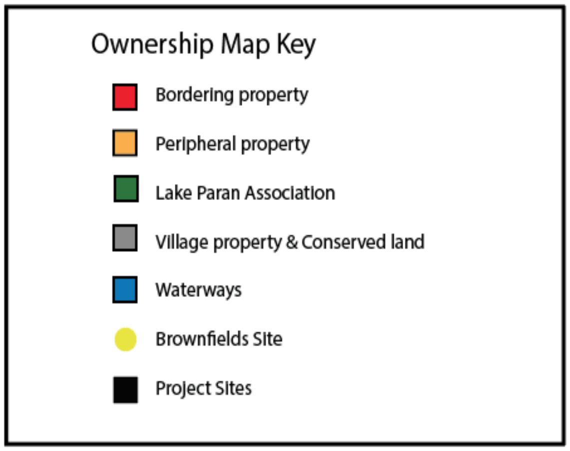
Bennington County

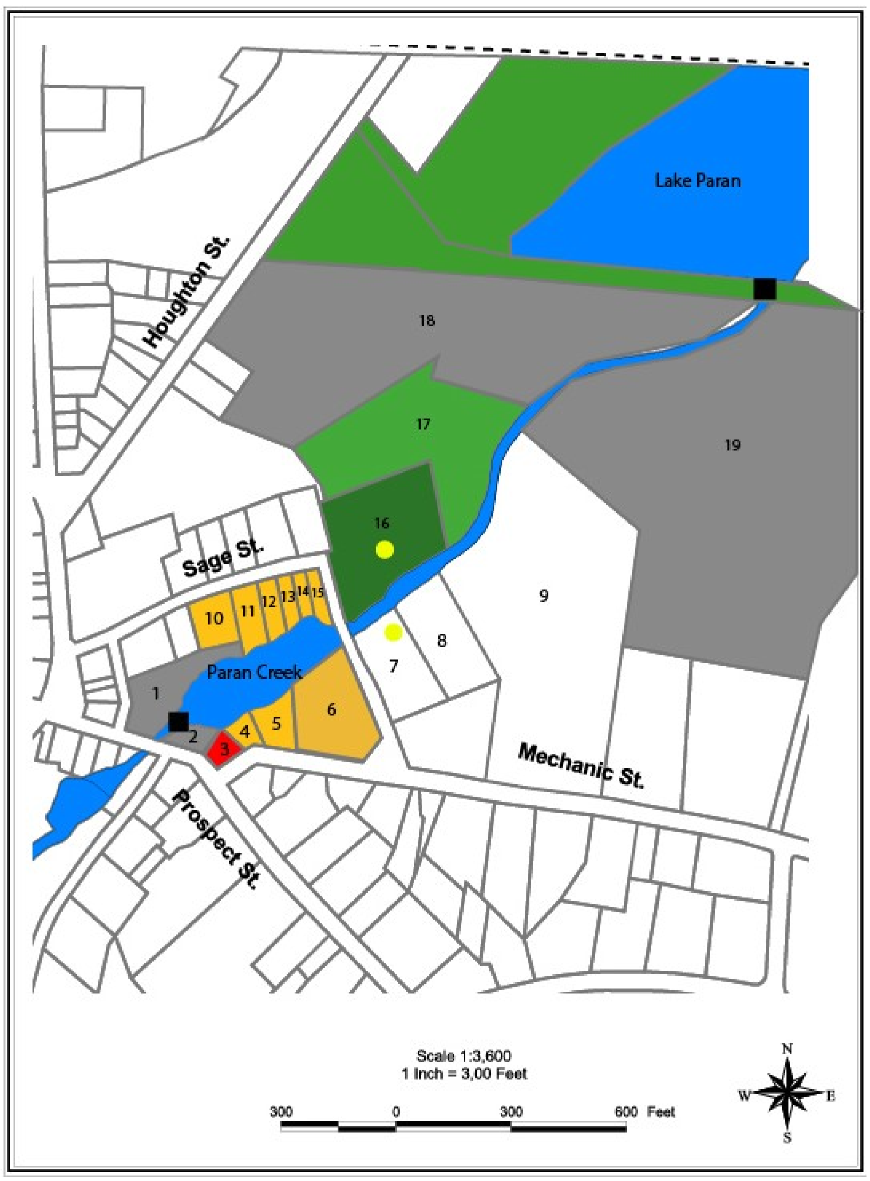


The Village of North Bennington



c. Site Ownership



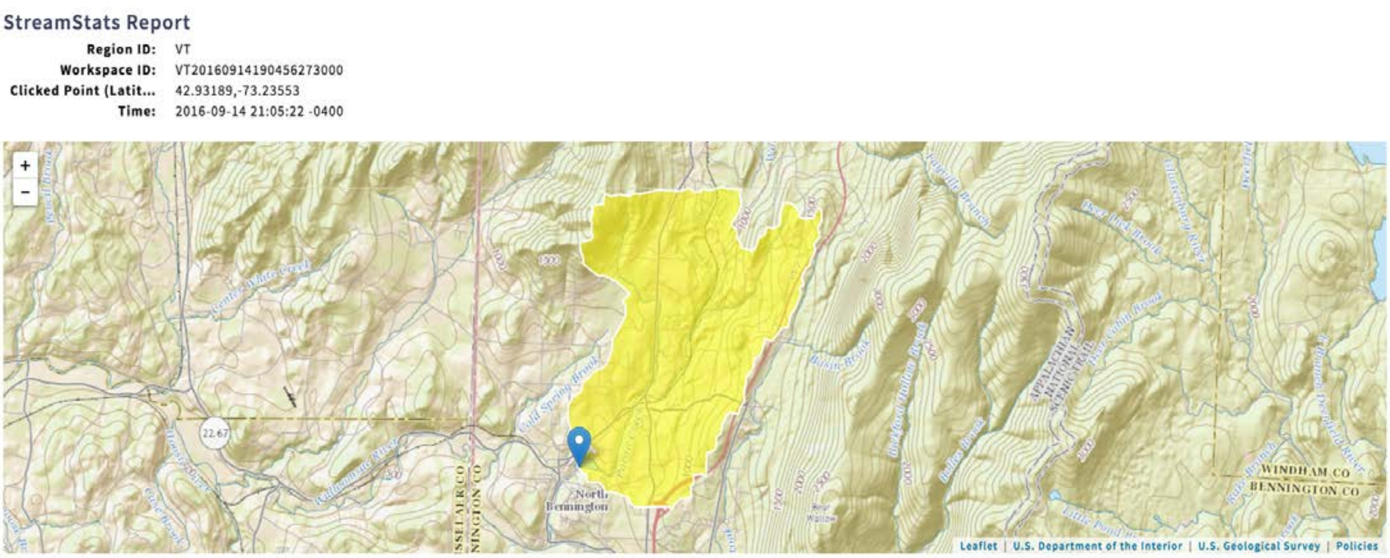


3. Watershed Characteristics

To assess the flow characteristics of each site, we used maps of the watershed, which show a convergence at the Unites Stated Geological Survey (USGS) Gauge 01334000 on the Walloomsac River[2], along with data for the area of the watershed of both sites as well as the remainder of the drainage area. The gauge is 1.7 miles downstream from the Firehouse site and 2.1 miles downstream from the Lake Paran Dam. We used the retrograde algorithm to calculate the percentage of the drainage area within the gauge watershed that corresponds to each of the sites. This allowed us to apply the appropriate percentage of the total gauge discharge by day for a period of 20 years (*see* Exhibit B). The gauge contains data records for the past 85 years. The model does not account for increasing flows due to global warming. The results are presented in the maps and tables below for each of the sites.

a. Watershed Maps and Flow Duration Curves

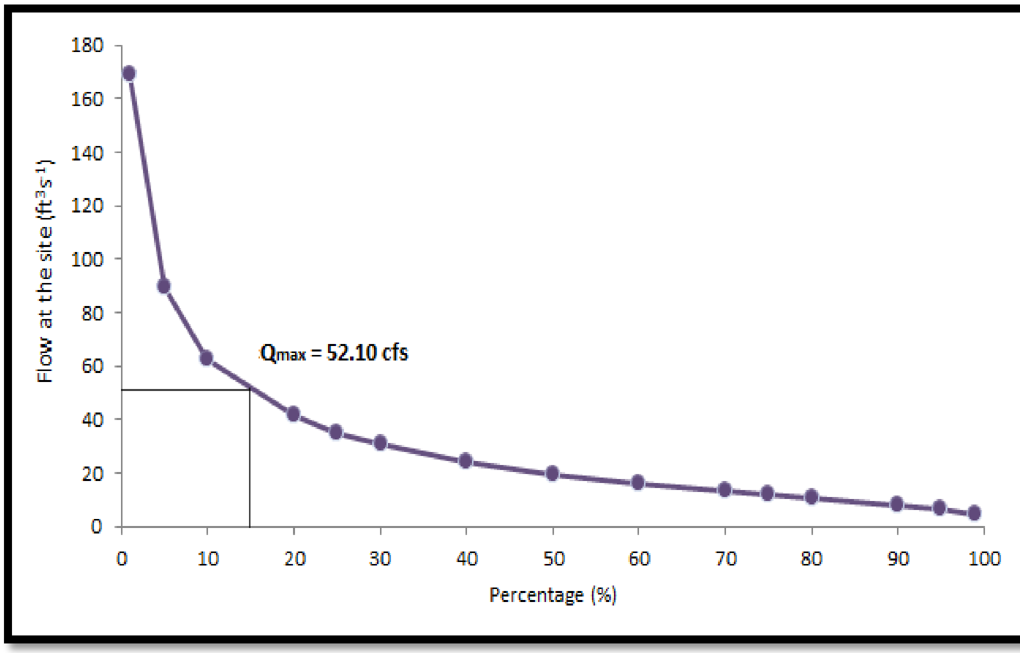
Watershed Map and Drainage Area (15.3 mi^2) for The Lake Paran Dam - Upper Site



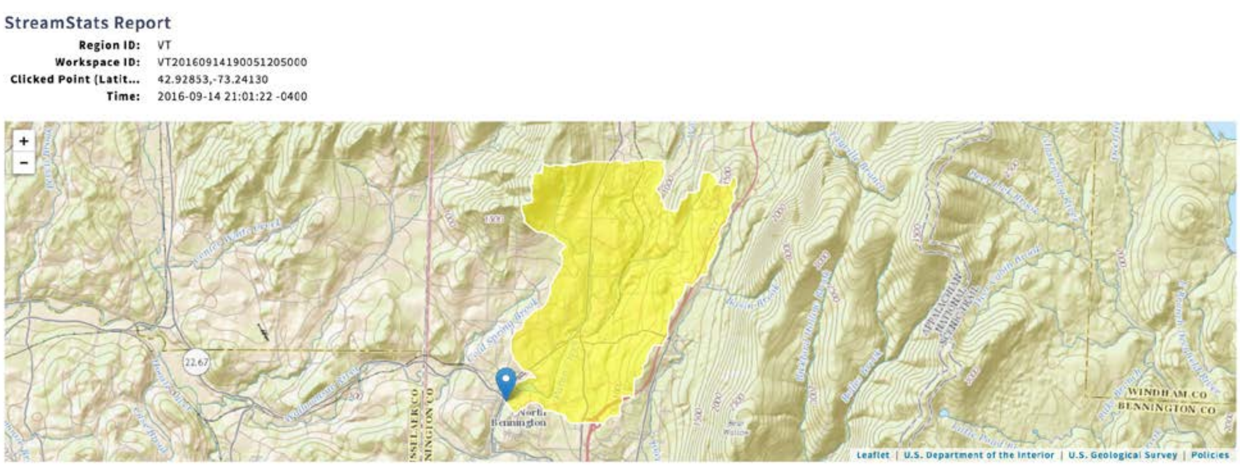
[2] http://nwis.waterdata.usgs.gov/vt/nwis/uv?cb_all_00060_00065=on&cb_00060=on&cb_00065=on&format=gif_stats&site_no=01334000&period=7&begin_date=2015-07-02&end_date=2016-07-01

Flow Duration Curve for The Lake Paran Dam - Upper Site

Percentage of year exceeded	Flow at Firehouse (cfs)
1	170,0382
5	89,9027
10	63,26486
20	41,62162
25	35,37838
30	30,93874
40	24,41802
50	19,7009
60	16,37117
70	13,5964
75	12,07027
80	10,68288
90	7,90811
95	6,52072
99	4,71712

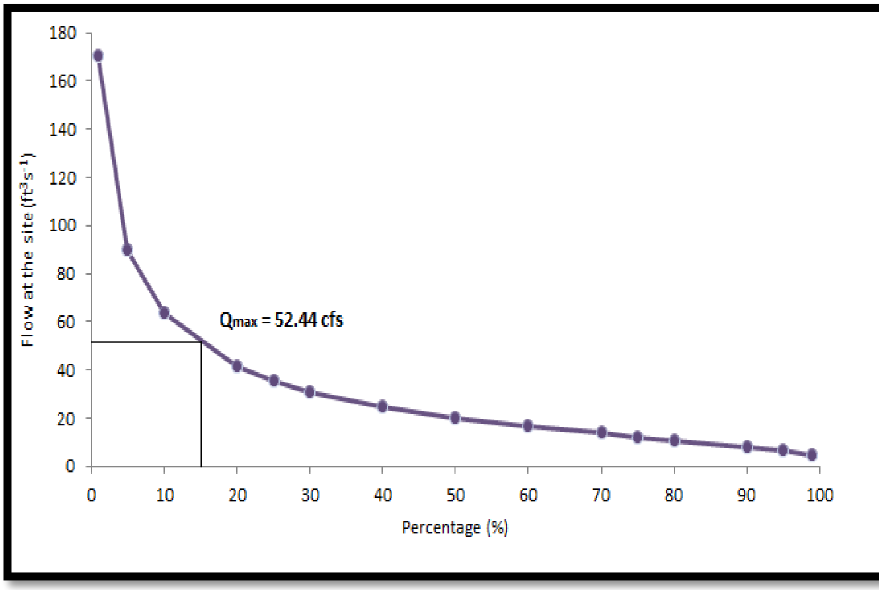


Watershed Map and Drainage Area (15.4 mi^2) for The Firehouse Dam - Lower Site



Flow Duration Curve for The Firehouse Dam - Lower Site

Percentage of year exceeded	Flow at Lake Paran (cfs)
1	168,93405
5	89,31892
10	62,85405
20	41,35135
25	35,14865
30	30,73784
40	24,25946
50	19,57297
60	16,26486
70	13,50811
75	11,99189
80	10,61351
90	7,85676
95	6,47838
99	4,68649



b. Watershed Habitat

In accordance with Vermont legislation and our own commitment to preserving the watershed's biodiversity and its overall health, we have identified the following wildlife and plant/flora species that inhabit the watershed. No endangered and/or threatened species are present in the local watershed. The project includes a paid position to carry out a watershed management plan to reflect the project's imperative responsibility to the environment.

<u>Aquatic Species:</u>

- Brown Trout
- Rainbow Trout
- Brook Trout
- Yellow Perch
- Northern Pike
- Largemouth Bass
- Panfish

None of the above fish species are listed as endangered/threatened by Vermont's Endangered Species Law or the Federal Endangered Species Act. [3]

- [3] Endangered and Threatened Animals of Vermont
http://www.vtfishandwildlife.com/common/pages/DisplayFile.aspx?itemId=268519

Trees:

- Red Maple
- Tamarack
- Herbs Species:
- Lakeshore Sedge
- Tufted Loosestrife
- White Snakeroot
- Sensitive Fern
- Umbellate Aster
- Broad-leaved Cattail
- Common Dodder
- Common Water-horehound
- Common Bluejoint Grass
- Turtlehead
- Marsh Fen
- Common Tussock Sedge
- White Boneset
- Purple loosestrife

Shrubs:

- Red osier Dogwood
- Speckled Alder
- Silky Dogwood
- Nannyberry
- Arrowwood
- Highbush Blueberry
- Maleberry

Herbs:

- Lakeshore Sedge
- Epilobium sp.
- Tufted Loosestrife
- White Snakeroot
- Sensitive Fern
- Umbellate Aster
- Rumex sp
- Solidago sp
- Broad-leaved Cattail
- Common Dodder
- Phragmites
- Common Water-horehound
- Common Bluejoint Grass
- Turtlehead
- Marsh Fern
- Common Tussock Sedge
- White Boneset
- Purple Loosestrife

- Paran Uplands Management Plan
http://northbennington.org/_assets/conservation_documents/Management_plans/Paran_management_plan.pdf

Pollutant/Invasive Species:

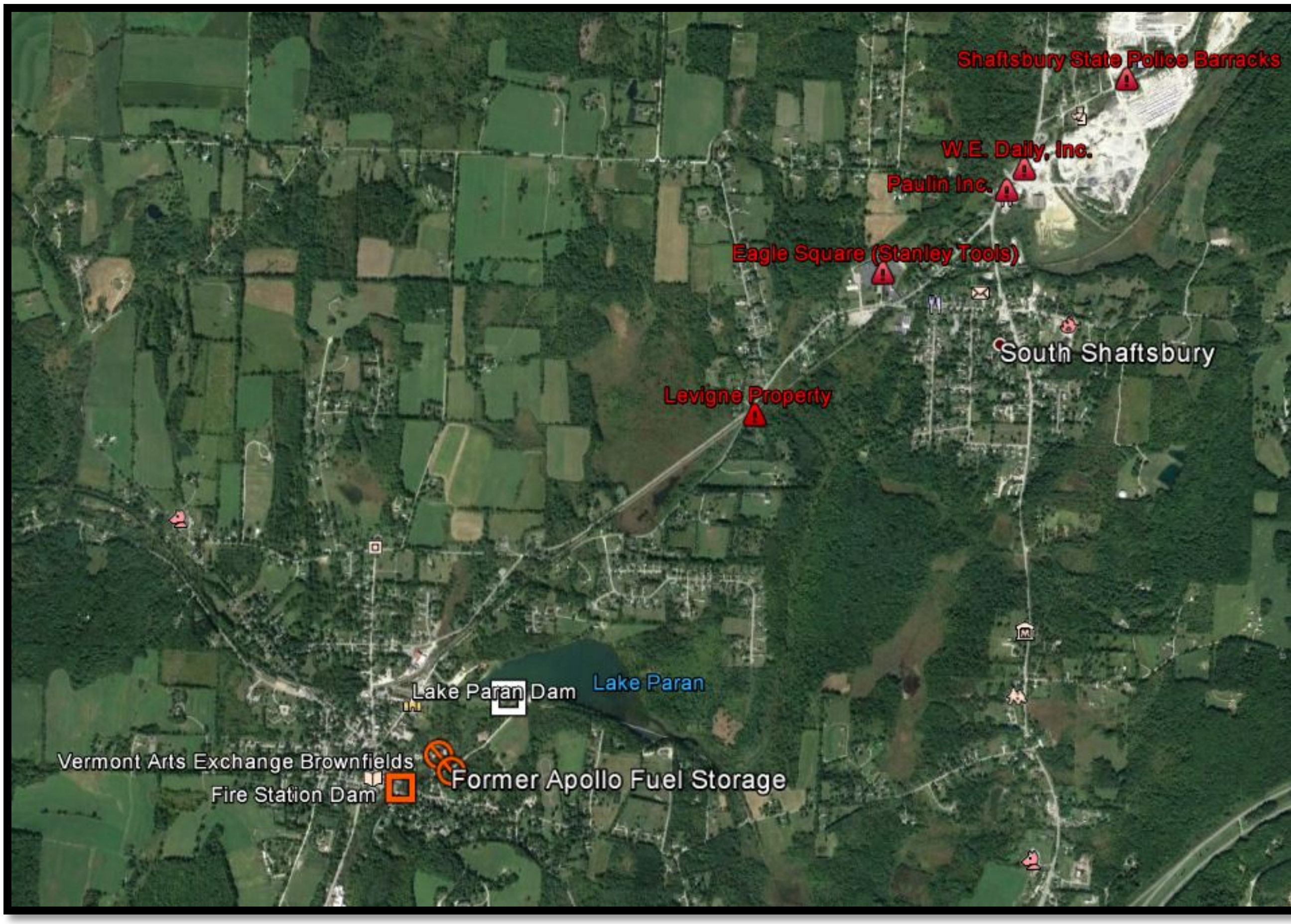
- Eurasian Milfoil
- Water Chestnut (No longer present since 2013)

- Vermont Agency of Natural Resources Watershed Management Division
http://dec.vermont.gov/sites/dec/files/wsm/mapp/docs/pl_basin1_BWH_Tactical%20Plan_FINAL_2015.pdf

c. Watershed Contamination

Should development on the Lake Paran Dam or the Firehouse Dam move forward, the following contamination sites listed by the Vermont Agency of Natural Resources will be used as a reference for potential site contamination testing.

Watershed Contamination Map



Lake Paran Dam Contamination Sites:

- Shaftsbury State Police Barracks
  - Contaminant: UST-gasoline
- Paulin Inc
  - Contaminant: UST-gasoline
- W.E. Dailey Inc
  - Contaminant: UST- diesel, UST-gasoline
- Eagle Square - Stanley Tools
  - Contaminant: Non-petroleum, other metals
- Levigne Property
  - Spill: unknown sheen in waterway

Firehouse Dam Contamination Sites:

- Vermont Arts Exchange
  - Contaminant: Not Available
- Apollo Fuel Former Bulk Plant
  - Contaminant: Heating oil

4. Existing Infrastructure and Proposed Design

Lake Paran Dam - Upper Site

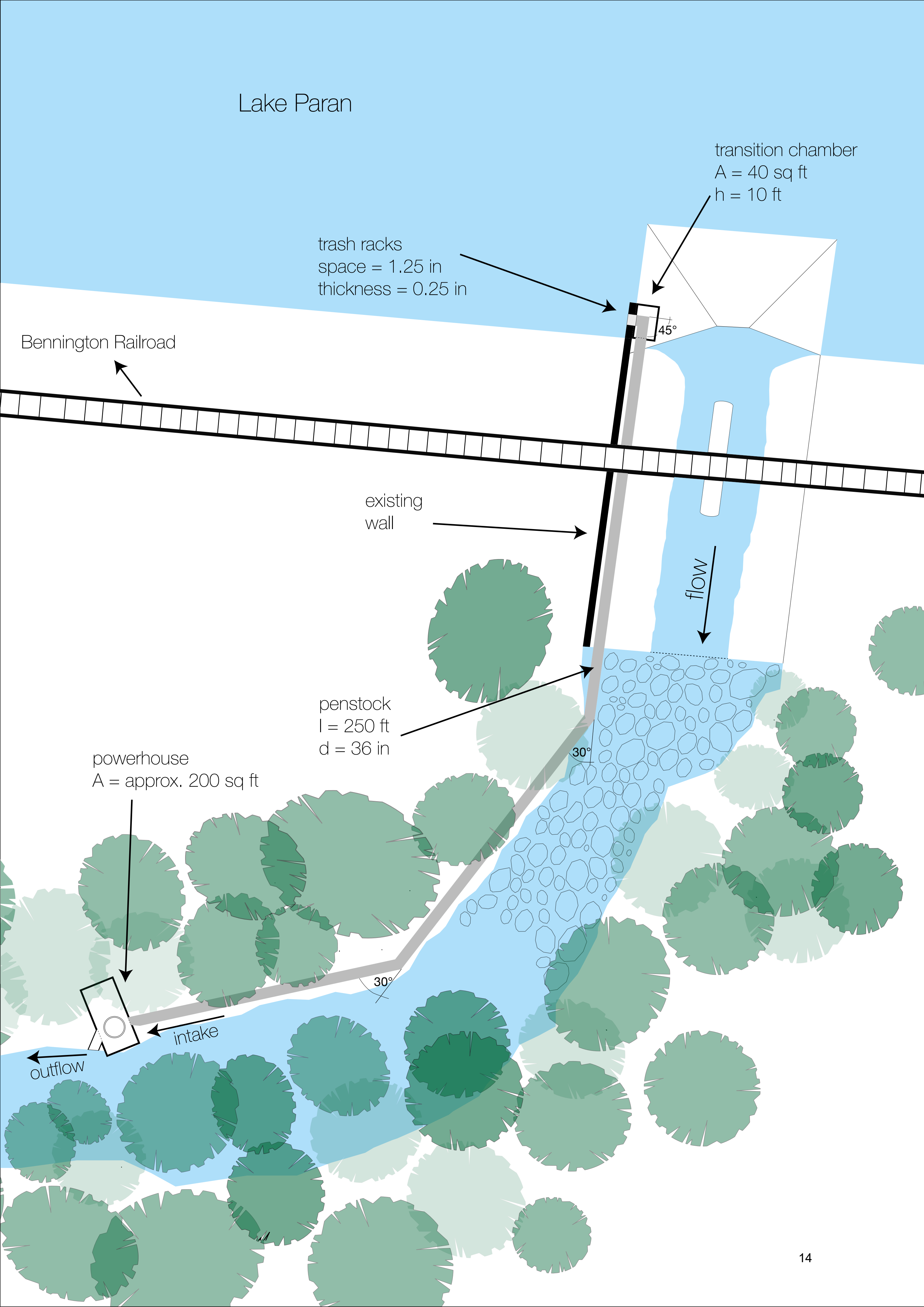
Existing Conditions:

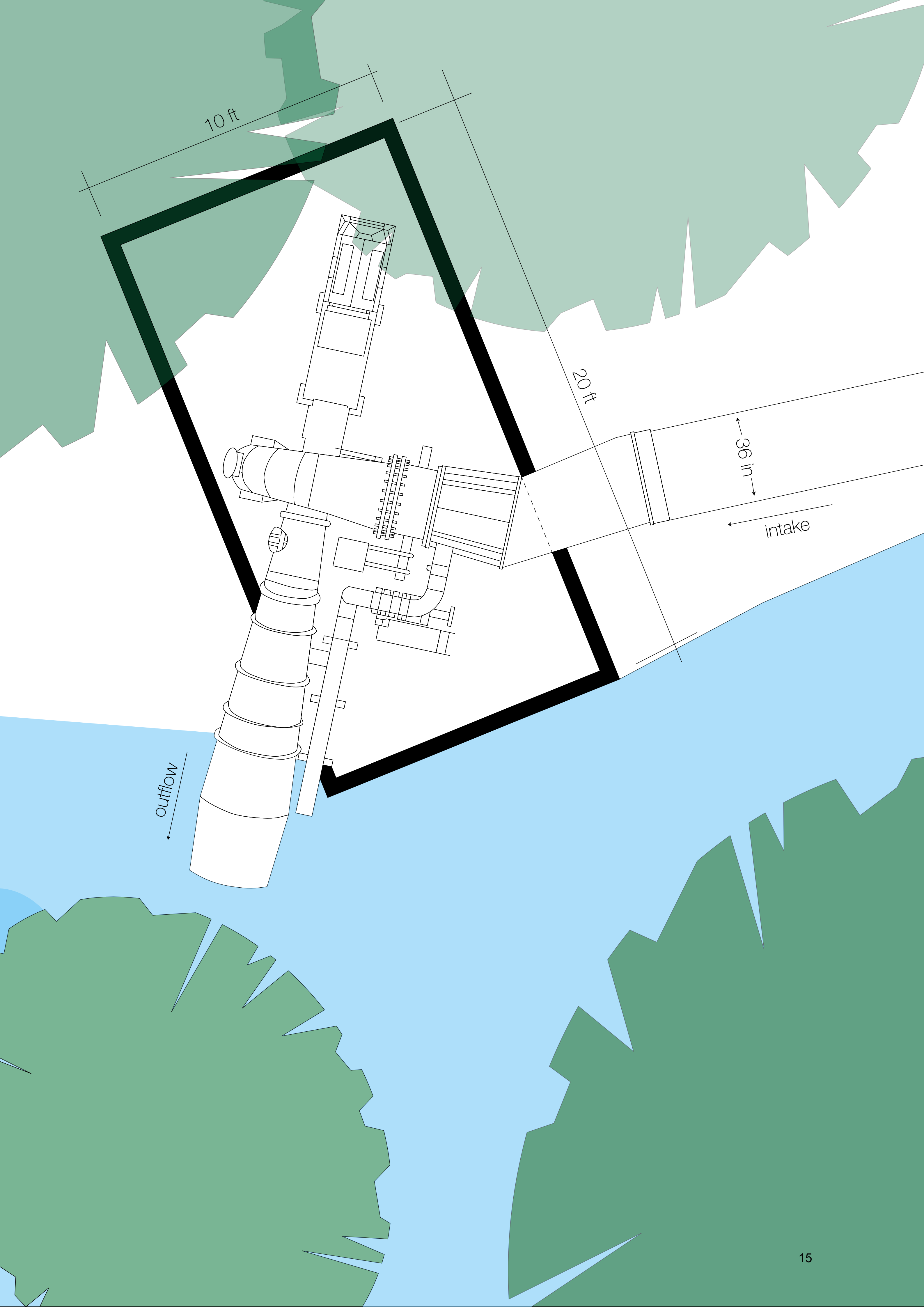
The Lake Paran Dam, built in 1978, is a (U-shaped) concrete gravity ogee spillway approximately 120 feet in overall length with vertical steel sheets reinforcing its strength. The smooth crest of the dam allows for the vertical height of 10 feet and contains a 4-foot-wide, 10-foot-tall wooden, low-level gate controlling the flow of the water further down the river. The current plant design would gain an additional 9' 3/4" of gross head; as it travels down along the downstream reach via a new 36" ID penstock. Lake Paran today serves primarily as a recreational area with fishing access points, parking lots, and train tracks running above the dam itself. The proposed design would not encumber any of the already existing uses of the Lake Paran site.

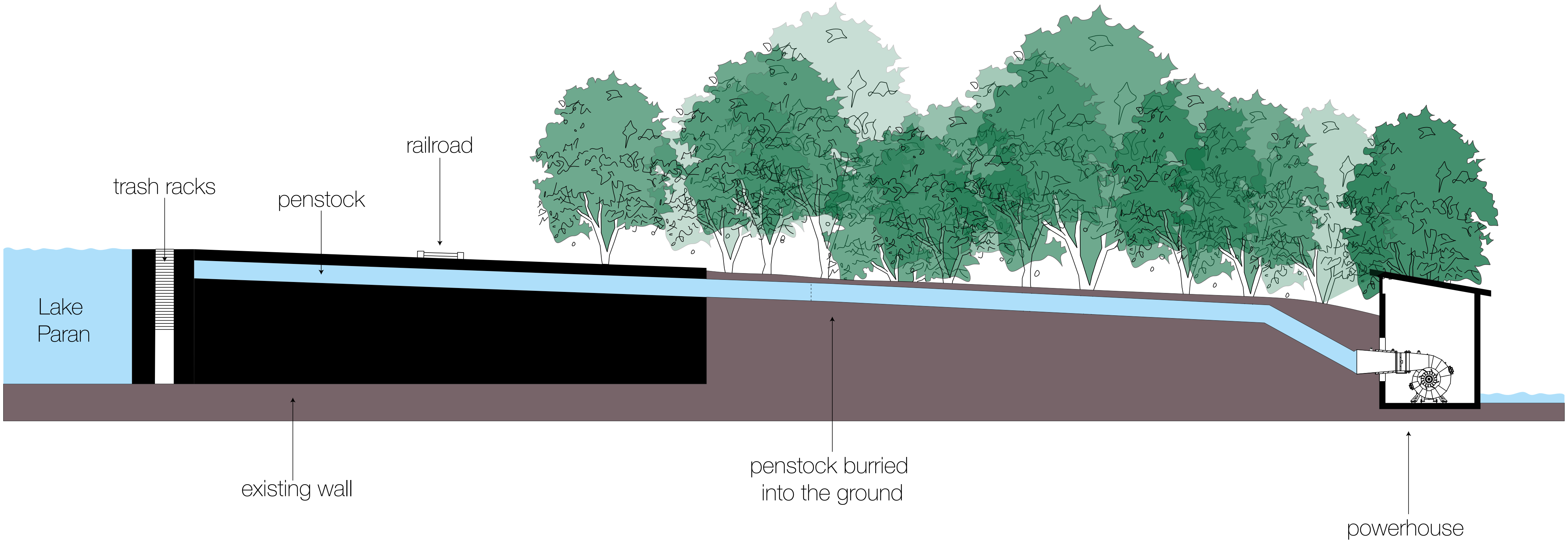
Aerial View of Lake Paran Dam

Proposed Design of the Lake Paran Dam - Upper Site:

The proposed design for the Lake Paran Dam utilizes the already existing structures and builds from them to acquire as much head as possible to generate sustainable power for the Village of North Bennington. The initial powerhouse designs (20’ x 10’), will house the generator, transformer, turbine and controls, and is located approximately 250 feet downstream from the dam. The 36’’, 250- foot long penstock begins in a 90-degree, 10-foot tall transition chamber at the sluice gate and runs to the powerhouse with two 30-degree bends. The transition chamber both provides for limited head-loss in the 90 degree turn and pressure relief for both surging and suction, as well as complete dewatering of the penstock. The required square footage of intake was determined by calculating the required spacing of trash racks (1.25 inches) and the steel thickness (0.25 inches). The area calculated must be no less than 30.5 square feet, required to achieve a flow speed of two feet per minute. The water exits the powerhouse at a 45° angle into the river through the draft tube, collecting 19’ 3/4’’ of gross head. The proposed design aims to be an asset to the community of North Bennington by generating sustainable hydropower, while remaining a neutral bystander to the current operations and utilization of the area around the dam.


Lake Paran
transition chamber
A = 40 sq ft
h = 10 ft
trash racks
space = 1.25 in
thickness = 0.25 in
45°
Bennington Railroad
existing
wall
flow
penstock
l = 250 ft
d = 36 in
30°
powerhouse
A = approx. 200 sq ft
30°
intake
outflow


10 ft
20 ft
36 in
intake
outflow


railroad
trash racks
penstock
Lake
Paran
existing wall
penstock burried
into the ground
powerhouse

The Village of North Bennington Firehouse Dam - Lower Site

Existing Conditions:

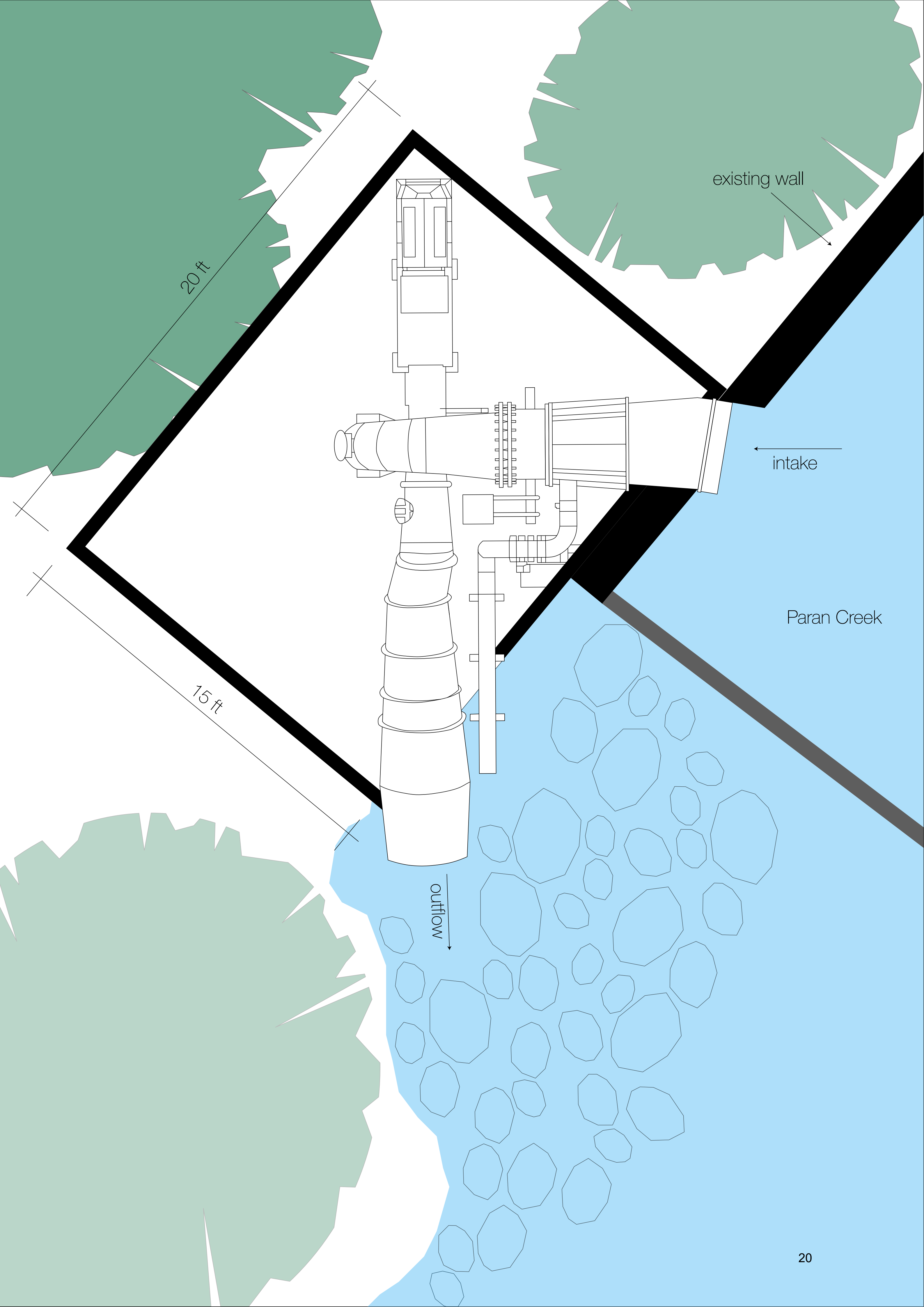
The Village of North Bennington Firehouse Dam is surrounded by the Village of North Bennington Fire Department, residential housing, several small businesses, as well as a small public park, providing attractive views and creating a space for the community to gather. The existing dam is a 40-foot-wide vertical concrete gravity structure, providing an initial 10 foot drop of water to pooling formed by rip-rap. The dam is equipped with pockets for flashboard pins, of which some failed pins remain in place. A 20-foot wall runs perpendicular to the dam on the west side. No other feature is extant.

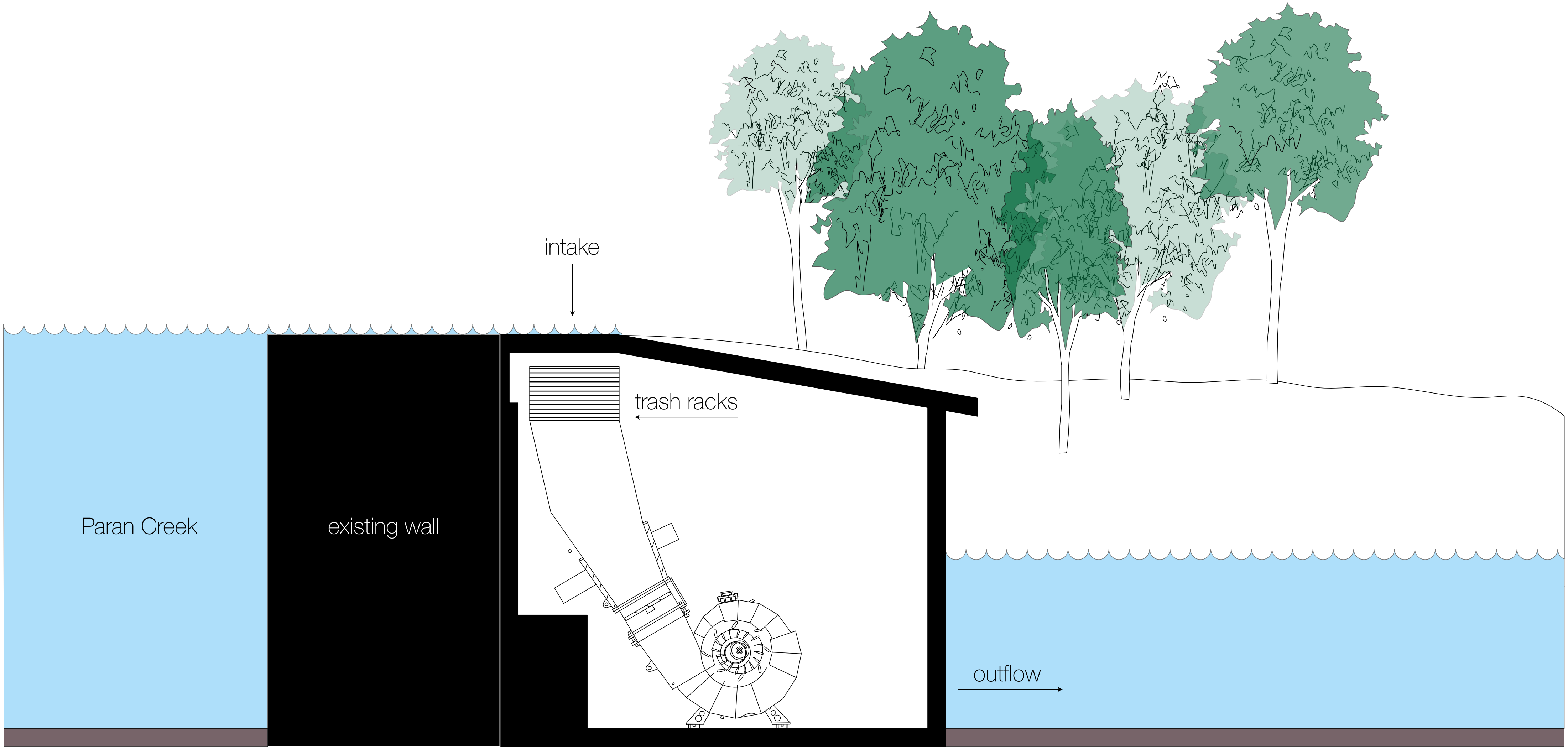
Aerial View of Firehouse Dam

Proposed Design of the Firehouse Dam - Lower Site:

The proposed design for the redevelopment of the Firehouse Dam aims to create a relationship between the generation of hydropower and its utilization, by serving as an educational feature to the community. By adopting the existing infrastructure and removal of the rip-rap at the bottom of the dam, the design gains an additional 2 feet. The powerhouse is located on the west side of the site between the existing 20 feet wall and the Firehouse. The existing wall is a critical design element in the development of the project, due to its role in letting the water enter and exit the powerhouse (20’ x 10’) at 45 degree angles relative to the direction of the river. The intention of this design is for the plant to become an unobtrusive yet active participant of the community by providing a space for interaction with its operations. The exterior of the dam structure will be mainly wooden incorporating glass into the design selectively to emphasize the transparency and aim of the project as an educational one, while simultaneously fostering a relationship with the existing natural and built environment. The location of the dam in relationship to the already built environment, and the strategic usage of various building materials, will allow the numerous visitors and community members to observe and engage in the generation of hydropower, as well as allow for a more panoramic observation of the beauty of North Bennington.


powerhouse
existing wall
Fire Department
Paran Creek
Prospect Street


20 ft
15 ft
existing wall
intake
Paran Creek
outflow


intake
trash racks
Paran Creek
existing wall
outflow


FIRE DEPT.

5. Hydropower Technical Analysis

a. Head and Flow

Hydropower is derived primarily from only two variables, head and flow. These two yield a quantifiable horsepower and by extension kilowatt potential. The modeling employed used multiple accepted methods for performing these calculations.

b. Design Flow

The flow duration curve describes the availability of various flow rates for the 85-year period of record for USGS Gauge 01334000. This data was used to determine the maximum flow for the turbine (Qmax). Typical practice is to select a design flow rate somewhere in the range of a 10 to 25 percent exceedance flow on the flow duration curve after accounting for conservation flows. Conservation, or bypass, flows are required minimum or aesthetic or habitat flows and would not be available to the turbine(s). A higher design flow will allow for a larger turbine and therefore a higher peak power generation capacity, but also limit lower end production and increase costs. Producing a variety of modelling variation helps to identify the best Qmax value.

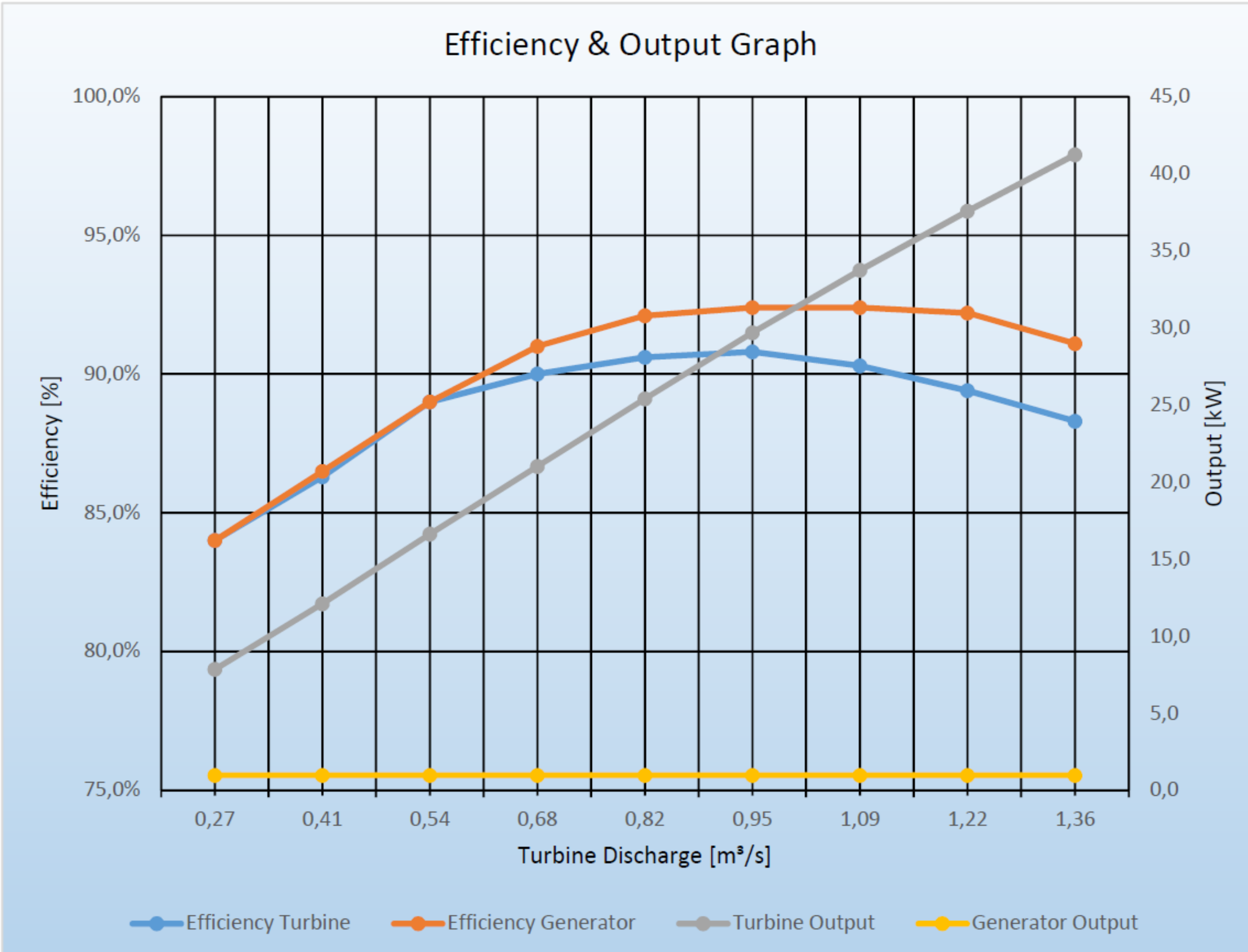
We examined the flow duration data for both the Upper and Lower sites, as shown in Section 3, Watershed Characteristics. Based on that data, we also identified on the flow duration curve which is shown on a scale of percent exceedance. For instance, the 40% exceedance at the Firehouse Dam is is 16.26 cubic feet per second (cfs). This flow in cfs is equal or exceeded 60% of the time. Though a variety of Qmax values are valid, industry standards and modelling proved that the design flow is optimal when the percentage of year exceeded is around 15%. The Qmax is the flow value used to define maximum flow parameters for the turbines.

Design Flow Options - Upper and Lower Site

	Flow Rate (cfs)	
Design Flow Option	Upper site Lake Paran	Lower Site Firehouse
Q_{max}	52.1027027	52.44324324
Intermediate	30.46216216	30.66126126
Low	8.325405405	8.37981982

The flow range varies by turbine, but Qmin defines the minimum operating flows (typically 10% of Qmax, but varies by turbine type) and Qmax the upper limit. The intermediate flow rates are those between Q10 and Q70 and are indicated for both sites in the table above. The intermediate flow rates are the ‘medium’ range of flow and we expect the hydropower system to operate efficiently across these flow rates. For higher flow rates above Qmax, the plant will be operating, but at lower efficiencies. As one moves to the right of the Flow duration curve, the plants would begin to shut down due to low flows.

Example Performance Range (Wasserkraft Full Vertical, Double Regulated Kaplan)



c. Design Head

At the beginning of the design process, the class visited both sites to get an idea of the existing conditions of the dams, as well as to begin thinking about the relationship between the site and possible designs. After several visits, the design team took detailed measurements of the dams using the direct distance measurement method. Using this method, the design team made a series of vertical measurements using a level, laser, and the vertical measuring pole for each of the two sites. Research about existing power plants around the world, development of series of drawings, and calculations of the gross heads allowed the team to start sketching potential design concepts for both dams. Based on our measurements, the gross heads for The Lake Paran Dam and The Village of North Bennington Firehouse Dam are 19 feet ¾ inches and 12 feet ½ inches respectively. This process allowed for the emergence and development of viable, innovative design solutions.

d. Equipment

To accurately model the projected costs and energy yields of the two sites, we required detailed technical parameters for the equipment involved. As a first step, basic and generic power modelling was used to determine achievable hydraulic power given the head and flow parameters detailed above. Next, using our flow duration data, physical parameters and estimations for the two dams, we developed a request for two separate budgetary quotes (*see* Appendix D) for a water-to-wire package (turbine, speed increaser, generator, switchgear, etc.) such as might be used at the two dams. This information was incorporated into a formal Request for Quote (RFQ) which called for, among other details, the guaranteed manufacturer efficiencies and power yields. The RFQ was sent to nineteen different manufacturers, including: Castinox, Ossberger, Natel Energy, Kossler, Leffel, Tschurtschenthaler, Watec Hydro, Rehart, Wasserkraft, Cargo and Kraft, Global Hydro, ZECO, Mavel, AC-TEC, Gugler, HSO Hydro Engineering, Gilkes, and JHP.

Nine manufacturers confirmed receipt of the RFQ. Two denied to quote as the project was too small scale. Companies that quoted the Project include: Wasserkraft, Ossberger and Natel, each of which quoted both dams. We did not receive the volume of quotes that we expected and are in the process of contacting Cargo and Kraft and others. Should the project proceed, more quotes should be sought.

In addition to quotes for a water-to-wire package, we received a budgetary quote from P.I.T. Piping for a penstock (pipe carrying water down from the dam to the turbines) for the Lake Paran Plant (*see* Appendix D).

Using the budgetary numbers we received, estimates for equipment lacking in some quotes and power production estimates for each company's equipment, we were able to calculate a cost per kilowatt-hour as a preliminary benchmark of value. Differences in costs to the civil works driven by equipment type were accounted for in the modelling.

e. Estimated Production

Process:

With the RFQ responses we received the turbine, speed increaser and the generator efficiencoies. Using that data and the site data, we built a power model that will predict the net energy output specific to equipment and site. We tested the model using data provided by Wasserkraft and Ossberger (Natel provided their own annual production estimation). We ran this model for both the Firehouse Plant and the Lake Paran Plant.

Other information that was incorporated into the model in determining the net power output included: the daily USGS gauge flow values over a twenty-year period, the site watershed area, the gauge watershed area, and the dimensions of the dams. In our calculations, we also accounted for power production loss due to civil works (station loss - friction due to the civil works, trash racks, penstock) and speed increaser loss as well as variable head and tailwater levels.

We set the upper and lower limits for the turbine based on the identified 85% exceedance Qmax for each site and the manufacturer lower end limits. Then we set up a series of logic problems to determine, based on the actual historical flow data at the site everyday over a twenty-year period, how much flow is available for power production when the turbine is operating.

The results below depict the average annual kilowatt hour output over the course of the last ten years for both the Lake Paran and the Firehouse Dam, using the generator and turbine efficiency quotes provided by Ossberger and Wasserkraft as well as the estimated production provided by Natel.

Table of results gathered from the power model

Results	**Lake Paran Dam**	**Firehouse Dam**
Ossberger	281, 838 kWh (58 kW)	171, 580 kWh (36 kW)
Wasserkraft	296, 078 kWh (62 kW)	165, 958 kWh (36 kW)
Natel	186, 000 kWh (76 kW)	116, 000 kWh (38 kW)

6. Statement of Cost and Financing

The scope of the hydroelectric feasibility included assessing the development of one of either or both dams. Within this set of guidelines fall several subsets of costs and returns used to values the long-term viability of the Paran Creek Watershed Project. Among these are the equipment costs, construction costs, soft costs, production and market and management assumptions.

Equipment Costs[4]

	Firehouse	Lake Paran
Wasserkraft	$ 234,400.00	$ 305,570.00
Natel Energy	$ 198,030.00	$ 198,030.00
Ossberger	$ 209,000.00	$ 214,000.00

[4] Assumptions were made for equipment quotes which are not yet available or not included in the RFQ responses.

Construction Cost Estimates

	Firehouse	Lake Paran
Wasserkraft	$ 227,900.00	$ 202,900.00
Natel Energy	$ 197,900.00	$ 202,900.00
Ossberger	$ 197,900.00	$ 202,900.00

Soft Cost Estimates – Lake Paran Plant

FERC Licence	$0.00
Legal	$7,500.00
Electrical Engineer	$4,500.00
Bookkeeping and Accounting	$0.00
Station Power	$50,000.00
Interconnection	$66,850.00
Architecture and Engineering	$25,000.00
Hydrology	$2,500.00
Surveyors	$2,500.00
Insurance	$5,000.00
Miscellaneous (public notices, travel)	$1,000.00

Soft Cost Estimates – Firehouse Plant

FERC Licence	$0.00
Legal	$7,500.00
Electrical Engineer	$4,500.00
Bookkeeping and Accounting	$0.00
Station Power	$5,000.00
Interconnection	$33,100.00
Architecture and Engineering	$15,000.00
Hydrology	$2,500.00
Surveyors	$2,500.00
Insurance	$5,000.00
Miscellaneous (public notices, travel)	$1,000.00

Soft Cost Estimates – Both Plant

FERC License	$0.00
Legal	$15,000.00
Electrical Engineer	$6,000.00
Bookkeeping and Accounting	$0.00
Station Power	$55,000.00
Interconnection	$99,950.00
Architecture and Engineering	$40,000.00
Hydrology	$5,000.00
Surveyors	$5,000.00
Construction Insurance	$10,000.00
Miscellaneous (public notices, travel)	$1,000.00

Market Assumption

Production value	$ 0.168
Rate of inflation (income)	2.75%
RECS	$ 0.03

Operating Expenses Annually

Rate of inflation (expenses)	2.50%
Continuing professional fees	$2,000.00
Annual maintenance reserve	$10,000.00
Communications	$2,880.00
Electrical expenses	$960.00
Salaries Plant Manager	$40,000.00
Insurance (additional)	$1,500.00
Development bond at 2% (20yr)	Varies

The overall estimated development cost for the preferred design is $1,166,825 which includes a 10% project wide contingency.

Discussion:

Project Financing Options

We assumed that if the proposal is approved, the project will be entirely funded by the Village with a 20 to 30-year bond at 2%. The modelling for this Study used the more aggressive 20-year term. To assist the Village with the funding of the project, we identified two separate grants that supported similar projects in the past, but are not considered for this financial model:

- United States Department of Agriculture Grant (up to $300,000)
- Vermont Agency of Commerce Regional Development Grant (matching up to $25,000)

Anticipated Project Revenue

We prepared a detailed thirty-year cash flow for the project. The Table 1. below shows that we will need 14 years to break-even. After that the project will start generating returns. We expect returns in the year 2033. Our estimates are based on assumption of annual rate of inflation at 2.75%, and the 2018 Net Metering Rate (Vermont Rule 5.100) for hydropower at $0.168, forecasted by *Evaluation of Net Metering in Vermont Conducted Pursuant to Act 125 of 2012.* Of the three options explored, Group Net Metering provided the only financially viable model.

Operations and Maintenance

The operation and maintenance of the facilities is assumed to be conducted by a new employee, hired by the Village, who can maintain both plants. The position is part time hydro and part time watershed management. In our budget, we assumed $40,000 a year for this employee and a $5,000 maintenance reserve for each of the facilities. If planned in this manner, creation of a long-term maintenance plan for the Fire Department dam is also included, a plan that does not currently exist for either site.

30 Year Financial Projections

	Firehouse	Lake Paran	Both Sites
Wasserkraft	$ (1,468,008)	$ (470,539)	$ 67,806
Ossberger	$ (1,343,364)	$ (481,761)	$ 181,229
Natel Energy	$ (1,829,389)	$ (1,250,533)	$ (1,147,152)

The following cash flow statement is for the most favorable of the projections.

OSSBERGER 30-YEAR CASH FLOW - BOTH SITES DEVELOPED

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	Total
Income																																
Generation revenue	76,174	78,269	80,421	82,633	84,905	87,240	89,639	92,105	94,637	97,240	99,914	102,662	105,485	108,386	111,366	114,429	117,576	120,809	124,131	127,545	131,052	134,656	138,359	142,164	146,074	150,091	154,218	158,459	162,817	167,294	171,895	3,652,646
RECS	13,603	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	13,977	432,901
Total annual income	89,777	92,246	94,398	96,610	98,882	101,217	103,616	106,081	108,614	111,217	113,891	116,638	119,461	122,362	125,343	128,405	131,552	134,786	138,108	141,521	145,029	148,633	152,336	156,141	160,050	164,067	168,195	172,436	176,793	181,271	185,871	4,085,547
Expenses																																
Electrical	960	984	1,009	1,034	1,060	1,086	1,113	1,141	1,170	1,199	1,229	1,260	1,291	1,323	1,356	1,390	1,425	1,461	1,497	1,535	1,573	1,612	1,653	1,694	1,736	1,780	1,824	1,870	1,917	1,965	2,014	44,160
Communications	2,880	2,952	3,026	3,101	3,179	3,258	3,340	3,423	3,509	3,597	3,687	3,779	3,873	3,970	4,069	4,171	4,275	4,382	4,492	4,604	4,719	4,837	4,958	5,082	5,209	5,339	5,473	5,610	5,750	5,894	6,041	132,481
Professional services	2,000	2,050	2,101	2,154	2,208	2,263	2,319	2,377	2,437	2,498	2,560	2,624	2,690	2,757	2,826	2,897	2,969	3,043	3,119	3,197	3,277	3,359	3,443	3,529	3,617	3,708	3,801	3,896	3,993	4,093	4,195	92,001
Insurance	1,500	1,538	1,576	1,615	1,656	1,697	1,740	1,783	1,828	1,873	1,920	1,968	2,017	2,068	2,119	2,172	2,227	2,282	2,339	2,398	2,458	2,519	2,582	2,647	2,713	2,781	2,850	2,922	2,995	3,070	3,146	69,000
Payroll	40,000	41,000	42,025	43,076	44,153	45,256	46,388	47,547	48,736	49,955	51,203	52,483	53,796	55,140	56,519	57,932	59,380	60,865	62,386	63,946	65,545	67,183	68,863	70,584	72,349	74,158	76,012	77,912	79,860	81,856	83,903	1,840,011
Maintenacne reserve	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	310,000
Private Investment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bond (2%)	70,833	70,833	70,833	70,833	70,833	70,833	70,833	70,833	70,833	70,833	70,833	70,833	70,833	70,833	70,833	70,833	70,833	70,833	70,833	70,833	0	0	0	0	0	0	0	0	0	0	0	1,416,665
Total expenses	128,173	129,357	130,570	131,813	133,088	134,394	135,733	137,106	138,512	139,954	141,432	142,947	144,500	146,092	147,723	149,396	151,110	152,867	154,667	156,513	87,572	89,511	91,499	93,537	95,625	97,766	99,960	102,209	104,514	106,877	109,299	3,904,318
Net	38,396	37,111	36,172	35,204	34,206	33,177	32,117	31,025	29,898	28,738	27,542	26,309	25,039	23,730	22,381	20,990	19,557	18,081	16,560	14,992	57,457	59,121	60,837	62,604	64,425	66,302	68,235	70,227	72,279	74,394	76,573	181,229
Running statement		75,508	111,679	146,883	181,089	214,266	246,383	277,408	307,306	336,044	363,586	389,895	414,934	438,663	461,044	482,034	501,592	519,673	536,232	551,224	493,768	434,646	373,809	311,205	246,780	180,478	112,244	42,017	30,263	104,657	181,229	

7. Summary Statement and Recommendation

The Paran Creek Watershed project set out to determine whether existing municipal infrastructure could be redeveloped into one or two hydroelectric plants with a goal of self-funding not only their own creation, but a management plan which could facilitate the long-term stewardship of the watershed.

Both the Lake Paran Dam and the Firehouse Dam are owned within the community - the Lake Paran Dam is owned by the group Lake Paran Association and the Firehouse Dam is owned by The Village of North Bennington.

Of the many species of fish, animals, and plants living in the Paran Creek watershed, none are listed as endangered by Vermont's Endangered Species Law nor the Federal Endangered Species Act. We found two invasive plant species living in the Watershed: Eurasian Milfoil (present) and Water Chestnut (not present since 2013). Ethan Swift, the Watershed Coordinator for Vermont's Department of Environmental Conservation, visited our class and provided his insight and expertise on the creation of a watershed management plan. Based on this meeting, we devised a stripped-down foundation for a possible watershed management plan. (*see* Exhibit B)

We found five sites of contamination upstream of the Lake Paran Dam that the Village should be aware of should testing should be considered. The sites are: Shaftsbury State Police Barracks, Paulin Inc, W.E. Dailey Inc, Eagle Square (Stanley Tools) and the Levigne Property. The contaminants are predominantly petroleum based. We found an additional two sites of contamination near the Firehouse Dam that the Village should consider if testing should be considered. The sites are: The Apollo Fuel Former Bulk Plant and the Vermont Arts Exchange. We found evidence of in-ground heating oil contamination at The Apollo Fuel Former Bulk Plant.

On November 10, 2016 Liam McRae and Cleo Zars distributed flyers about the project to Powers Market, Hair and Now, and TDS Architects on Main St, North Bennington. In addition, they distributed flyers at residences on both sides of Sage St. At the same time, Eloise Hess and Sarah Shames distributed flyers to residents on West Street and Prospect Street as well as and Pangaea Restaurant. They spoke with three people who seemed interested in the project. One resident had concerns about the visibility of the turbine and the impact it would have on their view. Prior to this, class members met with both Terry Creach (neighboring property to the Firehouse Plant) and the Lake Paran Association. Both were generally supportive of the project.

We looked at each of the two sites existing structural characteristics to determine whether the extant facilities would support a hydropower facility. We then drew preliminary architectural plans for both sites, considering the gross head, flow, water intake and output, and surrounding characteristics at each site.

To model the projected costs and yields of the two sites, we needed detailed technical parameters for the equipment involved. We requested budgetary quotes from nineteen manufacturers, and received budgetary quotes from three. We then built a model to project the costs and yields of the two sites using the data provided by the three manufacturers who responded to determine the most cost and yield effective equipment for both sites.

The financial modelling of the project aimed to provide an indication of costs for development, legal aid, various specialists, insurance and a watershed management plan that included and funded a salary for a full-time employee.

The projected returns for the most cost effective pairings of equipment to sites are as follows:

Firehouse	**Ossberger**	**$**	**(1,343,364)**
Lake Paran	**Wasserkraft**	**$**	**(470,539)**
Both Sites	**Ossberger**	**$**	**181,229**

It is the recommendation of this class that the Village Board of Trustees vote to proceed with exploring the feasibility of both plants, focusing on the quotes offered by Ossberger, as a means of developing a funded Watershed Management Program.

The next step would be to secure development rights under The Federal Power Act by applying for a Federal Energy Regulatory Commission Preliminary Permit. This can be achieved at little to no cost and would protect the Village's interests for a period of 3-5 years so that a more in depth Feasibility Study could be performed. Mandatory consultation would be conducted and a License or Exemption from Licensing Application(s) would be prepared. The watershed management plan could be drafted in greater detail during this time. Should the Trustees elect to do this, we recommend a vote be called to grant authority to proceed. A motion and vote to proceed with the previously stated recommendation would serve to move the project forward. Alternatively, should the Village wish to make a statement with this motion, we have drafted some language for the Board's consideration (*see* Exhibit A).

Feasibility Study completed by Eloise Hess, Linh Hoang, Amina Hodzic, Henry Hughes, Nejla Katica, Liam McRae, William Scully, Susan Sgorbati, Sarah Shames, Ajsa Udovicic, Lazar Vujanic and Cleo Zars. November 2016

Thanks to Rob Woolmington, Ethan Swift, Janice Lerrigo, Jim Henderson and the Bennington County Regional Commission, Alisa Del Tufo and the Lake Paran Association and Eileen Scully for their contributions to this project.

EXHIBIT A

Alternative Language for Motion

"The Village of North Bennington Board of Trustees recognizes that climate change is real and largely caused by human actions. Further, that is incumbent upon all humans and communities to act and to do so with urgency. The Village is the steward of two dams which were used historically for hydroelectric generation, a renewable energy source. It is the duty of the Village as both Steward and Citizen to act responsibly and in defense of our way of and to life. It is for these reasons that the Village herewith states its intent to explore the redevelopment of the long dormant infrastructure, an infrastructure that caused to form the Village and this great State of Vermont."

EXHIBIT B

Draft Watershed Management Plan

Watershed Management Plan: Recommendations

The Walloomsac River watershed drains much of the south-central portions of Bennington County being bounded by the Batten Kill watershed on the north and the upper Hoosic River watershed on the south. The headwaters of the Walloomsac River are located in Vermont draining 139 square miles of the state before entering New York. The Walloomsac River is a significant tributary to the Hoosic River.

The Paran Creek Watershed Project is focused on the land and water area north and south of the two dams sited on Paran Creek: the Lake Paran Dam and the Firehouse Dam. To begin a Water Management Plan, we recommend that a description of the watershed that includes the geographical location, source, deposits, and total length of the water system be completed, placing North Bennington as the central location. We recommend that the state, counties and towns that rely on the natural resources of the watershed be identified.

The rest of the plan should outline the following information:

1. Inventory of the biological species and woodland species that currently inhabit the basin. Species index should include:
    a. Aquatic
    b. Insects/flies and their larva (Macroinvertebrates)
    c. Mammals
    d. Herbs
    e. Shrubs
    f. Trees
    g. Invasive species
2. Propose courses of action that identify, contain and mitigate the presence of invasive species before their unchecked infestation creates increasing harm of the watershed and its uses.
3. Investigate possible or active contamination sites impacting the watershed.
4. Establish biomonitors that actively assess the species continued health.
5. Monitor the water quality and chemical makeup
    a. Temperature
    b. Dissolved oxygen
    c. Levels of pollutants (chlorides, phosphorus, etc)
    d. Sediment movement
6. Comprehensive geomorphic assessment that evaluates the impact, modification and manipulation of the watershed. This is both the water's current state as well as the historical and projected characteristics.

a. Agriculture
b. Industry
c. Recreation
d. Roads
e. Weather

7. Canvas and identify the soil type and associated runoff. Also, the extent of debris and vegetation in the water.
8. While the Watershed Management Plan should be tailored to specific concerns of the two proposed dam redevelopment sites, the whole Walloomsac basin should be assessed and considered.
9. The inclusion of all stakeholders of the watershed should be invited to participate in the drafting and implementation of the management plan, considering the economic, social and cultural values surrounding the watershed.
10. To not only determine, contribute, expand, and make visible data sets that contribute to the public's knowledge regarding the watershed, but also fill existing gaps in order to promote a fuller understanding of the watershed.