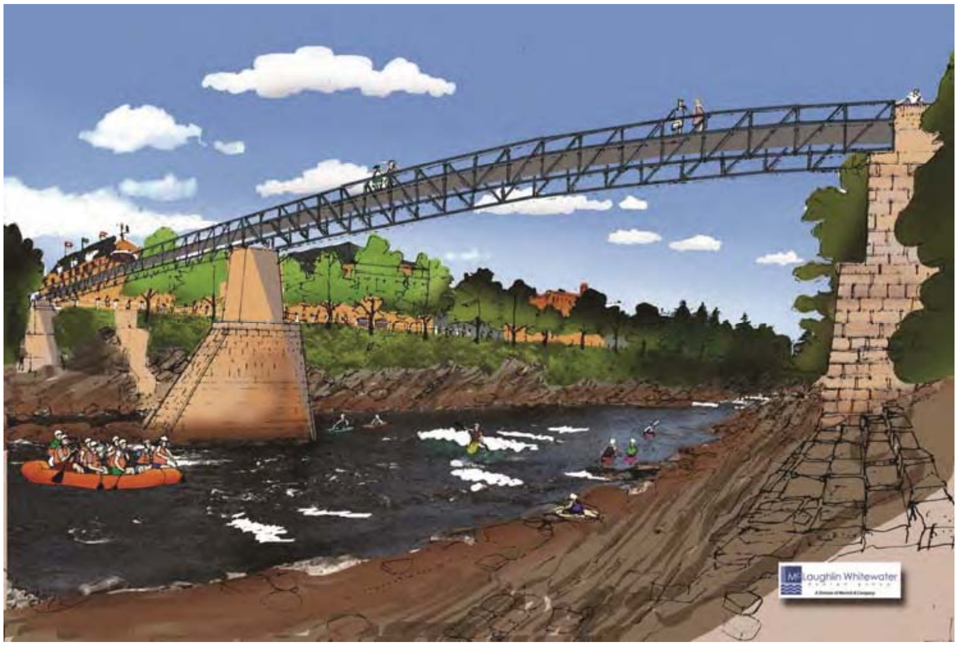
SKOWHEGAN RUN OF RIVER PROJECT
PRELIMINARY DESIGN REPORT
Town of Skowhegan, Maine

January 31, 2014



Prepared by:

McLaughlin Whitewater design group

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PART 1 EXECUTIVE SUMMARY

The Run of River project will create exciting whitewater features in the Skowhegan Gorge and realize a dream twenty years in the making. The objectives are to create whitewater waves that will attract boaters for a park and play destination, waves for surfers/bodyboarders, and a one-half mile run for private rafting and kayaking. It will also improve physical and visual access to the gorge by creating two foot trails down to the river as well as terraced seating along the shore. The project is also to remove the remaining debris from the washed-out bridge, and restore some of the structure and character that may have been lost to clearing during the early log driving days. Chiefly, the project is to promote economic development in downtown Skowhegan, increase visitation, and revitalize the commercial core which overlooks the river.

Our site analysis concluded that there is ample flow in the river during the summer to create several high quality whitewater features. The drop however is limited, approximately eight feet total over the length of the 3,000-foot long gorge. Our approach is a departure from the prior 2004 feasibility study which emphasized a large number of features (22) but with limited drop and quality at each. Each of the proposed features has 1.5 to 2 feet of drop and has a calm water area for resting and self-rescue in the event of a capsize.

We conducted a topographic survey of the river bottom, developed a hydraulic model, and evaluated four whitewater features in the gorge. The features start at the pedestrian bridge and extend downstream to the Great Eddy. Our modeling showed that three of the features could be built without impacting the hydro operations at Weston Dam.

The whitewater features at the pedestrian bridge and middle rapid are located on the right half of the river, leaving the left (looking downstream) half of the river unaltered and as a functioninEg fish passage. The type of feature selected for the project do not span the entire river, and have significant thought and design elements for fish movement through them. We are therefore hopeful of satisfying permitting agencies and complying with their requirements for fish passage and habitat creation. The feature at Great Eddy is located at the wastewater treatment plant discharge pipe and mitigates the potentially hazardous roller which occurs there at medium to high flows. This feature will work at medium to high flows while the two upper features will function in the full range of discharges from Weston Dam.

Costs for the whitewater features range from $1 million to $1.7 million depending on which on which option is selected, and $4.3 million for all three features. The features can be built in phases as funding allows.

Next steps include environmental permitting, a physical model of the upper two features, final engineering plans and construction.

PART 2 BACKGROUND

2.1. Introduction

The Run of River project will create exciting whitewater features in the Skowhegan Gorge and realize a dream twenty years in the making. The objectives are to create whitewater waves that will attract private boaters for a park and play destination, waves for surfers/bodyboarders, and a one-half mile run for private rafting and kayaking. It will also improve physical and visual access to the gorge by creating two foot trails down to the river as well as terraced seating along the shore. The project is also to remove the remaining debris from the washed-out bridge and restore some of the structure and character that may have been lost to clearing during the early log driving days. Chiefly, the project is to promote economic development in downtown Skowhegan, increase visitation, and revitalize the commercial core which overlooks the river.

2.2. Economic Development and Whitewater Courses

Whitewater courses generally have positive effects on the local economy. When constructed in populous areas, they add value to surrounding real estate, increase tourism, stimulate business development and add quality of life benefits to residents. Because of the demographic profile of users (generally college educated in their 20's though 40's and predominantly male) and the active nature of the sport, whitewater courses are seen by business as helping to attract and retain an educated work force. Cities that have constructed whitewater courses have found the juxtaposition of a whitewater river in an urban setting to be dynamic and have reaped economic impacts:

- South Bend, Indiana reports over $50 million in private real estate investment as a result of building the East Race whitewater slalom course in 1984.
- Reno, Nevada completed a $1.5 million course on the Truckee River in 2003 and reports $1.9 million annual visitor spending.

- Denver, Colorado has experienced a renaissance of its Lower Downtown region, thanks in part to a whitewater course and surrounding Greenway and parks development. Public funding of recreation is $70 million; private investment is over $4 billion.
- Columbus, Georgia opened an urban whitewater run last year and anticipates a $4 million to $7 million annual economic impact and a 60 percent increase in real estate value over 6 years, due to a dam removal and whitewater river restoration. Over 15,000 rafting customers floated the restored river in the first year.

As in all economic development projects, location, timing and a long view are keys to success. An adequately funded project with solid fundamental characteristics as described in this report has the potential to help shape the future of Skowhegan.

MWDG has reviewed several economic studies done for whitewater parks in small towns to medium size cities. The projected visitation and total economic impact is shown in the table below[1]. We divided the economic impact by the number of visitors for a per visit value, shown in the right column.

	Projected (Not Actual)		Estimated$/Vistor
	No. Visitors	Economic Impact	Economic Impact
Chattahoochee R., Columbus GA (low)	60,000	$ 4,200,000	$ 70
Chattahoochee R., Columbus GA (high)	100,000	$ 7,000,000	$ 70
Scandaga R. Hadley NY (low)	18,000	$ 630,000	$ 35
Scandaga R. Hadley NY (high)	25,000	$ 1,000,000	$ 40
National WW Center Charlotte, NC	500,000	$ 36,700,000	$ 73
		Average	$ 58

Figure 1 Visitation and impact per visitor from recent studies of whitewater parks

A conservative estimate of the payback period for an investment in a whitewater park can be obtained by using the lowest figure above of $35/visit and dividing by the overall cost in order to arrive at the break-even visitation rate. For each one million dollars invested the payback would be as follows:

Payback Years	
Per $1 million	No. Visitors
1	17,200
2	8,600
3	5,700
4	4,300
5	3,400

Figure 2 Break-even visitation using $35/visit

As an example, a $3 million project with an expected pay back of 5 years would need 10,200 visits per year.

[1] Chattahoochee River Restoration, Columbus, Georgia and Phenix City, Alabama, Daniels, Michael J and Lazzara, Frank, R, 2005 p. iii and
Economic Impact Analysis of a Proposed Whitewater Park on the Sacandaga River, Saratoga and Warren Counties, New York, Crane and Associates, Inc. 2008

2.3. Project Constraints

The Run of River project has three main constraints:

1. **No impact to Weston Dam operations.** Any increase in tailwater below Weston Dam due to the whitewater project would be unacceptable to the plant owners. This constraint reduced the number of possible whitewater features from four to three. The discussion of the tailwater is addressed in the section on hydrology/hydraulic design.
2. **Flood Conveyance Impact.** The Skowhegan Gorge is in a FEMA-mapped floodplain and floodway. The features at this level of design create a two-tenths rise is certain areas and a maximum rise of 0.7 feet in one localized are, which may be permissible as is appears that no structures are impacted by the rise. It is likely that a FEMA Letter of Map Revision (LOMR) will be required. However, MWDG recommends that the preliminary design and flood analysis be reviewed in detail and discussed with the local floodplain administrator to determine the adequacy of the impact.
3. **Permittable project.** The prior 2004 project was reviewed with agencies and found to be generally permittable. A similar review of this project in February 2013 did not reveal fatal flaws, though it was noted that since 2004, the Atlantic salmon was listed as a threatened species, a factor which increases the complexity and duration of permitting.

2.4. Scope of Project

The project initially envisioned one set of whitewater features at the walking bridge, due to funding limitations. This was expanded however, to include features at the two rapids downstream, encompassing the entire gorge, as the Town felt that there could be additional funds in the future. The current, more expansive project entails creation of:

- Whitewater features within the Skowhegan Gorge at all three rapids
- Access to the river and viewing near the walking bridge
- Access to river from Debe Park

The scope of work performed by McLaughlin Whitewater Design Group includes

1. Preliminary design drawings and report for the three project elements listed above to approximately 30 percent design level
2. Aerial and bathymetric survey of the river gorge
3. Computer modeling of the whitewater features for both the hydraulic design, and potential impacts to Brookfield Renewable's hydro operation and the regulatory flood plain
4. Structural stability analysis of proposed improvements
5. Cost analysis
6. Artist's rendering
7. Presentation to Town Council
8. Informal consultation with resource agencies

2.5. Prior Studies

A feasibility report prepared by Kleinschmidt Associates entitled *Skowhegan Gorge Run of River Project*, July, 2004, outlined a concept of water based and land-based recreation improvements and supported with background information and research. The plan included 22 separate whitewater wave generators and jetties to constrict and focus the flow. Using the consultant's costs, the project would be in the range of $8 million to $14 million. Included in the feasibility study is a report of a public meeting from December, 2004.

2.6. Data Received and Reviewed

A list of data provided by the town and others includes:

1. GIS mapping and aerial photographs of the town, including public utilities, roads and property lines.
2. Two-foot contour mapping from a 2004 aerial survey.
3. Design plan for the walkway at Debe Park
4. Design drawings for sewer siphon at the walking bridge
5. Design drawings for the walking bridge
6. Design drawings for the wastewater treatment plant sewer outfall pipe
7. FEMA Flood Insurance Study for the Town of Skowhegan, September, 1995 edition

Requested but not received, or not available data:

1. Tailwater curves or tables at Weston Dam. Absent this data we used our own water surface measurements in order to gage our impacts to the Brookfield Renewable plant operations.
2. Hydraulic flood model from FEMA. MWDG assisted the Town in filing for this information; however, FEMA reported that the electronic copy of the regulatory model was unavailable. A paper copy of the regulatory model input and output data was received by MWDG.

2.7. Data Collection/Creation

Original data collection consisted primarily of mapping and hydraulic water surface measurements:

1. Aerial survey of the upper half of the Skowhegan Gorge on the morning of August 7, 2012 at an altitude sufficient for one-foot contour intervals.
2. Cursory land based survey of water surfaces of upper two rapids, afternoon of August 7, 2012, flow approximately 2,500 cfs.
3. Comprehensive water surface profiles of the gorge at 4,000 cfs and 8,800 cfs.
4. Centerline profiles of proposed construction access road and foot trail from Debe Park to the river.
5. Bathymetric survey by boat, various dates. See Appendix 4 for data collection methods. Several areas could not be surveyed safely and are noted on the Preliminary Design Drawings.
6. From the above sources we complied a base map with one-foot contour intervals for use as a base for our drawings and surface terrain model for use our 2-D hydraulic model. The new aerial information was merged with the 2004 flight and Town GIS data. The datum used in all new work is North American Vertical Datum 1988 (NAVD 88).

PART 3 DESCRIPTION OF WHITEWATER FEATURES

3.1. Functional Flow

The project will function within the normal water releases from Weston Dam, approximately 2,500 cfs to 9,000 cfs[2]. This does not necessarily preclude their functioning at higher or lower flows, but these are not the main focus of the design. To calibrate the model we collected measurements at three flows at 50-foot stations along both river banks.

	Design Flows	Measured flows
Low:	2,400 to 3,500 cfs	2,700 cfs
Moderate:	3,500 to 6,000 cfs	4,000 cfs
High:	5,000 to 9,000 cfs	8,800 cfs

A fourth flow, 12,000 cfs was desired, but not possible, because there was no ice-free time period where it occurred during the contract period. Therefore it could be surveyed without undue risk to the survey personnel.

3.2. Features 1 and 2

The proposed features consist of side constrictions to create drop and high-velocity water needed for whitewater waves. The waves themselves are created by low, mounded obstacles within the fast water flow field. This type of feature works at a narrower range of discharge than traditional whitewater drops which span the entire river, like low weirs. We call it the “Catcher’s Mitt”. Because of the narrower range of flows, each feature will consist of a group of two to three obstacles at different elevations, each tuned to a different flow range. At low flow, the lowest elevation feature is “in”. As the river rises, the lowest feature washes out and the next feature comes in, and so on. The features are arranged in plan in a stepped fashion in order to focus the flow to the middle of the river and the lowest feature, or the feature that is in at a particular flow.

[2] The hydraulic capacity of the plant has been requested but not provided by Brookfield Renewable (formerly FPL).

Figure 3, Mid-stream feature and side constrictions in a recent physical model test.

3.3. Fish Passage

The catcher's mitt was selected because it does not require a structure the spans the entire river, which would be both expensive and could impact fish passage. The partial width approach with side constrictions and individual obstacles mid-stream, is consistent with the 2004 feasibility study, and less likely to impede fish passage. Specific features in this design to promote fish passage include:

- The west half of the river has no obstacles allowing it to function more or less as it does under existing conditions.
- The mid-stream features will add cover, resting areas, and hydraulic diversity: i.e. locally faster and slower flows, eddies and bottom roughness. Significant gaps between the features and their staggered arrangement are intended to allow fish to move upstream between the obstacles in a stair-step fashion.
- The divider islands create additional shoreline habitat and provide passage for fish which do not jump, such as American shad, but instead migrate along the margins of rivers, using eddies and interstitial spaces between shoreline rocks to attain strong rapids,. The divider islands have large boulders pinned to the sides and bottom of the slopes to promote interstitial flow and lower water velocities.
- Agencies suggested in our informal consultations that the project may be justifiable in that it adds structure and variety to the river which was lost when Maine rivers were cleared of snags to promote log drives.

Figure 4, Catcher's mitt example in Alberta, Canada. Note that the aerated water or "hole" is only in the center of the river and well downstream of where shore-running fish must make their move to attain the drop. Note also that the side constrictions are staggered.

3.3.1. Alternatives

The original plan had four sets of whitewater waves; one at the pedestrian bridge, two at the rapid downstream of the pedestrian bridge, and one at the water pollution control outfall at Great Eddy. In early model runs, however, the four features backwatered the Weston Dam significantly. The rise occurred from the upstream-most feature at the pedestrian bridge. A detailed discussion can be found in the section of Hydrology/Hydraulic Design. When the number of features was reduced to three, there was no backwater effect. This was true for two features at the middle rapid, or one each at the pedestrian bridge and the middle rapid. Therefore our viable alternatives were limited to:

1. One feature each at the walking bridge, the middle rapid, and Great Eddy or,
2. Two features at the middle rapid with one at Great Eddy.

In consultation with the client, we decided on the first alternative, since it would create a longer whitewater experience, provide more room between features, and most importantly, greater visibility from the walking bridge and the central business district. The one advantage of the second alternative, however, is the economy of a smaller footprint and related construction dewatering costs.

3.3.2. Physical Parameters for Initial Model Runs

The features are sensitive to tailwater, or the elevation of the pool downstream of the feature. Establishing the correct height of each obstacle is critical to its performance, and therefore the first task in the model runs is to verify the crest elevations. Physical model tests in 2013 indicate that a crest that is 0.5 foot to one foot lower than the downstream pool is optimal. The model also shows that Catcher's Mitt works well with 1.5 to 2.5 feet of drop with a unit flow of approximately 60 cfs per linear foot of obstacle. Based on the observed model we believe that the unit flow range should be 50 to 100 cfs per foot. The flow capture rate as a percentage of total river discharge will diminish as the stage rises, since it would be impractical to build structures large enough to capture all the flow. The design calls for a bifurcated channel in which the features are located on river right (looking downstream) with a low divider island to help shape the flow. This approach was taken because of the wide river channel and economic impracticality of building features across its entire width.

3.4. Lower Rapid Feature 3

Whitewater feature 3 takes different approach than the mid-stream features originally presented in the conceptual design. In considering features at this location, we noted that the sewer pipeline caused a potentially hazardous retentive hydraulic at medium to high flow while at very high flow (18,000 cfs) it formed a useable surfing wave[3]. We felt that it would not be responsible to introduce recreation to an area of the river with a potential hazard. Therefore we focused on reducing the hazard of the pipeline hydraulic and creating an economical surfing feature in the process.

Figure 5 Retentive pour-over at moderate flows

The approach to mitigate the hazard is to place a series of concrete steps just downstream of the pipe casing which will allow a more useable hydraulic to form. To increase the flow and velocity of water flowing over the steps, two side constrictions are located on each shoulder of the feature. This solution has two distinct advantages over the original concept of features mid-stream:

1. The project is more economical since it is located in shallow water close to shore. The cost of access and dewatering is significantly less than a mid-river project.
2. The steps can be adjusted with removable precast concrete blocks to fine tune the hydraulics.

The chief disadvantage is that it will not function at very low flow, less than 4,000 cfs. This solution however, would not preclude building an additional mid-stream low-flow feature at a later date.

[3] Josh Farrand, Personal communication, 2012

Figure 6 Adjustable precast whitewater features recently installed at an MWDG project in North Carolina.

PART 4 HYDROLOGY/HYDRAULIC DESIGN AND MODELING

4.1. Hydrology

The hydrology of the main stem of the Kennebec is influenced by seasonal storage and releases at Wyman Lake and Moosehead Lake, located upstream of the site. The Kennebec River is has several USGS gages that indicate flow at the Skowhegan Gorge:

Site Name	Gage No.	Drainage (Sq. Miles)	Location Relative to Site	Period of Record
Bingham	USGS 01046500	2,715	On main stem of the Kennebec, approximately 42 miles upstream of site	1907 to 2013
Madison	USGS 01047150	3,243	On main stem of the Kennebec, approximately 14 miles upstream of site	2009 to 2013
Sandy River	USGS 01048000	516	On Sandy River approximately 9 miles from the confluence with the Kennebec and 21 total river miles upstream of site	1928 to 2013
Carrabassett River	USGS 01047000	353	On the Carrabassett River approximately 4 miles upstream from confluence with the Kennebec and 25 total river miles upstream of site	1902 to 2013
North Sydney	USGS 01049265	5,403	On main stem of the Kennebec, approximately 27 river miles downstream of site	1978-2012 with no data 1994 to 2000

Figure 7 USGS Gages in the vicinity of the site.

The Bingham gauge has the longest period of record and receives regulated flow from upstream reservoirs. The closest site, Madison has only five years of record and therefore has limited value for hydrologic calculations. The North Sydney gauge, further downstream has a long period of record but has a significant gap from 1994 to 2000. The North Sydney gage receives a greater percentage of its early season flows from unregulated drainage areas and its hydrograph shows proportionally higher flows in the spring than Bingham. Therefore our statistical analysis uses the Bingham flow records combined with contributing flows from the two major (unregulated) tributaries, the Sandy and Carrabasette rivers which enter upstream of the project area. The combined flow records were combined and proportioned to account for the added drainage area of the site.

The combined drainage area of the Bingham, Carrabassett and Sandy gages is 3,584 square miles. The drainage area at Weston Dam, immediately adjacent to the site is 3,894 square miles[4], eight percent more. The gaged flow from Bingham, the Carrabassette, and the Sandy was increased by this amount to arrive at the proportioned flows shown in the figure below.

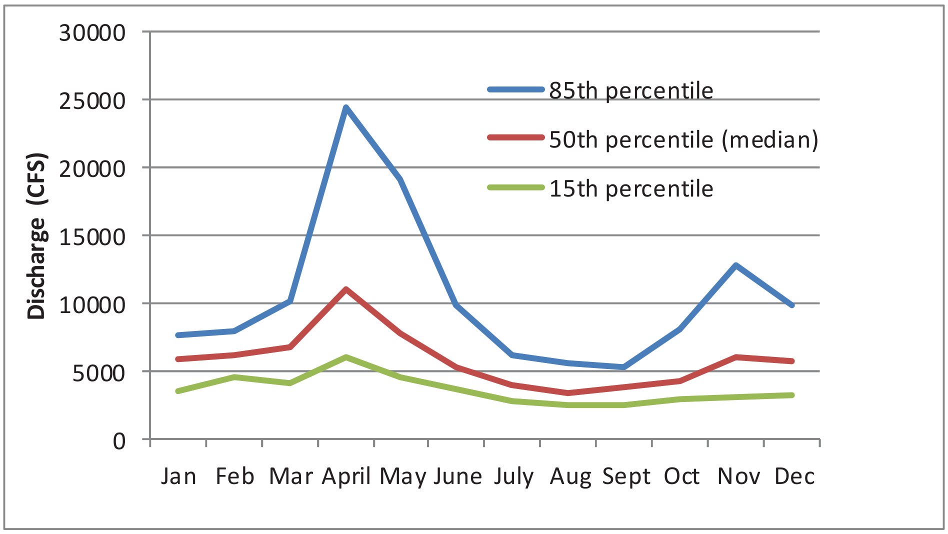


Figure 8 Hydrograph of proportioned flow of the Kennebec River at Skowhegan

Typically whitewater features can work with only a few hundred cubic feet per second (cfs) flow, so it is evident by inspection the site will support the project year round. For a whitewater river of this size it is our experience that 1000 to 10,000 cfs provides features of sufficient quality to attract boaters from out of town.

4.2. Hydraulics and Hydraulic Modeling

4.2.1. Weston Dam

Water is controlled locally by the Weston Dam, FERC project number 2325 which operates on a run of river basis. Hydraulic data for Weston such as total outflow flow capacity, log flume flows, number of units and tailwater curve were requested but not received at the time of writing. Nonetheless it is assumed and agreed among all parties that the whitewater project will not impact the tailwater of the Weston Dam. Without a tailwater curve however, the surveyed water surfaces will be used to judge impacts.

[4] Jerry Doughty, Brookfield Renewable Energy Partners (Formerly FPL), personal communication

4.2.2. Recreational Hydraulic Analysis

Hydrology for the Kennebec River was used as the basis of hydraulic analysis for recreational whitewater features. River flows during recreational months, specifically May to October, were of significance to the analysis, as whitewater features are designed to function best during these flow conditions. Three flow conditions were surveyed during the summer/fall 2013: 2,700 cfs, 4,000 cfs, and 8,800 cfs. These flows were consistent with expected flows during this period based on stream gage analysis performed (see section on Hydrology). Recreational hydraulic analysis was performed for the three surveyed river flows.

MWDG utilized one-dimensional and two-dimensional analytical hydraulic models to develop the preliminary design and evaluate performance. A HEC-RAS one-dimensional model was created to verify channel roughness and calibrate the TUFLOW two-dimensional model. Existing Conditions models were created from topographic and bathymetric survey data collected. Channel roughness and channel geometry (in areas were bathymetric data was not able to be collected) were calibrated until the surveyed water surface elevations were reflected in the models. Proposed Conditions models were developed for new improvements.

The following design criteria were used to develop proposed whitewater features:

- Maintain Weston Dam Tailrace pool levels for recreational river flows (i.e. pool level at dam with proposed structures matches existing pool levels)
- Target hydraulic drop at whitewater features: 18”- 32”
- Flow to whitewater features: 40-50% of total river flow
- Provide eddies for resting, queuing and self-rescue
- Optimize whitewater recreation experience

An alternatives analysis was conducted that included three proposed alternatives. All alternatives include a whitewater feature (Feature 3) at the Lower Rapid. The following alternatives are for structures in the Upper and Middle Rapids.

<u>Alternative #1 – Feature 1, 2A & 2</u>

Alternative #1 includes one whitewater feature at the Upper Rapid (Feature 1) and two features at the Middle Rapid (Feature 2A & 2). Three structures were selected based on the existing hydraulic drop in each rapid as surveyed. Modeling indicated that although recreational performance was achieved, the tailrace pool level was raised by approximately 1.0’ at 8,800 cfs. Therefore Alternative #1 was not selected for further design development. If a tailrace pool rise of 1.0’ is acceptable to the dam owner, this alternative may be revisited.

<u>Alternative #2 – Feature 2A & 2</u>

Alternative #2 includes two features at the Middle Rapid (Feature 2A & 2). Modeling results indicated that the tailrace pool level was not impacted. Whitewater performance criteria on a feature bases, such as, eddy service, hydraulic drop and flow split, were satisfied. However, the whitewater features are concentrated in the Middle Rapid. Features that are spread out provide a higher value recreational experience particularly for down river traffic from rafters, tubers and kayakers. This alternative is most likely the least expensive to build two river features due to economies related to dewatering and construction access. Depending on available funding Alternative #2 could be reconsidered. The preliminary design of Alternative #2 was not further developed.

Alternative #3 – Feature 1 & 2

Alternative #3 includes one feature at the Upper Rapid (Feature 1) and one feature at the Middle Rapid (Feature 2). Modeling results indicated that the tailrace pool level was not impacted. Whitewater performance criteria were satisfied including an optimized recreational experience with featured well-spaced in the river corridor. Economic benefits to Skowhegan are closely tied to the proximity of the Whitewater Park to the commerce center. Feature 1 is relatively close to the downtown area via the pedestrian bridge and will likely draw the most spectators and passive users. This alternative is not as cost efficient at Alternative #2 due to added construction dewatering and access of two distinct sites at the Upper and Middle Rapids. Alternative #3 was selected as the preferred alternative for preliminary design because it satisfies recreational objectives and the tailrace pool level constraints.

River Flow (cfs)	Water Surface Elevation (ft.)					
	Weston Dam Tailwater		Pool @ Ped. Bridge		Feature 2 Tailwater	
	Existing	Proposed	Existing	Proposed	Existing	Proposed
2,700	120.2	120.3	117.9	117.8	115.4	115.4
4,000	121.1	121.2	118.9	118.9	115.7	115.7
8,800	122.8	123.0	120.7	120.7	117.3	117.3

Figure 9, Recreational Hydraulic Analysis Results Water Surface Elevation: Alternative #3

River Flow (cfs)	Hydraulic Drop (ft.)		
	Feature 1	Feature 2	Feature 3
2,700	1.7	1.4	-
4,000	1.5	2.0	-
8,800	1.5	2.6	-

Figure 10, Recreational Hydraulic Analysis Results Hydraulic Drop: Alternative #3

River Flow (cfs)	Flow Split (cfs)					
	Feature 1		Feature 2		Feature 3	
	River-Left	River-Right*	River-Left	River-Right*	River-Left	River-Right
2,700	1,550	1,150	1,300	1,400	*Not Modeled*	
4,000	2,450	1,550	1,900	2,100		
8,800	5,500	3,300	3,550	5,250		

**Side with Whitewater Feature*

Figure 11, Recreational Hydraulic Analysis Results Flow Split: Alternative #3

Exhibits illustrating the two-dimensional modeling results for existing and proposed conditions (Alternative #3) are included in See Part 7.

4.2.3. Flood Analysis

The Town of Skowhegan made a formal request to the Federal Emergency Management Agency (FEMA) to obtain the regulatory hydraulic model and Flood Insurance Study (FIS) documents. The Flood Insurance Rate Map (FIRM) was also obtained and reviewed, however the model was not available. The following is a summary of related flood documents for the project site:

- Flood Insurance Study Town of Skowhegan Maine, Somerset County, September 20, 1995
- Flood Insurance Rate Map – Community Panel Number 230128 0004 C
- Effective Model Input/output Data (Hardcopy) SCS Water Surface Profile Model (WSP2) – January 10, 1993

A flood analysis was conducted for the preferred alternative (Alternative #3) to identify possible impacts to conveyance from whitewater features and structures in the Upper and Middle Rapid. Feature 3 at the Lower Rapid was not included due to lack of survey data at this location. A comparison of the Existing Conditions model and Proposed Conditions model was conducted to determine impacts. The Existing Conditions Model was developed from survey data collected for the project on NAVD 88 vertical datum. Channel roughness in the Effective Model (Manning's n values) were used for the Existing Conditions Model. The water surface elevation at the downstream model boundary was evaluated by linear interpolation of the FIS profile. A Proposed Conditions Model was created that includes the proposed whitewater features, access, and other proposed structures. The figure below summarizes the potential flood conveyance impacts as a result of the proposed improvements.

XS station	Flood discharge (cfs)	EFECTIVE MODEL- 1% Annual Chance Water Surface Elevation (feet NAVD 88) *	EXISTING CONDITIONS MODEL- 1% Annual Chance Water Surface Elevation (feet NAVD 88)	PROPOSED CONDITIONS MODEL - 1% Annual Chance Water Surface Elevation (feet NAVD 88)	Difference in Water Surface El. (Effective to Proposed) For 1% Annual Chance (feet)	Difference in Water Surface El. (Existing to Proposed) For 1% Annual Chance (feet)
4017	142400	157.2	153.14	153.26	-3.9	0.12
3936	142400	155.5	152.42	152.5	-3.0	0.08
3843	142400	153.8	151.85	151.95	-1.9	0.10
3741	142400	151.9	151.33	151.29	-0.6	-0.04
3698	142400	151.1	150.21	150.02	-1.1	-0.19
3687	Bridge					
3665	142400	150.4	150.53	150.51	0.1	-0.02
3608	142400	149.5	150.36	150.38	0.9	0.02
3476	142400	148.3	148.46	148.48	0.2	0.02
3359	142400	147.0	148.41	148.43	1.5	0.02
3265	142400	146.7	147.28	147.34	0.6	0.06
3125	142400	146.3	147.79	147.53	1.2	-0.26
3084	142400	146.2	148.06	148.02	1.8	-0.04
2956	142400	145.8	145.77	145.77	0.0	0.00

* approximate water surface graphically interpolated from FEMA 1995 flood profiles

**graphically interpolated from profile

Figure 12, Flood Analysis Results Summary for Alternative #3: Comparison of Existing Conditions and Proposed Conditions Models

Flood analysis results indicated that the proposed improvements impact flood conveyance in the project reach. The rise in compared 100-year water surface elevations is relatively small and may be mitigated with additional design refinement. It is important to note that even with the rise in 100-year and 500-year flood water surface elevations, these flood events are still contained in the gorge. The community Floodplain Administrator should be consulted prior to the next design phase to determine if a rise is allowable in this area and required analysis, permits, and documentation.

4.2.4. Structural Analysis

The structures must be adequately designed to resist forces in the river environment. The proposed structures are masses of boulders with concrete grout filling the voids. Grout will be recessed at the surface of the structures to provide a natural aesthetic and maximize interstitial spaces for aquatic habitat. The Kennebec River in the project reach appears to be primarily bedrock controlled. Proposed structures will be constructed on bedrock. In areas of localized alluvial bed material, loose rock and sediment will be removed to expose the bedrock.

There are two primary failure modes for grouted boulder structures founded on bedrock in a river. Failure by sliding occurs when the friction between the structure and bedrock is insufficient to counteract lateral loading (impact and tractive forces) in a buoyant condition. Failure by uplift occurs in areas of steep hydraulic gradient such as whitewater wave features. Relatively large differences in hydrostatic pressures typically at transitions from supercritical to subcritical flow conditions can result in upward vertical forces on the structure.

A preliminary structural analysis was completed at Whitewater Feature 2, the worst-case feature with the largest forces. Conservative structural loads were identified from the hydraulic modeling and used in the analysis at Feature 2. This location has the largest concentrated hydraulic drop in the project resulting in high shear stresses, uplift, and tractive/impact forces. Analysis at this location is considered conservative as compared to the expected loadings on others structures in the project.

The analysis indicates that rock anchors/dowels embedded into the bedrock is required for stability. Table 5 summarizes the required rock anchors/dowel required.

Rock Anchor Requirements	Whitewater Features	Divider Islands	Jetties
Anchors per 50 sq. ft. (surface area)	2.5	1	1
Minimum Anchors per Structure	4	4	4

Figure 13, Summary of Required Rock Anchors for Proposed Structures

Additional structural analysis is required during final design. Rock anchor size and quantity specific to each structure will be further evaluated and refined.

PART 5 AGENCY CONSULTATION

MWDG had several informal phone contacts with resource agencies and a formal presentation on February 26, 2013 to US Fish and Wildlife, Maine DEP and the US Army Corps of Engineers. A representative of Nextera Energy Resources (now Brookfield Renewable Energy Partners) also attended. Maine Department of Inland Fisheries and Wildlife and National Marine Fisheries Service (NOAA) were notified but did not attend.

MWDG presented the conceptual plan and summarized the differences with the previous 2004 plan (which had been reviewed by agencies at that time and was somewhat familiar to them). Informal feedback and information received included:

1. Nextera expressed concern over debris catching on the river structures especially those upstream of the walking bridge abutment. Jerry noted that the debris flume is in the center of the dam and directs floating debris to the center of the river. MWDG noted that at higher flows the center stream structures would be under water. Six percent of the flow at the dam is from debris sluicing.
2. Nextera noted that there would be little flexibility in providing set flows for whitewater events. Flow levels are set by others and they simply pass along what flows are in the river. MWDG noted that flow levels for events are flexible and adaptable, however it would be beneficial that once flows are decided, there would be no variation in flow during the event itself.
3. Public safety. Would it be advisable to control access to the feature? MWDG advises against controlling access, except that it is a known practice in urban rivers to close the parking lots and land access to rivers during floods. This avoids the issue of closing a navigable waterway.
4. MWDG requested the metes and bounds of the downstream limit of the FERC boundary.
5. Downstream migration is provided at the Weston dam. It is not anticipated that the Run of River project would impact downstream migration.
6. A needs analysis may be required for permitting
    a. Need for the project—possible need is to restore fish habitat by providing variety of hydraulic conditions (depth, flow, holding and resting areas) that were lost when rapids were cleared for log drives. (Note that documenting the extent of the clearing is anecdotal at this stage).
    b. Alternatives to the project. Full width weirs were presented as an alternative, also the 2004 plan which has larger volume of fill and larger footprint may also be presented as an alternative.

   c. A least impact analysis of the proposed action.

7. American Eel passage is provided at Weston Dam
8. Future passage to include: American shad, Atlantic salmon (a federally listed species), herring
9. Nextera will be required to install a fish passage in the future for these species once they are able to pass Shawmut Dam downstream. The potential re-direction of attraction flows by the whitewater features away from the preferred location for their fish passage facilities is a concern.
10. Atlantic salmon is a federally listed species and will slow down permitting. The listing occurred after the 2004 report and is a major change since the feasibility study was done.
11. Five federally recognized tribes will need to be notified of the proposed action. Prehistoric remains could be an issue with the downstream most whitewater features. MWDG noted that the best access to the river is in the area that was previously disturbed to construct the treatment plant outfall. The 1990 relicensing documents should be consulted.
12. US Fish and Wildlife will provide current fish passage criteria. Agencies did not feel that there would be mussels in the gorge.

In summary, Agencies did not note any possible “deal killers”, except that the listed Atlantic salmon is a new condition and one that will complicate permitting considerably. They suggested as possible justification for the project adding structure to the river as a way to restore some of the hydraulic diversity and holding water that was lost to past clearing of snags to promote log runs.

PART 6 COST ESTIMATE

6.1. Constructability

The Kennebec River, with its ample flow, is an excellent site for whitewater features; but at the same time is a very challenging environment for heavy construction. The main challenges for constructing the features are physical access and water control: their combined cost will be a significant percentage of the total construction costs. The builder assumes risk in building and maintaining his coffer dams and dewatering, and will pass the cost along to the Owner. The best way to manage the risk and related cost is to obtain the cooperation and favorable water control from upstream sources.

6.1.1. Construction Access

The two upstream-most rapids are accessed from the New Balance property on the right shore in the vicinity of the pedestrian bridge. We see no alternative site that is economical, so the project depends on obtaining a maintenance and access easement from the property owner, or other acceptable arrangement. The plans show construction haul roads down to the level of the river and along its banks that are sufficiently wide and smooth for rubber tire, highway vehicles, e.g. tandem dump trucks, concrete trucks and concrete pumper trucks to reach the work site. The detailed design of the roads is typically up to the contractor. For permitting purposes, the plans show approximately 1,200 lineal feet of haul road, 14 feet wide, composed of granular fill. The fill will be stabilized on the river side by a row of boulders cemented with a lean concrete mix. Both the fill and the boulders will be removed at the end of the work.

Construction access roads for a similar scale project in Columbus, Georgia

The access for Feature 3 is much simpler, provided that the wastewater treatment plant property is available. At that site, a road down to the features would be similar in scale to that which was likely installed for the outfall project several decades ago.

6.1.2. Coffer Dams and Water Control

All water control is dependent upon weather and river flows which means that if a flexible construction period can be negotiated with the project funders, better pricing may be obtained. The preliminary plans show dry construction with coffer dams surrounding the work area, as it is the most traditional, but likely the most costly form of water control. We calculate to protect the Feature 1 site from a 4,000 cfs flow, a coffer would be 10 feet in height and contain 3,200 cubic yards of material. For the middle rapid the height would be 16 feet and the volume would be 5,000 cubic yards. To protect from higher flows the height and costs go up proportionally.

Because the cost of working in the dry is so expensive, commitments for low or no water periods, even for short duration periods can help with dewatering costs significantly. We understand that the bridge debris removal and the sanitary sewer siphon were both done under zero flow conditions, albeit for very short time periods. Such conditions can help in the costs of installing traditional coffers and other key construction activities.

Coffer Dams on even this small creek have proven to be very challenging

6.1.3. Alternate Construction Methods

Alternate wet and semi wet construction methods should be explored to see what is permittable. Alternate methods proposed by contractors should be encouraged, to the extent they are allowed and do not unduly harm the environment or violate permit requirements. The 2004 report suggested a modular system and submerged grout placement. Alternate wet or semi-wet methods should be especially encouraged for the divider islands, as they more than double the cost of coffers when compared to the whitewater features alone. For example if the rock for the divider islands could be placed in the wet, then have a brief period of low or no flow for the grouting operations, then the divider island itself would be part of the coffer. The added advantage of the island as coffer is that it would take the most severe water velocities at the river side of the work site.

Construction of a MWDG designed project utilized two such submerged/semi-submerged techniques. The “Grout bag” technique was used to build whitewater sills underwater. Divers with equipment support from the bank would place the bag at the river bottom. Hoses were then connected to a port on the bag where grout was pumped into the bag. Rock anchors were utilized to connect the bags to the bedrock river bottom. Non-dispersant grout was a second and less complex method of submerged construction. An anti-dispersant admixture was added to the grout mix that allowed the grout to be placed underwater without washing away. In both techniques all surface flow was eliminated with an upstream coffer dam type structure. The work was permitted and completed in critical river habitat where there were listed and other sensitive species. It is recommended that these techniques (or similar) be presented during the permitting process because they can significantly reduce the size of temporary construction structures and river bed disturbance, as well as, costs.

6.2. Engineer's Opinion of Probably Construction Costs

The preliminary-level budget costs are based on analyses conducted by MWDG applying gross quantity estimates, comparable similar projects, and professional judgment. As discussed in the previous section, construction dewatering methodologies will greatly impact construction costs. The following are notes and discussion of estimated costs:

1. The estimates include contractor's access, water control and other "means and methods" items which are typically under the contractor's control and are not designed by the engineer. Since these items are a significant part of the cost, and the builder's risk, they could vary considerably according to site conditions and the owner's requirements, e.g. schedule, time of year, site access and lay-down area provided, etc. It is our judgment that the "sunk" costs of access, coffer dams and dewatering are significant compared to the permanent improvements in each of the three whitewater features presented. Therefore it is recommended that the Town retain a contractor to evaluate the construction approach and associated costs.
2. Dewatering and water control costs presented assume typical "dry" methods including coffer dam and pumping. Submerged or semi-submerged methods could significantly reduce these costs. These alternative techniques should be sought during permitting.
3. The quantity of bridge debris still remaining in the river is unknown and cannot be priced. It was reported that the Weston Dam was completely shut down for the initial emergency debris removal. Obtaining (or not obtaining) similar conditions for the remaining debris (and the contractor's temporary dewatering and coffering, for that matter) could greatly affect the cost of removal.
4. The region at the Great Eddy and the outfall has not been surveyed. While this area appears to be shallow, unforeseen subsurface conditions may arise which affect costs. Also, overly restrictive plant operations requirements or limited access may also affect contractor's costs.
5. The two upstream features depends on construction access and staging at the New Balance property just upstream of the walking bridge. No alternative site is apparent, so this cost analysis assumes the use of this property.
6. The estimates include general contractor's overhead and profit, general conditions and bonds. They also include a 30 percent contingency. They do not include engineering, permitting, construction oversight/administration, easements or land acquisition.
7. Riverbed materials are not known. It appears from site observation that this reach of river is generally bedrock controlled. However, loose material is likely present throughout the project. Design requires that overburden (loose material) be removed for river structures. Some estimate of overburden has been included in the quantities but will not be known entirely until dewatering and excavation is completed during construction. Depending on river bed conditions, additional structures or stabilization may be necessary in the river left channel to maintain whitewater performance (on river right). Costs for such structures is not included.
8. Bathymetric survey was complete in the project reach. In general, the bathymetric survey collection resolution was low due to river conditions. Some areas were not surveyed due to safety and data collection limitations. These areas are delineated on the drawings. Estimates of the river bottom contours was made from site photos and hydraulic model calibration. Quantities and project performance may vary depending on actual bathymetric elevations.
9. The costs do not include escalation beyond the current year.

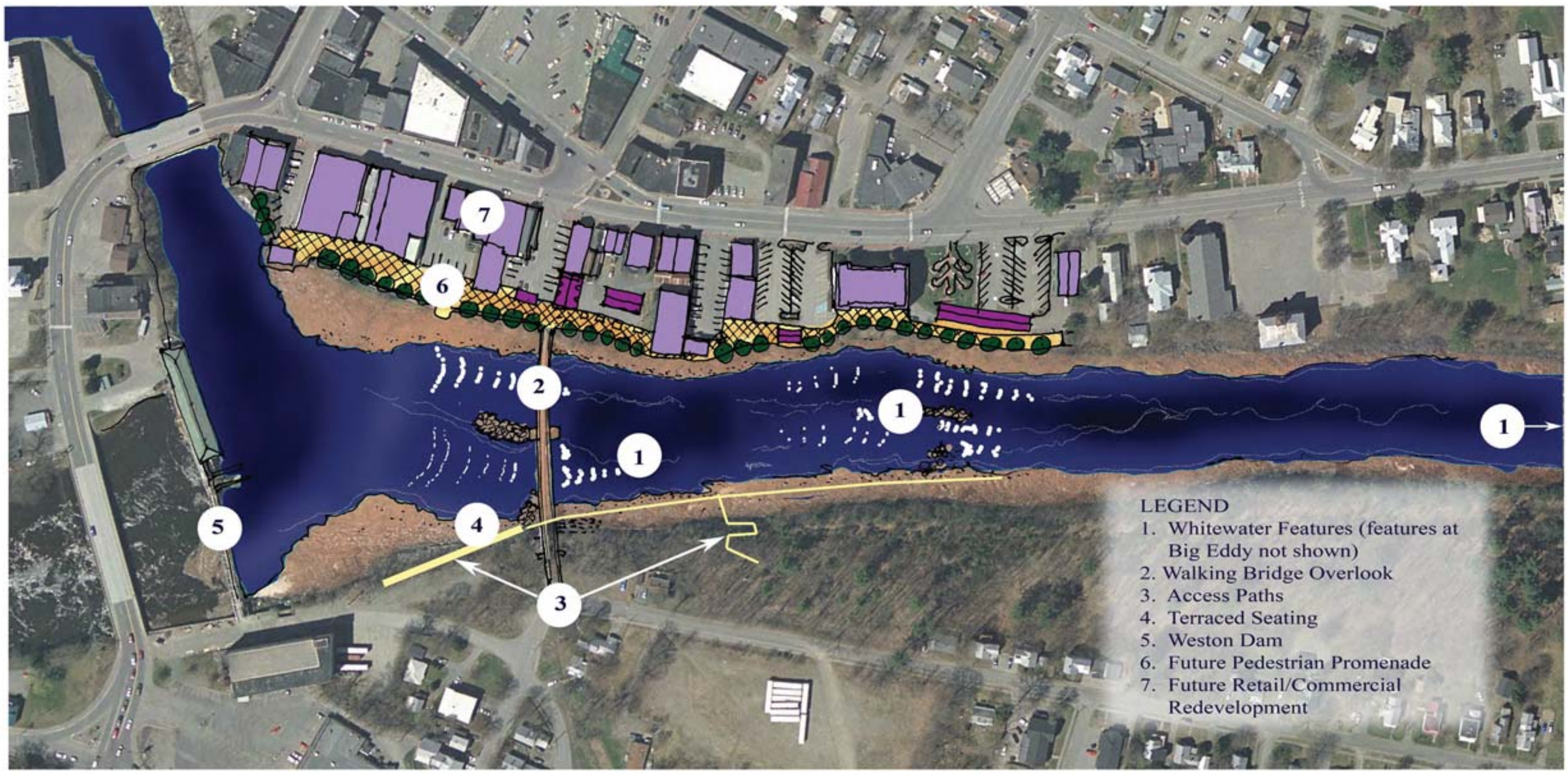
Upper rapid	$	1,720,000
Middle rapid	$	1,580,000
Lower rapid	$	1,010,000
Total	***$***	***4,310,000***

Figure 14, Table of Budget Costs Summary by Rapid

The full opinion of costs can be seen in Appendix 1.

PART 7 DRAWINGS & EXHIBITS

- Illustrations
  - Overall Project Rendering Plan
  - Rendering (Perspective) at Whitewater Feature 1 (Pedestrian Bridge)
- Preliminary Design Drawings
  - Drawings 1 – 10
- 2D Hydraulic Modeling Results Exhibits
  - Existing Conditions Results (2,700 cfs, 4,000 cfs, 8,800 cfs)
  - Proposed Conditions Results (2,700 cfs, 4,000 cfs, 8,800 cfs)
- Flood Study Plan & Profile



SKOWHEGAN RUN OF RIVER WHITEWATER PROJECT

January, 2014


L.L. Bean
Cabela's
Skowhegan Savings
Integrity. Trust. Community.
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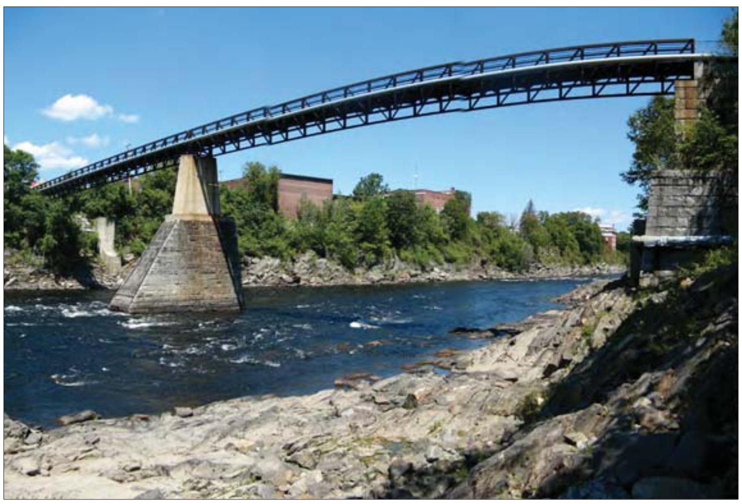
SKOWHEGAN RUN OF RIVER PROJECT

TOWN OF SKOWHEGAN, MAINE



PRELIMINARY DESIGN

JANUARY, 2014

PRELIMINARY

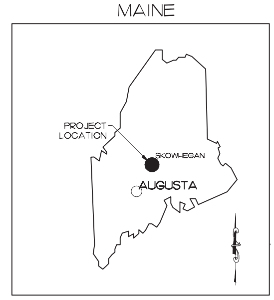
NOT FOR CONSTRUCTION

McLaughlin Whitewater design group
2420 Alcott Street
Denver, Colorado 80211
T 303.964.3333
F 303.964.3355

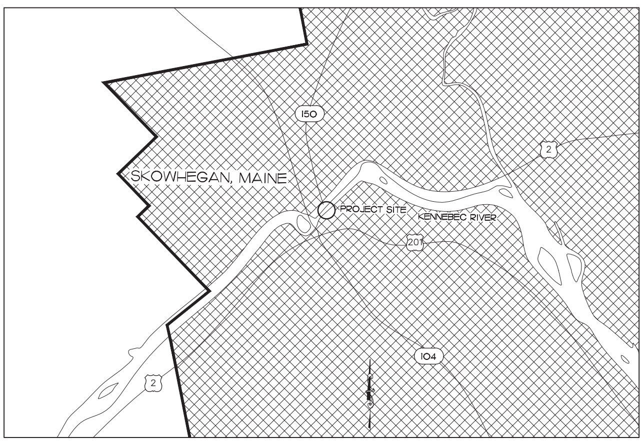
DRAWING LIST

1. COVER SHEET
2. DRAWING LIST, LEGEND AND SITE MAP
3. SITE PLAN
4. PLAN DETAIL
5. PLAN DETAIL
6. PLAN DETAIL
7. PROFILE
8. SECTIONS
9. SECTIONS
10. DEWATERING PLAN

MAINE



LOCATION MAP
N.T.S.



SITE MAP
N.T.S

LEGEND

215	PROPOSED MAJOR 5' CONTOUR
	PROPOSED MINOR 1' CONTOUR
215	EXISTING MAJOR 5' CONTOUR
	EXISTING MINOR 1' CONTOUR
3+00	℄ ALIGNMENT AND CONTROL LINE
	SECTION LINE
	DIRECTIONAL FLOW ARROW

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Number	Revision Description	By	Date

TOWN OF SKOWHEGAN, MAINE | RUN OF RIVER WHITEWATER PROJECT | DRAWING LIST LEGEND AND MAP

McLaughlin Whitewater design group
2420 Alcott St
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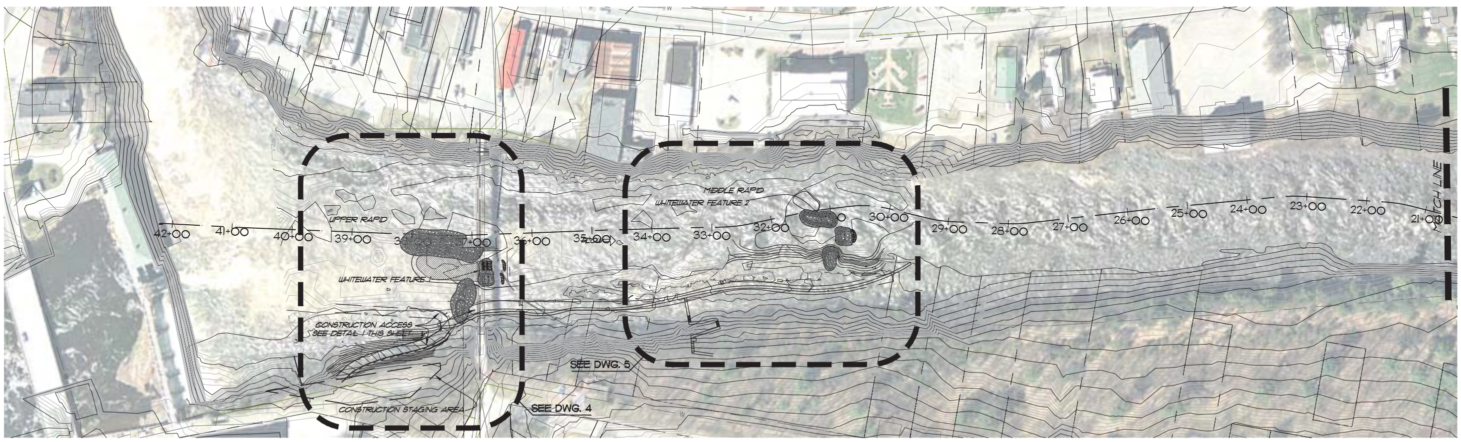
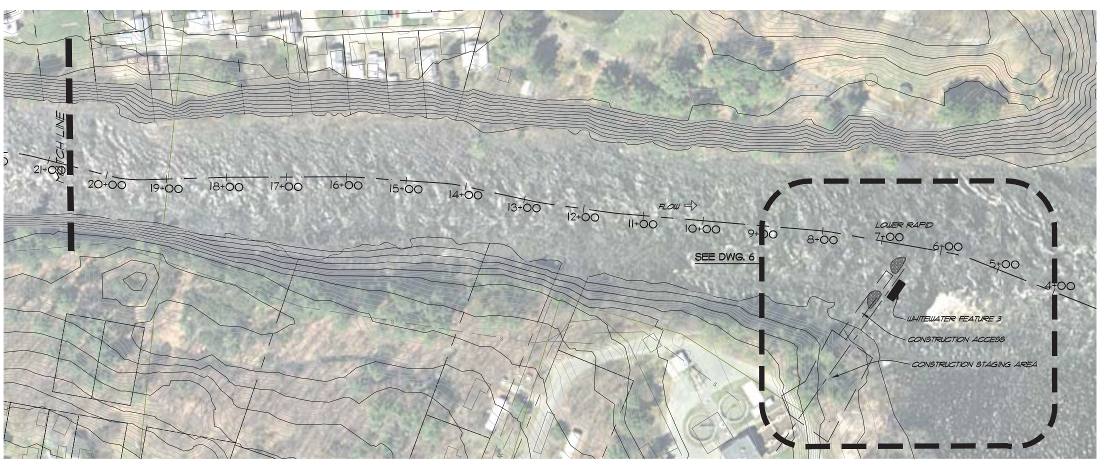
65417486

Drawing Number:
2





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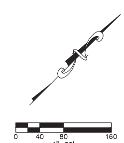

NOTE IF DRAWING SIZE IS NOT 22"X34" THEN GRAPHIC SCALE MUST BE USED.

Number	Revision Description	By	Date

TOWN OF SKOWHEGAN, MAINE

RUN OF RIVER WHITEWATER PROJECT

SITE PLAN

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65417486

Drawing Number:
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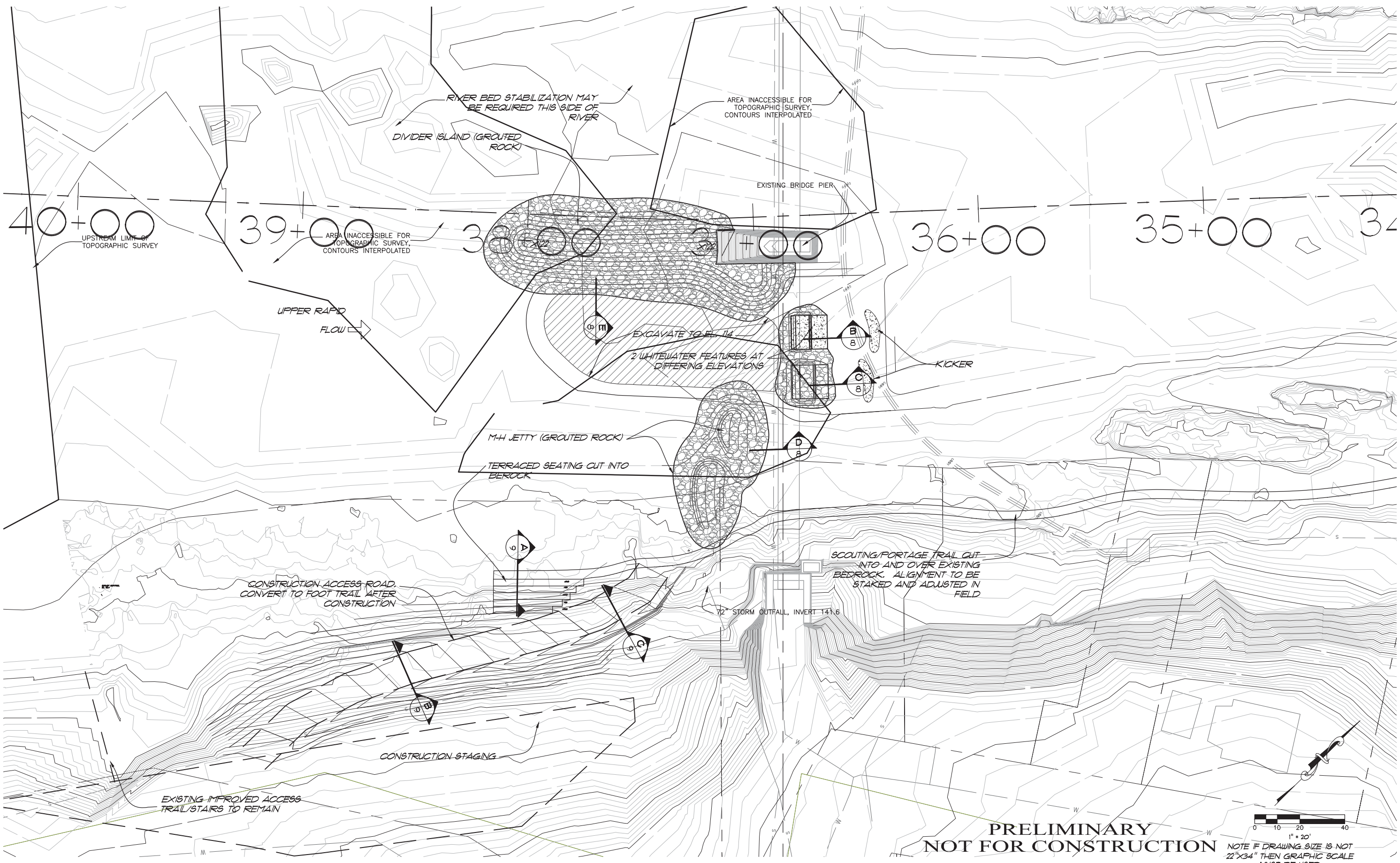

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NOTE IF DRAWING SIZE IS NOT 22"X34" THEN GRAPHIC SCALE MUST BE USED.

Number	Revision Description	By	Date						
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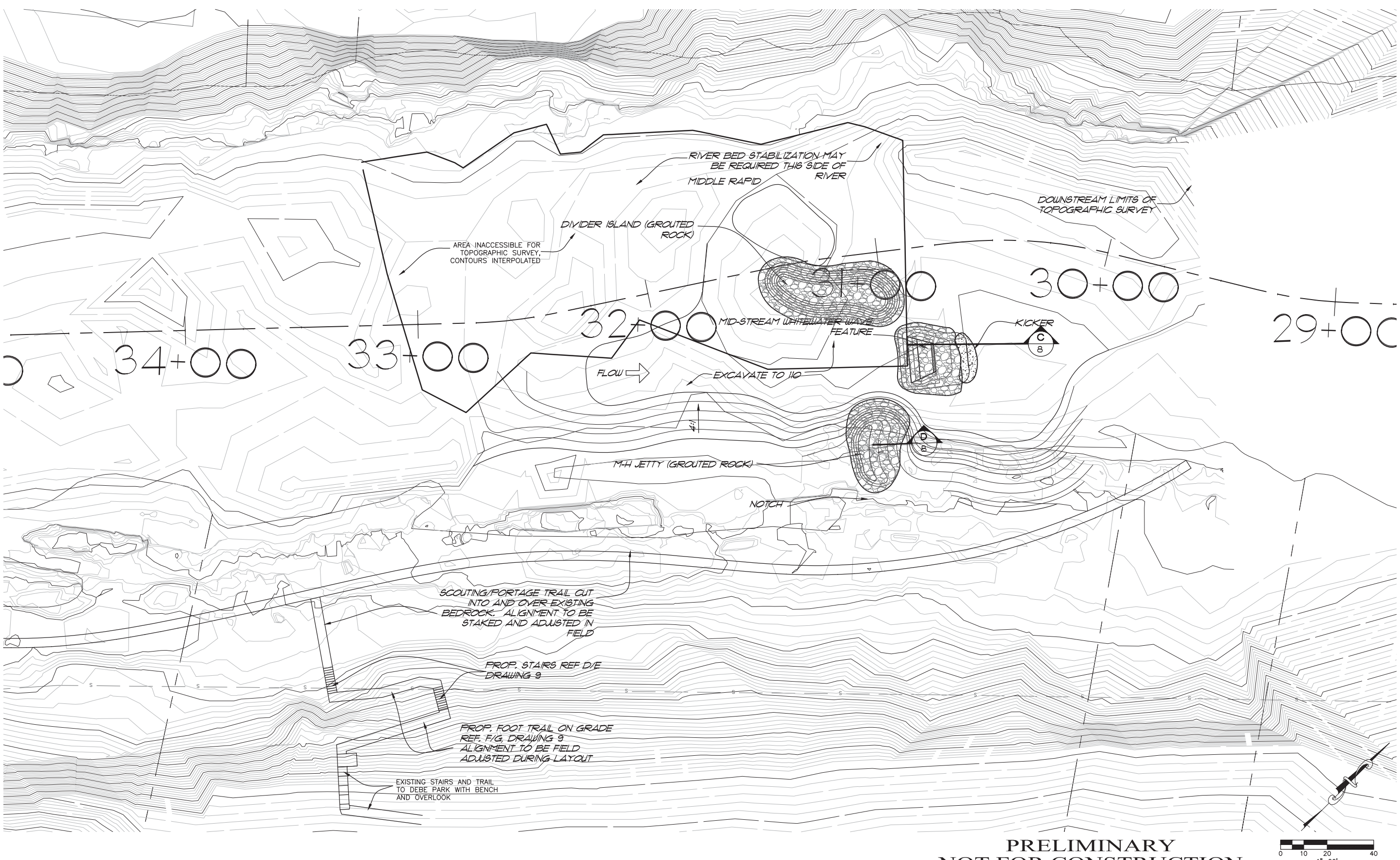

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Number	Revision Description	By	Date

TOWN OF SKOWHEGAN, MAINE

RUN OF RIVER WHITEWATER PROJECT

PLAN DETAIL
MIDDLE RAPID, FEATURE 2

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PROJECT NUMBER
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Drawing Number:
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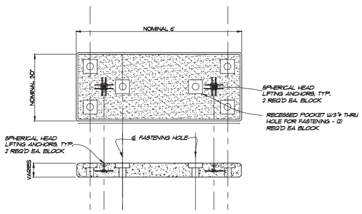
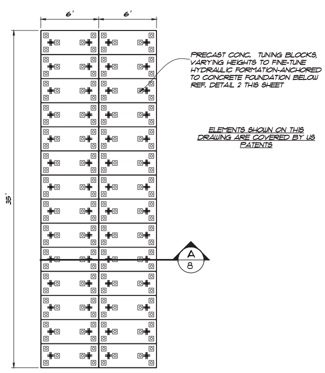


TUNING BLOCK DETAIL (2/6)

1" = 1'



PLAN DETAIL TUNING BLOCKS (1/6)

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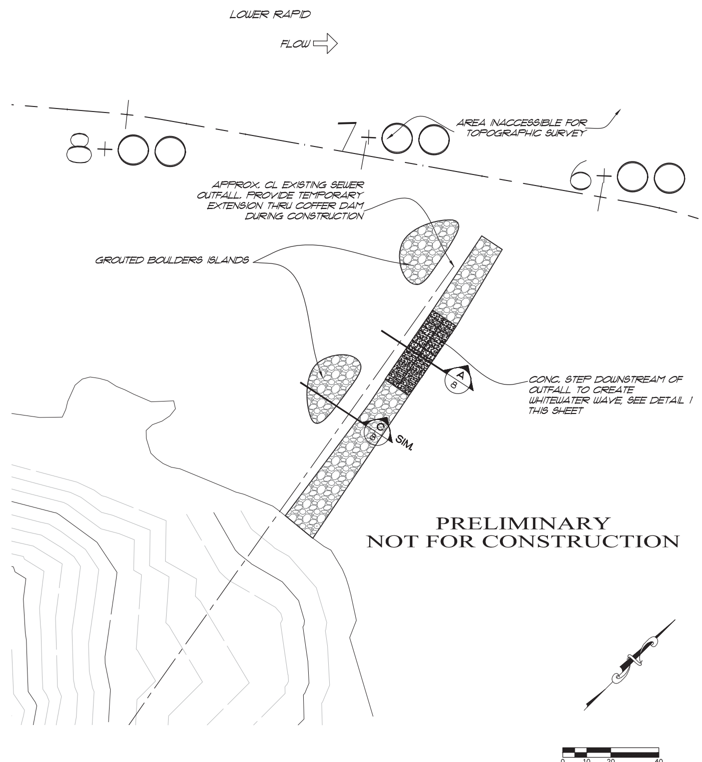

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Number	Revision Description	By	Date

TOWN OF SKOWHEGAN, MAINE

RUN OF RIVER WHITEWATER PROJECT

PLAN DETAIL
LOWER RAPID, FEATURE 3

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F303.964.3355

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DATE: JANUARY, 2014

PROJECT NUMBER
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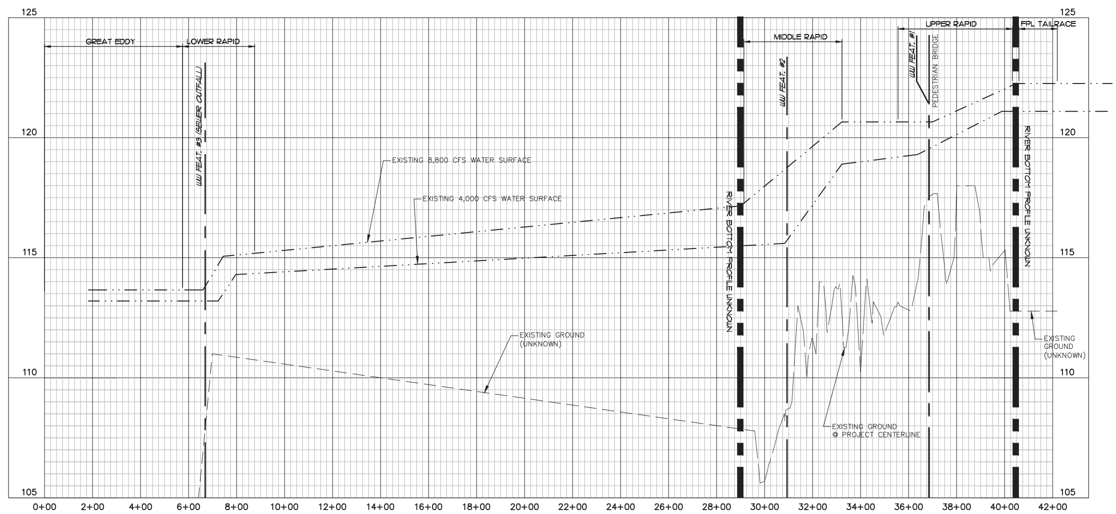
Drawing Number:
6



EXIST. RIVER WATER SURFACE PROFILE

HORIZ. 1" = 200'
VERT. 1" = 2'

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Number	Revision Description	By	Date

TOWN OF SKOWHEGAN, MAINE

RUN OF RIVER WHITEWATER PROJECT

RIVER PROFILE

McLaughlin Whitewater Design Group
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Denver, CO 80211
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F303.964.3355

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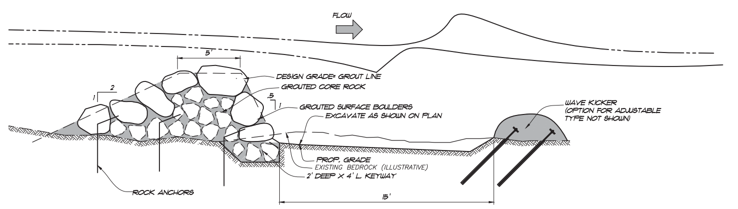
DATE: JANUARY, 2014

PROJECT NUMBER
65417486

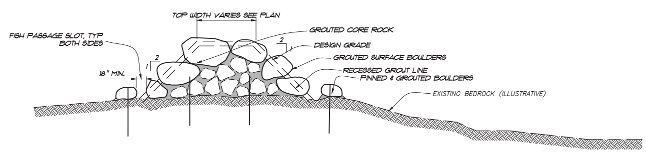
Drawing Number:
7

R:\1 MWDG ACTIVE JOBS\SKOWHEGAN\DESIGN\DRAWINGS - AUTOCAD\PRELIMINARY DESIGN Last Saved: January 23, 2014



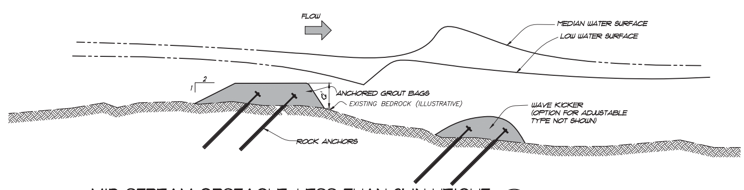
MIDSTREAM OBSTACLE, 2' OR MORE IN HEIGHT (C / 4,5,6)

1" = 5'



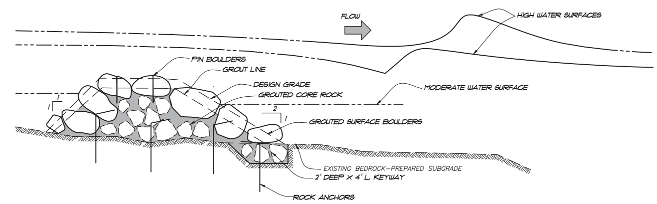
DIVIDER ISLAND (E / 4,5)

1" = 5'



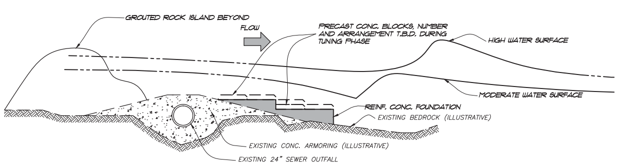
MID-STREAM OBSTACLE, LESS THAN 2' IN HEIGHT (B / 4)

1" = 5'



TYPICAL M-H JETTY (D / 4,5)

1" = 5'



SECTION AT SEWER OUTFALL (A / 6)

1"=5'

PRELIMINARY
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0 2.5 5 10
1"=5'

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Number	Revision Description	By	Date

TOWN OF SKOWHEGAN, MAINE

RUN OF RIVER WHITEWATER PROJECT

SECTIONS
ELEVATIONS

McLaughlin Whitewater Design Group

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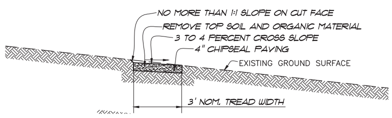
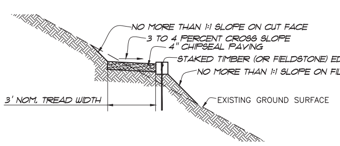
DETAIL: JA
CHECK: BAN
DATE: JANUARY, 2014

PROJECT NUMBER 65417486

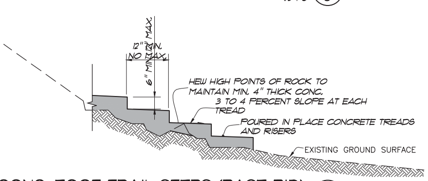
Drawing Number: 8



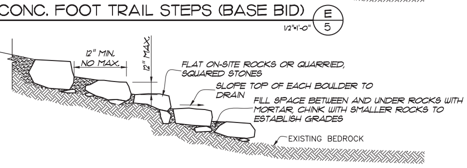
FOOT TRAIL. CROSS SECTION CROSS SLOPE <15% (G/5)
1/2"=1'-0"



FOOT TRAIL. CROSS SECTION CROSS SLOPE >15% (F/5)
1/2"=1'-0"



CONC. FOOT TRAIL STEPS (BASE BID) (E/5)
1/2"=1'-0"



ROCK FOOT TRAIL STEPS (ALTERNATE) (D/5)
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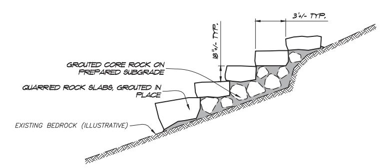
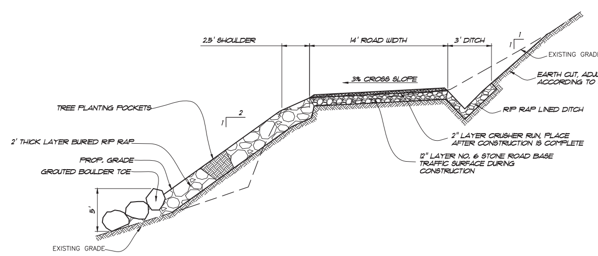


TERRACED SEATING (A/4)
1"=5'



ROAD-EARTH CUT (B/4)
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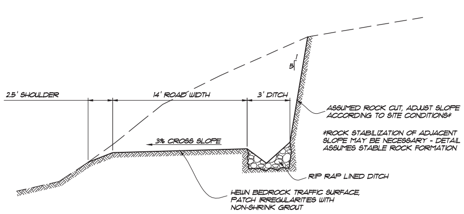

ROAD-ROCK CUT (C/4)
1"=5'

PRELIMINARY
NOT FOR CONSTRUCTION

0 2.5 5 10

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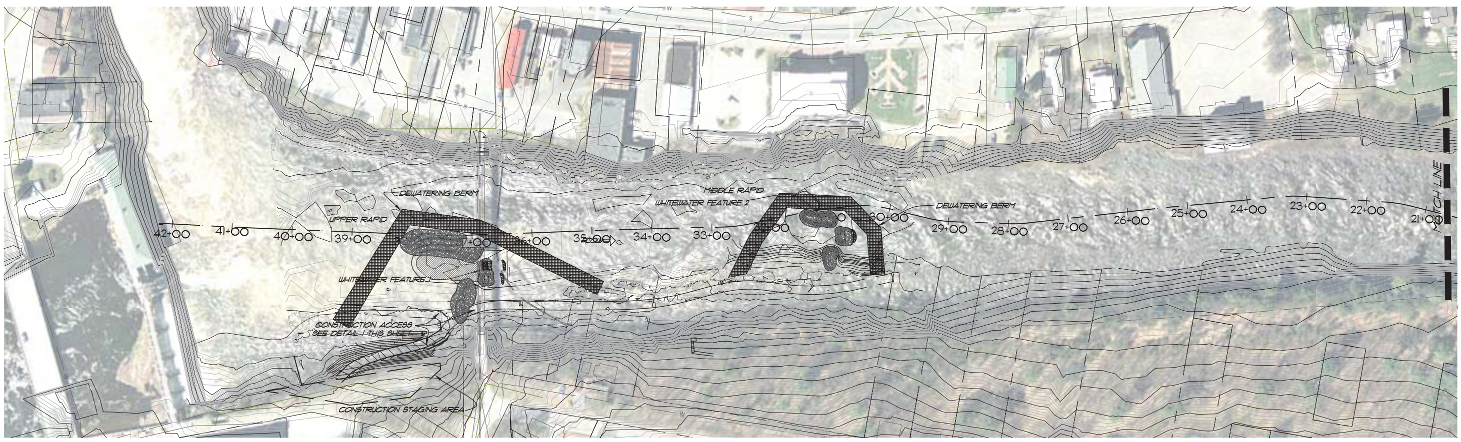
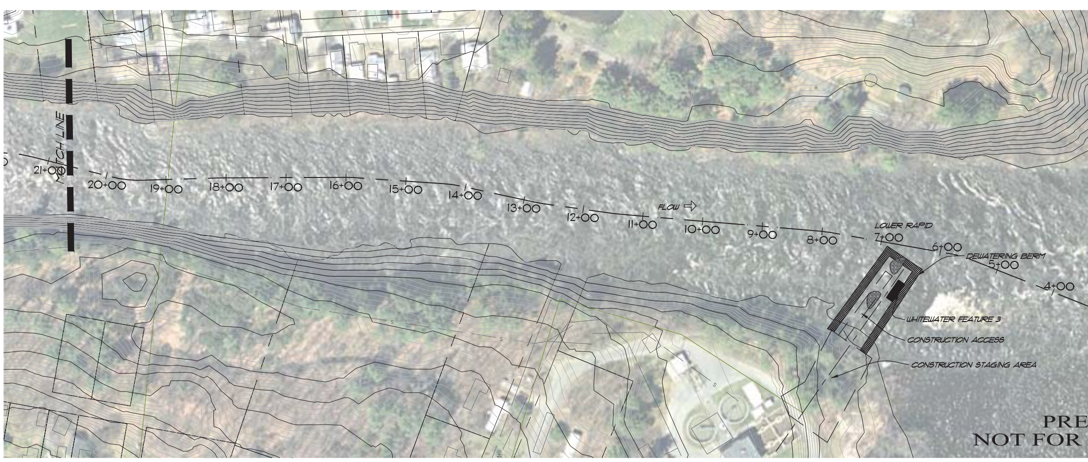
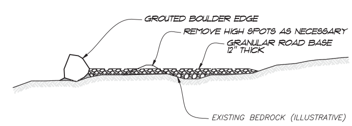
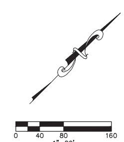
				TOWN OF SKOWHEGAN, MAINE	RUN OF RIVER WHITEWATER PROJECT	SECTIONS	McLaughlin Whitewater Design Group, A Division of Merrick & Company	2420 Alcott St Denver, CO 80211 T303.964.3333 F303.964.3355	DESIGN: JA DETAIL: JA CHECK: BAN DATE: JANUARY, 2014 PROJECT NUMBER 65417486	Drawing Number: 9







1/10 TEMPORARY HAUL ROAD DETAIL
NTS



PRELIMINARY
NOT FOR CONSTRUCTION

NOTE IF DRAWING SIZE IS NOT 22"X34" THEN GRAPHIC SCALE MUST BE USED.

Number	Revision Description	By	Date

TOWN OF SKOWHEGAN, MAINE

RUN OF RIVER WHITEWATER PROJECT

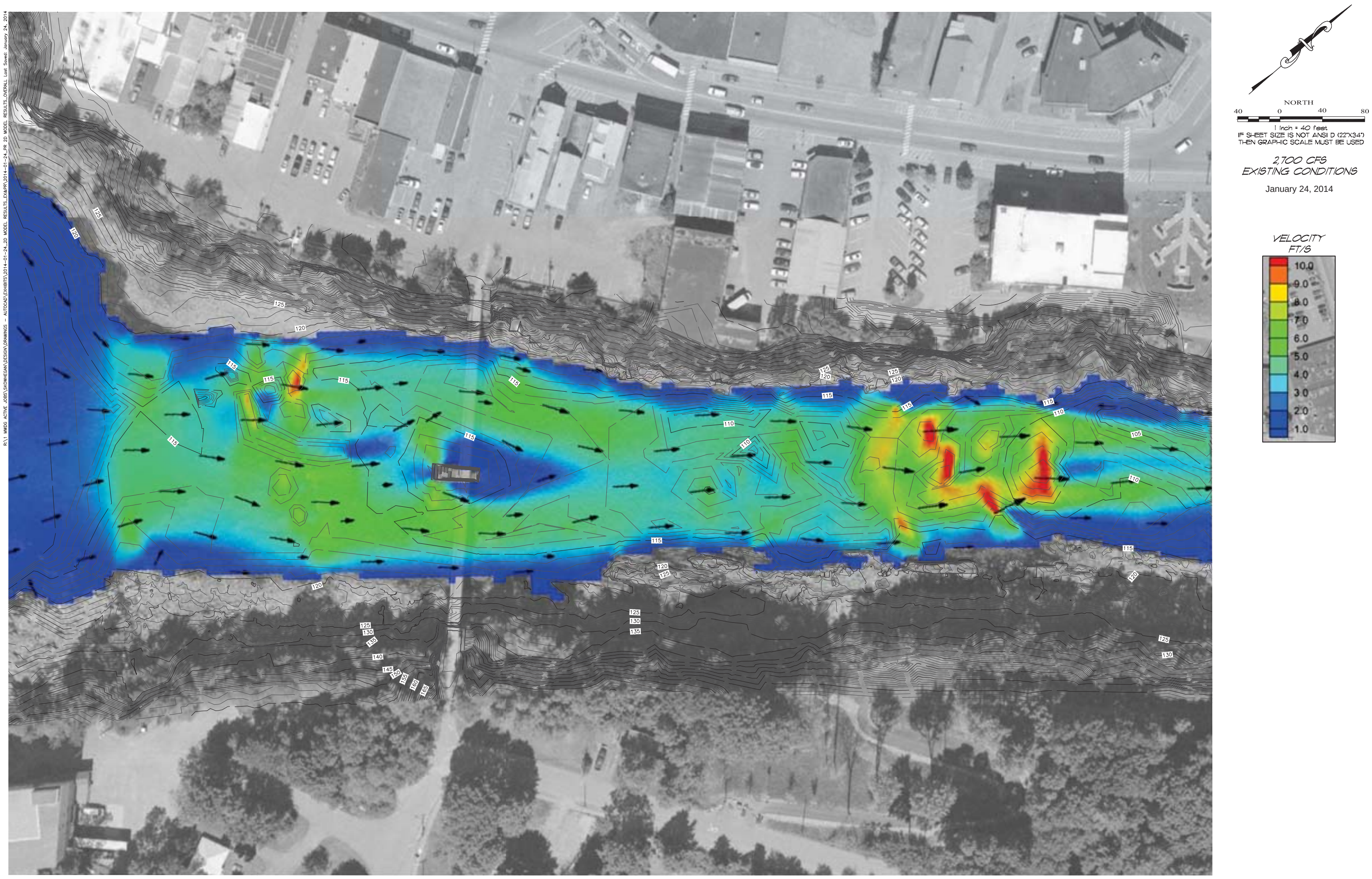
CONSTRUCTION DEWATERING PLAN
CONSTRUCTION STAGING & ACCESS PLAN

McLaughlin Whitewater design group
2420 Alcott St
Denver, CO 80211
T303.964.3333
F303.964.3355

DESIGN: JA
DETAIL: JA
CHECK: BAN
DATE: JANUARY, 2014

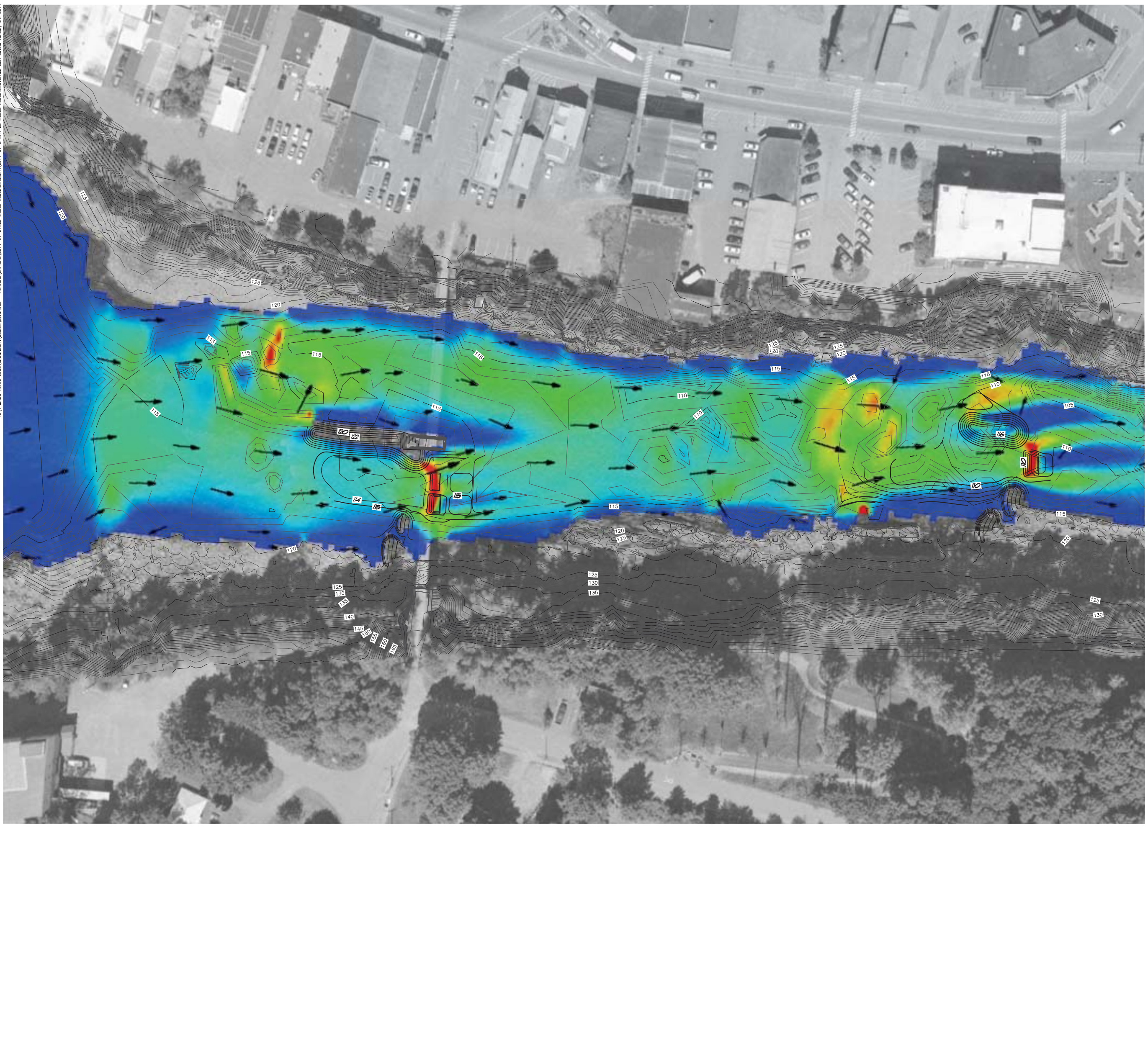
PROJECT NUMBER
65417486

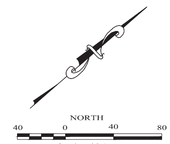
Drawing Number:
10



2,700 CFS
EXISTING CONDITIONS

January 24, 2014

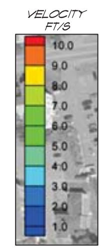


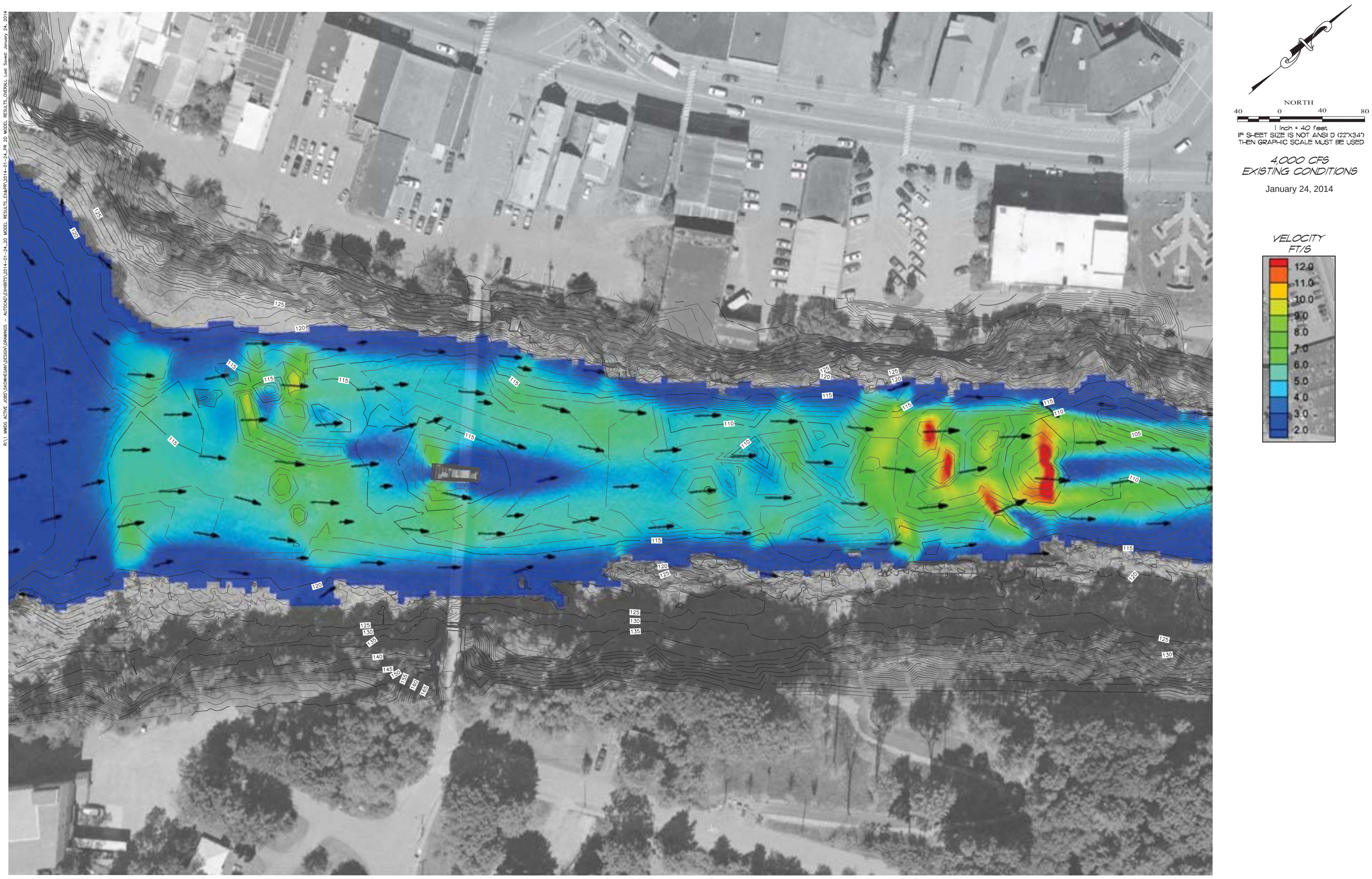


1 inch = 40 feet
IF SHEET SIZE IS NOT ANSI D (22"X34")
THEN GRAPHIC SCALE MUST BE USED

2,700 CFS
PROPOSED CONDITIONS

January 24, 2014

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1 inch = 40 feet
IF SHEET SIZE IS NOT ANSI D (22"X34")
THEN GRAPHIC SCALE MUST BE USED
4,000 CFS
EXISTING CONDITIONS
January 24, 2014
VELOCITY
FT/S
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10.0
9.0
8.0
7.0
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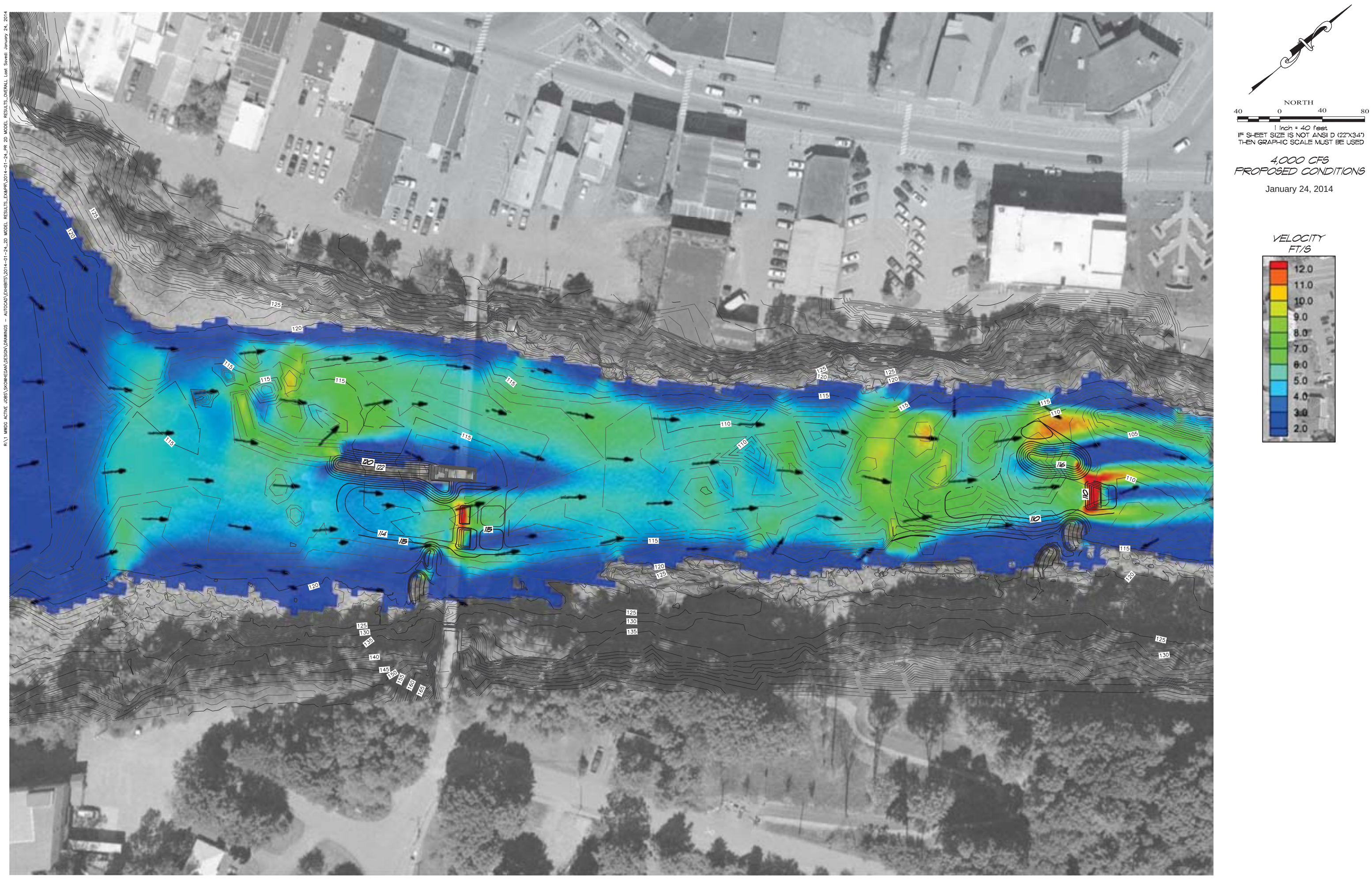
5.0
4.0
3.0
2.0


NORTH
40 0 40 80
1 inch = 40 feet
IF SHEET SIZE IS NOT ANSI D (22"X34")
THEN GRAPHIC SCALE MUST BE USED
4,000 CFS
PROPOSED CONDITIONS
January 24, 2014
VELOCITY
FT/S
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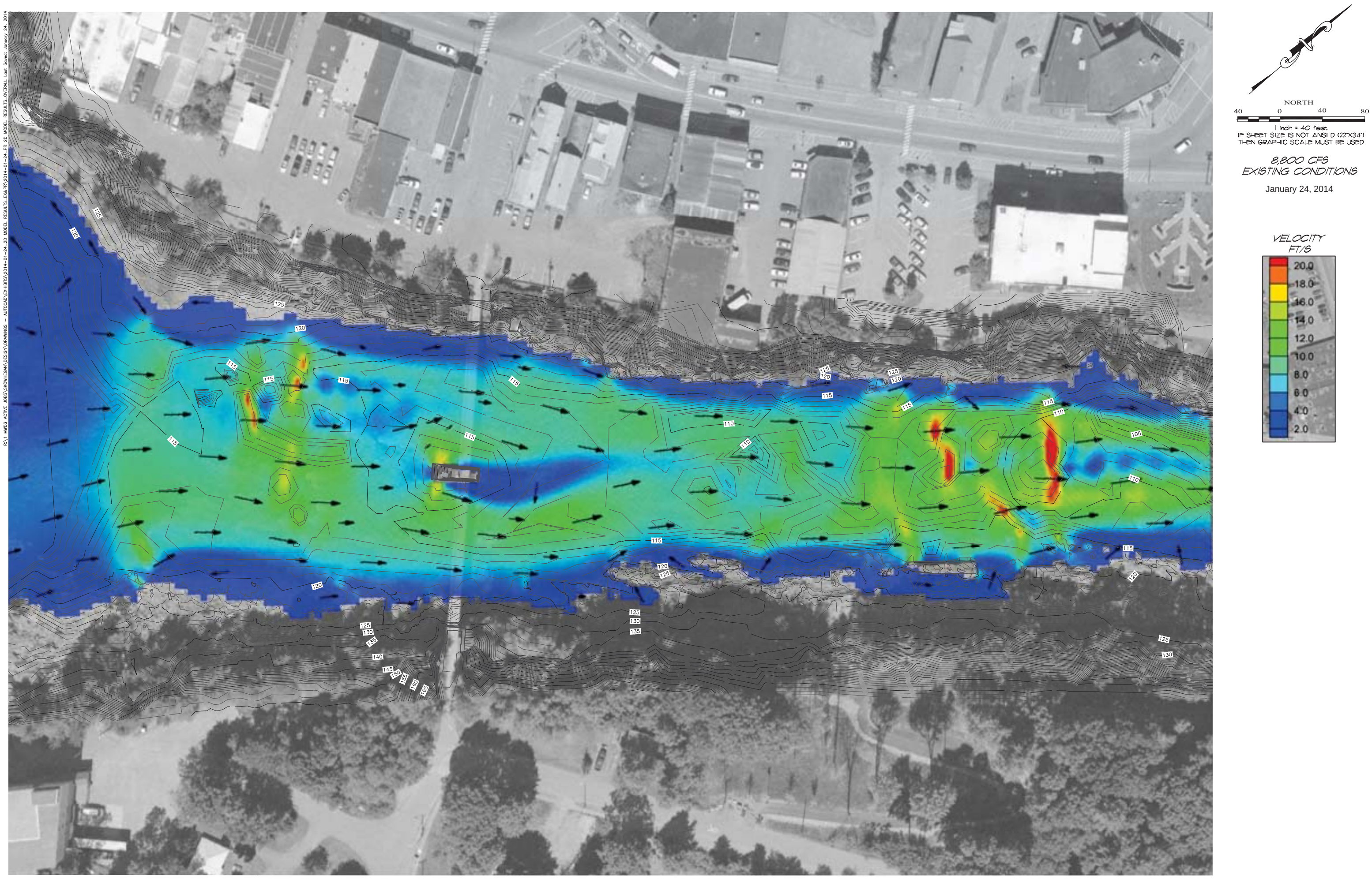
4.0
3.0
2.0


NORTH
40 0 40 80
1 inch = 40 feet
IF SHEET SIZE IS NOT ANSI D (22"X34")
THEN GRAPHIC SCALE MUST BE USED
8,800 CFS
EXISTING CONDITIONS
January 24, 2014
VELOCITY
FT/S
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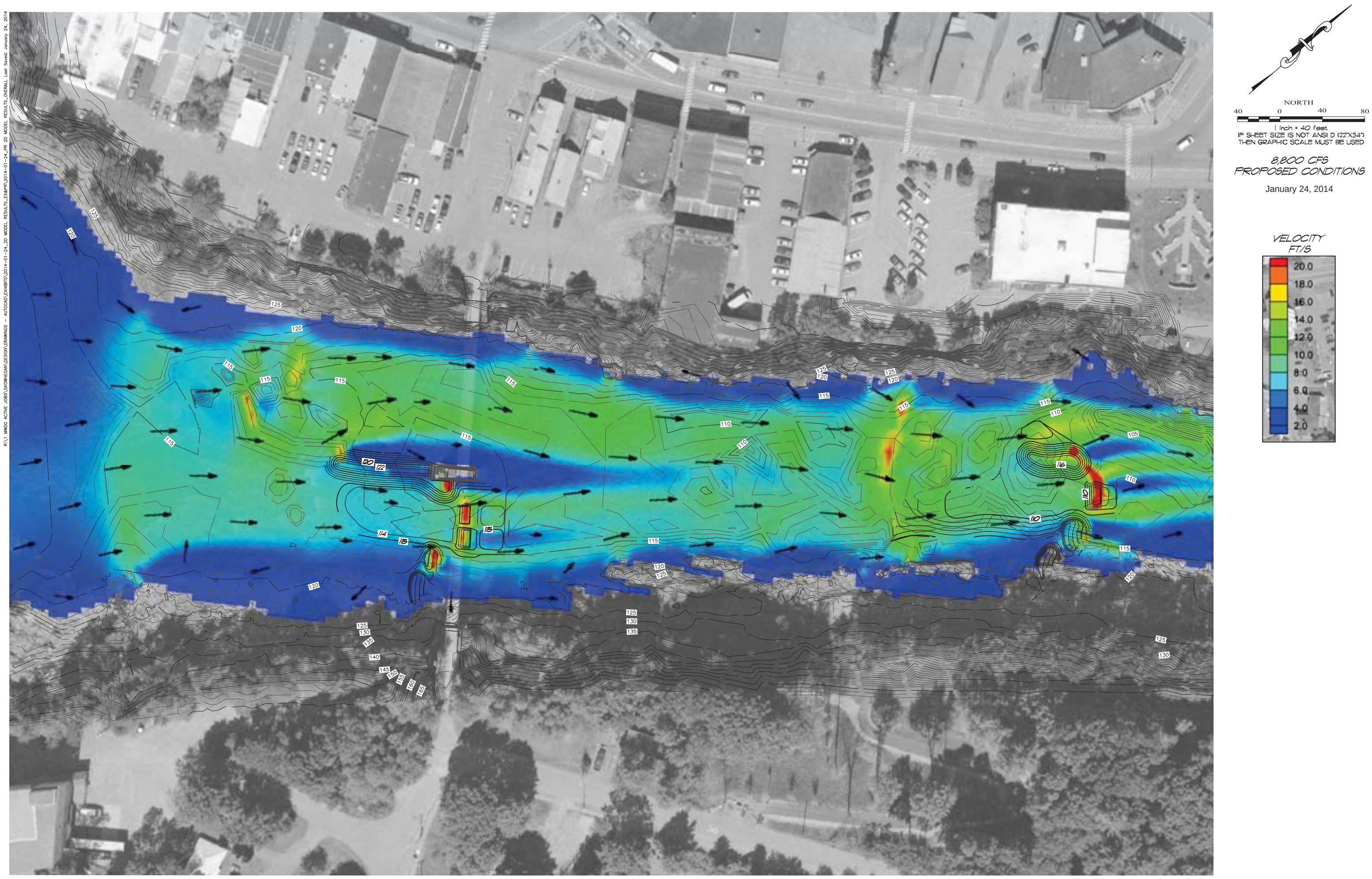
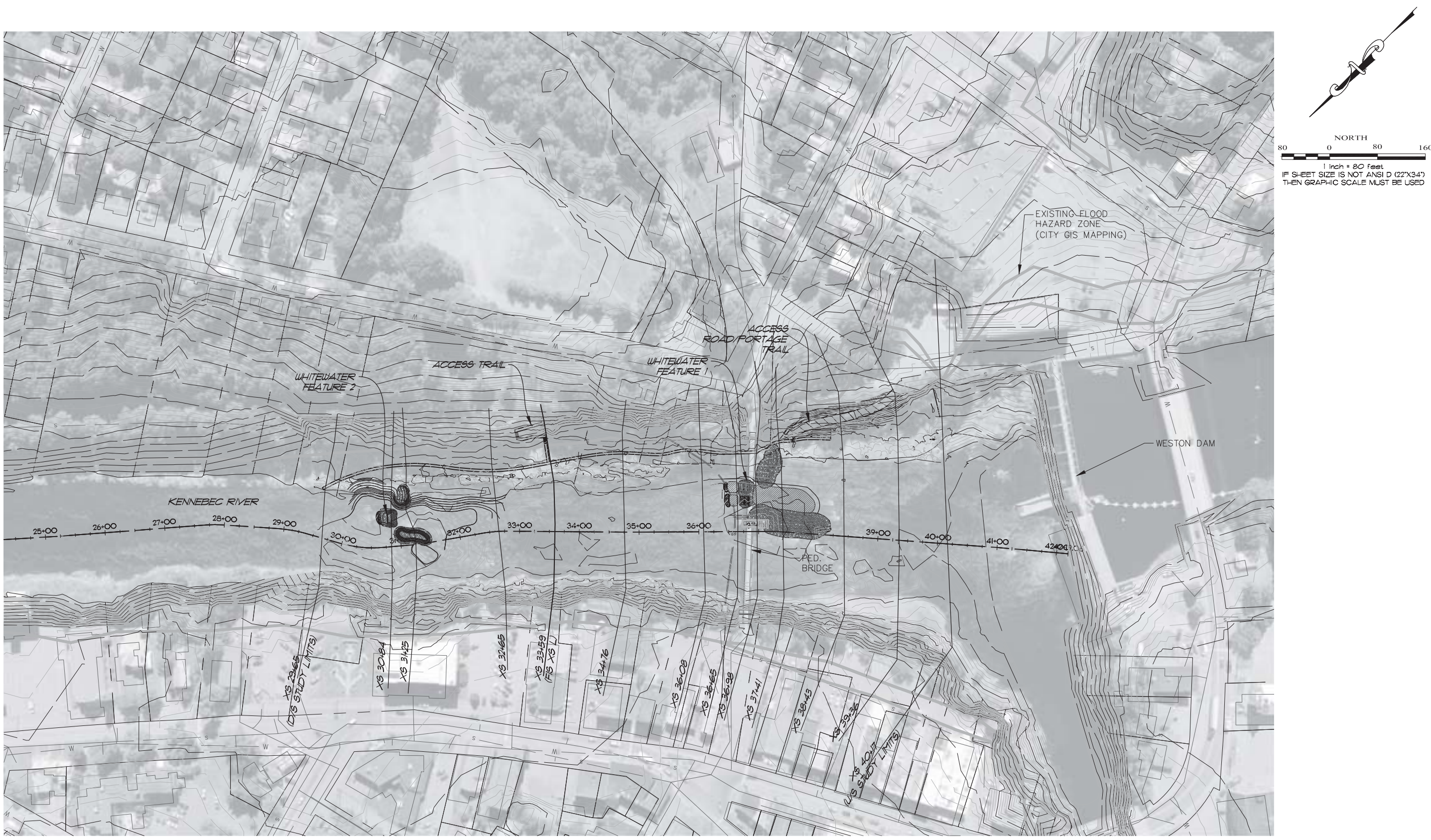
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0



8,800 CFS
PROPOSED CONDITIONS

January 24, 2014



PRELIMINARY

Number	Revision Description	By	Date

TOWN OF SKOWHEGAN, MAINE

RUN OF RIVER WHITEWATER PROJECT

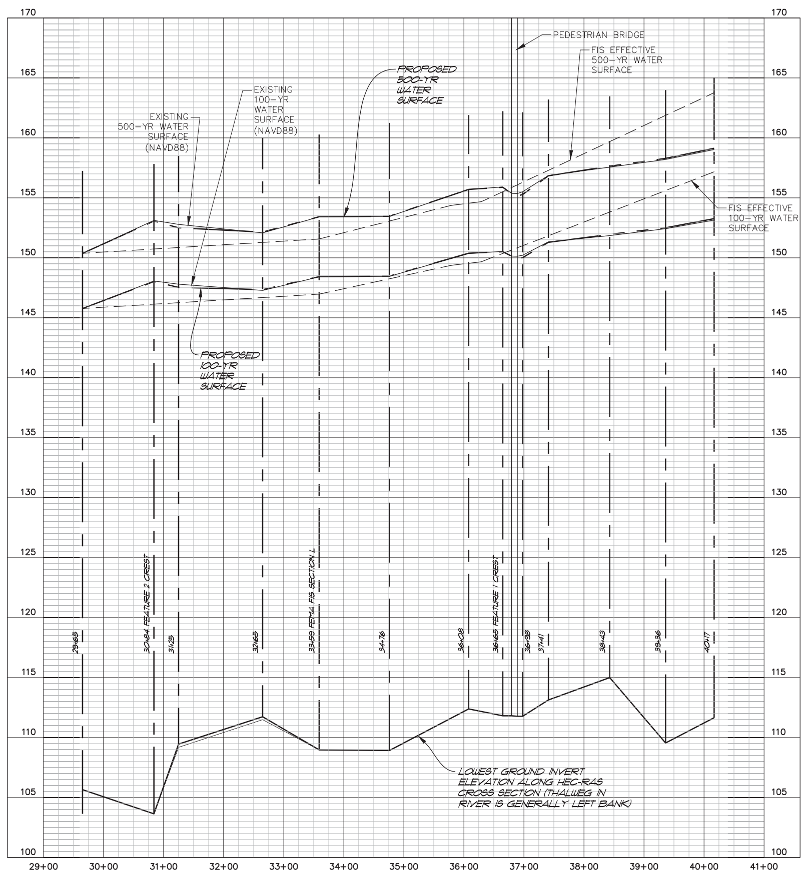
FLOOD STUDY
PLAN

McLaughlin Whitewater design group
2420 Alcott St
Denver, CO 80211
T303.964.3333
F303.964.3355

DESIGN: BAN, REM
DETAIL: ADR
CHECK: BAN
DATE: JANUARY, 2014

PROJECT NUMBER
65417486

Drawing Number:
1



PRELIMINARY

Number	Revision Description	By	Date

TOWN OF SKOWHEGAN, MAINE

RUN OF RIVER WHITEWATER PROJECT

FLOOD PROFILES

McLaughlin Whitewater Design Group
2420 Alcott St
Denver, CO 80211
T303.964.3333
F303.964.3355

DESIGN: BAN, REM
DETAIL: ADR
CHECK: BAN
DATE: JANUARY, 2014

PROJECT NUMBER
65417486

Drawing Number:
2

R:\1 MWDG ACTIVE JOBS\SKOWHEGAN\DESIGN\DRAWINGS - AUTOCAD\PRELIMINARY\DESIGN Last Saved: January 30, 2014

PART 8 APPENDIXES

1. Engineer’s Opinion of Probable Costs
2. International Scale of Whitewater Difficulty
3. Bathymetric Survey Data Collection Methods
4. Hydrologic Data
5. Public Presentations

Appendix 1 Engineer's Opinion of Probable Construction Costs

Skowhegan Run of River Project

Engineer's Opinion of Probable Construction Cost
Preliminary Design

31-Jan-14	Quan	Units	Unit Cost	Cost	Notes / Assumptions
Upper Rapid					
Dewatering + Access					Assumes protection to 4000cfs flow level
Dewatering berm, install & remove	3200	cy	$ 85	$ 272,000	25'w x 10'h x 560'l
Grout for Coffer Surface Armoring	685	cy	$ 150	$ 102,750	12"t surface layer grout all surfaces
water control	1	lump sum	$ 100,000	$ 100,000	pumping & sediment basin/water treatment
access road along river right install and remove	225	cy	$ 60	$ 13,500	400'x15' wide x 1' thick
site restoration	1	lump sum	$ 20,000	$ 20,000	
River Structures					
Divider Island - Boulders (imported)	1000	cy	$ 165	$ 165,000	Includes side constriction river right + 3' overburden removal
Divider Island - Grout	300	cy	$ 220	$ 66,000	30% of divider island volume - fill voids
WW feature 1: stream obstacles- conc.	45	cy	$ 500	$ 22,500	400 sf x 3't
WW feature 1: Boulders (imported)	90	cy	$ 165	$ 14,850	400 sf x 6't
WW feature 1: Grout	30	cy	$ 220	$ 6,600	30% of boulder volume
Wave kickers (2)	2	ea	$ 10,000	$ 20,000	rein. conc.
Side Constrictions (river right) (2) - boulders (imported)	135	cy	$ 100	$ 13,500	1200 sf x 3't
Side Constrictions (river right) (2) - grout	40	cy	$ 220	$ 8,800	30% of boulder volume
Excavation in D/S & U/S zones	400	cy	$ 25	$ 10,000	from ACAD
Rock anchors	100	ea	$ 200	$ 20,000	
Wave Kicker adjustability (optional)	1	lump sum	$ 75,000	$ 75,000	performance waves
Tuning	1	lump sum	$ 50,000	$ 50,000	TBD during startup of course
Land Improvements					
Access road grading from parking to river	360	cy	$ 25	$ 9,000	Volumes from ACAD (fill: 360cy)
rock cut	425	cy	$ 50	$ 21,250	Volumes from ACAD (cut: 425cy)
Access road stabilization - Grout	100	cy	$ 220	$ 22,000	30% fill volume
terraced seating	55	cy	$ 500	$ 27,500	500 sd x 3' quarried,faced rock
Foot trail from Debe Park	1	lump sum	$ 15,000	$ 15,000	narrow foot trail on grade with minor steps and excavation
Foot trail along river	2200	sf	$ 10	$ 22,000	4'w trail cut into rock/filled with concrete
Sub Total				***$ 1,097,250***	
General Conditions (5%)				$ 54,863	
Overhead & Profit (15%)				$ 172,817	
Sub Total				***$ 1,324,929***	
Contingency 30%				$ 397,479	
Total Construction (rounded)				***$ 1,720,000***	

Assumptions (Upper Rapid)
Landscaping by others
Costs do not include easement or property acquition costs
Event: spectator services, viewing stands platforms, NIC
Favorable flow conditions in the river - 4,000cfs or below
Schedule,permitting, etc as outlined in 2/8/11 letter
Favorable Bidding Conditions

31-Jan-14	Quan	Units	Unit Cost	Cost	Notes / Assumptions
Middle Rapid					
Dewatering + Access					assumes protection to 4,000 cfs
Dewatering berm, install & remove	5000	cy	$ 85	$ 425,000	37'w x 16't x 400'l
Grout for Coffer Surface Armoring	750	cy	$ 150	$ 112,500	12" over coffer surface
water control	1	lump sum	$ 100,000	$ 100,000	pumping & sediment basin/water treatment
access road from bottom of ramp to features	460	cy	$ 60	$ 27,600	550x15'wide x 1.5' thick
site restoration	1	lump sum	$ 20,000	$ 20,000	
River Structures					
Divider Island - Boulders (imported)	350	cy	$ 165	$ 57,750	6't x 1000 sf + 3' overburden
Divider Island - Grout	100	cy	$ 220	$ 22,000	30% of boulder volume
WW feature 2: Boulders (imported)	100	cy	$ 165	$ 16,500	from ACAD
WW feature 2: Grout	30	cy	$ 220	$ 6,600	30% of boulder volume
Side Constriction (river right) - boulders (imported)	110	cy	$ 100	$ 11,000	from ACAD
Side Constriction (river right) - grout	35	cy	$ 220	$ 7,700	30% of boulder volume
Excavation in D/S & U/S zones	850	cy	$ 50	$ 42,500	from ACAD
Rock anchors	75	ea	$ 200	$ 15,000	
Wave Kicker adjustability (optional)	1	lump sum	$ 75,000	$ 75,000	recommended for high performance waves
Tuning	1	lump sum	$ 50,000	$ 50,000	TBD during startup of course
Land Improvements					
Foot trail along river	1600	sf	$ 10	$ 16,000	4'w trail cut into rock/filled with concrete
Sub Total				***$ 1,005,150***	
General Conditions (5%)				$ 50,258	
Overhead & Profit (15%)				$ 158,311	
Sub Total				***$ 1,213,719***	
Contingency 30%				$ 364,116	
Total Construction (rounded)				***$ 1,580,000***	

Assumptions (Middle Rapid)
Whitewater feature 1 is built including access into the gorge
Costs do not include easement or property acquition costs
Event: spectator services, viewing stands platforms, NIC
Favorable flow conditions in the river - 4,000cfs or below
Schedule,permitting, etc as outlined in 2/8/11 letter
Favorable Bidding Conditions

31-Jan-14	Quan	Units	Unit Cost	Cost	Notes / Assumptions
Lower Rapid - Concept Design Level					
Access Roads + Dewatering					
coffer dams install and remove	1500	cy	$ 85	$ 127,500	4600sf 8' tall
Grout for Coffer Surface Armoring	250	cy	$ 150	$ 37,500	12" over coffer surface
water control	1	lump	$ 60,000	$ 60,000	pumping & sediment basin/water treatment
access road from treatment plant install + remove	450	cy	$ 60	$ 27,000	300x20'wide x 2' thick
site restoration	1	lump sum	$ 20,000	$ 20,000	
River Structures - Approximated quantities to be further refined during preliminary design					
Mid stream obstacles(2) - boulders	300	cy	$ 165	$ 49,500	2- boulder outcorppings upstream of pipe
Mid stream obstacles(2) - grout	100	cy	$ 220	$ 22,000	30% of boulder volume
Rein Conc. steps d.s. of pipe (Hazard mitigation)	40	cy	$ 750	$ 30,000	500 sf x2' thick
precast conc blocks, installed	30	ea	$ 500	$ 15,000	
Hazard mitigation @ pipe - boulders	500	cy	$ 165	$ 82,500	mitigate hazard
Hazard mitigation @ pipe - grout	200	cy	$ 220	$ 44,000	30% of boulder volume
Tuning activities	1	lump sum	$ 30,000	$ 30,000	
Rock Anchors	25	ea	$ 200	$ 5,000	
Land Improvements					
trail improvements	500	lf	$ 10	$ 5,000	
Sub Total				***$ 555,000***	
General Conditions (5%)				$ 27,750	
Overhead & Profit (15%)				$ 87,413	
Sub Total				***$ 670,163***	
Contingency 50%				$ 335,081	
Total Construction (rounded)				***$ 1,010,000***	

Assumptions (Lower Rapid)
Cooperation with WWTP for construction access
Costs do not include easement or property acquition costs
Event: spectator services, viewing stands platforms, NIC
Favorable flow conditions in the river - 4,000cfs or below
Schedule,permitting, etc as outlined in 2/8/11 letter
Favorable Bidding Conditions

Appendix 2 International Scale of Whitewater Difficulty

Class I: Easy. Fast moving water with riffles and small waves. Few obstructions, all obvious and easily missed with little training. Risk to swimmers is slight; self-rescue is easy.

Class II: Novice. Straightforward rapids with wide, clear channels which are evident without scouting. Occasional maneuvering may be required, but rocks and medium sized waves are easily missed by trained paddlers. Swimmers are seldom injured and group assistance, while helpful, is seldom needed. Rapids that are at the upper end of this difficulty range are designated "Class II+".

Class III: Intermediate. Rapids with moderate, irregular waves which may be difficult to avoid and which can swamp an open canoe. Complex maneuvers in fast current and good boat control in tight passages or around ledges are often required; large waves or strainers may be present but are easily avoided. Strong eddies and powerful current effects can be found, particularly on large-volume rivers. Scouting is advisable for inexperienced parties. Injuries while swimming are rare; self-rescue is usually easy but group assistance may be required to avoid long swims. Rapids that are at the lower or upper end of this difficulty range are designated "Class III-" or "Class III+" respectively.

Class IV: Advanced. Intense, powerful but predictable rapids requiring precise boat handling in turbulent water. Depending on the character of the river, it may feature large, unavoidable waves and holes or constricted passages demanding fast maneuvers under pressure. A fast, reliable eddy turn may be needed to initiate maneuvers, scout rapids, or rest. Rapids may require “must'' moves above dangerous hazards. Scouting may be necessary the first time down. Risk of injury to swimmers is moderate to high, and water conditions may make self-rescue difficult. Group assistance for rescue is often essential but requires practiced skills. A strong Eskimo roll is highly recommended. Rapids that are at the upper end of this difficulty range are designated "Class IV-" or "Class IV+" respectively.

Class V: Expert. Extremely long, obstructed, or very violent rapids which expose a paddler to added risk. Drops may contain large, unavoidable waves and holes or steep, congested chutes with complex, demanding routes. Rapids may continue for long distances between pools, demanding a high level of fitness. What eddies exist may be small, turbulent, or difficult to reach. At the high end of the scale, several of these factors may be combined. Scouting is Recommended but may be difficult. Swims are dangerous, and rescue is often difficult even for experts. A very reliable Eskimo roll, proper equipment, extensive experience, and practiced rescue skills are essential. Because of the large range of difficulty that exists beyond Class IV, Class V is an open ended, multiple level scale designated by Class 5.0, 5.1, 5.2, etc... Each of these levels is an order of magnitude more difficult than the last. Example: Increasing difficulty from Class 5.0 to class 5.1 is a similar order of magnitude as increasing from Class IV to Class V.

Class VI: Extreme and Exploratory. These runs have almost never been attempted and often exemplify the extremes of difficulty, unpredictability and danger. The consequences of errors are very severe and rescue may be impossible. For teams of experts only, at favorable water levels, after close personal inspection and taking all precautions. After a Class VI rapids has been run many times, It's rating may be changed to an appropriate Class 5.x rating.

Developed by American Whitewater for rating of rivers for private (non commercial) boating. Does not necessarily apply to professionally guided rafting.

Appendix 3 Bathymetric Survey Data Collection Methods

MEMORANDUM

TO: John Anderson, McLaughlin Whitewater Group

FROM: Jennifer Austin, Kleinschmidt

CC:

DATE: November 22, 2013

RE: Skowhegan Gorge Bathymetric Survey

This memo is to serve as documentation of Kleinschmidt's efforts to provide you with bathymetric data within the approximately 1,100 foot reach of the Kennebec River below Weston Dam.

Initially, Kleinschmidt proposed to collect the data using a boat-mounted SonarMite single beam echosounder (SBES) that integrated with a Trimble Global Navigation Satellite System (GNSS) receiver & datalogger. The intent was to traverse the study area in a raft, using a two-meter grid, for development of contours of the study area.

During the fall of 2012, this process was attempted on two occasions corresponding to two river flows. On October 18, 2012, a field crew collected data in the tailrace of Weston Dam when flows were approximately 6,000 cubic feet per second (cfs). This high flow seemed prudent for data collection as the majority of the rapids appeared, from shore, to be washed out and navigable for the most of the study area. It was expected there would be significant turbulence in the tailrace due to the nature of the water converging from the spillway and the powerhouse.

The high flow proved to be difficult to traverse the channel as safety concerns arose and the crew felt capsizing during these conditions was a real possibility. The remainder of the field effort was abandoned on that day.

On November 29, 2012, a second field crew attempted data collection in the channel using a larger raft and motor with flows at approximately 5,000 cfs. At the lower flow, the channel was navigable in the direction of flow, but not across the flow. Again, safety concerns arose due to the water temperature and strong flows and so this second effort was abandoned. In addition to this effort, the approach to use the echosounder was abandoned.

Over the winter months, Kleinschmidt teamed with Sackett & Brake surveyors, to propose a more traditional survey method of running transects across the river and collect depths with a weight and segmented chain and then record depths by traditional survey method of instrument and rod. As this method required the low flows, in order to steady the boat long enough to collect the data, the survey effort was halted until the dam operator could provide the lowest possible steady outflow from the dam.

On October 25, 2013, the survey crew navigated the majority of the channel from the tailrace approximately 1,200 feet downstream using the revised survey method. On this day, the flows in the river were approximately 2,800 cfs. The intent was to collect data within the study area in a five-meter grid pattern, which would have been sufficient to produce two-foot contours of the river bottom. Again, river conditions proved to be difficult for navigation due to the riffles at the day's flow and three pockets within the river were inaccessible. The data that collected was in approximately a 15-meter grid.

Following this third effort, two sets of data products were produced; each containing a text file of elevation points and a Civil 3D drawing file of a TIN created from the text file married with the aerial survey from August of 2012. One data set was only the data that collected on October 25, 2013. The second data set was all points collected over the three survey days.

As I had indicated in an e-mail to you and Ben Nielsen on November 1, 2013, because of the areas that were inaccessible for survey, the data are not accurate enough to support development of the two-foot contours within the channel.

Appendix 4 Hydrologic Gage Data

The following gages were used in calculating flow at the project site. Records from 1987 to 2011 were downloaded and sorted to arrive at the exceedance table on the following page. The electronic data is available in the project folders in Excel format.

Sandy River Gage Information

USGS 01048000 Sandy River near Mercer, Maine
Available data for this site
Stream Site
DESCRIPTION:
Latitude 44°42'29", Longitude 69°56'15"
NAD83
Somerset County, Maine, Hydrologic Unit
01030003
Drainage area: 516 square miles
Contributing drainage area: 516 square miles,
Datum of gage: 197.10 feet above NGVD29.

Bingham Gage Data

USGS 01046500 Kennebec River at Bingham,
Maine
Available data for this site
Somerset County, Maine
Hydrologic Unit Code 01030003
Latitude 45°03'07", Longitude 69°53'08"
NAD83
Drainage area 2,715 square miles
Contributing drainage area 2,715 square miles
Gage datum 330.20 feet above NGVD29

Carrabassett River Gage Information

USGS 01047000 Carrabassett River near North Anson, Maine
Available data for this site
Stream Site
http://waterdata.usgs.gov/nwis/nwisman/?site_no=01047000
DESCRIPTION:
Latitude 44°52'09", Longitude 69°57'18" NAD83
Somerset County, Maine, Hydrologic Unit 01030003
Drainage area: 353 square miles
Contributing drainage area: 353 square miles,
Datum of gage: 303.30 feet above NGVD29.

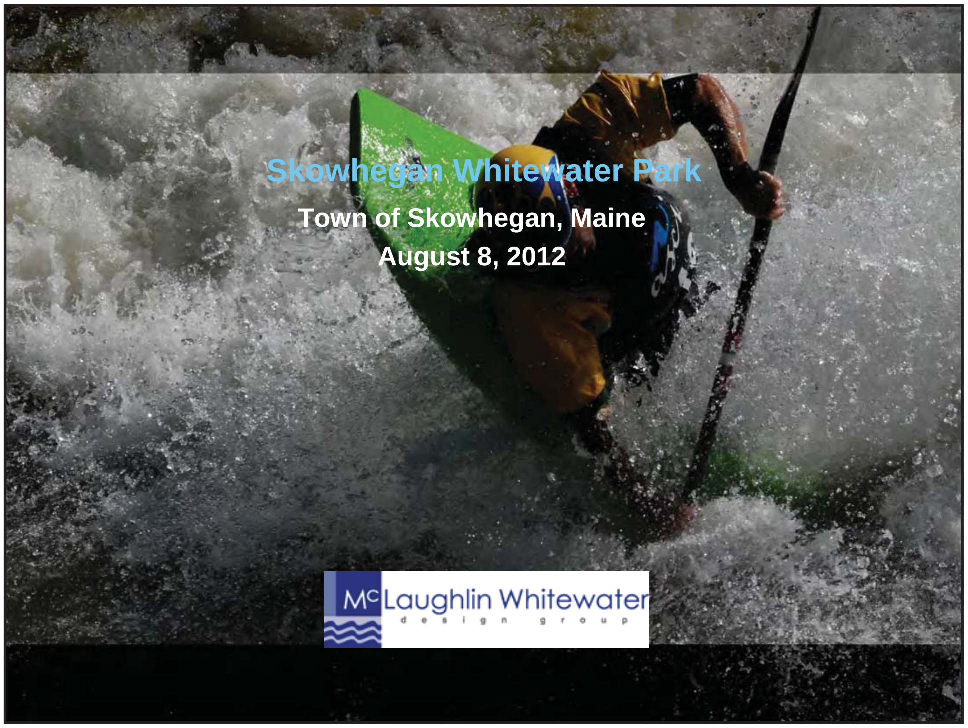
	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
85th percentile	7599	7918	10150	24420	19033	9776	6083	5613	5222	8008	12761	9753
50th percentile (median)	5911	6186	6794	10974	7798	5254	3928	3262	3746	4201	5961	5720
15th percentile	3479	4441	4010	5948	4511	3598	2709	2422	2517	2855	3051	3127

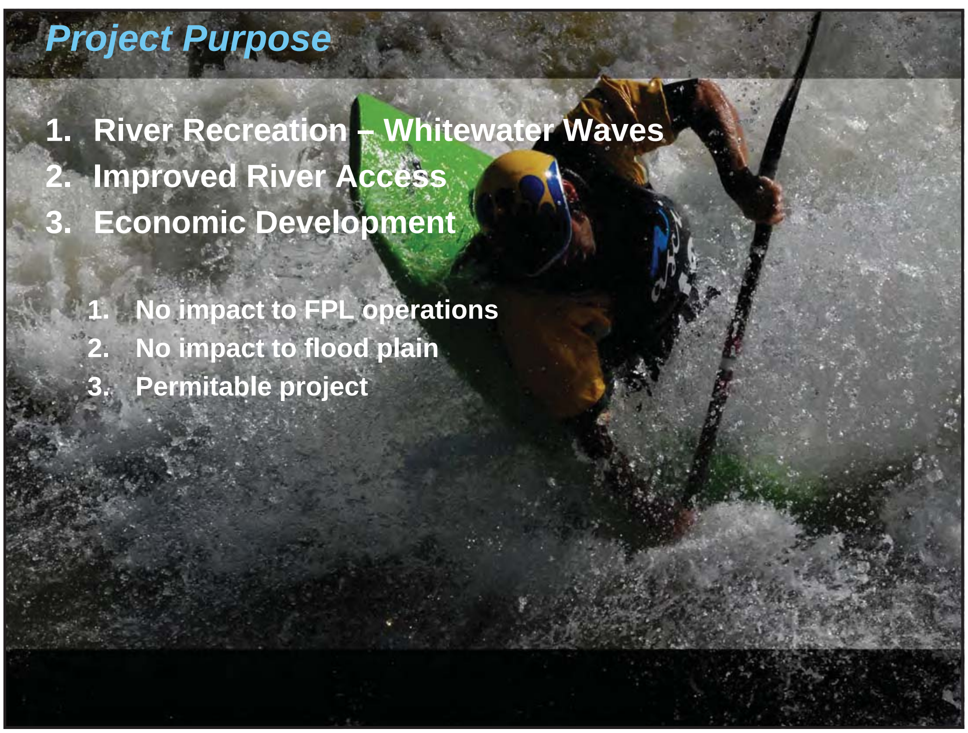
Combined Flow Exceedance table, all three sites, proportioned to additional drainage at Weston Dam (plus 8 percent).

Appendix 5 Public Presentations

August, 2012

February 2013


Skowhegan Whitewater Park
Town of Skowhegan, Maine
August 8, 2012
McLaughlin Whitewater
design group


Project Purpose
1. River Recreation – Whitewater Waves
2. Improved River Access
3. Economic Development
1. No impact to FPL operations
2. No impact to flood plain
3. Permitable project

Project Scope

- Additional mapping/batyhymetric survey
- Conceptual design
- Hydraulic modeling
  - 1 Dimensional model for flood impacts
  - 2 Dimensional model for whitewater features
- Preliminary design and cost estimate
- Artist's rendering

Economic Impact of Whitewater

Confluence Park,
South Platte River
Denver Colorado

- Before (1966):

Today: centerpiece for sports stadiums, amusement park, residences, and "walkable" retail

Confluence Area, Denver Return on Investment

Project Funding

•	Public	$ 55 m
•	Private/Corporate	15 m
	Cost to Date	$ 70 m

Private Investment

•	Coors Field	$ 220 m
•	Pepsi Center	175 m
•	Invesco Field	350 m
•	R.E.I.	35 m
•	Six Flags Elitch Gardens	110 m
•	Aquarium, Children's Museum	120 m
•	Residential Development	3 billion
	Investment to Date	$ 4 billion

Source: South Platte River Greenway Central Platte Valley Investment Summary (10/06)

Whitewater can be part in town's image and a major attraction for visitors

TRAVEL

THE MILE HIGH CITY

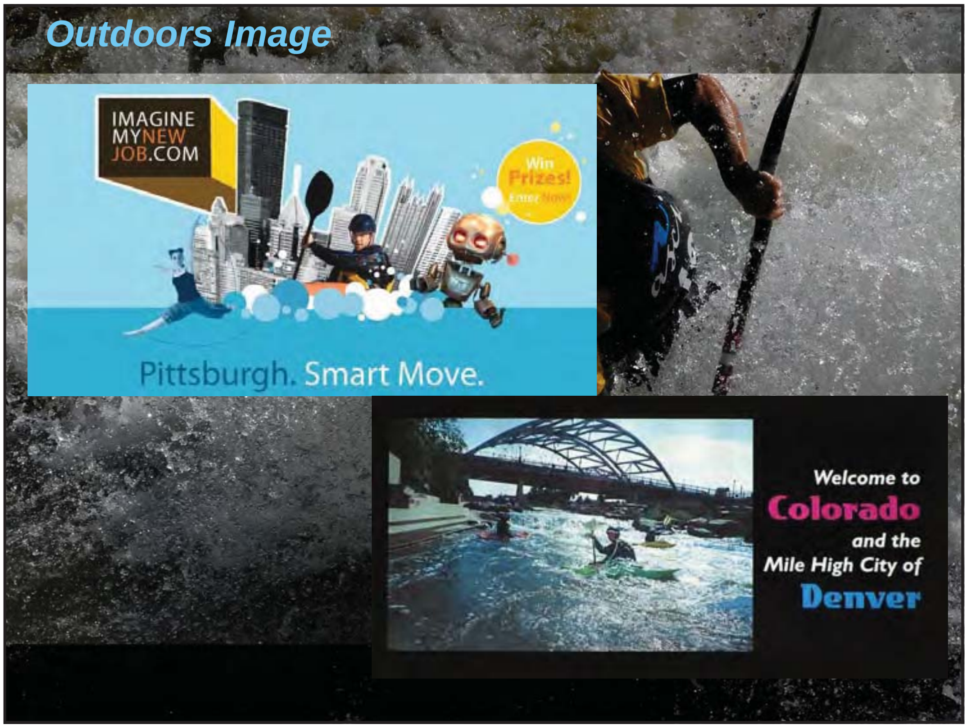
Denver has a lot to offer for frugal travelers

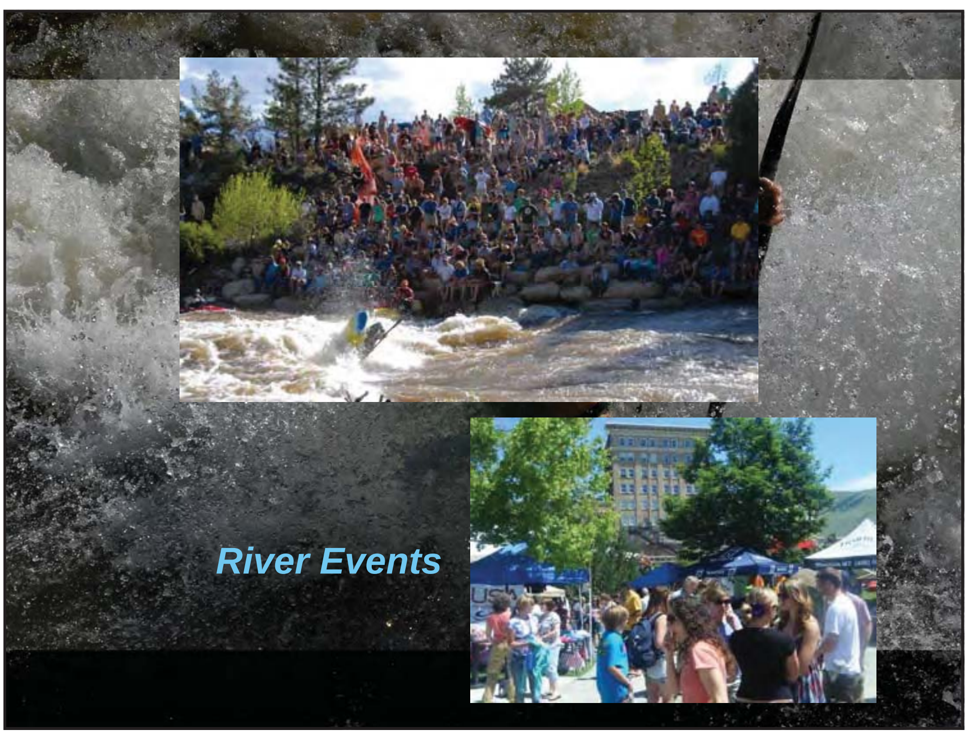
Park goers watch from the banks of the Platte River at Confluence Park in Denver as a couple of kayakers make their way through the white water. Denver has more than 200 parks, rivers and trail areas, public golf courses and recreation centers.

Getting around

Food and drink

Where to stay


Outdoors Image
IMAGINE
MYNEW
JOB.COM
Win
Prizes!
Enter Now!
Pittsburgh. Smart Move.
Welcome to
Colorado
and the
Mile High City of
Denver


River Events

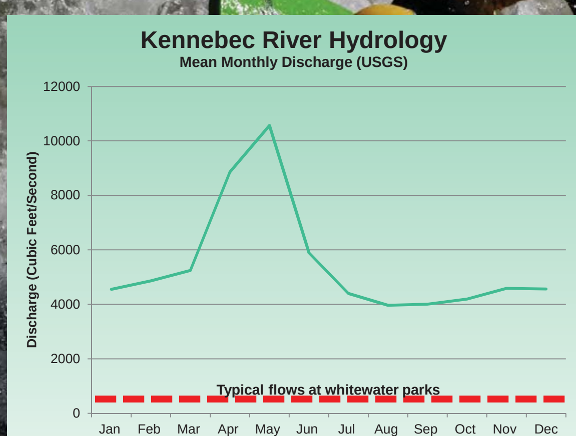

families, kids,
and visitors


Anatomy of a Whitewater Play Spot
• Retentive wave or "hole"
• Constrictions to focus flow and power
• Eddies
• Access
– Physical access
– Visual access

Whitewater Fundamentals

- Flow
- Gradient or Drop
- Access
- Location (economic development)

Kennebec River Hydrology



Importance of Access

- Construction and constructability
- Self rescue
- Assisted rescue

Available Drop

- Photo of bridge site and big eddy

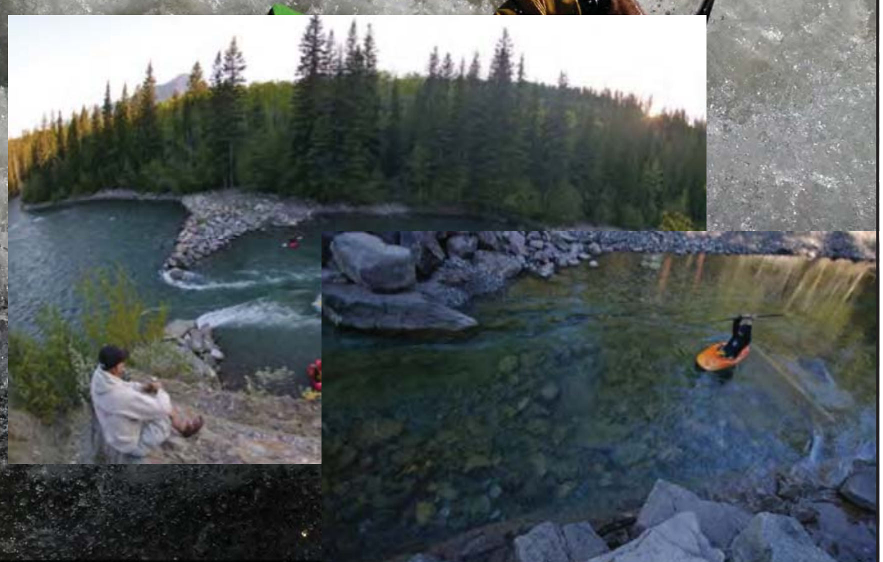
Debe Park Site

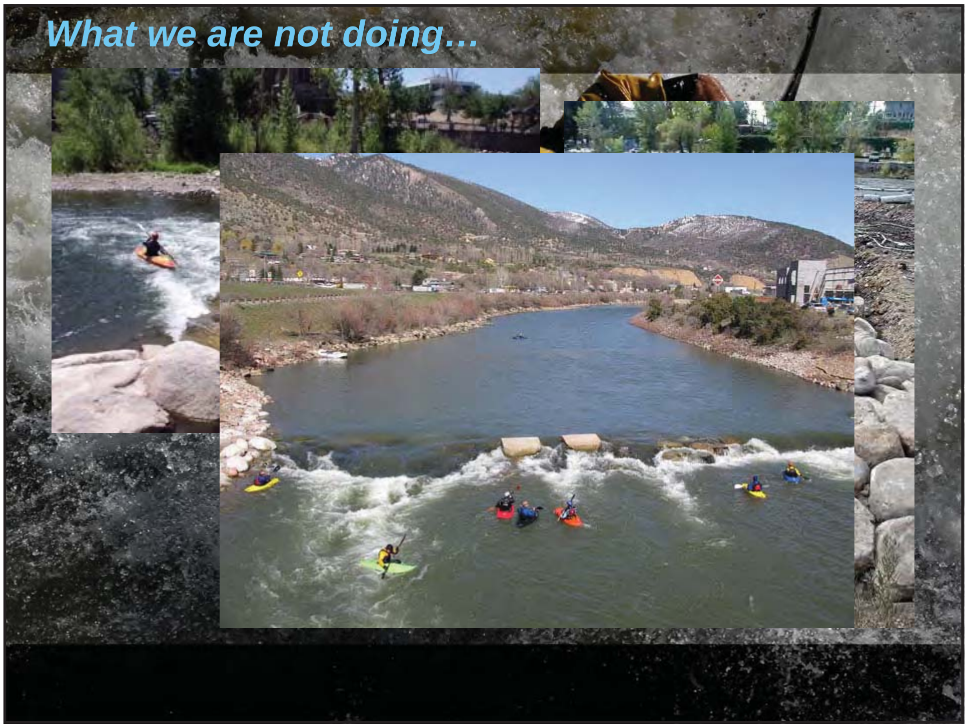
1. Improved access
   1. Spectators and participants
   2. Construction equipment
2. Steepest natural river gradient
3. Location – closest to downtown

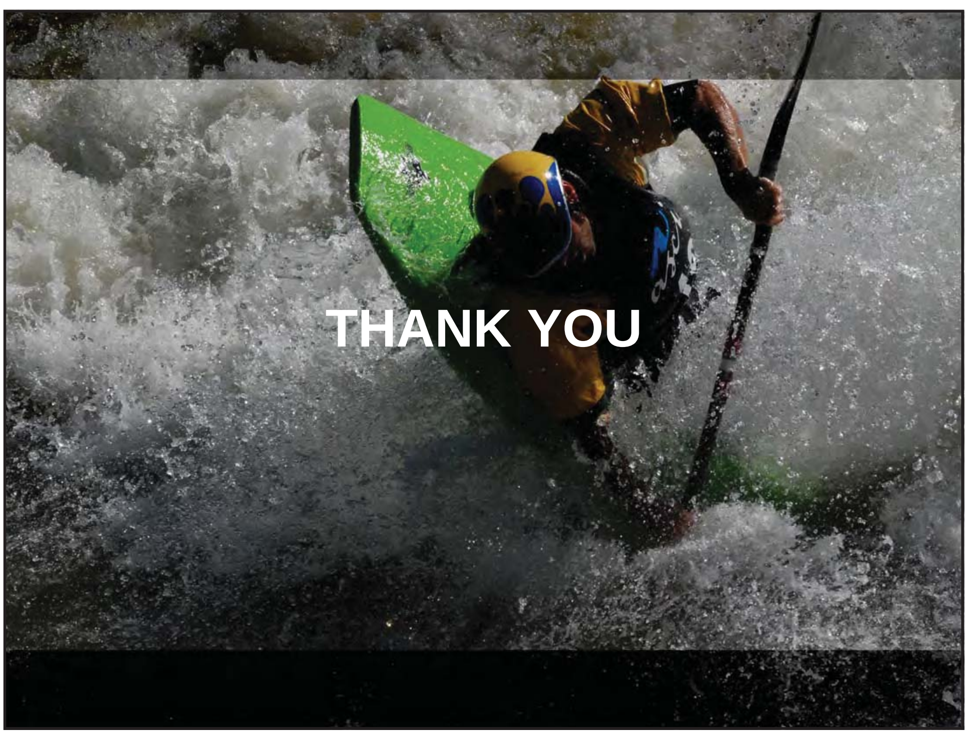
Sites Not Considered

1. Big Eddy/Treatment Plant
2. Coburn Park

Precedents – Kananaskas River, Alberta




What we are not doing…


THANK YOU

Enhance the River for the Community

Run of River Project

Presented to

Town of Skowhegan

February 26, 2012

McLaughlin Whitewater design group

MERRICK & COMPANY

McLaughlin Whitewater Design Group
A Division of Merrick & Company

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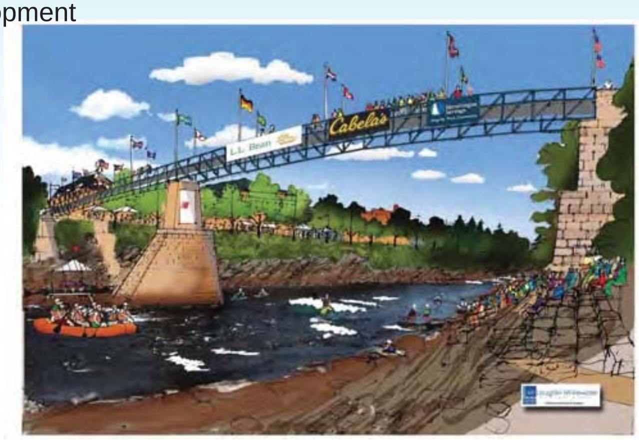
Project Purpose

- River Recreation – Whitewater Features
- Improve River Access
- Remove Debris in River
- Economic Development

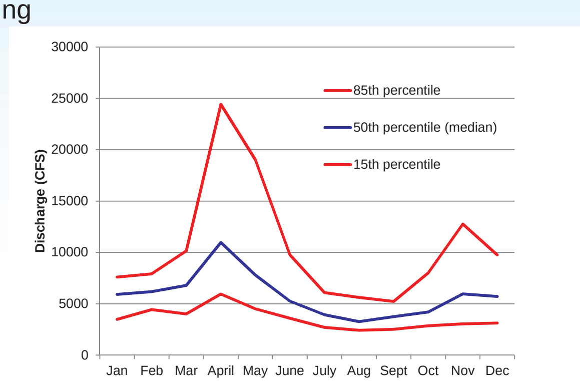


Project Constraints

- No impact to FPL operations
- No impact to flood plain
- Permitable project

Project Status

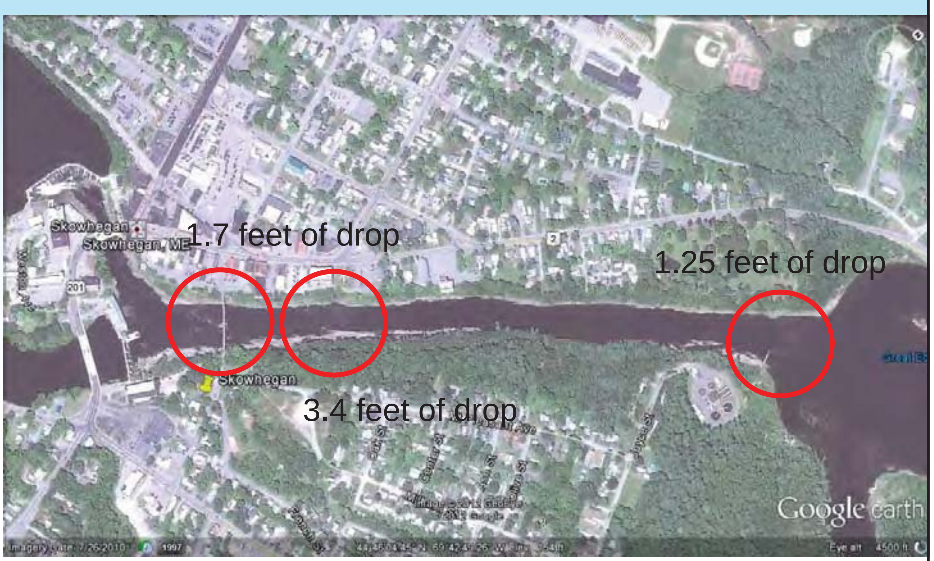
- Work Accomplished
  - Aerial Survey, Water Profiles
  - Conceptual Design
  - Artist's Rendering
  - Hydrology



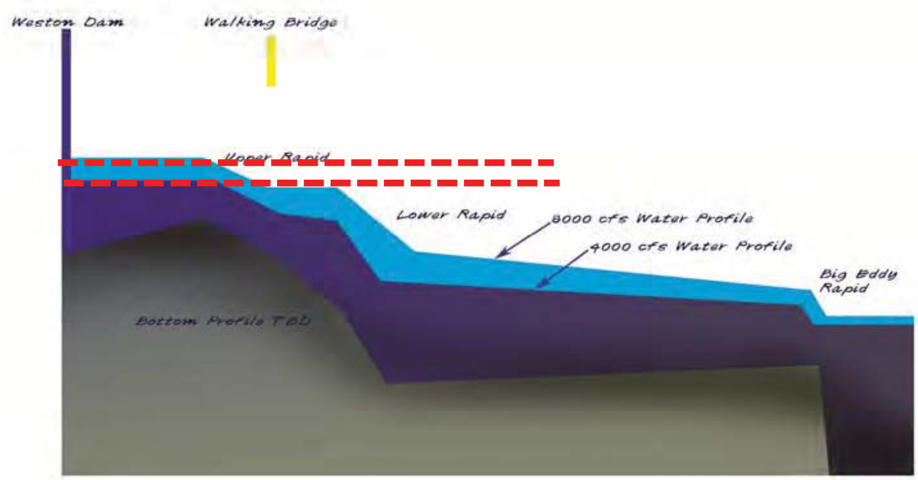
Project Status

- Current Work
  - Conceptual Design + Presentation
  - Initial Agency Consultation
- Work to be Completed – Spring/Summer 2013
  - Bathymetric survey
  - Hydraulic modeling
  - Preliminary design, cost estimate and report

Results of Survey



Results of Survey



Walking Bridge (upper) Rapid

Plus

- Closer to Central Business District & Viewing
- Less Expensive Construction Access
- Requires Construction on One Side of River (Economy + Permitting)

Minus

- Less Drop (1.7')
- Less Flow
- Cultural / Historical Resources
- Avoid Impacts to FPL

Middle Rapid

Plus

- More Drop (3.4')
- More Flow

Minus

- Further from Business District
- More $$ Construction Access
- More $$ Construction Dewatering

Lower Rapid

Plus

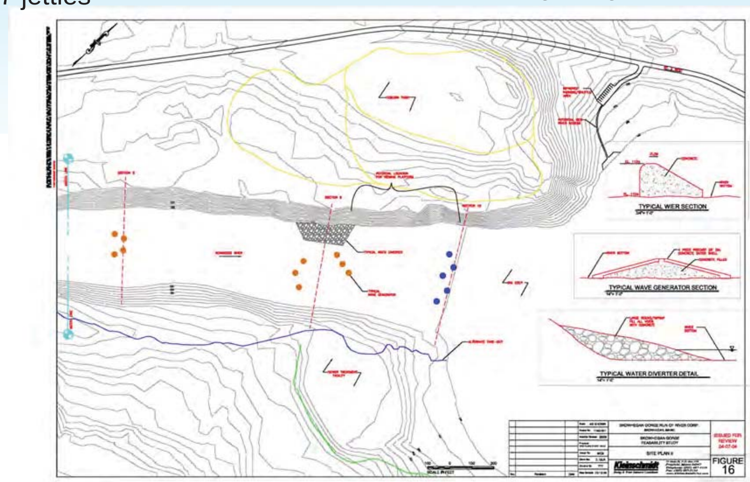
- More flow
- Good access

Minus

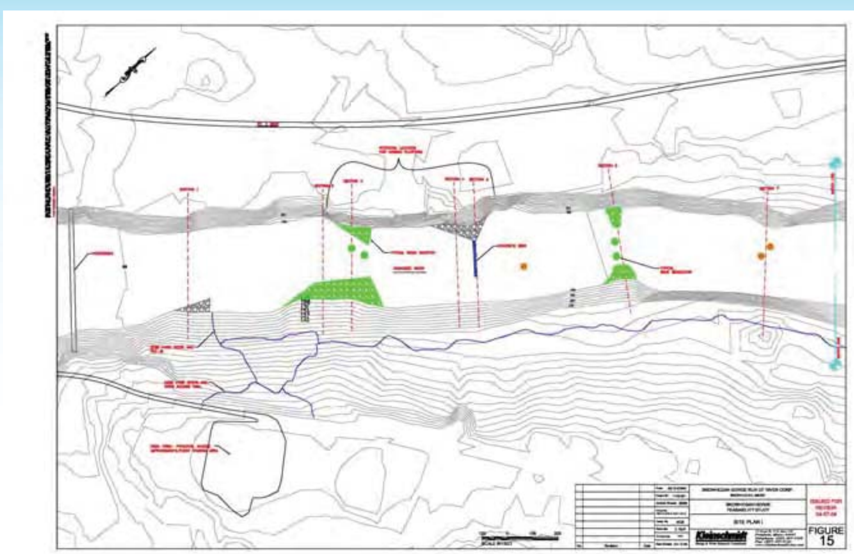
- Less drop (1.25')
- Further from Business District
- Good construction access
- Existing high water feature at pipeline

2004 Plan

- 3000–foot whitewater course
- 22 precast concrete obstacles
- 7 jetties
- 1 weir (partial width of river)
- Located entirely downstream of the walking bridge



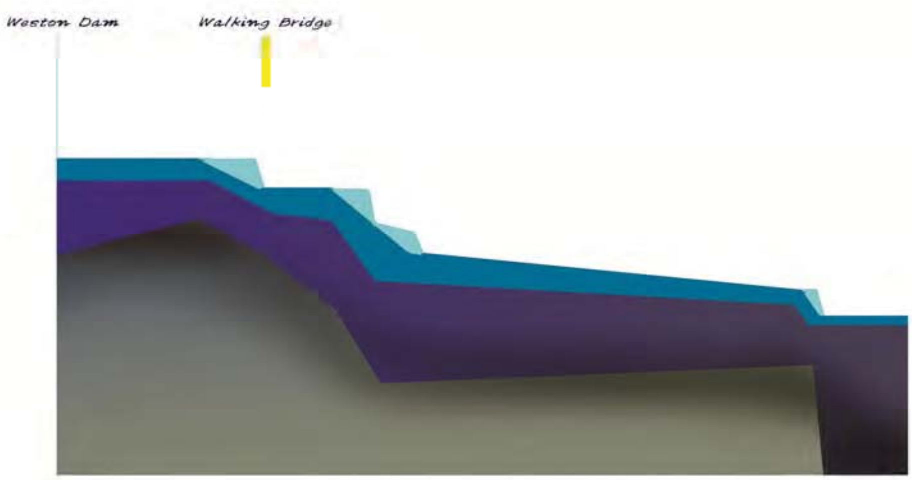
2004 Plan, upstream half



What we are not doing…

- River-wide weirs

What we are not doing…



What we are not doing…

- Movable vanes

What we are not doing…

- Modular plastic obstacles

Design Approach responds Site Conditions

- Large water volume
- Low gradient, featureless rapids without abrupt drops

Design Approach

- Big water features using ample river flow
- Low gradient drops of 1+ to 2 feet
- Use water velocity to create wave features, not abrupt drops
- Utilize only a portion of the river's width at any given flow
- Preserve shorelines for fish passage
- No construction on north side of river (lack of access)

Current Plan

- 3,000–foot whitewater course with 3 rapids
- Mid-stream obstacles, side jetties and islands to create attractive whitewater features
- Terraced seating for viewing
- Improved foot access

Precedents – Kananaskas River, Alberta

Natural Precedent – Storm Hole, Susquehanna River

"Catcher's Mitt" Concept – Upper Rapid

“Catcher’s Mitt” Concept

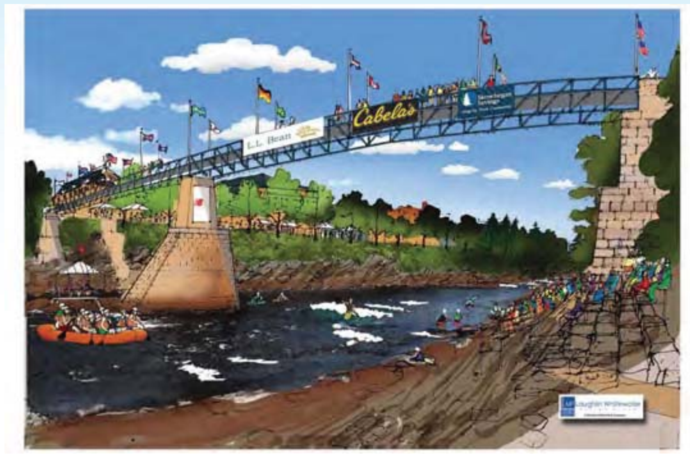
Low Flow

Medium Flow

High Flow

Shoreline Improvements

- Viewing terraces
- River access



Commercial Waterfront District Revitalization

- River Promenade with Commercial Frontage
- Revitalized Commercial District
- Infill Buildings

River Promenade-Images




Next Steps

- Complete Bathymetric Survey and Base Mapping
- Modeling & Design
  - Existing Conditions
  - Proposed Conditions
- Assess Impacts
  - FPL
  - Floodplain
  - Permitability
- Preliminary Design and Report

Thank You

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Upper Site-Constructability

- Construction Staging and Access