Site Visit and Conceptual Design Study

Danville River Park
Danville, Virginia

March 2nd, 2017

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Contents

Introduction:

Danville, VA is investing in its waterfront. A planned Riverfront Park is in its planning stages but will include both wet and dry play areas, parking, a gathering and stage area, river access points, and, potentially, a whitewater park. Whitewater Parks are a growing trend in the United States. These parks function both as community riverside parks and active in-stream features that provide for rafting, whitewater kayaking, tubing and other healthy, active, outdoor recreational activities. River sports are some of the fastest growing sports in America and there is a growing trend among many towns and cities to create these parks in their own backyards. River parks often achieved their original goal of attracting paddle sports enthusiasts, and often exceeded these expectations by becoming focal points of their communities and destinations for outdoor recreation-based tourism from throughout the region. Whitewater parks often play host to major events centered on slalom or freestyle competitions or to community celebrations such as river festivals. Additionally, river parks can have a significant economic impact on the local community, as visitors spend money at local restaurants, hotels, and retail establishments. Some cities, like Golden, Colorado; and Reno, Nevada have reported impacts on the local economy, from tourism generated by the park, on the order of millions of dollars per year.

DHM Design has commissioned a study to investigate the preliminary feasibility of creating a Whitewater component to be included in the Waterfront Park in Danville, VA. The purpose of this study is to begin the process of conceptualizing possible design solutions that meet project objectives. This report summarizes the findings of that study.

Site Information

The proposed site is located along the Dan River Mill in Downtown Danville, VA. A context map, provided by DHM Design, shows the project site in relation to the City of Danville:

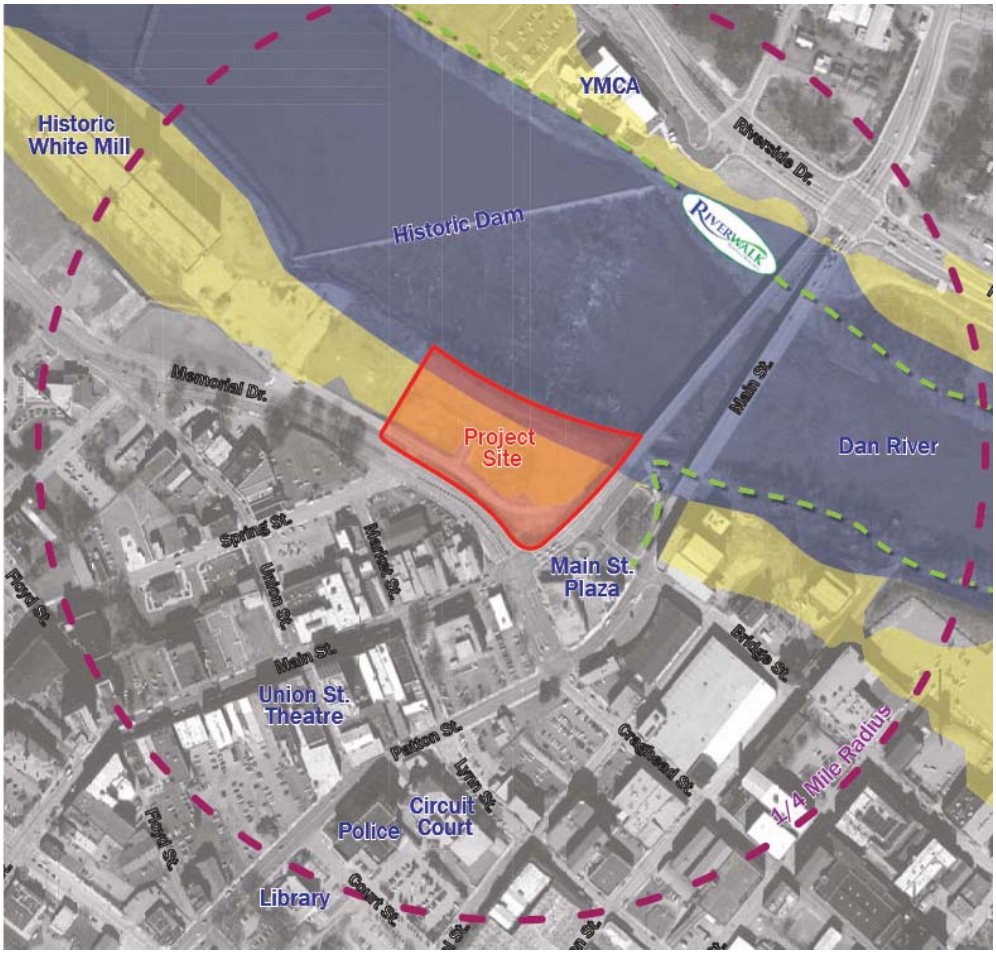


Figure 1. A context map for the project site in central Danville, VA.

The project site is located north of downtown adjacent to the White Mill at the corner of Main Street and Memorial Drive. The former White Mill, which is privately owned, has potential for redevelopment and is significant in that there is substantial parking available on the site as well as a former industrial canal that passes the former mill along its western boundary. There is also a historic dam in the river located just downstream of the White Mill and adjacent to the project area. A potential project in this location would have significant impacts not just in the project area, but also to the businesses within this part of Danville. These impacts would draw people from the local community as well as surrounding region. It is pertinent to the study to understand the local region in the context of the proposed park.

Regional Population within the Danville Micropolitan Statistical Area

The City of Danville, VA is an economic and cultural hub of south-central Virginia. The Dan River flows through Danville, just north of the Downtown District. The City is host to numerous cultural events,

festivals, and museums. A River Park in Danville has the potential to further revitalize the City and make a positive economic and social impact to the community.

While Danville is a smaller city with a population of 43,055 people, the City is located less than 100 miles from numerous metropolitan areas, including:

- Greensboro, NC (Population 269,666)
- Durham, NC (Population 251,893)
- Winston-Salem, NC (Population 241,218)
- Raleigh, NC (Population 538,066)

A River Park in Danville will draw upon the paddling and adventure minded populations from these nearby cities and provide a positive overall economic impact to the City (Census, 2014). Studies have shown the between 2 to 3% of the population in this region of the country identify themselves as avid paddlers or rafters. These numbers are significant in the context of the local region. The location of Danville is displayed below in Figure 2, and the surrounding cities are shown in Figure 3

Figure 2: Location Map for Danville, VA.

Figure 3. There are more than 1 million people that live within 100 miles of Danville, VA.

Hydrology

The hydrology of the project sites has been analyzed to identify target flow rates for the project site that balances both the magnitude and duration of the recreational experiences sought. Stream gauging data was obtained from a USGS station just upstream of the proposed site (USGS, 2016). Flood flows in Dan River are seasonal, with highest flows occurring during spring and with lower flows over the summer. The timing and magnitude of available flows are key factors in the overall potential of a river park.

Average daily and monthly flows are shown below in Figure 4:

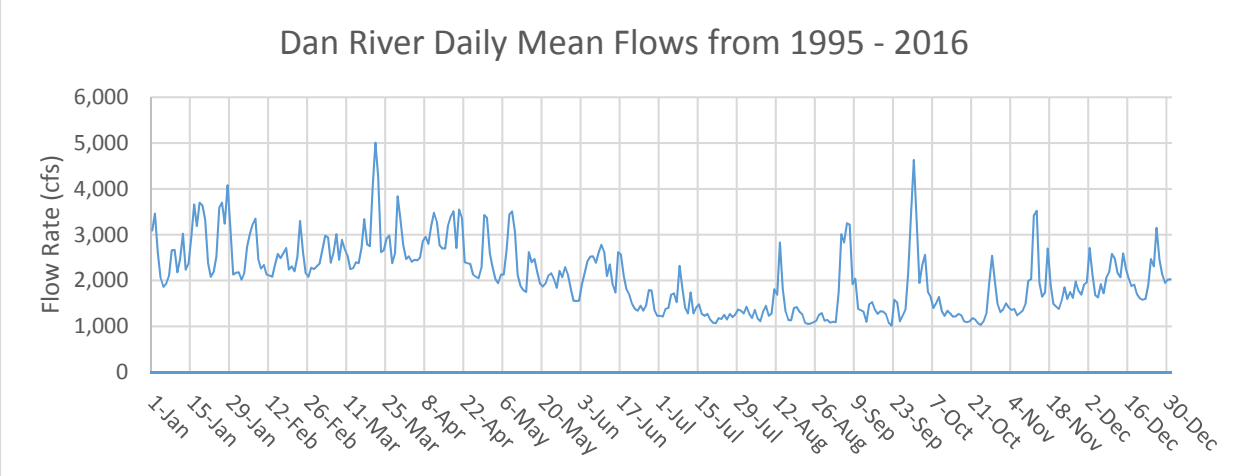


Figure 4. Mean Daily Flows for the Dan River (USGS, 2016).

Gauge data shows that flows are significant throughout the year with peak flows that follow local rainfall cycles. Higher flows are present throughout the year and tend to rise and fall dramatically. The average flows by month are shown below in Figure 4:

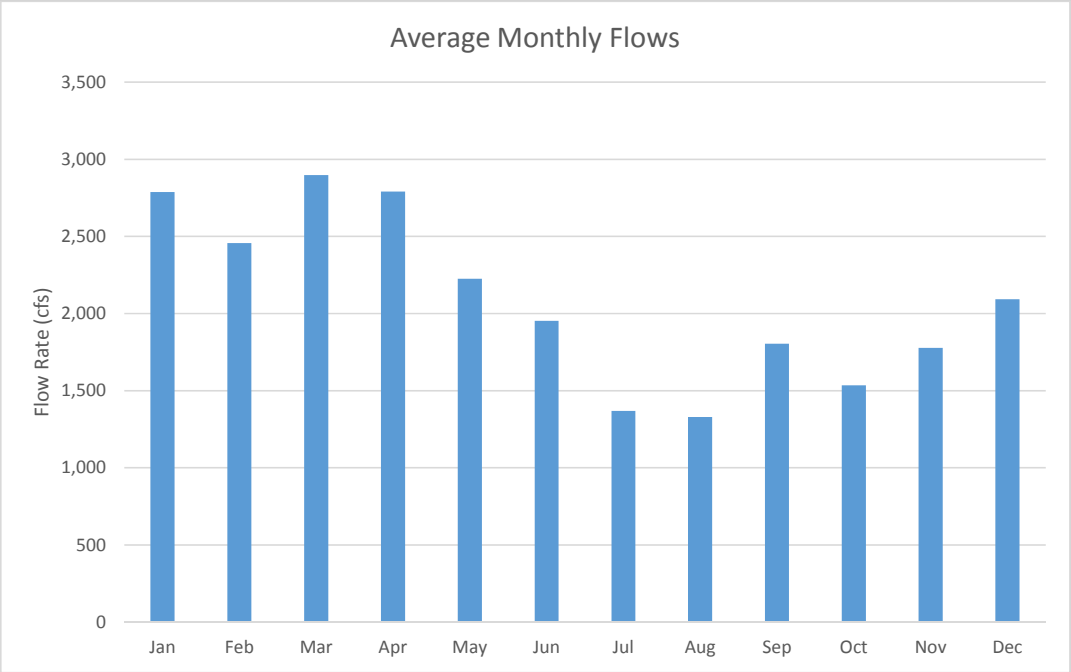


Figure 5. Average Monthly Flows on the Dan River (USGS, 2016).

Flows in the Dan average almost 3,000 cfs in the spring and average greater than 1500 cfs throughout the remainder of the year. These flows are higher, on average, than most whitewater parks in America and are sufficient to create attractive whitewater within a whitewater park that features sufficient drop.

In general, river parks provide a competition-level whitewater experience in a natural river channels at flows approaching 1000 cfs or greater. Though expert level whitewater may only be available in peak runoff events, recreational opportunities including surfing, spinning, rec paddling, tubing, slalom, skills training, as well as paddle-through recreation will still be available seasonally. General floating activities, such as tubing or inexperienced rafting, typically happen in low slope or low flow portions of the river or during lower flow seasons of the year.

Flooding in Danville

A Flood Insurance Study on Danville, VA was issued on September 29th, 2010 to describe Flood Insurance Rate Maps (FIRM) for the City of Danville (Federal Emergency Managment Agency, 2010). Danville's flood risk stems primarily from the Dan River, which creates a floodplain that inundates up to Memorial Drive on the south bank of the river and up to Riverside Drive on the north side of the river. The following naming conventions are used for flood mapping:

> Zone A: Areas subject to inundation by the 1% annual chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed,

no Base Flood Elevations (BFEs) or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Zone AE: Areas subject to inundation by the 1% annual chance flood event determined by detailed methods. Within Zone AE there can be a subzone known as the "Active Floodway" or simply "Floodway". The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Shaded Zone X: Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

A review of the flood hazard zoning for the proposed site shows that it is included in Zone AE, displayed below in Figure 6. This map shows that the active floodway is located directly adjacent to the southern bank meaning that improvements in the river will need to be balanced using a HEC-RAS model to ensure no-rise. Proposed changes to the existing channel geometries will require coordination with FEMA to either demonstrate no-rise to the effective Base Flood Elevations (BFE) or to revise FIRMs to reflect changes in 100 year flooding before and following construction activities (undesired).

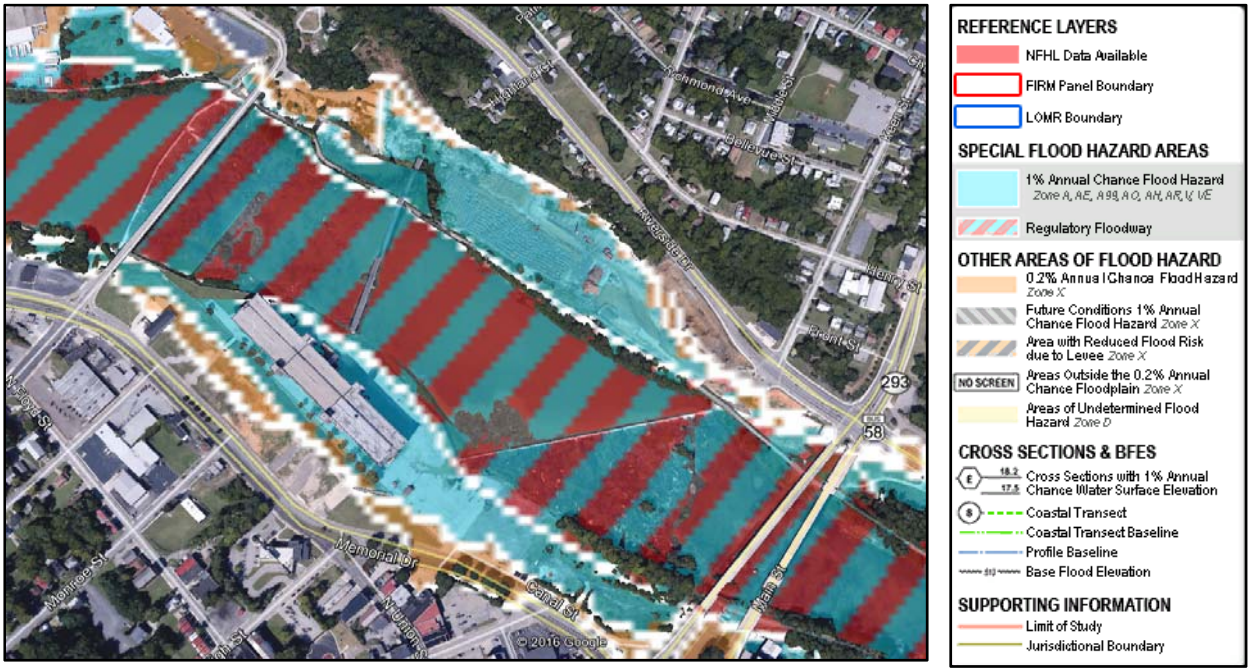


Figure 6. FEMA flood map of the proposed project site.

Historic Structures in Danville

The City of Danville has a rich history dating back the 18th century when the town was first settled. Danville was home to the largest textile mill in the world, known as Dan River Inc. The proposed project sites were subject to a preliminary review for nearby historic properties listed on the National Register of Historic Places. The proposed River Park lies within Dan River Inc. Riverside Division Historic District, as well as adjacent to the Dan River Mill No. 8 (National Park Service, US Department of Interior, 2014)

A complete archeological assessment of proposed sites may be required to determine impacts to the proposed project sites in order to receive 404 Authorization to begin construction. Though this assessment typically has little impact on in-channel river parks, the project owner should be aware of this potential requirement as it could result in significant delays and/or costs to a project if an impact to a culturally or historically significant site is found.

Threatened and Endangered Species

Using the Endangered Species U.S. Fish and Wildlife Service database, federally listed endangered species to consider within the greater project areas are shown in Table 1.

Table 1: Listed species within the vicinity of the project sites within the City of Danville (U.S. Fish and Wildlife Service, 2016).

Group	Common Name	Scientific Name	Status
Clams	James spinymussel	Pleurobema collina	Endangered
Clams	Atlantic pigtoe	Fusconaia masoni	Under Review
Fishes	Roanoke logperch	Percina rex	Endangered
Mammals	Northern Long-Eared	Myotis septentriona	Threatened

Within the region, there are four species of concern, with two listed as federally endangered and one as federally threatened. The proposed project area does not contain any Critical Habitat designations for the listed species, any National Refuge areas or any National Wetlands areas (U.S. Fish and Wildlife Service, 2015), however this does not yet fulfill the requirements of Section 7 of the Endangered Species Act of which compliance is mandatory for the project to proceed.

Additional assessments of the sites and impacts to these species may need to be conducted during the preliminary design/permitting stages of the project, especially as there are several federally endangered species present in the watershed. Additional consultation with the U.S. Fish and Wildlife Service is anticipated, once the final project configuration is selected, to ensure that it does not include known populations or critical habitat for federally listed species and/or additional species of concern within the project areas. If critical habitats are identified, the project will need to work with Fish and Wildlife to determine if the project, in design or implementation, can minimize impacts in an acceptable manner.

Some species of bird are protected under the Migratory Birds Protection act and the Bald and Golden Eagle Protection Act. The project will need to comply with the appropriate regulations for these acts throughout the duration of the construction.

Economic Impacts of the Proposed Whitewater Park

An economic impact study for the proposed project has not been conducted yet. However, studies have been conducted for several similar facilities in the United States. Many of these river parks, built in similar towns and settings throughout the United States, have become significant tourist attractions. These parks bring enthusiasts and spectators alike to their respective communities and create measurable economic impacts through increased property values, direct spending at the site, and tourism dollars spent at local restaurants, hotels, and businesses. A river park like the ones proposed in Danville could attract tourists and generate total economic impacts on the order of hundreds of thousands of dollars per year. In-stream river parks located in Colorado have had impacts as high as $7-9 million dollars per year. Table 2 illustrates some typical economic impacts of these parks:

Table 2: Economic Impacts of River Parks (per year in US Dollars) (Multiple sources).

Economic Impacts of River Parks

River	Location	User Days	Additional Spending	Total Impacts (Millions)
Clear Creek	Golden, CO	13,000-14,000	$910,000-$1.1 Million	$1.3-2.2 Million
Blue River	Breckenridge, CO	1,200-2,300	$220,000-$460,000	$0.4-$1.1 Million
Gore Creek	Vail, CO	1000-2,300	$3.5 Million	$3.5-$4 Million
Sacandaga River	Saratoga/Warren County, NY	17,600-25,400	$1.8-$2.8 Million	$2.3-$3.7 Million
Cuyahoga River	Kent, OH	10,000-40,000	$200,000-$800,000	$0.5-$1.7 Million
Yampa River	Steamboat Springs, CO	75,700	$4.9 Million	$7.2 Million

The impacts of these parks are diverse and are based on regular usage of the River Park, as well as instructional programs, competitions, festivals, and other recreational events. Freestyle events like those that occur weekly in Colorado during spring can bring millions of dollars into the local economy on a single weekend alone such as the GoPro games in Vail, CO which reported an economic impact of $4.7 million dollars in 2013 (Wong, 2014). In addition to creating economic impacts, these events also help to market a particular community as an outdoor town and whitewater destination.

Land Ownership

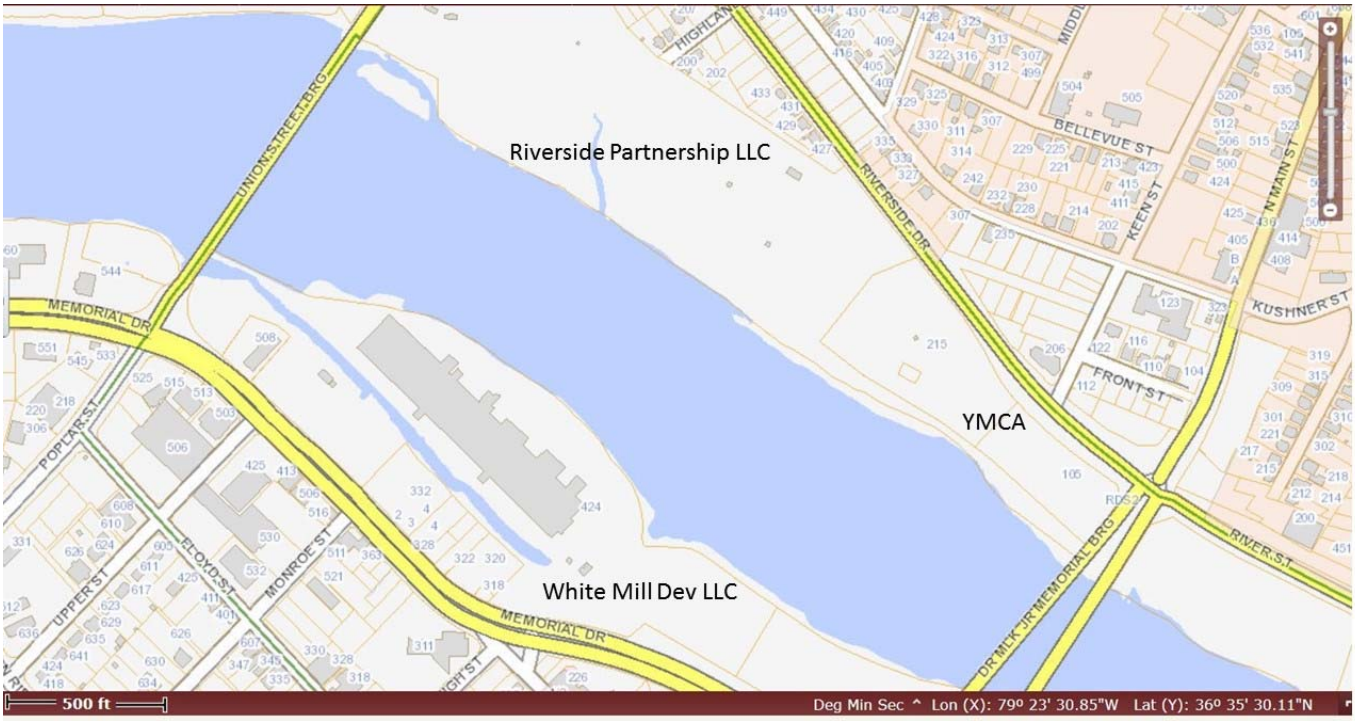


Figure 7. Land ownership adjacent to the proposed river park (City of Danville, 2016).

All proposed changes to the channel and developments of the overbank area for access and ease of spectating would require the written approval of both landowners. Figure 7, above, shows the land ownership near the site and details are listed below in Table 3.

Table 3: Land ownership adjacent to the Dan Rive project site (Buffalo County Assessors, 2015)

Parcel ID	Owner	Mailing Address
21344, 23568, 23264, 22028, 23110	WHITE MILL DEV LLC	9855 WARREN H ABERNATHY SPARTANBURG, SC 29301
5151, 5152	YMCA	215 RIVERSIDE DR, DANVILLE, VA
1110	River Partnership LLC	135 HOLBROOK AVE, DANVILLE, VA

Conceptual Design

The proposed project is tasked with providing whitewater recreation to users of varying abilities. The proposed project is an attempt to preserve the existing dam while mitigating the risks to in-stream navigation and providing an attraction for the City of Danville. The park's design is tasked with meshing with the proposed concepts for the proposed Danville Waterfront Park.

S2o evaluated three potential types of Whitewater Park at this site. These types included:

1. River-wide Drop Structure: A drop structure that crosses the entire river and provides three separate chutes that will form waves.
2. Bypass Channel: A bypass channel located along the west bank of the river and separated from the main flow by a berm. This channel would extend from the historic dam downstream most of the way to the Main Street Bridge.
3. Canal: An out-of-river canal that extends from the White River Mill Canal to the proposed Waterfront Park, discharging back into the river just upstream of the Main Street Bridge. All of these concepts were sketched onto a site map to contrast layout and utility below:

Figure 8. Three design options were considered for the Danville Whitewater Park. Option 1 is Riverwide, Option 2 is the Bypass Channel, and Option 3 is the Whitewater Canal..

The River-wide Drop Structure is the most typical type of whitewater park in the United States. These types of drop structures are known for creating attractive surfing features that are easily navigable to inexperienced river traffic at reasonable flows. However, this design concept in a river as wide as the Dan has some design issues. The structure would draw people away from the Waterfront Park towards the center of the river. The design would also serve to attract users to attempt to navigate the historic dam, leaving them vulnerable to the risks associated with this structure.

The Bypass channel/Berm solution addresses some of these issues. This concept would utilize a portion of the total flow and place it in a controlled channel directly along the west bank of the river. The headgate to this channel could be configured to improve fish passage while also controlling the amount of flow and degree of whitewater in the channel. This type of channel would likely not create a significant national attraction, but would draw many local users who could safely navigate the channel in a variety of craft.

The canal option would have the most impact to the City of Danville. This option utilizes the drop from not just the historic dam, but also from the next dam located upstream. The combined drop is more than 15'. This type of canal would mimic the drop and flow in the US National Whitewater Center (USNWC) providing world class whitewater that can be used by many types of users. This site would be significantly cheaper to operate than the USNWC, which requires extensive pumping.

For these reasons the second two options were selected for further refinement. The following section shows the two proposed design concepts along with typical images that show how this type of whitewater park can look and function:

The Bypass Channel

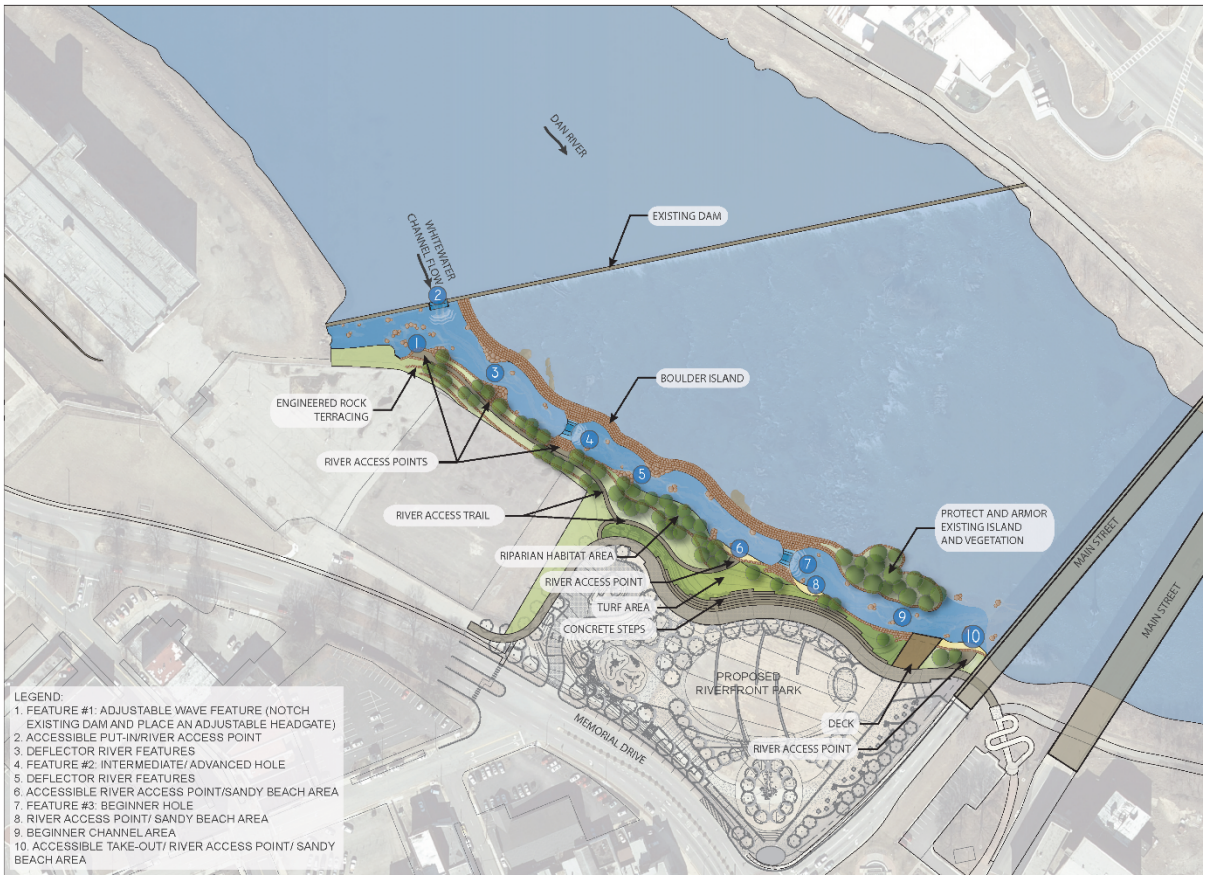


Figure 9: The proposed bypass channel would utilize the existing bed, but separate the channel from the main flow by means of a long berm.

Figure 9, above, shows the proposed layout for the bypass channel. This concept would require tapping the historic dam with a headgate structure that would regulate flow into the bypass channel. This type of headgate would be lowered to a submerged state and flows would flow over the headgate forming a wave as they enter the channel. At all reasonable flows this headgate would control how much flow came into the proposed canal and could be articulated to allow less flow for beginner/intermediate usage or more flow for intermediate/expert usage.

The berm would be formed of natural rock and would be irregular with areas for planting riparian vegetation as well as hard armoring where appropriate.

The channel would create waves, eddies, chutes and other whitewater features conducive to floating, recreational paddling, river surfing, and competitions. There would be two additional feature waves in addition to the headgate. Each of these would be surfable at varying flows and would create the signature attractions within the channels. All of the features would be navigable by inner-tube at lower flows but

would require more advanced paddling skills for higher flows. The figures below show how this channel could look and function:

Figure 10. A head gate and berm would separate the channel from the main flow over the dam.

Figure 11. The channel would create waves, chutes, eddies, and other features that are attractive to paddlers of all abilities.

Figure 12. River-wide structures can be built in parallel with the bypass channel, allowing for many types of in-stream recreation.

The Canal

Figure 13: The canal utilizes an existing headgate and canal located adjacent to the Former White Mill to provide flow for a whitewater channel that flows through the Proposed Waterfront Park.

The whitewater canal is a unique and innovative way to showcase Danville's manufacturing history. The historic mill race can be retasked as a tourist attraction that would draw visitors from throughout the region. This type of park, which is similar in nature to the USNWC, mimics a project in South Bend, Indiana, wherein the East Race was transformed into a whitewater channel that features rafting and kayaking and has hosted national and international competitions.

The canal would revitalize the entrance to the Former White Mill which is now being offered for sale and redevelopment. Active, but calm and slow, flow along this canal would allow for canoeing, punting, or stand-up paddleboarding in a controlled environment adding energy and activity to this gateway corridor to the mill.

The whitewater would begin at the south side of the building and would extend along a 1022 foot reach before discharging into the Dan River. This channel would have the same approximate slope and shape as the USNWC allowing for reconfigurable whitewater that could be configured to be either difficult, for expert competitions, or simple, for day-to-day usage. A channel of this type would have a significant advantage over pumped facilities due to the low operating costs. This design option would draw paddlers from throughout the nation and region and would be a significant, and potentially very profitable, attraction within the City of Danville.

The figures below show how this channel could look and function:

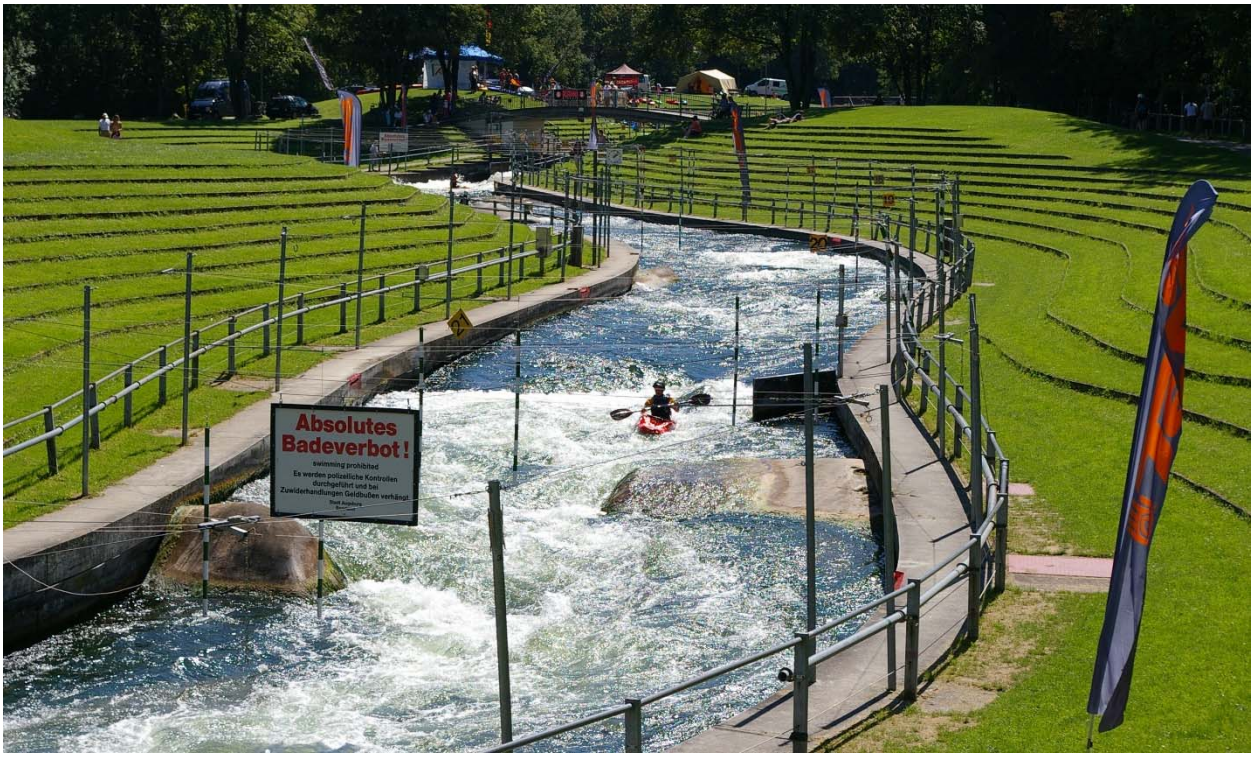


Figure 14. The Eiskanal in Augsburg, Germany connects industrial canals back to the Lech River and played host to the 1972 Olympic Games.

Figure 15. The East Race transformed a former industrial canal into a rafting and kayaking channel in the heart of downtown South Bend, IN.

Figure 16. The USNWC in Charlotte, NC attracts almost a million people a year to raft and play in these whitewater canals.

Opinion of Probable Costs

The conceptual level cost estimates for the Bypass Channel concept are shown below:

Table 4: Cost Estimate for the Bypass Channel configuration.

Project: Danville Whitewater Park **Issue Date: 2/28/2017** **Developed By: MR, SS**				
Danville In-Stream Bypass Channel				
Description	**Quantity**	**Unit**	**Unit Cost**	**Item Total Cost**
Site Setup				
Install & Maintain Best Management Practices	1.0	LS	$ 5,000.00	$ 5,000.00
Circulation Paths & Access Steps				
Trail Excavation	1333.3	yd^3	$ 33.00	$ 44,000.00
Retaining Walls	0.0	yd^3	$ 250.00	$ -
Steps	101.7	yd^3	$ 250.00	$ 25,416.67
In Stream River Structures				
Operate & Maintain Water Control	1.0	LS	$ 55,000.00	$ 55,000.00
Install Equipment Access Ramps & Roads	4.0	EA	$ 1,500.00	$ 6,000.00
Reclaim Equipment Access Ramps, Roads, & Staging Areas	4.0	EA	$ 2,500.00	$ 10,000.00
Headgate Works	1.0	EA	$ 250,000.00	$ 250,000.00
Obermeyer Adjustable Gates	1.0	EA	$ 120,000.00	$ 120,000.00
Furnish & Install Boulder (Avg 36" B Axis)	6392.2	Tons	$ 85.00	$ 543,334.92
Excavate & Grade Native Alluvium	1279.3	CY	$ 22.00	$ 28,144.05
Furnish & Install Bedding Material	8715.6	Tons	$ 30.00	$ 261,467.57
Furnish & Install Mirafi 180n Filter Fabric	3260.7	SY	$ 8.00	$ 26,085.56
Furnish & Install Concrete Grout, Including Rebar, & Marine Epoxy	674.2	CY	$ 272.00	$ 183,375.14
Furnish & Install by Hand Washed Rock Veneer	464.8	Tons	$ 120.00	$ 55,781.35
Unclassified Hauloff	1279.3	CY	$ 20.00	$ 25,585.50
				$ -
Additional Included Items				
Additional Excavator Time as directed by S2o	80	HR	$ 220.00	$ 17,600.00
PROJECT SUBTOTAL				$ 1,656,790.75
Contingency (20%)				$ 331,358.15
CONSTRUCTION SUBTOTAL				$ 1,988,148.90
Bathymetric/Topographic Survey				$ 19,881.49
Engineering Design				$ 139,170.42
Hydraulic Modeling				$ 19,881.49
Permitting 404, 401				$ 39,762.98
Permitting Floodplain				$ 39,762.98
Construction Bonding/Ins				$ 59,644.47
Mob and Demob				$ 59,644.47
Construction Stakeout				$ 9,940.74
Construction Monitoring				$ 159,051.91
TOTAL PROJECT COST OPINION				**$ 2,534,889.8**

The conceptual level cost estimates for the Whitewater Canal concept are shown below:

Table 5: Cost Estimate for the Canal Configuration

Project: Danville Canal Concept
Issue Date: 3/2/2017
Developed By: SS, MR

Danville Canal: Estimated Design and Construction Costs

Description	Quantity	Unit	Unit Cost	Item Total Cost
Site Setup				
Install & Maintain Best Management Practices	1.0	LS	$ 5,000.00	$ 5,000.00
Water Source				
Restore headgate	1.0	LS	$150,000	$ 150,000.00
Clean and restore feeder canal (assumes only excavation)	3238.8	yd^3	$ 20.00	$ 64,775.93
Circulation Paths & Access Steps				
Trail Excavation	2201.4	yd^3	$ 33.00	$ 72,645.83
Retaining Walls	875.0	yd^3	$ 250.00	$ 218,750.00
Steps	171	0	$ 250.00	$ 42,638.89
Trail Concrete	114	0	$ 250.00	$ 28,472.22
Canal River Structures				
Excavate & Grade Native Alluvium	10523.3	yd^3	$ 22.00	$ 231,513.33
Channel Concrete	1275.6	yd^3	$ 250.00	$ 318,888.89
Waterproof Membrane	45920.0	ft^2	$ 3.65	$ 167,608.00
Furnish and Install Rapidblocs	336124.0	EA	$ 1.00	$ 336,124.00
Furnish and Install Unistrut	20440.0	LF	$ 4.88	$ 99,707.32
Bridges				
Furnish and Install Bridges	2.0	ea	$60,000	$ 120,000.00
PROJECT SUBTOTAL				$ 1,856,124.41
Contingency (15%)				$ 278,418.66
CONSTRUCTION SUBTOTAL				$ 2,134,543.07
Bathymetric/Topographic Survey				$ 21,345.43
Engineering Design				$ 149,418.01
Hydraulic Modeling				$ 21,345.43
Permitting 404, 401				$ 21,345.43
Permitting Floodplain				$ 21,345.43
Construction Bonding/Ins				$ 64,036.29
Mob and Demob				$ 64,036.29
Construction Stakeout				$ 10,672.72
Construction Monitoring				$ 170,763.45
TOTAL PROJECT COST OPINION				**$ 2,678,851.6**

Permitting

River parks, typically require Federal, State, and Local permits prior to the initiation of construction activities. Obtaining these approvals may require a number of tasks, including but not limited to:

- Detailed site survey;
- Wetland delineations;
- Historic structures and/or culturally significant resources surveys;
- Threatened and endangered species surveys;
- Establishment of a Proposed Conditions flood model; and
- Issuance of design drawings stamped by a licensed professional engineer.

Federal and State Permitting

River Parks within the United States require, at minimum, a 404/401 permit. This joint permit application involves a thorough review process, which includes an assessment of all impacts of the proposed park to the environment including an alternatives analysis demonstrating that the selected project is the least environmentally damaging and most practicable alternative. During this review, coordination with both the Virginia Department of Water Quality and the US Fish and Wildlife Service (USFWS) may be required. The Virginia Water Protection Permit Program serves as Virginia's 401 certification program for federal Section 404 permits issued under the authority of the Clean Water Act. The following Federal and State permits are anticipated for this project:

- U.S. Army Corps of Engineers (USACE) –Section 404 Individual Permit; and
- Virginia Department of Environmental Quality - Section 401 Water Quality Permit.

City of Danville

Depending on the location or locations of the selected project sites, various Danville City development permits may be required including land use review and/or local building permits. The following development permits are anticipated. Building permits and other approvals may also be required.

- Virginia Storm Water Management (VSMP) Permit
- Land Disturbance Permit
- Floodplain Development Permit (possibly with the County)

Floodplain Development Permit (City or County)

Whitewater Parks are constructed to meet all Federal, State, and Local codes and are designed using flood modeling software approved by the US Army Corps of Engineers in order to receive floodplain development permits. These river parks can typically be designed to a "no-rise" condition, which ensures no impact during the 1% chance annual flood (100 year flood) to neighboring properties or changes to existing flood hazard zoning and associated flood insurance requirements. This condition requires that proposed changes within 100 year floodplain create no net increase in modeled water surface elevations

during the 100 year base flood. Base Flood Elevations (BFE) are used to define effective water surface elevations at sites where detailed flood studies have been performed.

A requirement of the National Flood Insurance Program is that a proposed project can create no-net-negative-impact to insurable structures. This requirement is particularly robust in the regulatory floodway.

The configuration of this site substantiates the need for a project designed to meet a no-rise requirement. The challenge in this instance will be to find a design that focuses flows and energy at lower flows (by consolidating drop at average flows) but that does not cause a rise at higher flows.

The Design and Construction Process

This study has evaluated the site and suggested possible design solutions that satisfy specific project site constraints and requirements and that would provide for a river based recreational attraction. This is not, however, a completed design that is ready to be constructed. Additional project phases including preliminary design, detailed design and final construction documentation are necessary before construction at the preferred alternative project sites can begin.

Design

Figure 17: River Parks are designed for many differing kinds of users.

River parks typically require several stages of design. The following outlines S2o's typical process from design through construction:

a) **Feasibility/Conceptual Design**—this is the first must-do part of a project. This phase is tasked with determining whether a particular project is possible and, if so, how it could look and function and what the approximate costs of the project would be. If done right this part of the project is very powerful as it provides the client with the materials necessary to pursue funding and grants and documentation useful for preliminary public process and stakeholder coordination. Deliverables include a feasibility report outlining project site opportunities and constraints, tasks

for completion, and permit requirements along with conceptual design drawings and budgetary cost estimates.

b) **Preliminary Design**—this phase gets to the heart of the design elements of project. If the Feasibility phase is about identifying what needs to be done to complete a project, Preliminary Design is about doing them. It is a phase tasked with completing the necessary actions required to finalize the design functionality and layout and to gather and process the data necessary to undertake detailed design. Preliminary Design often includes all of the tasks related to preparing for permitting, surveying, creating baseline models, meeting with stakeholders and agencies to define constraints and objectives, and completing design documents to the permitting level.

c) **Permitting**—permitting is a process that permeates most of the design phases. It is typical to work with regulatory authorities during the preliminary design phase to establish criteria and priorities for the project. Permit applications are typically submitted following the completion of Preliminary Design. Some permits, as outlined below, have lengthy review times for specialty projects such as river parks.

d) **Detailed Design**—the detailed design is about getting to the nuts-and-bolts of the project. Now that the project has been defined and adapted to the constraints and objectives laid out in Preliminary design the project is ready for detailed calculations and modeling. Often the level of computations and modeling is defined by the nature of the project. In some cases, such as the Holme-Pierrepont River Park, the project can be accomplished with 1-dimensional modeling. In other cases, such as the Calgary River Park, detailed physical models were undertaken.

e) **Construction Documentation**—this is the "after-design" phase. Documents are created that help define the project for the contractor including all sections, details, specifications and bid items. Often the River park designer will work with the client or the community to step through these processes.

f) **Project Bidding and Construction**—the project is put to bid by the project owner and a contractor is selected and contracted.

g) **Construction Oversight and Inspection**—in this phase the contractor and the design team work together to build the project to our exacting specifications. Often we have representatives in the field virtually full-time to ensure an accurate build that is aesthetically beautifully and highly functional!

h) **Course Commissioning**—the final phase and the one where we finally get to get wet! Paddling experts get in the water and test the project, often tuning wave characteristics and project features until the project is fully functional and meets design objectives.

The process of design is informed by the input from the project owner, local stakeholders, and regulatory agencies and is typically based on a standard of care that is evolving for this new industry.

Construction

Once detailed construction drawings, specifications, and bid information have been developed and the permits have been obtained, construction of the project may begin. The anticipated construction timeline for each of the concept plans described above ranges from three to six months, depending on the number and size of the drop structures proposed, along with the overall complexity of the total project area

improvements. In-channel construction activities typically occur when the flows are at seasonal lows and when there is the least impact to aquatic species.

Appendix A: Glossary

These terms are often used in the white water parks business. Let us know if you are left wondering about a term or phrase—we'll add it to the list!

2-Dimensional Flow Models: Flow models such as River 2d show the nature and distribution of flows. Flow 2d models are often useful for establishing fish passage by adjusting the design to meet flow criteria established with permitting authorities.

3-Dimensional Flow Models: Flow models such as Fluent or Flow 3d that use computational fluid dynamics to compute virtually every characteristic of the flow including vortices, turbulence, water surface character, and more. These models are often less informative and more expensive than creating an actual physical model.

Business and Market Analysis: A study that establishes what the market potential for a whitewater park is in a given community including total expected visitorship and the character and demographics of these visitors. We also use research data to establish price point and complementary amenities. Based on this information we create a business and operations model for the client. Our models are very robust and have, without comment, been reviewed by independent as well as state and banking reviewers in preparation for grant and loan funding. Beware of freebie and cheap "general purpose" business models. These are the only white water park business models that provide operators and financiers the information that they need, for their project, to make it happen.

Class I-VI: Whitewater rapids can be classified according to difficulty and risk. A generally accepted classification system typically uses roman numerals between I and VI with I being the easiest to navigate and appropriate for beginners with obvious lines and very little power and class VI being the most difficult with steep and powerful lines that are difficult to attain and maintain even for the best expert boaters.

Dangerous "Keeper" Hydraulic: Hydraulic jumps vary in power and character. In general the gamut of hydraulic jump types varies from glassy green wave to a hydraulic jump that features dangerous recirculating currents that swimmers have difficulty existing. The designers challenge in whitewater park design is to create a whitewater feature that has sufficient power to be a play feature, but not so much power that it creates a hazard to beginner boaters.

Economic Impact Study: A study completed in cooperation with a PhD in economics. We study the economics of the region surrounding the park and establish, based on published data (or surveyed data if published data does not exist) what the economic impact of a whitewater park will be to a host community in terms of total dollars, increased tax revenue, increased average incomes, increased jobs, and other pertinent economic metrics.

EPDUK: S2o's design partner in Great Britain. S2o and EPDUK partnered together on several projects including the London Olympic Park Project.

Floodplain Analysis: A process that undertaken to understand the effect of a whitewater park on a floodplain at a particular project site. Often the floodplain analysis is conducted hand-in-hand with the project design to minimize or eliminate flooding impacts.

Freestyle Feature: A surf or play feature of sufficient size and power to be used for Freestyle, or trick kayaking, competitions.

Freestyle kayaking: A type of whitewater competition in which paddlers surf in a wave or hydraulic and perform tricks over a set time period. The paddlers are scored according to style, difficulty, and number and variety of tricks. Large events such as the GoPro (formerly Teva) Mountain Games, which are held in the Nick Turner (now of S2o) designed pneumatically adjustable play feature can have an economic impact of $3.5 million dollars in a single weekend event!

HEC-RAS Model: a one dimensional flow model developed by the Army Corps of Engineers to predict flood elevations in rivers. This software has limited applications to Whitewater Design—particularly within floodplains.

Kayak Park: A whitewater park designed specifically for kayaking. Many of the freestyle whitewater parks are custom designed to create waves and play-holes specifically for kayaking

Physical Model: A Froude scaled model that is hydraulically scaled (using the Froude number relationship) to mimic the behavior of a full-sized river. If done properly this model can accurately predict wave size, height, and shape as well as depths, velocities, and other pertinent course features.

Play Features: Similar to Surfing Features. Surfing features in whitewater parks are waves or hydraulic jumps which are conducive to surfing a kayak, stand-up-paddleboard (SUP) or surf board. These waves are called standing waves and remain stationary in the current (in comparison to waves in the ocean which transit a body of water and break on the beach).

Run-Of-The-River Type Features: Whitewater Park features which are a challenge or that augment the experience of running the river. These features contrast with Freestyle and Play features in that they provide a navigational challenge to varying levels of boater.

Slalom kayaking: A type of whitewater competition in which kayakers are timed going through a set course of slalom gates (poles hung from wires above the river/channel). Paddlers are timed and scored with the winner posting the fastest time. Large events, such as the 2008 Olympic Team Trials can have as many as 30,000 spectators in a single weekend and can have millions of dollars in economic impact to a hosting town or city.

Slalom Racing/Slalom Features: Whitewater Slalom Racing is a timed event wherein kayakers race through a set of 18-25 slalom gates hung in a whitewater rapid. Athletes are scored based on total running time plus assessed penalties for touching or missing the gates. Slalom Features are features that are conducive to setting challenging slalom courses.

Surfing Features: Similar to Play Features. Surfing features in whitewater parks are waves or hydraulic jumps which are conducive to surfing a kayak, stand-up-paddleboard (SUP) or surf board. These waves are called standing waves and remain stationary in the current (in comparison to waves in the ocean which transit a body of water and break on the beach).

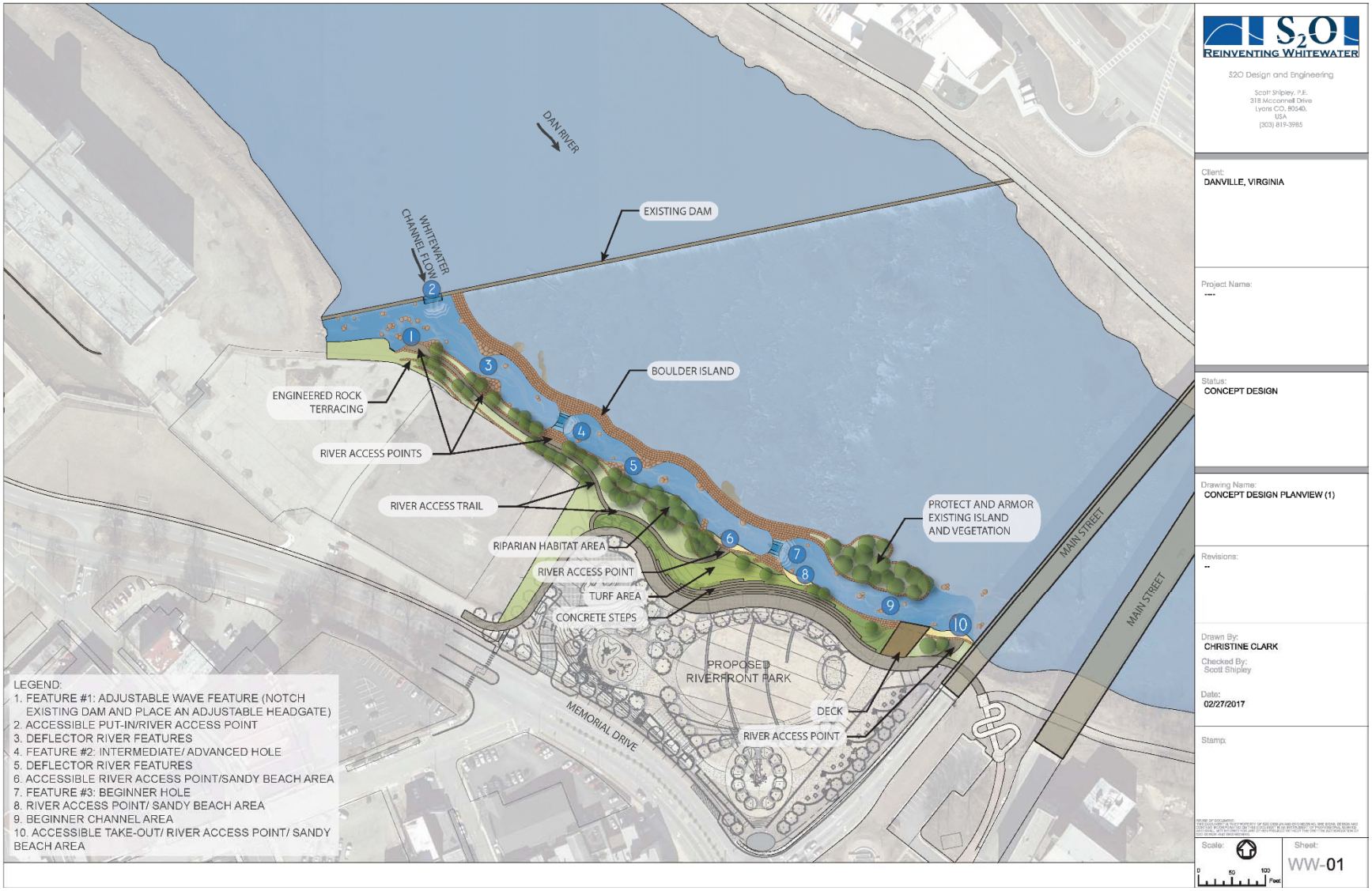
Swiftwater Rescue Park: a park designed specifically to help train rescue authorities in swift water rescue. These parks can hold cars, trees, and platforms in the main flow and can be turned off in an instant if a rescue or scenario becomes dangerous.

Whitewater Park Design: The planning, design, market and business analysis, and creation of construction documents for a white water park.

Whitewater Raft: a watercraft that is inflatable that is typically designed to carry paddlers through a whitewater rafting. Rafters can be commercial rafters as a part of a for-profit business, or private rafters, who own or acquire their own inflatable watercraft.

Width, Depth, And Aspect Ratio When Referring to Whitewater Features: Constructed whitewater features—in particular freestyle features—typically span the river or channel in which they were built. These features, in order to meet permit and FEMA requirements need to match existing river morphology in the reach. As a rule the existing bed therefore defines the width, depth, and aspect ratio of the existing river bed and the designer often checks, by inspection, that the selected location is appropriate for improvements given the existing aspect ratio of the river.

Appendix B – Conceptual Designs


DAN RIVER
EXISTING DAM
WHITEWATER CHANNEL FLOW
BOULDER ISLAND
ENGINEERED ROCK TERRACING
RIVER ACCESS POINTS
RIVER ACCESS TRAIL
RIPARIAN HABITAT AREA
RIVER ACCESS POINT
TURF AREA
CONCRETE STEPS
PROTECT AND ARMOR EXISTING ISLAND AND VEGETATION
MAIN STREET
MAIN STREET
PROPOSED RIVERFRONT PARK
DECK
RIVER ACCESS POINT
MEMORIAL DRIVE
LEGEND:
1. FEATURE #1: ADJUSTABLE WAVE FEATURE (NOTCH EXISTING DAM AND PLACE AN ADJUSTABLE HEADGATE)
2. ACCESSIBLE PUT-IN/RIVER ACCESS POINT
3. DEFLECTOR RIVER FEATURES
4. FEATURE #2: INTERMEDIATE/ ADVANCED HOLE
5. DEFLECTOR RIVER FEATURES
6. ACCESSIBLE RIVER ACCESS POINT/SANDY BEACH AREA
7. FEATURE #3: BEGINNER HOLE
8. RIVER ACCESS POINT/ SANDY BEACH AREA
9. BEGINNER CHANNEL AREA
10. ACCESSIBLE TAKE-OUT/ RIVER ACCESS POINT/ SANDY BEACH AREA
S2O REINVENTING WHITEWATER
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Client:
DANVILLE, VIRGINIA
Project Name:

Status:
CONCEPT DESIGN
Drawing Name:
CONCEPT DESIGN PLANVIEW (1)
Revisions:
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Drawn By:
CHRISTINE CLARK
Checked By:
Scott Shipley
Date:
02/27/2017
Stamp:
Scale:
0 50 100 Feet
Sheet:
WW-01


DAN RIVER
EXISTING DAM
BRIDGE
TERRACED WALLS
CHANNEL ACCESS TRAIL
TURF AREA
CHANNEL ACCESS TRAIL
PROTECT AND ARMOR
EXISTING ISLAND
AND VEGETATION
MAIN STREET
MAIN STREET
RIVER ACCESS TRAIL
TURF AREA
CONCRETE STEPS
PROPOSED
RIVERFRONT PARK
DECK
RIVER ACCESS TRAIL
MEMORIAL DRIVE
LEGEND:
1. PUT-IN/CHANNEL ACCESS POINT
2. FEATURE #1: BEGINNER HOLE FEATURE
3. BEGINNER CHANNEL SECTION
4. FEATURE #2: BEGINNER WAVE
5. FEATURE #3: INTERMEDIATE WAVE
6. INTERMEDIATE/ ADVANCED CHANNEL SECTION
7. FEATURE #4: ADVANCED COMPETITION WAVE FEATURE
8. FEATURE #5: ADVANCED COMPETITION HOLE FEATURE
9. ACCESSIBLE CHANNEL TAKE-OUT/ RIVER ACCESS POINT/ SANDY BEACH AREA
10. ACCESSIBLE TAKE-OUT/ RIVER ACCESS POINT/ SANDY BEACH AREA
S2O
REINVENTING WHITEWATER
S2O Design and Engineering
Client:
DANVILLE, VIRGINIA
Project Name:
Status:
CONCEPT DESIGN
Drawing Name:
CONCEPT DESIGN PLANVIEW (3)
Revisions:
Drawn By:
CHRISTINE CLARK
Checked By:
Scott Shipley
Date:
02/27/2017
Stamp:
Scale:
Sheet:
VW-03