Site Visit and Conceptual Design Study

Willamette Falls Whitewater Park
Oregon City, OR

April 27, 2015

Prepared for:

We Love Clean Rivers, Inc. 501c3
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Executive Summary

This study investigates the feasibility and possible configuration of a potential whitewater park on the 22 acre Falls Legacy Site, formerly the Blue Heron Paper Mill Site, in Oregon City. The study evaluates four possible design solutions that include one in-stream concept and three channels which bypass Willamette Falls via a low-slope, purpose-built, whitewater canal.

- The In-stream Concept utilizes an existing ravine that would be fed with water from a former generating facility located in the Falls themselves. This type of amenity would provide recreation for avid kayakers and rafters but recreational amenities for the general public, such as swimming, wading and fishing would be limited. Due to the limited recreational amenities, the study finds that the In-Stream Concept would have a limited appeal and would not produce significant economic impacts to the area.
- The Riverwalk Concept would be built into a grade along the Willamette River's bank and would function as a retaining wall for the remainder of the site. This would decrease the instance that water would flood into the venue and would provide a recreational attraction in its own right. Moreover, the Riverwalk Concept would provide a platform for the Riverwalk as well as a large common space in the center of the venue. The creation of a Riverwalk and common area would provide an attraction to visitors, which in turn creates significant positive economic impacts to the owner and municipality.
- The Grand Plaza Concept creates a central attraction out of the whitewater channel. This attraction, like the Riverwalk concept, could provide demonstration power generation as well as, or alternately, a waterfall in the central redevelopment site. Both the Riverwalk and Grand Plaza concepts could be provided with demonstration fish passage channels as well. This concept would also have a significant economic impact. There are also branding, monetary and interpretive impacts from the proposed power generation.
- The Perimeter Channel Concept is a much longer channel that meanders around the perimeter of the site. This channel would provide the most whitewater recreation and a continuous fluid connection between the upper basin and the river below. The channel would also provide for fish passage up the waterfall. This layout has the most impact to proposed construction at the site, but also has the most capacity for whitewater users and therefore the greatest potential impact.

The varying concepts have different benefits and weaknesses but provide a starting point for further refinement as design on the site progresses. The construction costs of these channels vary and are listed in this report. However, in addition to these costs, there are significant additional costs associated with developing the site from its current state including demolition, bedrock removal, and construction.

Given the significant construction costs, an economic impact study was completed to determine if this facility was worth building. The results of the study concluded that there is a substantial market in the State of Oregon as demonstrated by the significant numbers of outdoor enthusiasts, who recreate in rivers by rafting, tubing, kayaking or other means many times a year. Moreover, based on study data it was found that users are many times more likely to visit, and revisit, a whitewater attraction that is in

close proximity to their location. Research shows that there are more than two million people living within an hour of the Falls Legacy Site and that this whitewater park, if built, would be the closest whitewater to that location.

An estimated usage was created by modeling the attractive power of whitewater parks in other, similar communities, and scaled to the region and climate. This model also used inputs such as typical spending, typical costs of business, and typical spending multipliers in order to estimate the total potential impact of a whitewater park in Oregon City.

This analysis examined the economic benefits and market impacts under two possible scenarios: 1) **a small whitewater play park** and 2) **a large whitewater center.** The whitewater center concept expands on the small park with increased opportunities for commercial rafting and large-scale spectating, including races and events. These analyses found the potential annually for several million dollars' worth of expenditures and net benefit to participants and spectators at this site.

Scenario 1: Whitewater Play Park

	Activity	Users	Net Economic Benefit	Expenditures	
				Local	Overnight (25%)
Events	Kayaking/Rafting/Canoeing	1,500	$189,696	$69,785	$67,555
	Tubing	0	$0	$0	$0
	Surfing/SUP	150	$18,970	$6,979	$6,756
	Spectators	15,000	$692,537	$190,074	$260,680
Annual Totals (Event and Non-Event)	Kayaking/Rafting/Canoeing	10,998	$1,390,812	$511,650	$495,301
	Tubing	2,892	$365,677	$134,525	$130,226
	Surfing/SUP	6,574	$831,345	$305,834	$296,061
	Spectators	20,463	$944,761	$259,300	$355,620
Totals	Participants	22,113	$2,796,500	$1,028,772	$995,899
	All Users	57,576	$4,433,798	$1,478,146	$1,612,198

A modest whitewater play park could provide 22,000 annual in-water users and 35,000 spectators, with annual expenditures by these groups of over $3 million. The total economic value net over 50 years, discounted, would be $157 to $314 million, summing net benefits to users and their expenditures.

Scenario 2: Whitewater Center

Activity	User Days	Net Economic Benefit	Expenditures	
			Local	Overnight (25%)
Private Users	22,113	$2,796,500	$1,028,772	$995,899
Commercial Rafters	120,259	$15,208,454	$5,594,863	$5,416,088
Spectators	239,628	$11,063,410	$3,036,473	$4,164,404
Totals	**382,000**	**$29,068,364**	**$9,660,108**	**$10,576,391**

A whitewater center builds on the private users that would take advantage of Scenario 1 and expands with commercial rafting as well as increased spectator activities. It could provide 382,000 annual total visitors, with annual expenditures of $20 million. The total economic value net over 50 years, discounted, would be over $1 billion, including net benefits to users. It would also induce an additional

122 new jobs in the vicinity from non-local visitor. In terms of return-on-investment any of the concepts presented on the Falls Legacy property would pay for itself in a short period of time and continue to reap returns long into the future.

Introduction:

Oregon City plays host to a hidden gem in the form of the 40 foot Willamette Falls. The Falls convey thousands of cubic feet per second of water over 40 feet of drop along an extended crest that spans the full width of the Willamette River. The falls site is rich in history dating back from first nations, early settlers and American industrialization. Despite the rich history and dramatic spectacle presented, there are few ways for the general public to access the site which is largely surrounded by highly industrialized development and private property. All of this is about to change. The Blue Heron Paper Company, the former owner of the Southeast bank of the river, has gone out of business and the current owner of the site, Falls Legacy, LLC, has expressed a desire to redevelop the site in a way that opens it up to the general public for access, viewing, and other opportunities. At long last, there is an opportunity to redevelop the site in a way that celebrates the falls and provides public access to this stunning attraction.

This potential redevelopment project is focused around the 22 acre Falls Legacy property. A master plan, commissioned by local municipalities, and created by the engineering firm Walker Macy (Walker Macy, 2014) proposed several redevelopment options. These options included a number of features including retail, public spaces, a river walk, and a possible Whitewater Park. The current study, commissioned by the foundation *We love Clean Rivers*, focuses on design options for a whitewater amenity within the context of the redevelopment of the property.

Whitewater parks are community parks that are centered on the river. The parks include waves, eddies, and other features that are attractive to river users and allow them to pursue recreational kayaking, surfing, and floating. These parks, surrounded by trails and recreational areas, have not only achieved their original objective of attracting paddle sport enthusiasts, but have often exceeded expectations by becoming focal points for their communities and recreational destinations for outdoor tourism. Whitewater parks often play host to major events centered on slalom or freestyle canoeing and kayaking competitions or host river festivals that feature local arts and culture. In addition, Whitewater Parks can have a positive economic impact on the local community, as visitors spend money at local restaurants, lodging, 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. Other cities, which host larger whitewater parks, have become regional attractions that have tens of millions of dollars in economic impact per year. Quantifying the specific potential economic impacts of a whitewater park in Oregon City is the subject of another, parallel, study. (EcoNorthwest, 2015)

Section 1: Whitewater Parks

Whitewater Parks Defined

Figure 1: The Hawea Surf Park is an in-stream natural-river type surf park, consisting of drop structures in the Hawea River, NZ

Whitewater Parks are river parks in which the whitewater has been designed in order to create a regional attraction[1] and community resource. In some cases whitewater parks are built in natural rivers and consist of natural rock “drop structures”. At higher flows these parks create waves, eddies, deflectors and other features conducive to recreational, instructional, and often competition-level kayaking as well as rafting. At lower flows these features are less powerful and allow for all-types of in-stream usage including tubing and other float traffic. The parks are designed to function in a number of ways providing streamside access for fishermen and other visitors to the park as well as viewing for spectators and spaces for the general public to gather and recreate on the banks as well as in the water.

Figure 2: The Eiskanal Whitewater Park, shown in plan and perspective, is a bypass channel around the historic Hochablass dam on the Lech River in Augsburg Germany

[1] Whitewater Parks, like many specialty fields, have a language all their own. Definitions for typical terms are shown in Appendix B

In other instances, “bypass” Whitewater parks are created. These parks are typically created near locations where sudden grade changes occur, such as dams or waterfalls. At these grade breaks the river has sufficient flow but is too steep for whitewater recreation. A Bypass Channel creates an extended channel that is typically out of the stream (but not always) and that extends the drop over a longer reach—creating a rapid. These bypass channels consist of excavated, formed, and often concrete reinforced channels that provide an avenue for fish passage and recreational whitewater such as the bypass channel shown above in Figure 2 for Augsburg, Germany. These channels can be designed to have a natural character and be created out of cobble and rock, or can have a canal-type character reminiscent of a lock or industrial canal.

In other cases—cases where natural flow and gradient sufficient for whitewater do not exist—whitewater rapids are artificially created through the use of pumps and purpose-built channels. These systems recirculate water in the same manner that theme parks or fountains draw from a single storage source, and do not rely on the flows of nearby rivers and streams. Figure 3, shown below, is an example of a pumped recirculating, whitewater park:

Figure 3: The US National Whitewater Center is a pumped whitewater park that pushes water from the bottom pond to the top where it then flows naturally through four channel segments.

Figure 4 shows the US National Whitewater Center in Charlotte, NC in perspective view. This is a pumped facility that only contains whitewater when the pumps are in operation. Figure 4, shown below, shows this channel system in operation. These types of whitewater parks are typically designed to host all types of users from highly experienced competitors who come to these whitewater venues for Olympic-standard events to families and tourists who come to these venues to experience whitewater for the first time. The venues provide for commercial rafting wherein visitors are able to buy a rafting pass and take a guided raft trip down the channels, as well as recreational kayaking, floating, streamside seating and events.

Figure 4: The US National Whitewater Center features commercial rafting as well as a number of other active outdoor activities.

In-stream, bypass, and pumped whitewater parks can become significant regional attractions that draw people not just from surrounding states, but from throughout the country and world. Often the visitors are drawn not just for the whitewater, but for the events that are hosted at these parks.

One of the limiting factors to pumped parks is the cost of pumping. The Willamette sites are fortunate in that sufficient flow and drop are available to create a whitewater park without the need for pumps (although there are pumped options). The options presented in this report are primarily gravity fed, in lieu of pumped, whitewater parks.

Designing whitewater parks to accomplish all of these objectives is a process. Often the process is iterative and includes opportunities for local stakeholders to comment and update the designs. The following section details this process.

Design Factors for In-Stream Whitewater Facilities:

Figure 5: A before and after view of the Hawea Whitewater Park

Figure 5, above, shows the improvements made to the Hawea Whitewater Park in Wanaka, NZ and is an example of an in-stream whitewater park. Design can be a challenge in some river environments due to the many factors that make up a river's morphology. Whitewater Parks are a new phenomenon and typical design standards are just beginning to be created. There are some standards and guidelines which lend guidance to the design of in-stream whitewater parks that often define the character of whitewater parks in a given reach. The most comprehensive set of standards defined for Whitewater Parks was set by the Colorado Board of Professional Engineers in their review of Gary Lacy, P.E.'s work on the Steamboat Springs Whitewater Park. The Board found that the following tasks should be standard for whitewater park design:

a) Plans specifications and calculations should contain the following information:
   - Existing and proposed topography
   - Exact dimensions and proposed elevations/distances for any of the improvements
   - Methods of water control and erosion control during construction, or any type of construction phasing.

b) Calculations should contain the following:
   - Structure calculations
   - Stability analysis
   - Seepage analysis
   - Backwater calculations
   - Analysis of sequent depths and hydraulic jump movement tendencies for smaller or larger flows
   - Calculations for smaller or larger flows other than the design flows.

c) Technical Specifications should include the following
   - Stability analysis
   - Backfill
   - Water control
   - Erosion control
   - Un-grouted rock/rip-rap or landscaping

Stability

The structures which are built in the riverbed need to be stable and robust and need to be anchored in such a way that they are not moved by flows up to the 100-year flood event. Typical design guidelines for these types of drop structures are found in the Denver Urban Drainage Handbook (Urban Drainage Criteria Manual, 2013)

Experience shows that the structures tend to fail from scour/erosion and piping. These failure modes are a function of the soils upon which the structure is built with bedrock, for example, being the most stable foundation for a structure, and sandy soils being the most problematic. In order to determine stability a geotechnical analysis is typically conducted and a scour and piping analysis are undertaken as a part of the design process.

Guidelines for the stability of drop structures can be found in the Urban Drainage and Flood Control District Handbook called the *Urban Storm Drainage Criteria Manual* (Urban Drainage Criteria Manual, 2013).

Costs

There are many factors that could affect the cost of a particular Whitewater Park. These factors include physical constraints, such as the nature of the soils or the width of the river. Structures built on unstable soils, if feasible, require extensive construction in order to construct a stable platform for the drop structure. In some cases this includes expensive requirements such as sheet-pile cut-off walls.

Width of the river can also affect costs. Typical drop structures are founded on arched structures anchored into the bed and banks of the river. Arches are typically exponentially more expensive with width. An efficient drop structure is typically located in a narrow part of the river such that project costs are not prohibitively high.

The scope of the project can also affect costs. Some projects, such as whitewater parks at the base of dams, are necessarily large in scope and require multiple structures. Other projects are created in locations ideally suited to smaller scale improvements. In some cases a phased approach is recommended such that manageable portions of the project are completed per phase.

Location of the park in relation to sensitive ecosystems can also be a factor. Parks that are planned in critical habitat are more difficult to design and permit and often require extensive review periods and costly redesign. Selection of a site that is already impacted and that could benefit from the inclusion of a whitewater park to provide, for example, fish passage, can have the opposite affect and make permitting and approvals easier to attain.

Design Factors for Bypass Channel Whitewater Facilities:

Figure 6: Paddlers race in the 2012 Olympic Games on the S2o Designed Lee Valley Whitewater Park

Bypass channels are typically created in controlled environments and are subject, at regular river flows, to measurable canal flows that are passed through a head-gate or other type of control structure into the canal. The channels are often—particularly at the downstream end—susceptible to flooding, both active and passive. The channels are designed to standard engineering practice including standard structural and canal design specifications such as the USACE's *Structural Design of Concrete Lined Flood Control Channels* (US Army Corps of Engineers, 2007).

Additionally, given that the canal(s) will be used intimately by the public, health code will apply with regards to water quality. This is not expected to be an issue at Willamette Falls.

Hydraulic safety is also an issue and typically a hydraulic study, including either computer modeling of flows or a Froude-scaled physical hydraulic model are also utilized. These models help the designer sculpt a whitewater park that has fun, but not intimidating, whitewater.

Stability

The structures which are built in the riverbed need to be stable and robust and need to be anchored in such a way that they are not moved by flows up to the 100-year flood event. Typical design guidelines for these types of drop structures are found in the source listed above.

Costs

There are many cost factors that can affect bypass channels. The largest two factors in a typical bypass channel are height of dam (and therefore length of channel), and required site work. Both of these factors are significant for this project in that the amount of drop is twice the amount of drop seen at Olympic standard whitewater parks such as the London 2012 venue. Additionally, the site work required is extensive. Demolition and cleanup of the existing construction will be substantial at the Falls Legacy Site and much of what remains is basalt bedrock, which will be expensive to excavate and remove. Any fill material required for grading and planting will need to be imported and it is likely that some site remediation will be required. There are further details in the Site Information section of this report.

Pumped Whitewater Parks

The design standards for Pumped whitewater parks are beyond the scope of this project.

Section 2: Site Information

Oregon City, Oregon

Oregon City is the County seat for Clackamas County Oregon. It is located on the southern limits of the Portland Metropolitan area. The City was established in 1829 by the Hudson's Bay Company and was incorporated in 1844; making Oregon City the first US city west of the Rocky Mountains to be incorporated. (Wikipedia, various authors, 2015). Historically the City has benefited from the available energy and water at the Falls including power generation as well as flows used for industrial uses such as paper making.

The City was historically dependent on the forestry industry with accompanying industry. Since the decline of this industry the City has subsequently developed some notable high technology and light manufacturing concerns (Wikipedia, various authors, 2015). The City features a modest population of approximately 35,000 people but is near the larger population centers including and surrounding the City of Portland.

A large amount of demographic information that would typically be included in this report is contained in the economic impact study being prepared in parallel to this report by ECONorthwest. For demographics and market analysis, please refer to that report.

The Study Site:

All of the concepts evaluated for this project are on the Falls Legacy Site[2]. The Falls Legacy Site is located in Oregon City about 20 miles south of Portland. Figure 7, shows the location of the project site in relation to the greater Portland area:

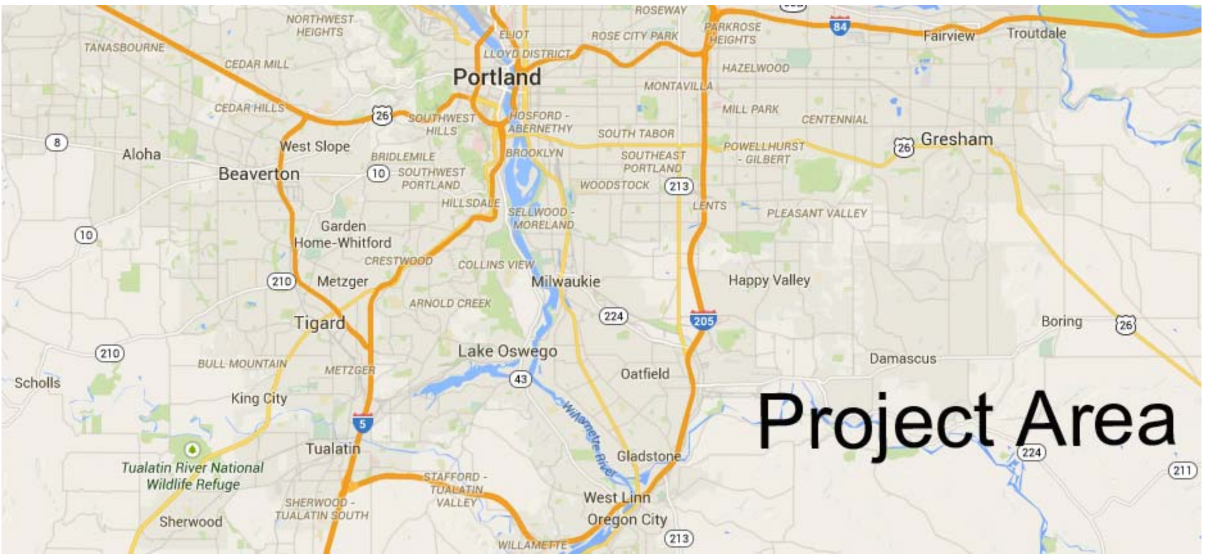

Figure 7: The project area with respect to the Portland Area ((Google, 2015)

Figure 8 shows the project area in relation to the city of Oregon City.

[2] A site visit was also conducted at the Willamette Locks. This information is included in the Appendices.

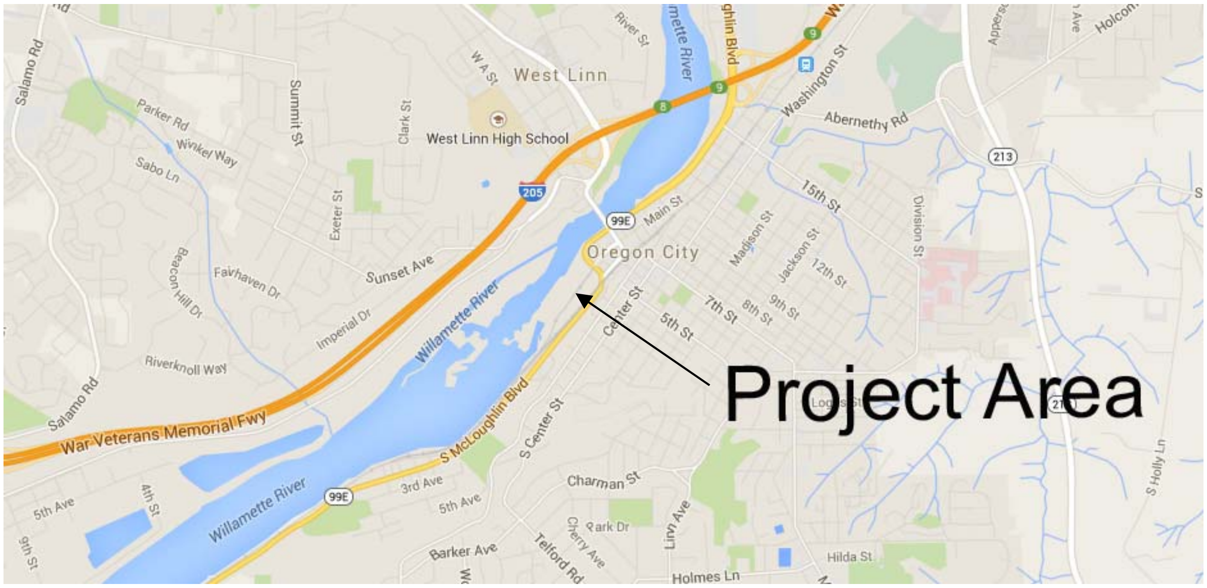

Figure 8: The project area is located just to the Southwest of the central business district of Oregon City.

A closer view shows the location of the proposed project sites in relation to the falls and downtown Oregon City:

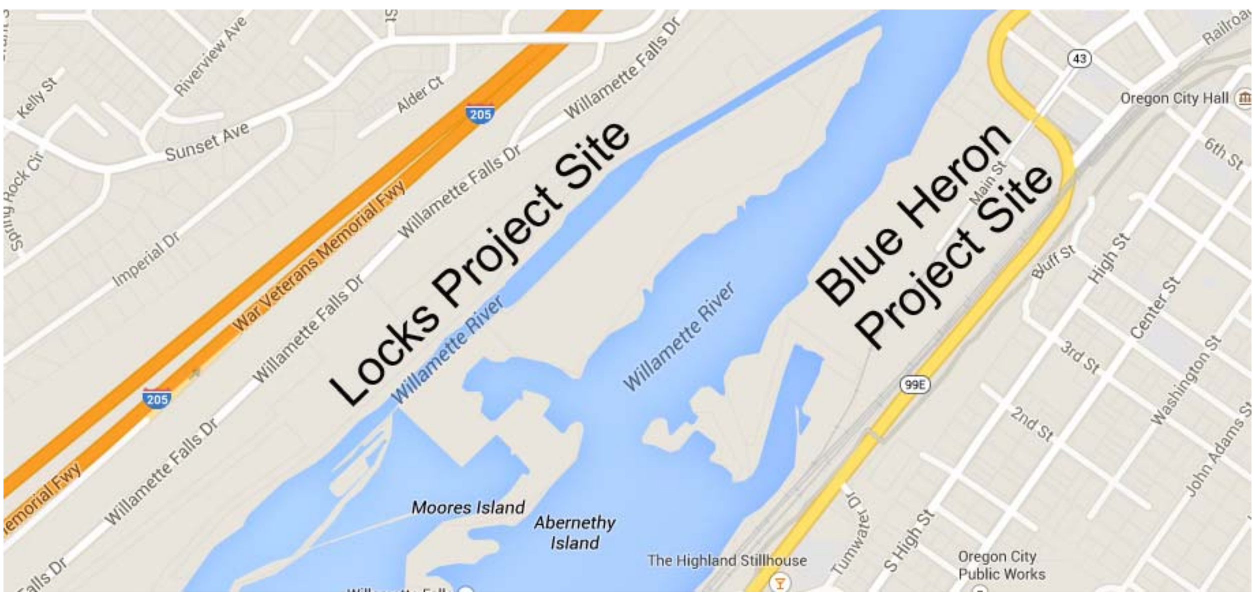

Figure 9: The project area is located directly adjacent to the dam and hydroelectric power reservoir and across the river from the potential Willamette Locks restoration project.

Channel Morphology

The Willamette River is a major tributary of the Columbia River. The drainage area for the river is approximately 11,478 square miles (Wikipedia, various authors, 2015) and has considerable flows as it passes through the City of Oregon City. The river provides habitat for many species including Coho and Chinook salmon as well as lampreys and steelhead. Passage for these critical species is provided through Willamette Falls via both natural pathways as well as improved fish passage routes (Landre, 2015).

The Falls and project area are created by a basalt shelf in the river floor. The Falls form a horseshoe shape across a width of approximately 1500 feet and drop approximately 40 feet from upper water surface elevation to lower. The river below the Falls is influenced by tidal fluctuations. Specifically, the river rises and falls 24-36 inches every day, twice a day. Also, in high flood conditions the geologic constriction at the west linn Oregon City Bridge makes much of the Fall Legacy site an inundation zone due to the backwater effect of this constriction. The river features significant flows, detailed below, on a year round basis and provides drinking water and power for the greater Portland area.

Flow information:

Approximate Streamflows for the Willamette River in Oregon City can be seen below in Figure 10:

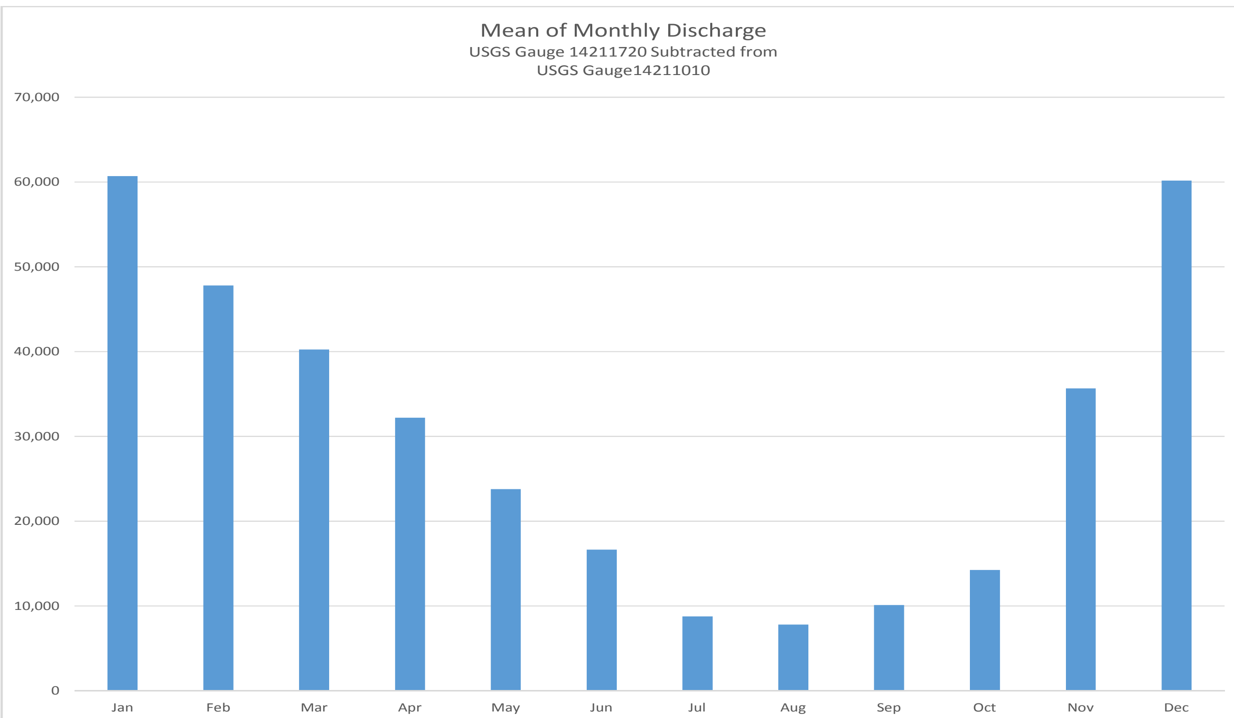

Figure 10: Average Monthly Flows on the Willamette River (cfs). (USGS, 2015) This chart was created by subtracting the flow data from 14211720 Clackamas River at Oregon City from USGS Gauge 14211010 Willamette River at Portland from Gauge.

The Willamette sees significant flows throughout the year with the highest flows typically seen in December and January and significant flows throughout the fall, winter, and spring. The summer flows are typically lower, but still very significant, with average flows below 10,000 cfs

This project will not only require water in the river, but also water available to pass through a bypass channel around the falls. Typically a water right is needed to allow the channel operator to divert water around the falls. There are currently several water rights in priority recorded at Willamette falls. These water rights are related to the existing power generation plant for Portland General Electric, the operation of the Willamette Locks, as well as the West Linn paper plant located on the northern side of the river.

Portland General Electric Co. (PGE) TW Sullivan Plant: The operator of the power plant (Heinzman, 2014) stated that the generating station had a water right of 6850 cfs for generation at the plant with an added 895 cfs that was transferred from the former Blue Heron Paper Company.

There is a small industrial water right on the Fall Legacy Site. This right was appropriated by the Publisher's Paper Company in 1945 and represents a flow rate of .512 cfs.

There are also minimum streamflow requirements that limit the amount of flow in the Willamette River that can be claimed. The Oregon Water Resources Department possesses an in-stream water right of 1500 cfs. The flows are characterized as purposed to maintain minimum flow levels to maintain wildlife in the river as well as to minimize the impacts of pollution. The right ensures that no future appropriations shall be granted by any state agency or public corporation of the state for the Willamette at this location when flows are below 1500 cubic feet per second[3]. (Simpson, 2001)

The Oregon Department of Water Resources provides an evaluation of available flow for the Willamette River in this location. The study suggests that ample flows are still available and can be claimed at the site. This summary was confirmed during a conversation with representatives from the Oregon Water Resources Department (Pierceall, 2015). A summary of available flow at the mouth is shown below:

Limiting Watersheds

Monthly Streamflow in Cubic Feet per Second
Annual Volume at 50% Exceedance in Acre-Feet

Month	Limiting Watershed ID #	Stream Name	Water Available?	Net Water Available
JAN	181	WILLAMETTE R > COLUMBIA R - AT MOUTH	Yes	23,200.00
FEB	181	WILLAMETTE R > COLUMBIA R - AT MOUTH	Yes	20,500.00
MAR	181	WILLAMETTE R > COLUMBIA R - AT MOUTH	Yes	19,400.00
APR	181	WILLAMETTE R > COLUMBIA R - AT MOUTH	Yes	16,700.00
MAY	181	WILLAMETTE R > COLUMBIA R - AT MOUTH	Yes	14,700.00
JUN	181	WILLAMETTE R > COLUMBIA R - AT MOUTH	Yes	7,070.00
JUL	181	WILLAMETTE R > COLUMBIA R - AT MOUTH	Yes	2,410.00
AUG	181	WILLAMETTE R > COLUMBIA R - AT MOUTH	Yes	1,260.00
SEP	181	WILLAMETTE R > COLUMBIA R - AT MOUTH	Yes	1,670.00
OCT	181	WILLAMETTE R > COLUMBIA R - AT MOUTH	Yes	3,750.00
NOV	181	WILLAMETTE R > COLUMBIA R - AT MOUTH	Yes	10,200.00
DEC	181	WILLAMETTE R > COLUMBIA R - AT MOUTH	Yes	21,900.00
ANN	181	WILLAMETTE R > COLUMBIA R - AT MOUTH	Yes	16,100,000.00

Figure 11: Available water in the Willamette River. (Oregon Water Resources Department, 2015)

Flooding in the Willamette can be significant. Significant floods have occurred in recent in years including a major flood in 2009. Peak streamflows from the USGS gauge 1411720 are shown in Figure 12 below:

[3] There are agricultural and storage exemptions to this rule that do not apply to this site.

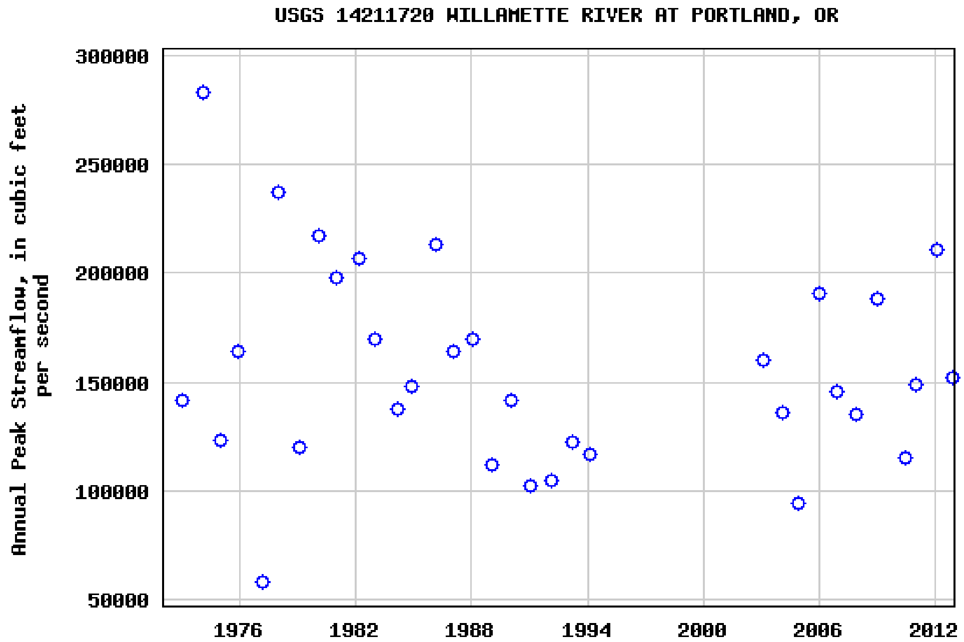

Figure 12: Peak Stream flows in the Willamette River near Portland City (USGS, 2015)[4]

Figure 12, shown above, shows the peak flood each year for the period of record at the USGS gauge in Portland. The Figure describes a river in which historic flows in the reach regularly exceed 100,000 cfs. The largest recorded flood at this gauge is nearly 300,000 cubic feet per second. The size of these floods within the Willamette River corridor suggests several project concerns. Amongst these concerns are regulatory concerns. Oregon City is a part of the Federal Flood Insurance Program (FIS) which places several limitations on the proposed project. In order to understand the limitations it is important to understand how the FIS delineates the river corridor.

Floodplain—The Federal Emergency Management Agency, FEMA, regulates development within the 100 year floodplain of the river. The 100-year floodplain is defined as the area that has a 1 percent chance of being flooded in any given year. One of the purposes of the Flood Insurance Study is to determine the boundaries and elevation of the 100-year floodplain at each location along the area of study. The area inundated during the 100 year flood is defined as the 100 year regulatory floodplain. Development is limited in the 100 year floodplain. A 500 Year floodplain is also often delineated and can be used by the local municipalities to regulate, for example, critical facilities.

Floodway—within the 100 year floodplain an FIS defines a sub-area known as the active floodway. The regulatory floodway is designated as the river and adjacent lands required to dissipate flows without increasing the base flood elevation by a certain height, typically 1 ft (Floodway, n.d.). The floodway, also known as the conveyance zone, is the portion of the floodplain which the government preserves in order to ensure that the river actively conveys

[4] These flows include the contribution from the Clackamas River

flood flows through the river corridor. Development within the active floodway is typically limited to changes that do not cause a rise to the 100 year flood elevation. Such a project can receive a “no rise” floodplain development certificate. This is a typical permit approval for whitewater parks. In some limited cases a rise within the active floodway can be allowed. This requires an extensive Letter of Map Revision (LOMAR) process with FEMA. One of the requirements of approval for a LOMAR is no negative flood impacts to insurable structures within the floodplain[5].

The FEMA flood study for Oregon City is shown below in Figure 13:

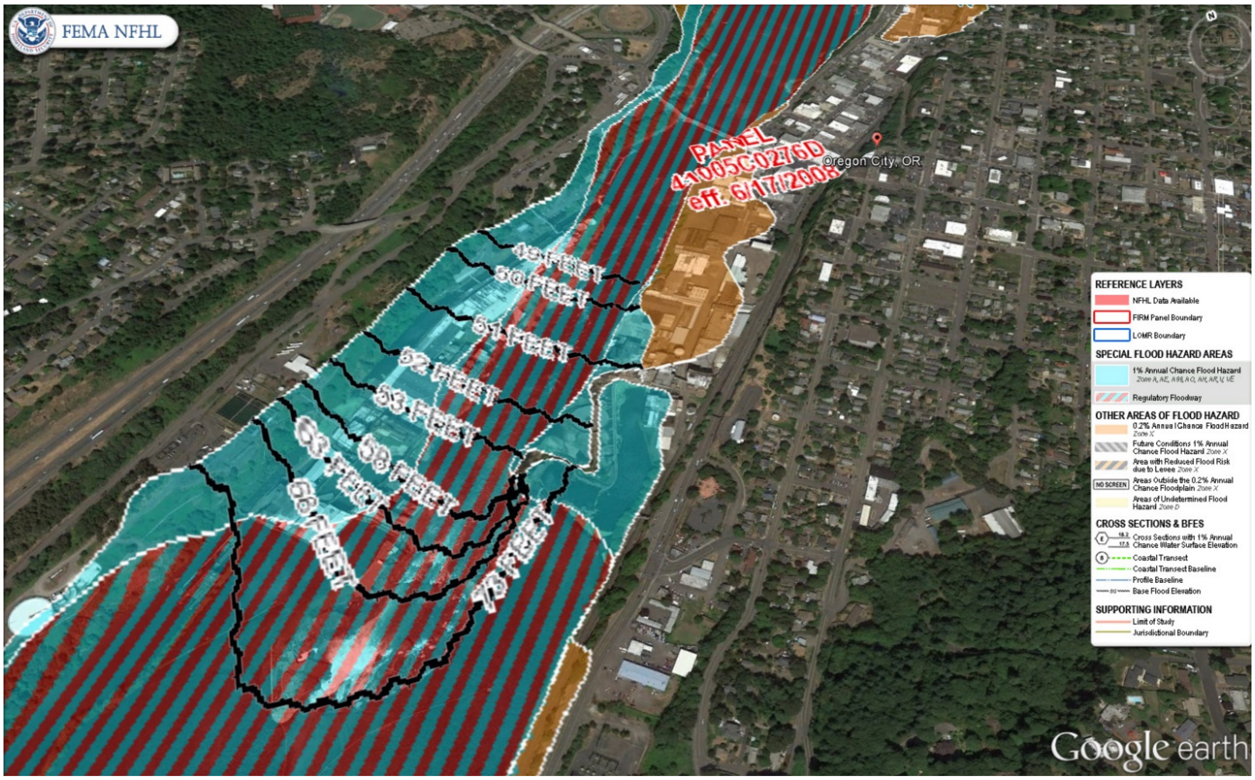

Figure 13: The FEMA flood map for Oregon City shows that parts of the site are in the 100 year floodplain and parts are in the 500 year floodplain. (FEMA, 2015)

This model shows the 100 year regulatory floodplain in blue. Within the blue area is a sub-area that is hatched in red stripes. This area is the active floodway. The 500 year floodplain is shown in orange. As noted above, it is very difficult to develop at all in the active floodway, however, some limited development can be constructed in the 100 year floodplain. Whitewater parks and associated un-occupied spaces can be developed in this region. Occupied buildings in Zone AE would need to have finished floor elevations that are typically 1 foot above the 100 year flood elevations. Figure 14, shown below, shows a closer and more detailed look at the same map:

[5] A full description of required permits is shown below in the permitting section of this report.

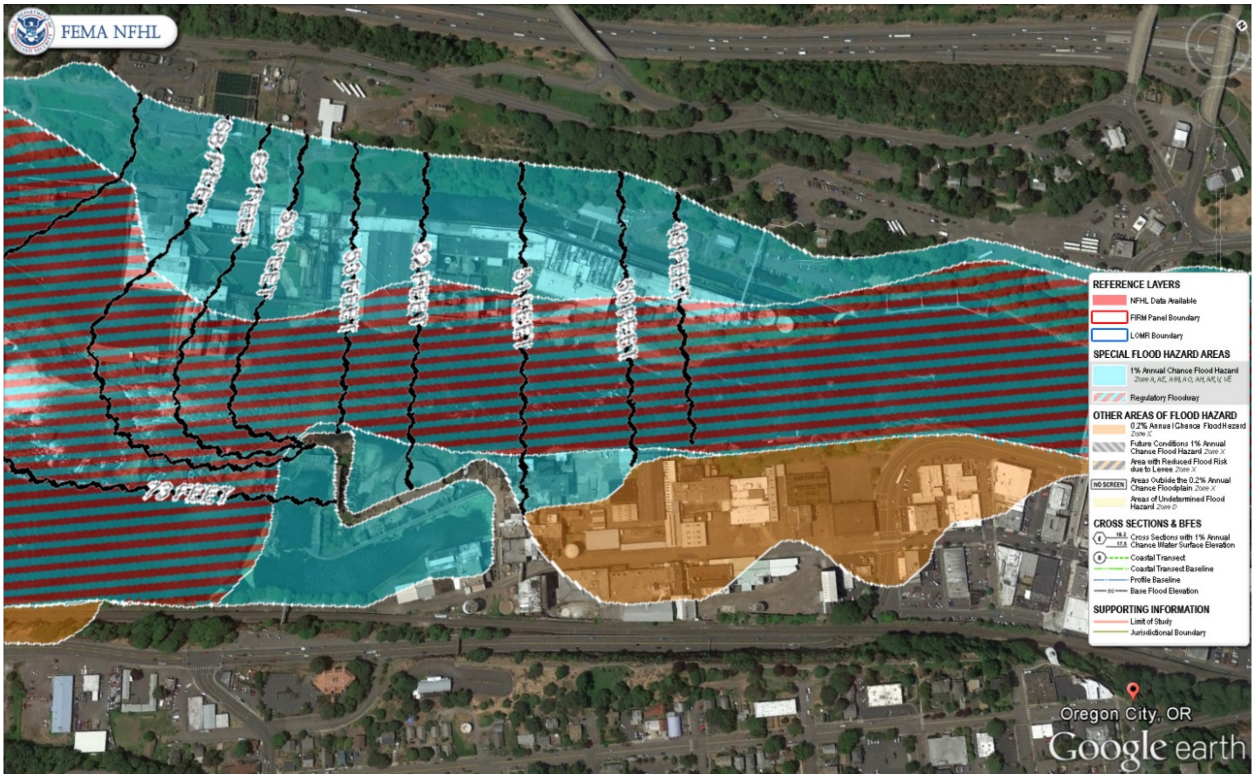

Figure 14: The FEMA flood map for Oregon City rotated and zoomed directly into the proposed project site. (FEMA, 2015)

Figure 14 shows that the bulk of the property is likely developable for whitewater parks without requiring additional flood modeling. It should be noted that, given the size of flooding and the amount of energy in the river just downstream of Willamette Falls, improvements should be designed to be robust and anchored and armored to withstand significant forces even outside of the regulatory floodway. Redevelopment of the site may further change the layout of the active floodway in mapping and in the field. Further requirements dictated by the local Oregon City development code require a balance of cut and fill within the 100 year floodplain for any new development *(Moosbrugger, 2015)*.

The Falls Legacy Site

Figure 15: The Falls Legacy Site is the former Blue Heron Paper's manufacturing facilities which, sits on the south east side of the river just downstream from Willamette Falls.

During S2o's site visit on the 2nd of February, 2015, the former Blue Heron Paper Company's manufacturing plant located on the Falls Legacy Site was also toured. The manufacturing site has been utilized for one purpose or another since the 1800's. There is an extended history of industrial development at the site that includes a multitude of differing purposes from wool to lumber to paper, amongst others. The remains of the sites manufacturing history literally cover the entire site.

The varied background of the site contributes to a confused and overlapping site configuration at present. A number of commercial and industrial buildings dot the site each with varying original purposes. There are also ruins of old sites, such as the Woolen Mill, which have been roughly preserved, but which have not served any recent function.

The evolving history of the site has contributed to a structural configuration which is also confused and, though cohesive, inconsistent. The larger part of the northwest portion of the site is built on pillars of apparently varying history, that raise the dry ground level of streets, sidewalks, and buildings above flood elevation[6]. A tour of the "underground" area of this site reveals that the vertical construction is entirely founded in basalt rock in the form of exposed bedrock that covers the riverbank. The structural layout of the pillars appear random and largely driven by the needs of the construction which was supported at the time. Removal of areas of development as is suggested in the Metro Plan (Walker Macy, 2014) would create an elevation difference between existing streets, usable building space, and walkways and the exposed bedrock at these locations. Any site design would require that this elevation difference be accommodated with sensible planning that involves access between levels or a large amount of structural fill.

[6] Some industrial manufacturing at the site took place below finished floor elevation and likely was exposed to flooding during significant events. Some of these spaces may be re-tasked to provide storage for the proposed whitewater park.

Figure 16: The Falls Legacy Site largely rests on pillars into bedrock in its current configuration. Demolition at the site will expose an elevation difference between native ground surface and finished floor elevations of any preserved buildings.

The Metro Master Plan points out that there are several buildings on site that could be preserved as valuable historic structures. Others—especially those that extend to the active floodway—would be difficult to replace from regulatory standpoint if they were removed. As such, a cohesive site plan is recommended that is mindful of the site's heritage, environmental value, and tribal legacy while also creating a sustainable attraction to business and visitors (Walker Macy, 2014)

Site Ownership:

Site ownership at the Falls Legacy Site is shown below in Figure 17:

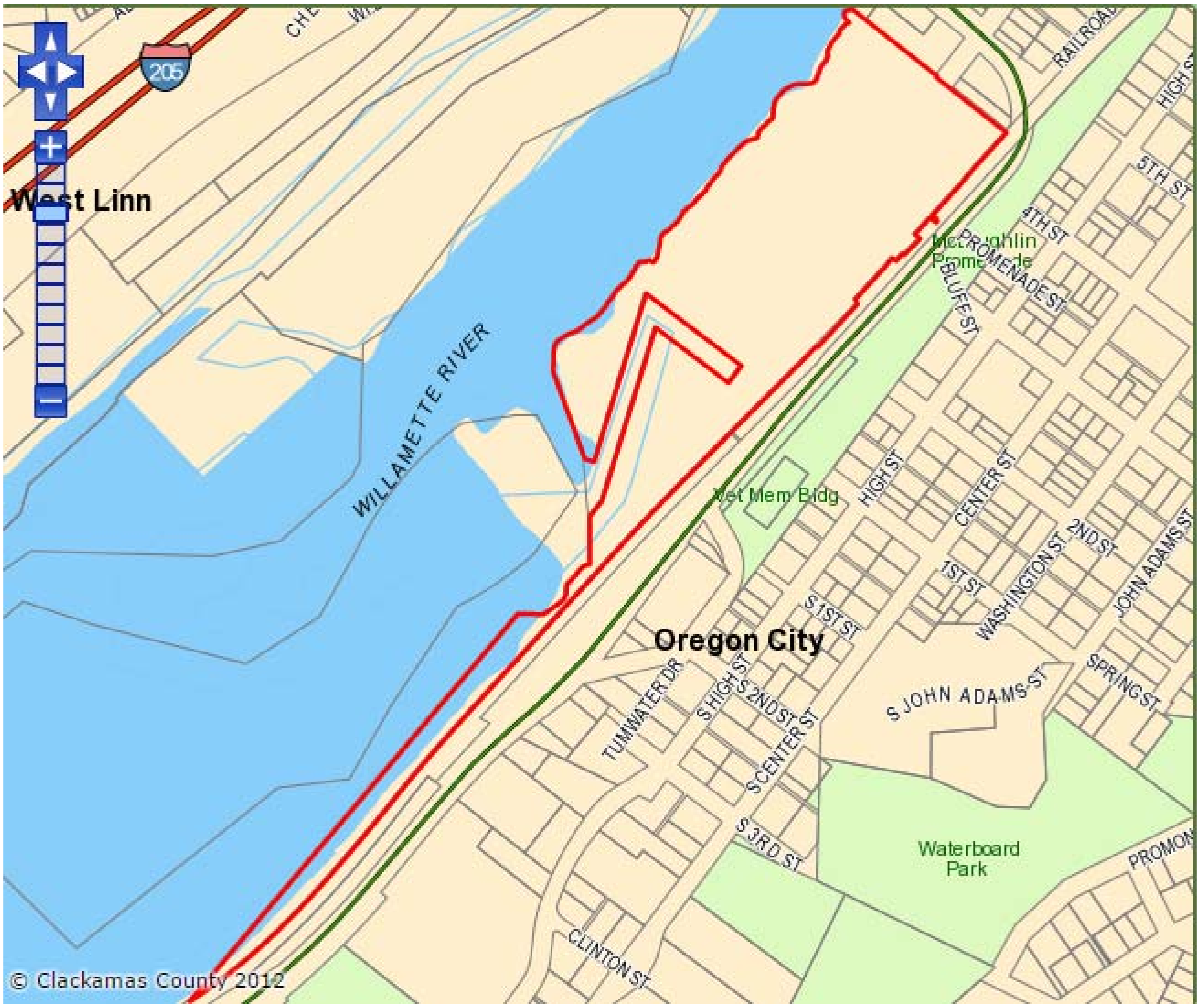

Figure 17: The former Blue Heron site, delineated by the red boundary, is now owned by the private development company Falls Legacy, LLC

The Falls Legacy Site, formerly the Blue Heron Paper Mill Site, is now owned by the private development company, Falls Legacy LLC. This company is headed by George Heidgerken. The ownership map shows that the dam structure is owned separately and, based on discussions with Louis Landre (Landre, 2015) this ownership is controlled by PGE. Additional discussions with George Heidgerken, suggest that an easement has been allowed for a riverwalk that would cross the Falls Legacy Site and would provide access and viewing of the Falls to the general public. Oregon City has an easement at the Falls Legacy Site and discussions with Oregon City Planning staff suggest that consultation and approval of any channel that crosses the City's easement would be required as a part of the planning and approvals process. (Moosbrugger, 2015). A layout of the easement is shown below in the permitting and process section of this report. In addition, several tribes, including Grande Ronde, Warm Springs and Siletz, have tribal fishing rights at the Falls.

Additional Considerations

Historic Structures

The National Register of Historic Places lists several locations that are registered as historic places in Clackamas County (Wikipedia, 2014). None of these listed sites are located at either of the proposed project sites. However, there are sites of significant historic value at both locations.

At the Locks Site, the locks themselves can be considered to have historic value. Given that the locks are on Federal Property, evaluation of improvements or changes to the location would likely be evaluated in relation to the historic nature of the site.

At the Falls Legacy Site, there have been several buildings that have been cited as being of historic value. A recent master plan (Walker Macy, 2014) for the site mapped these locations. This map is shown below:

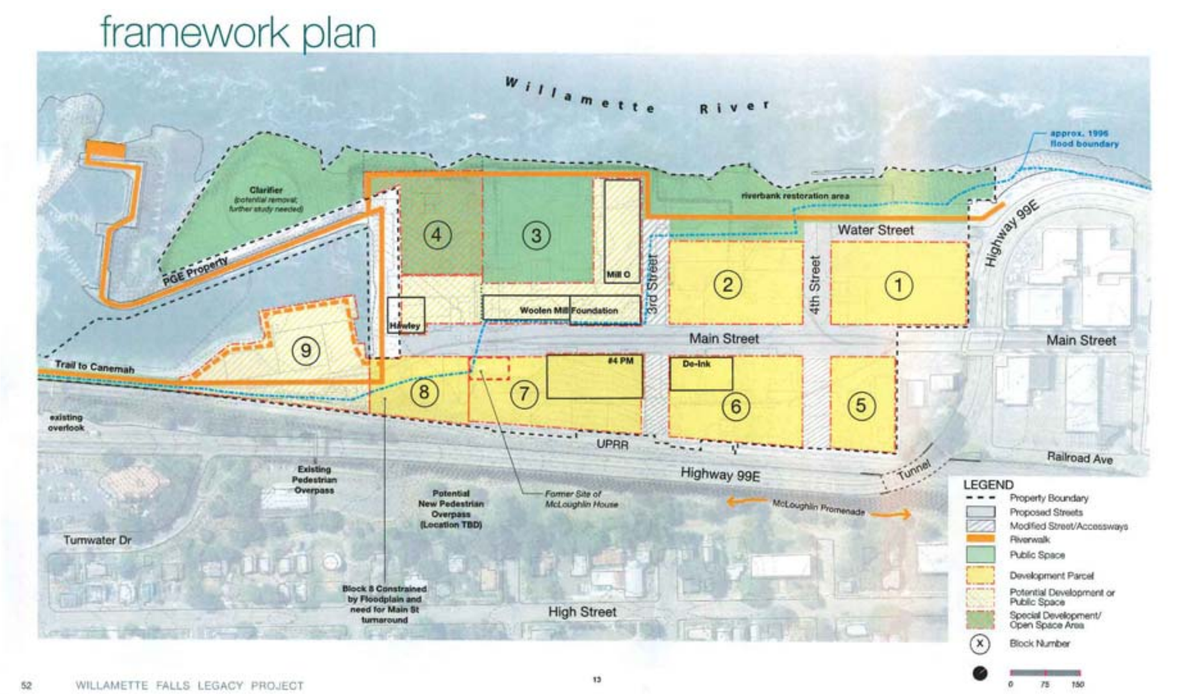

Figure 18: A map of locations of historic significance in the Falls Legacy Site. (Walker Macy, 2014)

Figure 18 illustrates the locations of specific buildings/features of historic significance. While it is not a requirement that these buildings be preserved, there can be benefits to the project and to the preservation of local history, if the character of these locations can be preserved. Not called out on the plan, but of significance is the former Woolen Mill site shown outlined in red in the center of the site.

Endangered Species

S2o was not able to find a threatened and endangered species list specific to Clackamas County. Consultation with regulatory and environmental authorities should be conducted prior to beginning preliminary design for the site.

S2o was able to find a list of species of concern at the falls on the OWRD's website. This list is shown below:

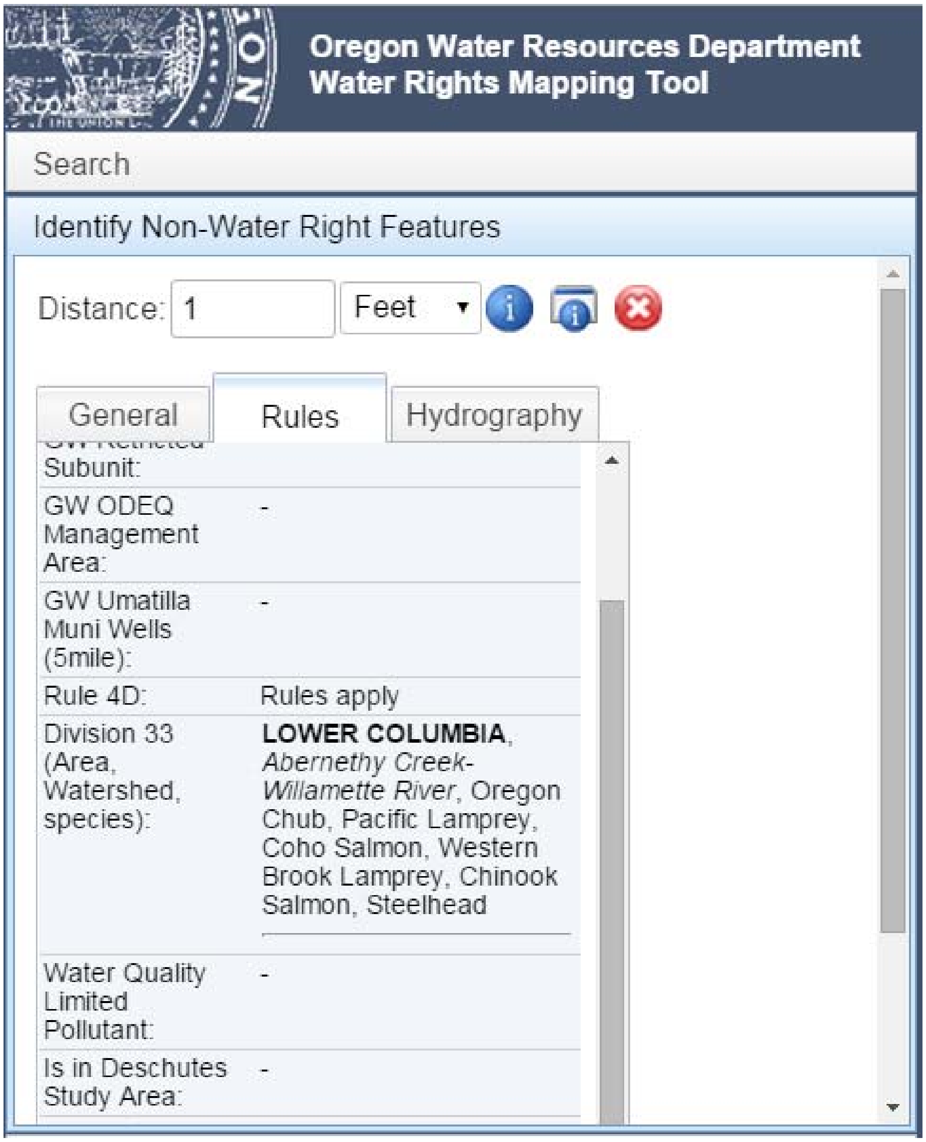

Figure 19: Listed watershed species of concern at Willamette Falls (Oregon Water Resources Department, 2015)

Of primary concern are in-stream and migratory species such as salmon, steelhead and lamprey. There is a tremendous effort underway to preserve and enhance migration for these species. Preliminary design should begin with consultations with regulatory authorities to ensure that the selected concept meets species, migration, habitat and preservation requirements.

Protected Viewsheds

A study conducted by Greenplay (Greenplay, LLC, 2008) for Oregon City cites one of the primary objectives of the updated City Master Plan as the protection of viewsheds. The study does not specifically identify any current viewsheds. Consultation with City Planning staff cite no existing protected viewsheds (Moosbrugger, 2015), however, the Falls Legacy Site has an extensive set of design guidelines governing recommended design practice. These practices include, for example tiered roof elevations that open up the river to viewing and that protect existing views for buildings behind the development site. These design guidelines carry significant weight in the development process given that proposed development guidelines would provide evaluation criteria during the Planning Board's review of the project. Approval by the Planning Board is required for the site to be developed. A full list of these guidelines is shown in Appendix 1.

Whitewater Park Potential at These Sites:

Figure 20: Whitewater parks have the potential to create surfing waves that are attractive to all types of users, not just experienced kayakers.

One of the relevant questions for a project of this nature is, given the amount of drop and flow, is a whitewater park feasible at this location? The International Canoe Federation (ICF) which is the international governing body of paddle sports attempted to define potential for whitewater parks in a study conducted in 1989. At the time, the study was targeted at identifying sites that were candidates for future development into whitewater parks. The metric that was created as a result of this study was called the Power Surface Index (PSI) (R. Goodman, 1994).

The Power Surface Index

Understanding the potential energy available at the site is key to understanding how great a potential resource this project could be. One way to quantify this potential energy is to use the Power Surface Index, and its derivatives, to characterize the potential energy available at this site.

A study was undertaken by Goodman and Parr (R. Goodman, 1994)[7] from Great Britain to try to develop an empirical method for determining the suitability of particular sites for Whitewater Park improvements. The study's authors were the original designers of the Holme-Pierrepont National Watersports Centre[8]. The study uses typical flows, widths, and channel slope to determine the Power Surface Index (PSI) for a particular venue. The number created—though largely targeted at slalom developments at the time of the study—provides a way to compare potential energy available for development of Whitewater Parks at various locations.

The Power Surface Index, created by Goodman and Parr, Equation 1 and Equation 2, considers factors including width of the river and surface roughness. This metric measures the available power normalized by the factors that cause diffusion of this power, namely roughness over the surface area of the river. The Power Surface Index (PSI) is shown below:

The PSI can be expressed as,

$$\Psi = \frac{(discharge)(Drop)(10000)}{(Length)(Width)}$$

Equation 1

for smooth concrete channels and,

$$\Psi = \frac{(discharge)(Drop)(10000)}{(2)(Length)(Width)}$$ [9]

Equation 2

For natural waterways.

This metric can be used to establish that a site has adequate drop and slope to provide for an international level slalom whitewater park. However not all of the sites analyzed in this study are necessarily slalom sites.

In this instance there is a tremendous amount of drop available in relation to other whitewater parks around the world. As an example, the London Olympic Park utilizes less than 20 feet of total drop and a flow near 500 cfs. At times the park is operated at lower flows of approximately 350 cfs.

Figure 21, shown below, shows the power surface index for the proposed *bypass* channels shown in the design concepts below. Note that the Power Surface Index decreases for the longer channels. A flow of 400-500 cfs is assumed for these channels with a drop of approximately 40 feet.

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[8] The author of this study was a part of a redesign effort of this channel in 2008

[9] Note that in Equation 1 and Equation 2 the value of 10,000 has replaced the published value of 10^{-4} from Goodman and Parr's document. Recalculation of their table revealed that this constant was listed incorrectly.

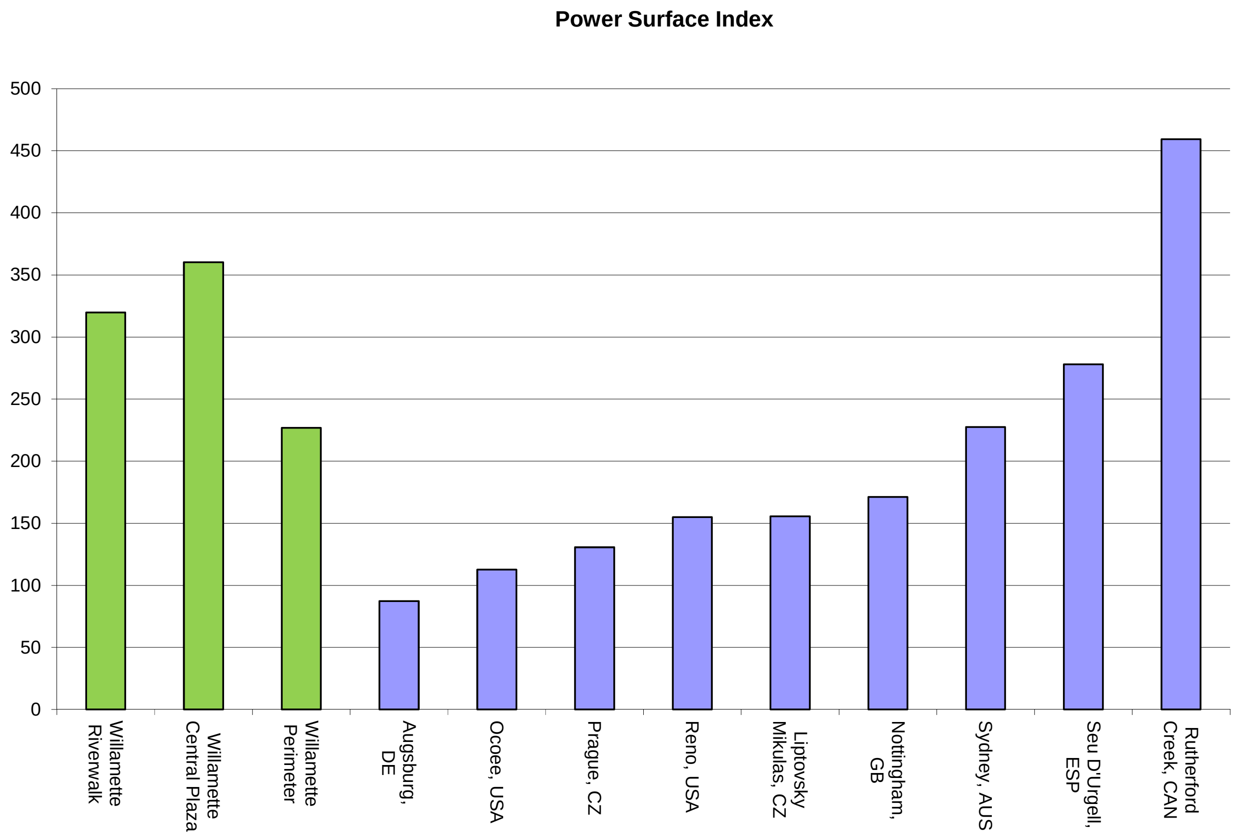


Figure 21: Power surface index for the bypass channels in Willamette in comparison to other international standard whitewater park sites around the world.

Figure 21, shown above, shows that the power available at the proposed layouts far exceeds the power required for a whitewater park. In fact, whitewater parks with the type of power available to the Riverwalk and Grand Plaza concepts typically create dangerous flow conditions that are inappropriate for even the best paddlers. As such, these concepts have been revised to dissipate energy in the stilling pool at the top of the channel and then drop approximately 16-18 feet across their length. This results in PSI values of between 100 and 150. It should be noted that the stilling of this energy provides the opportunity for small-scale hydro, or sculpted waterfalls at the site.

S2o's proposed solution to still the excess water is to install small-scale hydro at the upstream end of the project. This type of hydro can help to celebrate the industrial history of the site and will also generate power. S2o was a part of a project in the United Kingdom at the Teesside Whitewater Park in which fish-friendly Archimedes screw pumps/generators were installed into a whitewater park as a part of an urban renewal project. The screw pumps/generators create an exciting visual attraction as they turn and also help to create a self-sustaining site by generating significant amounts of energy. Figure 22, shown below, shows the screw pumps in Teesside complete with view windows for the public:

Figure 22: The Teesside Whitewater Park features fish-friendly screw pumps which can be used to either pump, or generate electricity. S2o proposes to use a similar system for some concepts at the Falls Legacy Site.

Another common usage of whitewater parks is Freestyle, or trick, kayaking. The in-stream site would be a freestyle site and would utilize a freestyle-specific metric. For this usage a metric has been created, the Freestyle Surface Index, to aid in the analysis of potential for this type of Whitewater Park as well. This metric, shown below, is commonly used to evaluate and scale Freestyle features.

The Freestyle Surface Index

With regard to freestyle attractions, there is no existing metric that can be used to establish potential for a freestyle feature. However, it is of note that the Power Surface Index was intended to quantify the available power at a slalom/boating park site and relate it to other *slalom sites.* A similar analytical approach for existing freestyle sites, though it may suffer from some of the same shortcomings as the previous metric, will help to compare claims and design choices made at one park with other similar parks. A modified Power Surface Index can be used to consider available energy at the drop normalized by area of the drop structure. This modified index, called, for purposes of clarity, the "Freestyle Surface Index" [10] (FSI) can be used to compare available energy at each drop normalized by roughness over the width of the river.

[10] Note that the author acknowledges that this is not a unique metric of his own invention. The name has been modified to provide clarity in this discussion.

This index is similar to the Power Surface Index with the exception that the constant of 10,000 has been changed to 10 to put the numbers in a range more easily understood.

$$FSI = \frac{(discharge)(Drop)(10)}{(Drop\ Length)(Width)}$$

Equation 3

For this whitewater park the FSI is the metric of most interest to the study.

The Freestyle Surface Index for this site is interesting. While the design needs to meet certain minimums (it has been found through experience that a minimum of 1.5' of drop is required for this type of feature), the power surface index allows the potential of this project to be compared to other projects. Figure 23 shown below, illustrates the Freestyle Index for the in-stream concept vs. other similar projects that have been built[11]:

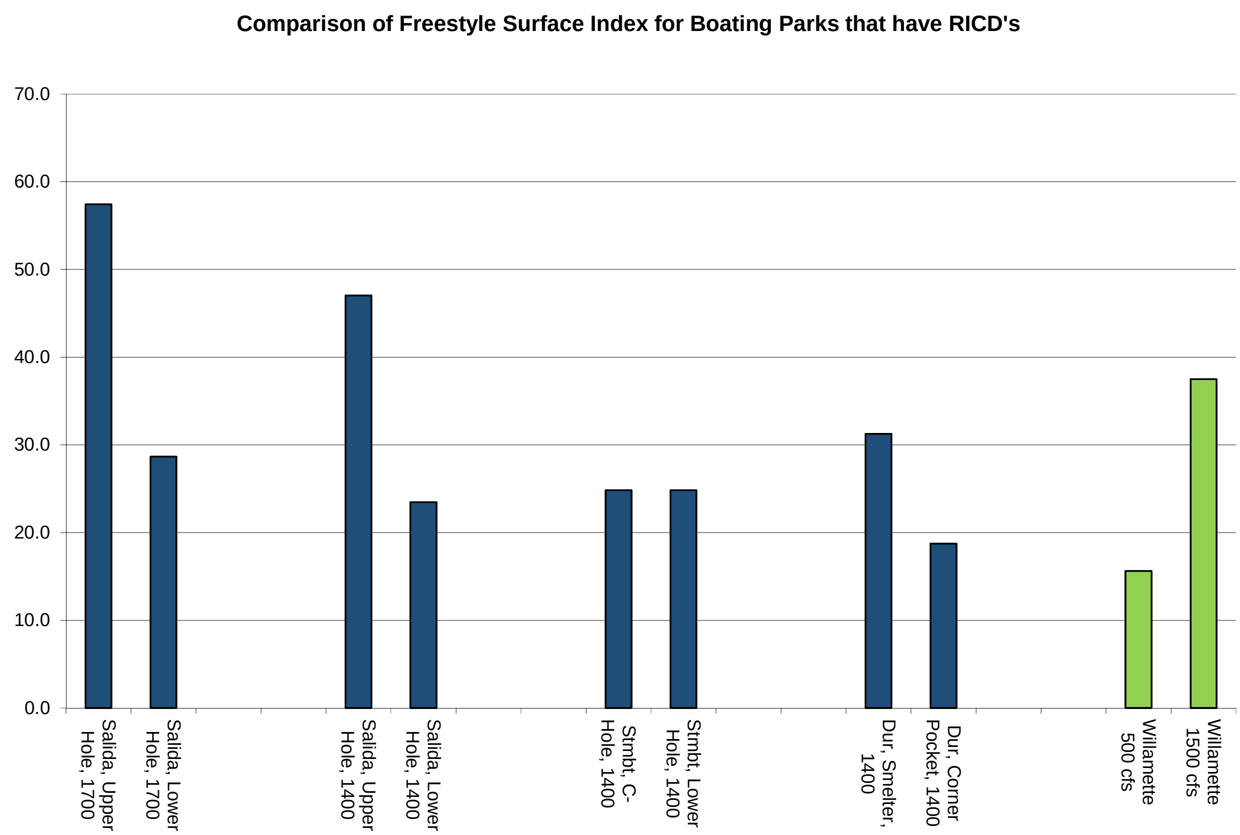


Figure 23: The power index of the proposed in-stream feature in Willamette in comparison to those of other, similar features that have been built.[12]

[11] For the purposes of this study, a total drop amount of 2.4 feet has been assumed for this feature. This may evolve depending on the backwater curve of the Willamette River at the site.

Figure 23 shows that the amount of flow diverted into this channel is of utmost importance. More flow in the in-stream channel will result in greater potential for a whitewater park in this channel. Typically a nice freestyle feature begins to form around 900-1000 cfs in a configuration such as the one shown in the concepts below and 1500 cfs would provide a significant attraction.

Metro Masterplan

Metro created a masterplan for the Falls River Site entitled *A Vision for the Willamette Falls Legacy Project* (Walker Macy, 2014). The plan is founded in the values of creating a venue that honors the site's rich history through historic and cultural interpretation and that stimulates the local economy by, or perhaps through, creating public access and viewing of the Willamette Falls. The plan presents several concepts but the key components that permeate each are:

- **Environmental Values:** the redevelopment should be created and should deliver a final product that respects the environmental values of restoring and maintaining healthy habitat and fish passage along the river. The plan emphasizes the use of a cohesive waterfront design to accomplish this.
- **Riverwalk:** The redevelopment should include a public access way via the "Riverwalk" A riverside path that provides access for the public to cross the site via public walkways and access viewing points that provide panoramic views of the Falls.
- **Public Spaces:** The redevelopment is also slated to have public spaces that offer opportunities for the community to gather, to recreate, and to create a more open and appealing aesthetics.
- **Commercial:** The plan proposes significant redevelopment of the existing buildings (along with new construction), to provide for a retail, hospitality, residential, and commercial district (mixed use).

City Planning

Discussions and correspondence with City Planning Staff (Moosbrugger, 2015) state that the redevelopment of the site will need to proceed through a Type III planning review with the City of Oregon City. This type of review involves review by a City committee. The City planning policies and design guidelines suggest that these key values are key to meeting planning committee requirements:

- Enhancement of the special character of the Willamette falls Downtown District
- Design for the comfort and safety of pedestrians
- Maintain the Downtown Character of Oregon City
- Re-Use, rehabilitate, restore and interpret buildings and structures.
- Build for long-term use
- Incorporate ecology into the design.
- Create a world-class riverwalk
- Create quality public spaces

City planning staff also emphasized the importance of respecting the riverwalk easement and ensuring that whitewater park design concepts be vetted through the City for approval if they pass through the easement. A map of the easement, provided by City staff, is shown below:

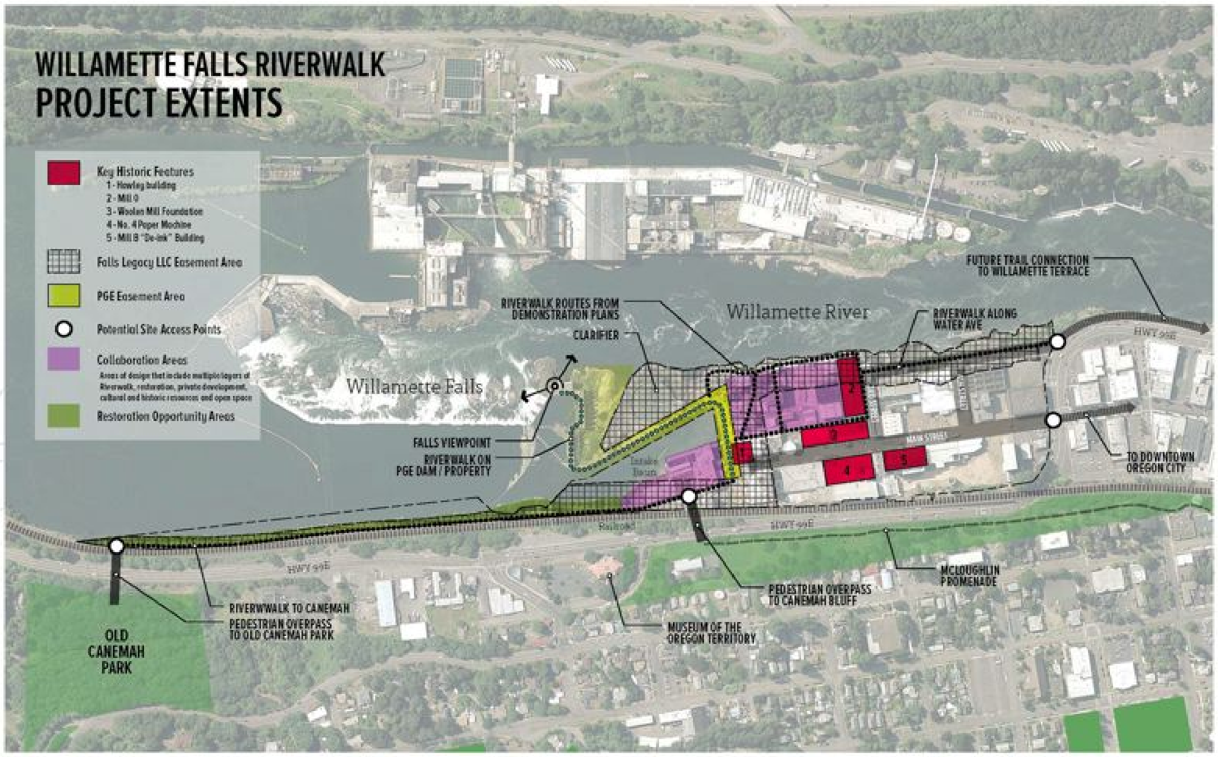


Figure 24: A map of the Riverwalk Easement through the Falls Legacy Site.

The City has issued a Request for Proposals (RFP) for design services for the Riverwalk and so the timing of this conceptual design effort appears to mesh well with the forward movement of the project. A variety of design concepts are shown below in Section 3.

Section 3: Proposed Improvements

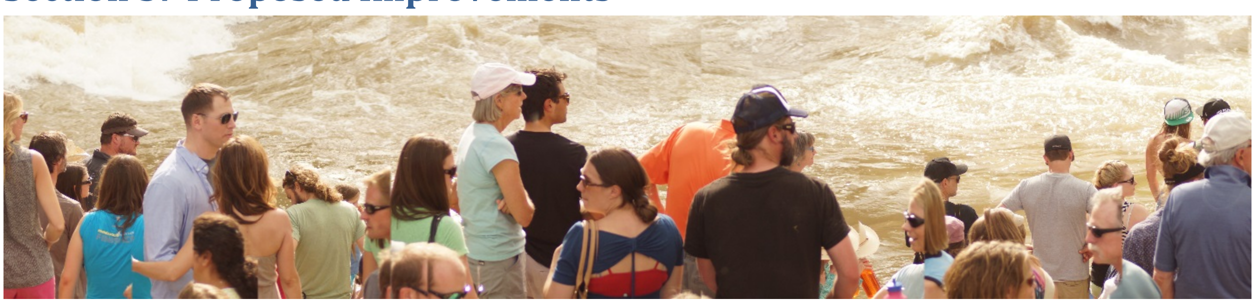


Figure 25: Spectators watching the Animas River Days event.

The purpose of the conceptual design phase is to create a variety of ideas which may appeal to the owner and stakeholder groups. As such, the final design selected for advancement may be one of these proposed concepts, but may also be a hybrid or differing design based on feedback received as a part of this process. An in-stream concept is presented in this conceptual design pallet as well as three bypass channel options. All of the concepts are presented on Falls Legacy Site. The bypass channels are of varying lengths and configurations and provide differing functionality and complementary benefits depending on owner and stakeholder priorities.

Concept 1: The In-Stream Concept:

This design concept creates a single, adjustable, in-stream design feature. The purpose of the feature would be to create an attractive freestyle feature that could be used when actuated by the operator. The feature could also be turned off if water were required in priority for other uses such as power generation, other water rights, or in-stream minimum flow requirements.

The site of the proposed in-stream feature is in an existing inlet upstream of the existing and abandoned clarifier. The flow-channel is typically dry during regular flows but could be fed through valves placed in an intake bay located just above the dry channel. The intake bay was the former site of the DC generating station located at this site prior to the turn-of-the-century (Wikipedia, various authors, 2015). A picture of this location is shown below:

Figure 26: The potential location of an in-stream feature upstream of the abandoned clarifier on the Falls Legacy property.

The proposed feature would be turned on and off depending on flow needs and recreational needs at a given time. This would allow for an adjustable feature using the simple adjustment system called RapidBlocs. The RapidBlocs system allows blocs of varying shapes to be placed to adjust the flow characteristics of a particular channel allowing for the fine-tuning of the desired hydraulic. RapidBlocs were used in both the London 2012 Olympic Games Venue and will also be used in the Rio 2016 Olympic Games venue and have a history of successfully providing adjustability and tuning of a feature.

The design of the channel will need to provide for the health of in-stream and fish species. The adjustable nature of the venue will be one part of this control. The channel can be operated during months that users desire to utilize the feature but can also be turned off during migratory times (of day, or of season). Additionally, the staging channel can be filled to remove the pool shown in Figure 26 so that fish are not trapped, as they are now, in a channel that they cannot migrate through. The operations manager will have to adjust flows in a manner that does not prevent fish from descending this channel. The concept design for this in-stream feature is shown below:

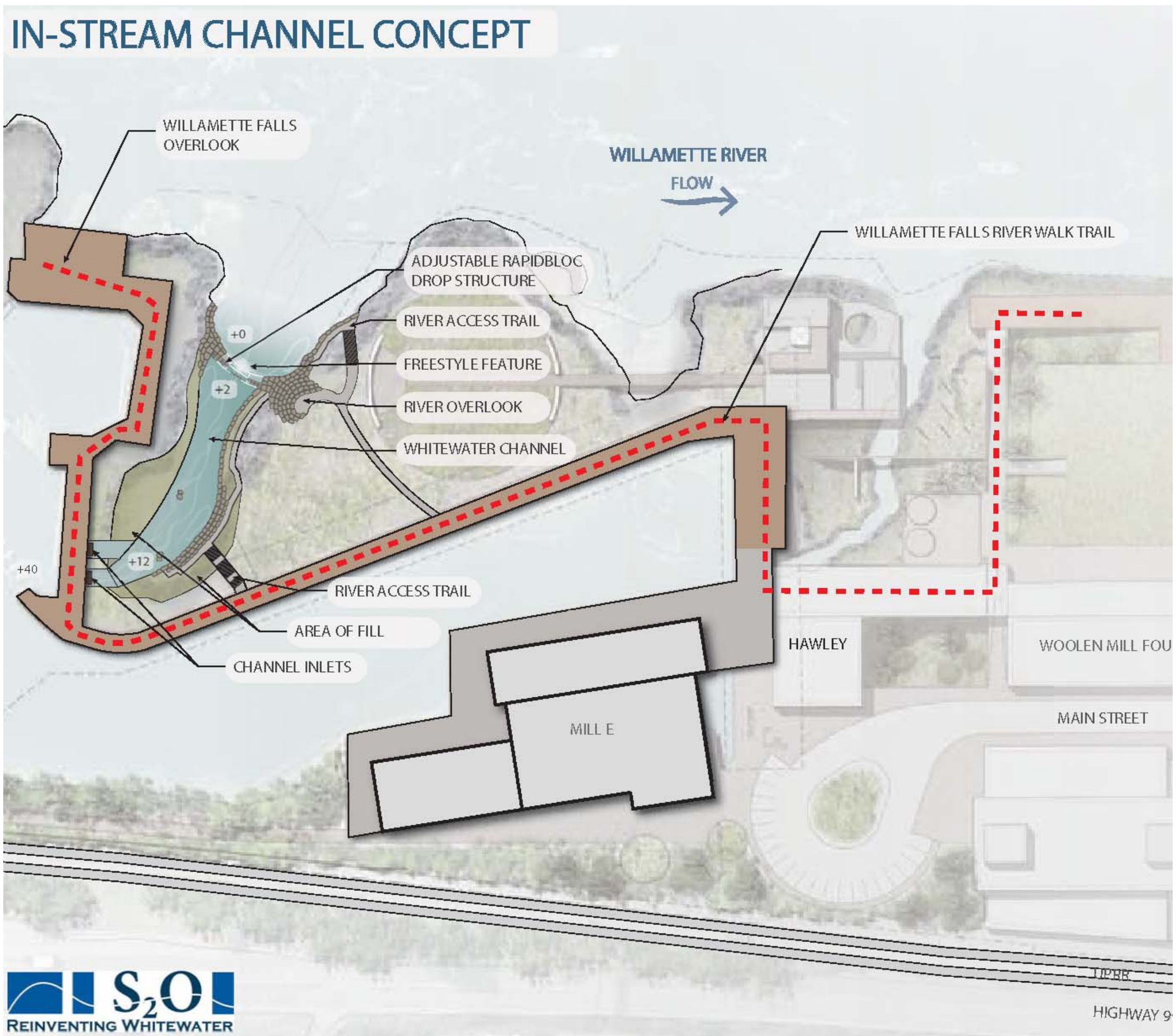


Figure 27: Rendering for the In-Stream Concept Design.

The pricing for this in-stream concept might be considered prohibitive depending on the project proponent's objectives. While in-stream whitewater parks can be great attractions, this particular one would require that the operator install a flow control device to allow water into this area of the falls and also would require that the construction team likely barge in materials and equipment to complete the work. While S2o does not have experience with projects that require this type of access, the estimate does show higher than average costs for materials, mobilization and flow control.

Willamette Preliminary Pricing

In-Stream

4/22/2015 Scott Shipley

Item	Description	Material	Quantity	Unit	Cost/Unit	Total
l Construction Costs						
1	Mobilization to include costs for bonding, insurance, traffic control, staging, etc. as well as erosion control at the work area; no measurement for payment shall be made of any of the work, materials equipment used for mobilization.		1	EA	$75,000	$75,000.00
2	Water Control on-site including the creation of separate coffer dams at each structure, excavation and storage of bed materials, and replacement of bed fills and removal of water control items		1	EA	$40,000	$40,000.00
	Subtotal					$115,000.00
Drop 1						
3	Drop #1	Rock	57	CY	$220	$12,540.00
4	Drop #1	Pitfill	170	CY	$75	$12,750.00
5	Drop #1	Concrete Grout	57	CY	$220	$12,540.00
6	Drop #1	Obstacle System including Connections	55	SY	$277	$15,235.00
7	Drop #2	Bedding	650	CY	$65	$42,250.00
	Subtotal					$95,315.00
ecial Features						
9	Head Gates		3	EA	$250,000	$750,000.00
10	Additional Heavy Equipment if required or authorized by Engineer (not part of any bid item): Backhoe w/thumb (CAT 225 or equiv.)		45	HR	$140	$6,300.00
11	Bank Terracing (estimated)		1322	LF	$90	$118,980.00
12	Hardscape (Standard)		4140	SF	$10	$41,400.00
13	Hardscape (Standard With Steps)		680	SF	$14	$9,520.00
14	Structural Fill		5907	CY	$40	$236,280.00
15	8' Dia Rocks		5	EA	$500	$2,500.00
	Subtotal					$1,164,980.00
Construction Costs						$1,375,295.00
ıated Soft Costs						
		Permits	2.50%			$34,382.38
		Testing and Inspections	1.25%			$17,191.19
		Equipment (Owner Furnished)	1.50%			$20,629.43
		Architectural and Engineering Design	11.00%			$151,282.45
		Legal/ Marketing Fees	0.00%			$0.00
		Developer Fees	0.00%			$0.00
	Subtotal Estimated Soft Costs					$223,485.44
	Contingencies (25%)					$399,695.11
	Grand Total					$1,998,475.55

Figure 28: Conceptual Estimate of Costs for the In-Stream Concept

Concept 2—The Riverwalk Channel

Three bypass channel concepts were created. The first of these revolves around the idea of keeping the river located along the river corridor. In this concept, the water drops from the elevation of the upper basin down to an elevation 16-18 feet above the average river water surface elevation, adjacent to the Falls Legacy Site, over a length of approximately 850 linear feet. This elevation drop can be accomplished in several ways. Amongst the more innovative would be the use of screw turbines (or a substitute) or via a sculpted waterfall that would still the water once it settles into the upper pond of the channel.

The Riverwalk concept would be built into a grade along the river's bank and would function as a retaining wall for the remainder of the site. This would decrease the instance that water would flood into the venue and would provide a recreational attraction in its own right while also providing a platform for the Riverwalk as well as a large common space in the center of the venue.

The channel itself would provide an amenity to the Riverwalk. The whitewater and trails system would connect to the riverwalk and would provide a complementary activity with potential walking trail amenities such as workout circuits and gathering spaces/shaded pavilions. The channel would be regulation length for slalom competitions and would allow for recreational boating of all types (including tubing at some levels), as well as commercial rafting.

The primary benefit of this layout is that it creates and maintains the existing flat expanse between Mill O and Mill G as shown in Demonstration Plan B of the Metro plan (Walker Macy, 2014). The design affords a large flat viewing and gathering area in the central redevelopment area. This location also provides a connection and showcases the Woolen Mill Location which is of historical significance.

From an ecological perspective the shape and layout of the channel can be adjusted to maximize the potential character and expanse of riverfront that can be restored to its natural configuration. This layout would require significant fill to create the flat areas and the layout and elevation of these flat areas will need to be tailored to meet the balanced cut and fill requirements of the City and Metro floodplain codes. Figure 29, shown below, shows this concept design:

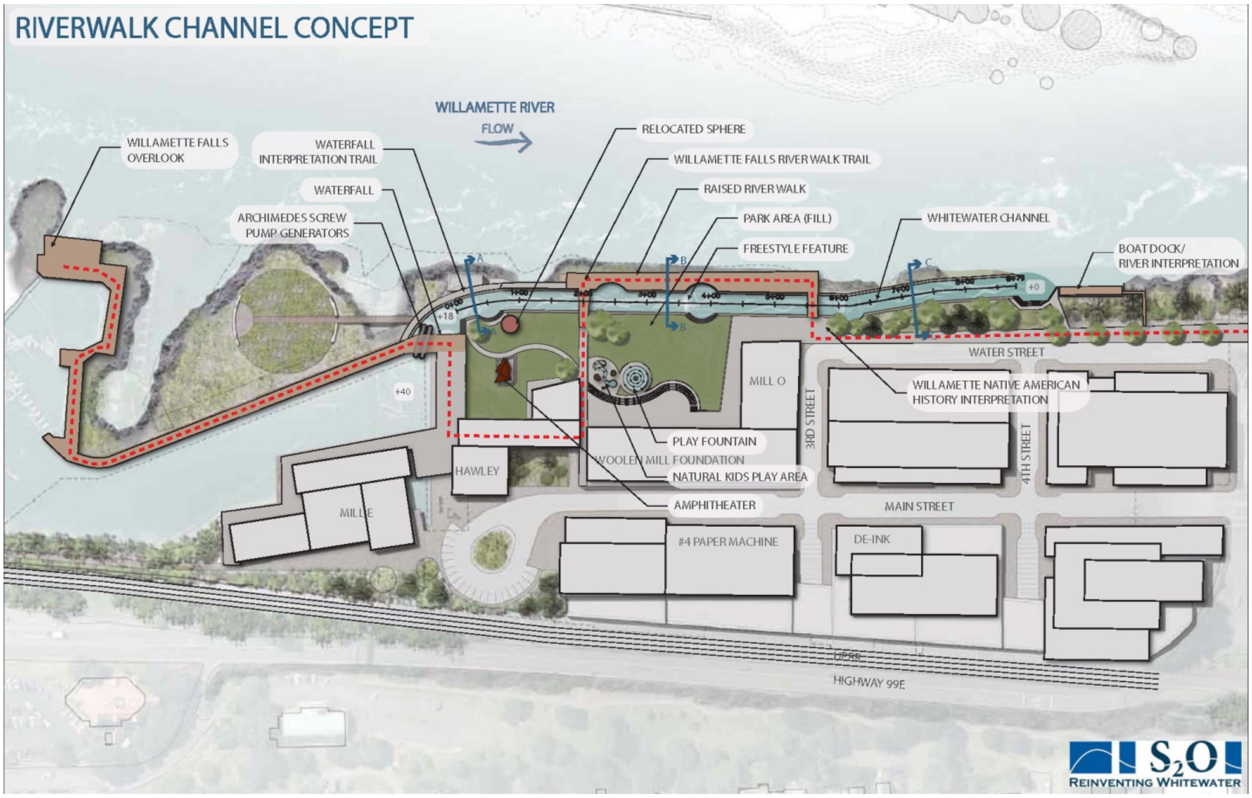


Figure 29: Rending of Concept 1, the Riverwalk Channel, with Sections labeled below.

One of the primary characteristics of this layout is that it serves as a retaining wall for the remainder of the site, creating a large amount of space that is potentially protected from all but the largest of floods. The Figures shown below illustrate potential cross sections of this site plan:

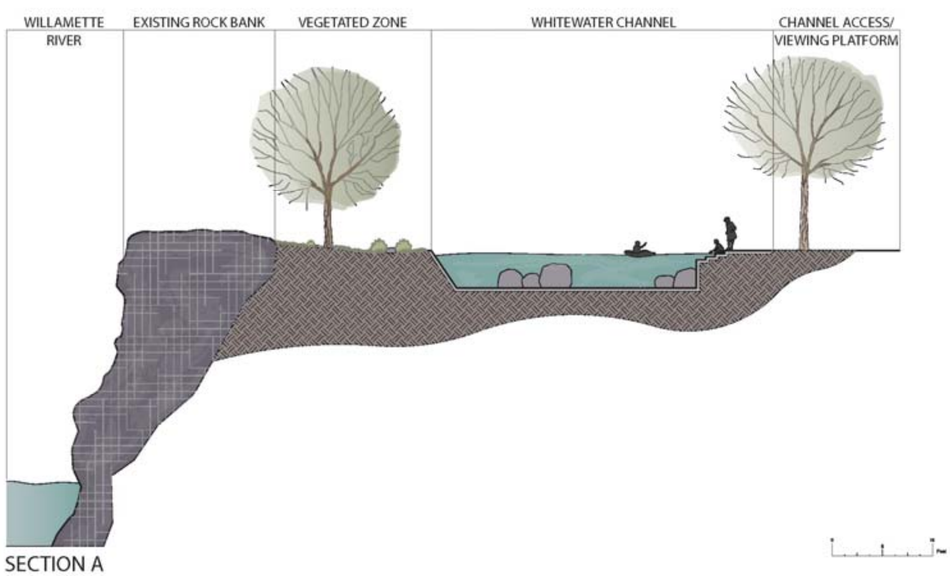


Figure 30: A section through the upper portion of the Riverwalk Concept.

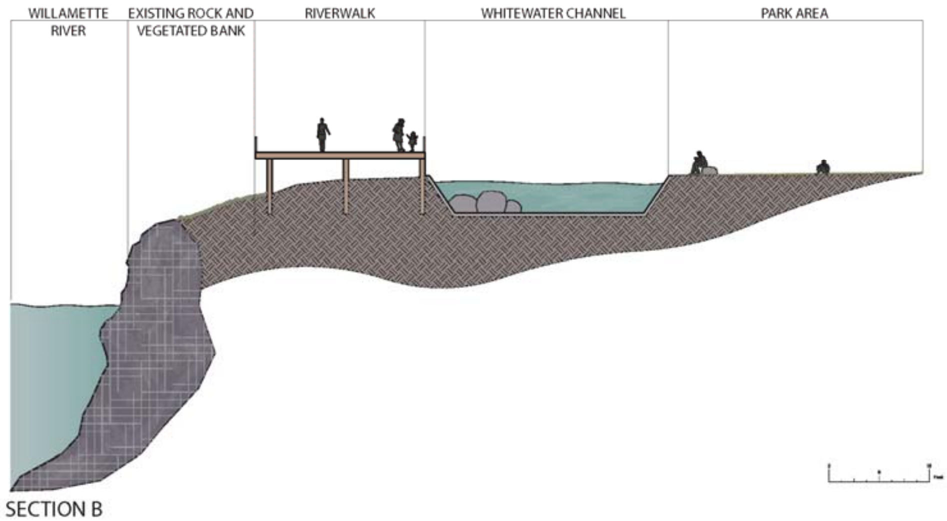


Figure 31: A section through the mid-section of the Riverwalk Concept.

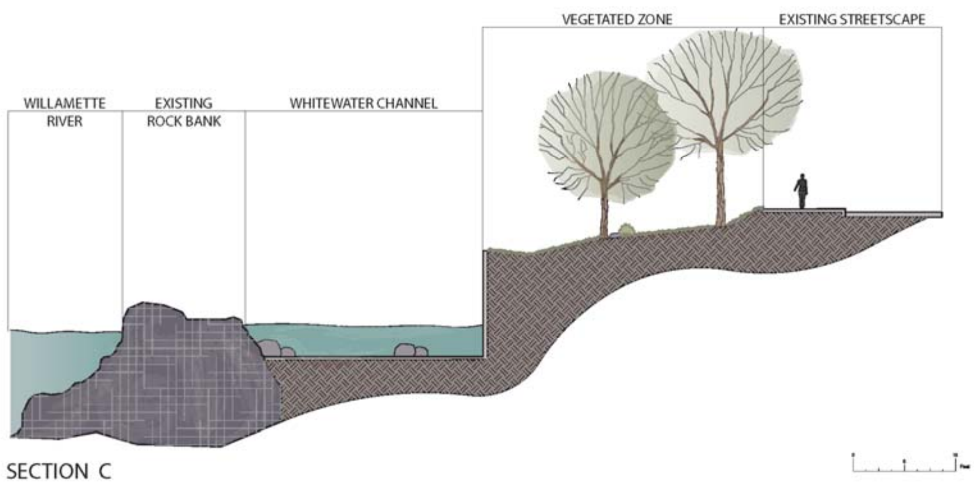


Figure 32: A section through the upper portion of the Riverwalk concept.

A similar channel configuration (though less steep) was created in South Bend, Indiana as a part of an urban revitalization of a former industrial channel. Figure 33, shown below, shows an image of what this type of channel, with retaining walls on one side, can look like:

Figure 33: Image from the South Bend, Indiana Whitewater Park with a retention wall and river walk on the right side.

The costs for the Riverwalk concept are shown below. The costs for all of the canal-type concepts are difficult to estimate as they are necessarily a part of a much larger project. The Riverwalk, for example, will be constructed prior to, or in parallel with the whitewater concepts. It is difficult to know what portion of the demolition, site remediation, grade control, paths, etc. that should be attributed to the whitewater park vs. the Riverwalk. The costs shown below have attempted to balance these costs. Additionally, accuracy of some of the estimates is difficult to determine without a detailed ground elevation survey.

The Riverwalk concept could also feature green energy in the form of generators at the upstream end of the project. For the purposes of informing the Client, this concept has been shown without the generators and the Grand Plaza concept with the generators.

Willamette Preliminary Pricing

Riverwalk (With No Screw-Pump Generators)

4/22/2015 Scott Shipley

Item	Description	Quantity	Unit	Cost/Unit	Total
Estimated Construction Costs					
1	Clear and Grub/Demo (this is an estimate based on internet research)	5	Acre	$75,000	$375,000.00
2	Structural Fill	44650	CY	$20.00	$893,000.00
3	Grading	44650	CY	$8.00	$357,200.00
4	Bedrock Removal	2700	CY	$280.00	$756,000.00
5	Paving	0	SF		$0.00
6	Site Utilities	1	EA	$120,000.00	$120,000.00
7	Hardscape (Standard)	15100	SF	$4.80	$72,480.00
8	Hardscape (Standard With Steps)	2450	SF	$6.50	$15,925.00
9	Hardscape (Enhanced)	16000	SF	$6.50	$104,000.00
10	Riverwalk Decking	400	SF	$15.00	$6,000.00
Landscape					
11	Retaining Wall 10'-12'	150	LF	$230.00	$34,500.00
12	Retaining Wall 5'-10'	400	LF	$142.08	$56,833.33
13	Retaining Wall 2'-5'	400	LF	$56.53	$22,611.11
14	Landscape (softscape)	3	Acre	$175,000.00	$437,500.00
15	Site Power/Lighting	1	EA	$220,000.00	$220,000.00
16	Perimeter Fencing / Gates	1100	LF	$30.00	$33,000.00
Channel					
17	Linear Foot of Channel Bottom	927	LF	$165.00	$152,955.00
18	Linear Foot of Channel Edge	1960	LF	$101.25	$198,450.00
19	Moveable Obstacle System including connectors	3090	SY	$227.00	$701,430.00
20	Head Gate Flow Control System	1	EA	$350,000.00	$350,000.00
21	Gate System	1	EA	$45,000.00	$45,000.00
22	Conveyor Belt System	0	EA	$500,000.00	$0.00
23	Timing System	1	EA	$25,000.00	$25,000.00
Special Features					
24	Screw-Pump Generators (estimated)	0	EA	$450,000	$0.00
25	Controls/Electric (estimated)	0	EA	$1,200,000	$0.00
26	Generating Station	0	EA	$4,200,000	$0.00
27	Amphitheater	750	SF	$150	$112,500.00
28	Boat Storage	2000	SF	$150	$300,000.00
29	Office Space	1200	SF	$220	$264,000.00
30	Bridge	2	EA	$75,000	$150,000.00
31	Relocate Sculpture Structure	1	EA	$380,000	$380,000.00
32	Kids Stream and Natural Outdoor Playground	2244	SF	$120	$269,280.00
33	Kids Play Feature	1	EA		$0.00
34	Boat Dock	1000	SF	$35	$35,000.00
Subtotal Construction Costs					$6,487,664.44
Estimated Soft Costs					
	Pre Funding Costs	1.75%			$113,534.13
	Permits	2.50%			$162,191.61
	Testing and Inspections	1.25%			$81,095.81
	Equipment (Owner Furnishings)	2.75%			$178,410.77
	Architectural and Engineering Design	11.00%			$713,643.09
	Legal/ Marketing Fees	1.25%			$81,095.81
	Developer Fees	3.00%			$194,629.93
	Contingency	15.00%			$973,149.67
Subtotal Estimated Soft Costs					$2,497,750.81
Grand Total					$8,985,415.26

Figure 34: Conceptual Opinion of Costs for the Riverwalk Concept

Concept 3—The Grand Plaza Concept

The Grand Plaza concept creates a central attraction out of the whitewater channel. This attraction, like the Riverwalk concept, could provide demonstration power generation as well as, or alternately, a waterfall in the central redevelopment site. Both the Riverwalk and Grand Plaza concepts could be provided with demonstration fish passage channels as well.

The Grand Plaza concept has a total drop of approximately 16 feet over roughly 750 linear feet of channel. The Grand Plaza concept is founded in the idea of creating a Willamette Falls Whitewater Park as the central theme of the new development. The vision is to create a waterfall or Archimedes screw into the central pavilion area directly adjacent to the old Hawley building. There are two visions here:

- If a waterfall were created within the site it would draw the aesthetics of the Willamette Falls right into the central area.
- In a separate incarnation, the Archimedes screw could be used to create a green site that has educational, interpretive, and historical value to the falls. The Archimedes screw generators would celebrate the generation of green power at the venue for over a century and would visually demonstrate how river flow can be used to generate power. As an added bonus, the generators would provide significant power, depending on flow rates, that could offset usage at the site.

The channel layout would be closer to being “at grade” than the Rivewalk concept and could easily be constructed within the constricts of the City’s balanced fill requirements. Additionally, this concept would allow for restoration of the channel edge as well and could allow for a river’s edge configuration similar to that shown in Demonstration Plan A from the Metro Plan. The concept is shown below in Figure 35:

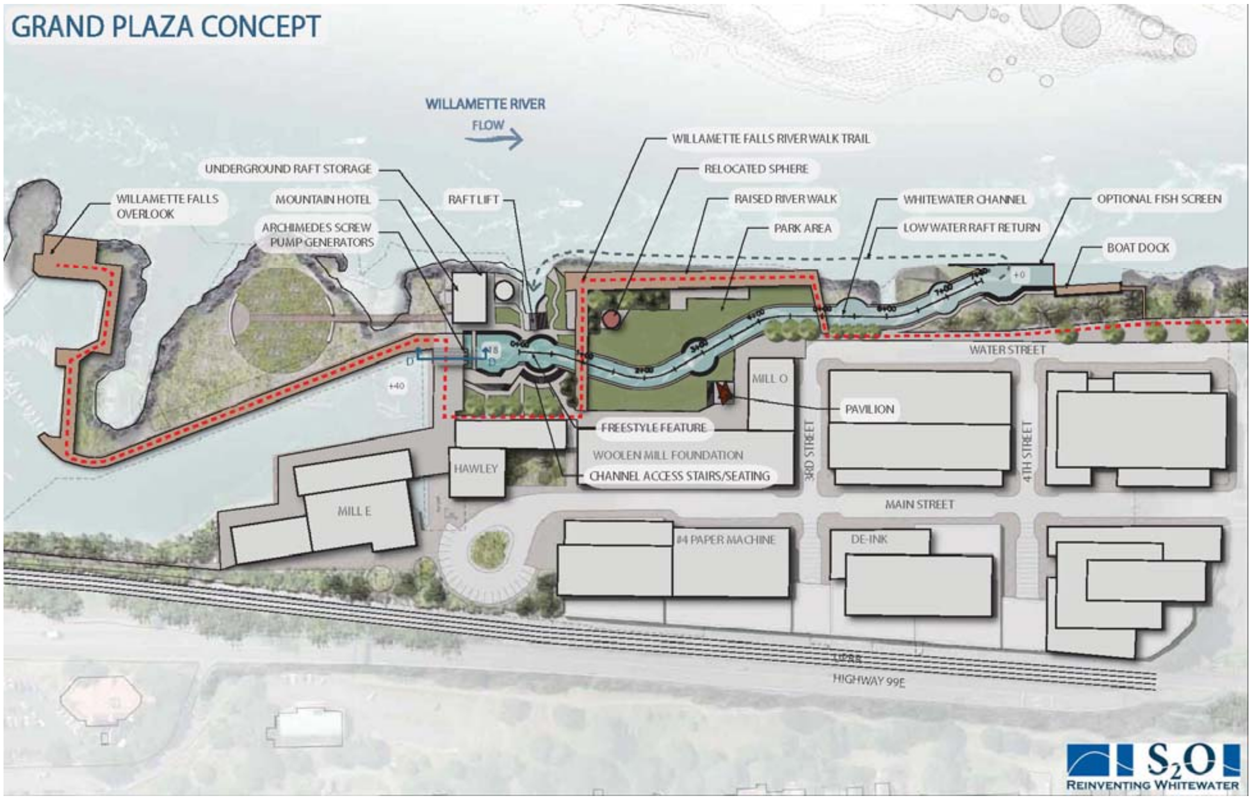


Figure 35: The Grand Plaza Concept for the Willamette Falls Whitewater Park.

A cross section of this concept is shown below in Figure 36 this cross section shows a possible configuration of the grand plaza area including the Archimedes generators.

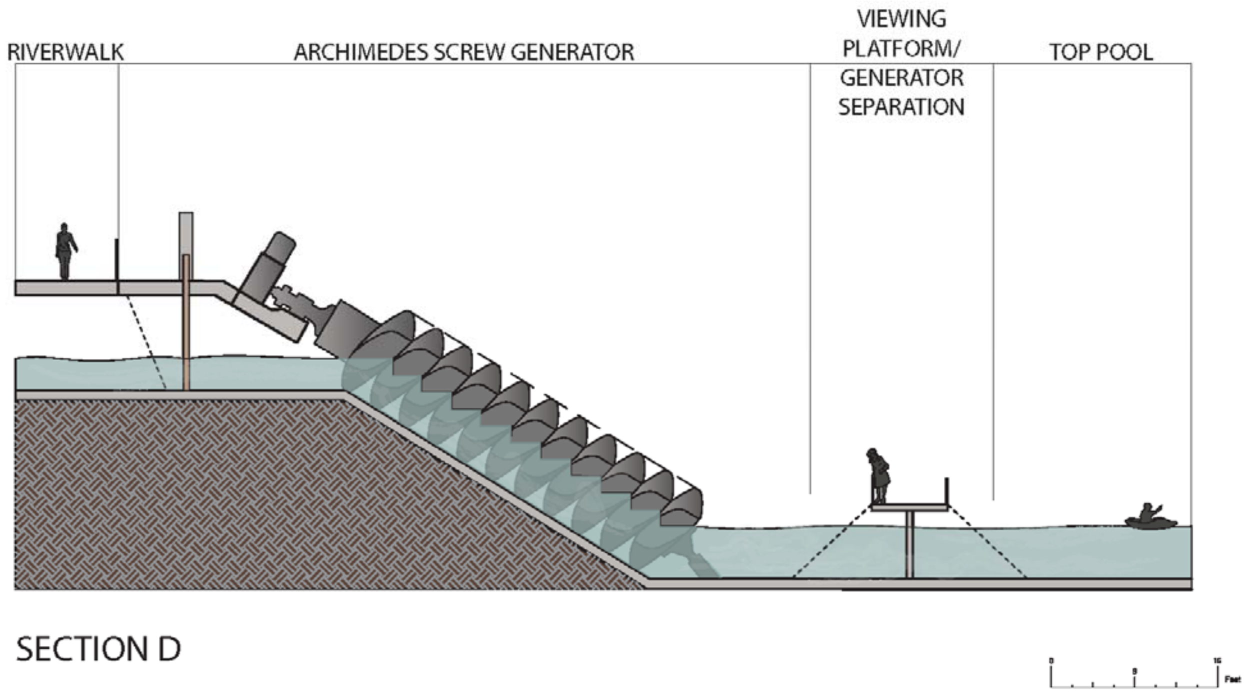


Figure 36: A section through the proposed screw generators and the top pool of the Grand Plaza concept.

As noted above, the use of the Archimedes generators has been done before on a channel that S2o worked on in Teesside England. This venue was also a part of an urban renewal project and the Archimedes screws are used for both pumping and generating (depending on the tide). The benefit to the screw pumps is that they are fish friendly and can aid in fish passage. This may be one solution to the fish passage issues raised by the configuration suggested in this design. A picture of the Teesside venue is shown below:

Figure 37: The Teeside Whitewater Park uses screw pumps in parallel with the whitewater channels.

The costs for the Grand Plaza are again balanced against the restoration backdrop in which they will be constructed. The costs created are a best-effort to balance demolition and remediation, grading and restoration between the site as a whole and the whitewater park in particular.

Willamette Preliminary Pricing

Grand Plaza

4/22/2015 Scott Shipley

Item	Description	Quantity	Unit	Cost/Unit	Total
Estimated Construction Costs					
1	Clear and Grub/Demo (this is an estimate based on internet research)	6	Acre	$75,000	$412,500.00
2	Structural Fill	63069	CY	$20.00	$1,261,380.00
3	Grading	63069	CY	$8.00	$504,552.00
4	Bedrock Removal	2590	CY	$280.00	$725,200.00
5	Paving	0	SF		$0.00
6	Site Utilities	1	EA	$120,000.00	$120,000.00
7	Hardscape (Standard)	36200	SF	$4.80	$173,760.00
8	Hardscape (Standard With Steps)	2200	SF	$6.50	$14,300.00
9	Hardscape (Enhanced)	16900	SF	$6.50	$109,850.00
10	Riverwalk Decking	500	SF	$15.00	$7,500.00
Landscape					
11	Retaining Wall 10'-12'	300	LF	$184.50	$55,350.00
12	Retaining Wall 5'-10'	825	LF	$116.25	$95,906.25
13	Retaining Wall 2'-5'	800	LF	$46.25	$37,000.00
14	Landscape (softscape)	5	Acre	$175,000.00	$875,000.00
15	Site Power/Lighting	1	EA	$220,000.00	$220,000.00
16	AV Show Power	1	EA	$70,000.00	$70,000.00
17	Perimeter Fencing / Gates	1100	LF	$30.00	$33,000.00
Channel					
14	Linear Foot of Channel Bottom	847	LF	$143.00	$121,121.00
15	Linear Foot of Channel Edge	1844	LF	$101.25	$186,705.00
16	Moveable Obstacle System including connectors	3482	SY	$227.00	$790,439.22
17	Head Gate Flow Control System	1	EA	$350,000.00	$350,000.00
18	Gate System	1	EA	$45,000.00	$45,000.00
19	Raft Lift	1	EA	$450,000.00	$450,000.00
20	Timing System	1	EA	$25,000.00	$25,000.00
Special Features					
21	Screw-Pump Generators (estimated)	4	EA	$450,000	$1,800,000.00
22	Controls/Electric (estimated)	1	EA	$1,200,000	$1,200,000.00
23	Generating Station	1	EA	$4,200,000	$4,200,000.00
24	Amphitheater	500	SF	$150	$75,000.00
25	Boat Storage	2000	SF	$150	$300,000.00
26	Office Space	2500	SF	$220	$550,000.00
27	Bridge	2	EA	$75,000	$150,000.00
28	Relocate Sculpture Structure	1	EA	$38,000	$38,000.00
29	Boat Dock	1000	SF	$35	$35,000.00
Subtotal Construction Costs					$14,258,563.47
Estimated Soft Costs					
	Pre Funding Costs	1.75%			$249,524.86
	Permits	2.50%			$356,464.09
	Testing and Inspections	1.25%			$178,232.04
	Equipment (Owner Furnishings)	1.50%			$213,878.45
	Architectural and Engineering Design	11.00%			$1,568,441.98
	Legal/ Marketing Fees	1.25%			$178,232.04
	Developer Fees	3.00%			$427,756.90
	Owner Contingency	15.00%			$2,138,784.52
Subtotal Estimated Soft Costs					$5,311,314.89
Grand Total					$19,569,878.37

Figure 38: Conceptual Opinion of Costs for the Grand Plaza Concept

Concept 4—The Perimeter Channel

The Perimeter Channel is a much longer channel that meanders around the perimeter of the site. This channel would provide the most whitewater recreation and would also provide a continuous fluid connection between the upper basin and the river below, providing for fish passage up the waterfall.

The concept for the Perimeter Channel was conceived in order to create a continuous streambed from the Upper Basin to the river below the falls. The channel is necessarily longer in order to accommodate the tremendous amount of drop available at the site. In this layout the flows will pass around the perimeter of the project and actually pass under Main Street before discharging into the river just upstream of the existing Mill O location. This concept provides a tremendous amount of capacity for rafting and kayaking within the venue and would create a water-themed venue throughout. There are impacts to this layout, however, when taken in context of the Metro Plan. The layout would significantly impact ground level parking/development along the channel's path. This is not to say that the development precludes the construction of buildings along this route however. This type of controllable channel does allow for structures to be built over the channel system creating portions of the channel that are covered, or indoors. Walking bridges and road bridges could allow for pedestrian crossing of the channel where needed.

This layout has a lot of appeal in terms of commercial operations as well as creating a venue that is water themed in its entirety. There is ample length along this route to create competition venues, instruction areas, and festival areas as well as other river-themed parkland features. The long channel also provides an avenue for fish passage over the falls. Figure 39 shows the proposed layout for this concept.

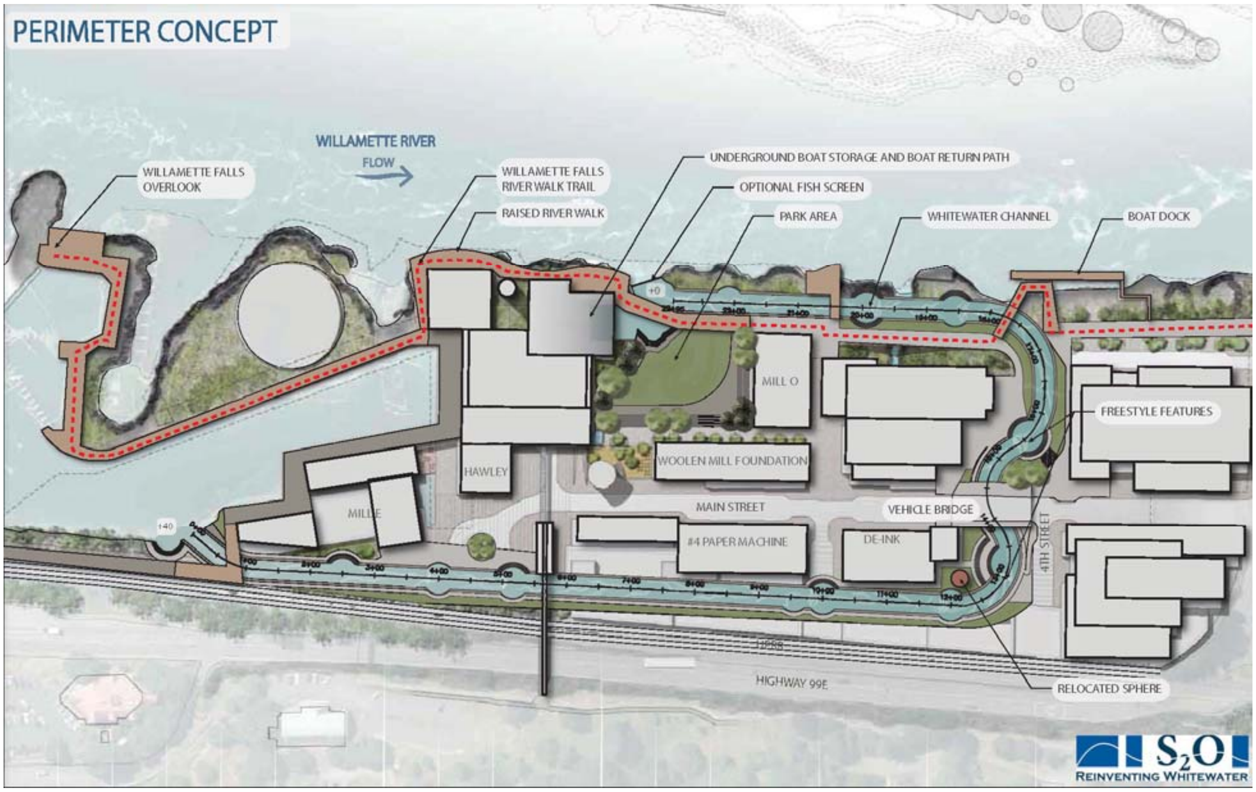


Figure 39: Rendering of the Perimeter Channel Concept.

The Perimeter Channel Concept is a channel that will be approximately 2300 linear feet in length and that would drop the full 40 feet of drop between the Upper Basin and the river downstream of the falls. The Perimeter Channel would be controlled through an actuating head gate that would allow water to be turned on and off as needed or available for recreational uses. The channel could then be run at higher, or lower, flows depending on the type of user in the channel for that type of session.

Figure 40, shown below, shows the South Bend/East Race channel run at lower flows with adjacent development and road bridges:

Figure 40: The East Race at low flows with development directly adjacent to the channel.

Willamette Preliminary Pricing

Perimeter Concept

4/22/2015 Scott Shipley

Item	Description	Quantity	Unit	Cost/Unit	Total
Estimated Construction Costs					
1	Clear and Grub/Demo (this is an estimate based on internet research)	8	Acre	$75,000	$600,000.00
2	Structural Fill	2933	CY	$20.00	$58,660.00
3	Earthwork (General)	2933	CY	$8.00	$23,464.00
4	Bedrock Removal	2590	CY	$280.00	$725,200.00
5	Paving	19450	SF	$6.00	$116,700.00
6	Site Utilities	1	EA	$120,000.00	$120,000.00
7	Hardscape (Standard)	44500	SF	$4.80	$213,600.00
8	Hardscape (Standard With Steps)	10600	SF	$6.50	$68,900.00
9	Hardscape (Enhanced)	14000	SF	$6.50	$91,000.00
Landscape					
10	Retaining Wall 10'-12'	600	LF	$184.50	$110,700.00
11	Retaining Wall 5'-10'	600	LF	$116.25	$69,750.00
12	Retaining Wall 2'-5'	800	LF	$46.25	$37,000.00
13	Landscape (softscape)	4	Acre	$175,000.00	$612,500.00
14	Site Power/Lighting	1	EA	$220,000.00	$220,000.00
15	AV Show Power	1	EA	$70,000.00	$70,000.00
16	Perimeter Fencing / Gates	2500	LF	$30.00	$75,000.00
Channel					
17	Linear Foot of Channel Bottom	2430	LF	$143.00	$347,490.00
18	Linear Foot of Channel Edge	5030	LF	$101.25	$509,287.50
19	Moveable Obstacle System including connectors	9990	SY	$227.00	$2,267,730.00
20	Head Gate Flow Control System	1	EA	$350,000.00	$350,000.00
21	Gate System	1	EA	$45,000.00	$45,000.00
22	Conveyor Belt System	1	EA	$500,000.00	$500,000.00
23	Timing System	1	EA	$25,000.00	$25,000.00
Special Features					
24	Screw-Pump Generators (estimated)	0	EA	$450,000	$0.00
25	Controls/Electric (estimated)	0	EA	$1,200,000	$0.00
26	Generating Station	0	EA	$4,200,000	$0.00
27	Amphitheater	0	SF	$150	$0.00
28	Boat Storage	3000	SF	$150	$450,000.00
29	Office Space	2500	SF	$220	$550,000.00
30	Bridge	3	EA	$75,000	$225,000.00
31	Relocate Sculpture Structure	1	EA	$380,000	$380,000.00
32	Vehicular Bridge	1	EA	$250,000	$250,000.00
33	Boat Dock	1000	SF	$35	$35,000.00
Subtotal Construction Costs					$9,146,981.50
Estimated Soft Costs					
	Pre Funding Costs	1.75%			$160,072.18
	Permits	2.50%			$228,674.54
	Testing and Inspections	1.25%			$114,337.27
	Equipment (Owner Furnished)	2.75%			$251,541.99
	Architectural and Engineering Design	11.00%			$1,006,167.97
	Legal/ Marketing Fees	1.25%			$114,337.27
	Contingency	15.00%			$1,372,047.23
Subtotal Estimated Soft Costs					$3,247,178.43
Grand Total					$12,394,159.93

Figure 41: Conceptual Opinion of Costs for the Perimeter Concept

Site Evaluation

Figure 42: An eleven-year old boater surfs the Hawea wave during competition.

In order to aid the City in evaluating the proposed sites and selecting a preferred solution or solutions, S2o has created a site-selection matrix which evaluates the proposed designs against the objectives and challenges of this project. This matrix is shown below:

Table 1: Site Selection Matrix[13]

Item	Description	In-Stream	Riverwalk	Central Plaza	Perimeter
1	Provides Intended Recreation	2	4	4	5
2	Creates a Significant Attraction	2	5	5	5
3	Impacts Development Plans at Site	5	4	3	2
4	Requires Water Right	+ (likely)	+	+	+
5	Requires design/operational elements to prevent impacts to protected species	3	5	5	1
6	Creates the most economic impact	2	4	4	5
7	Cost	1*	3	2	3

[13] The scale chosen is between 1 and 5 with 5 being the most-desirable and 1 being the least-desirable. Scoring was objective and may vary from the readers

The Matrix above evaluates the differing concepts against seven criteria. The matrix shows that the in-stream project, in comparison to the bypass channels, provides modest recreation. As noted above this type of recreation is primarily used by avid kayakers and rafters and therefore focuses on one user group. The bypass channels allow for commercial rafting and floating which vastly expands the potential users by allowing the general public to utilize the channel in addition to existing whitewater enthusiasts. This greater usage means that the bypass channels have greater economic impacts and become a greater attraction.

The bypass channels, however, are located centrally in the project and therefore have greater impacts to the project and come at greater costs. They also impact proposed development at the site to varying degrees by limiting available development space. Of these, the Perimeter channel would create the greatest impact by passing through areas furthest from the river which are slated for vertical development including parking, retail, and residential. The design of these structures, however, could accommodate the channel with minimal impacts.

In terms of costs and return on investment there is a lot to consider. The Riverwalk concept would maximize developable land and would create parallels with the existing River Walk project. The costs of this concept are significant, but on-par with attractions like it around the world that have a profitable return.

The Grand Plaza concept has a significant cost related to the electrical generation, but then has costs and returns similar to the Riverwalk Concept. The generating station, which could be included in either concept, might be a joint-venture with a power company which sees a return, or might have value in the concept of creating a self-sustaining site.

The Perimeter concept provides the greatest capacity for users and so, given that the channel is operated for profit, would generate the most profit in terms of user fees and impacts. This channel would come at great costs due to its length and impacts to developable land, but is not in an expensive configuration to create. Therefore, return on investment, if designed and operated successfully, would be significant.

Section 4: Process and Permitting

The Whitewater Design Process

Figure 43: Whitewater Parks are designed for many differing kinds of users.

Whitewater Parks typically require several stages of design. This project is currently in the Feasibility/Conceptual design phase. Future phases include:

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. Deliverables include a report and design documents such as a conceptual design and cost estimate, tasks required to complete a project, and permit requirements.

b) **Preliminary Design**—this phase gets to the heart of the design elements of the 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 Whitewater 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 Whitewater Park, the project can be accomplished with 1-dimensional modeling. In other cases, such as the Calgary Whitewater 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 whitewater 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**—this is the dirty work. 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.

Falls Legacy Park Process

This study has evaluated four separate design concepts. One of the solutions proposed is an in-stream solution and follows a somewhat different trajectory than the bypass channels. Following this study, our typical design process, shown above, would involve a number of phases utilized to refine the design through science, engineering, public process, and agency review. Following the preliminary phase permits would be submitted and would need to be attained. The planning and permitting processes of a larger channel system at this site could be extensive and would require some extensive time in negotiations and design iterations. The design and permitting phases of a project of this type are typically 2-3 years but can be quicker.

Once construction documents have been completed and the permits have been attained the project will need to be constructed. Typical construction times for a project of the size shown would vary from 8-12 weeks for the in-stream feature to a little more than a year for the bypass channels (assuming that the site was demolished and rough graded prior to the beginning of construction). For the in-stream feature the construction window may be limited. Construction typically takes place during the months when the flows are lower and when there is less impact to in-stream species. Construction windows are often set by permitting authorities.

In addition to local city and county permitting requirements, the project will require Federal and State permits as well. At a minimum, the project will require:

Federal and State Permitting:

Permitting for this project, depending on the concept chosen, will vary. At a minimum it is expected that the following permits/processes will be required.

U.S. Army Corps of Engineers (USACE)

Clean Water Act, 404/401 Permits (Joint Application): Although there are numerous federal and state laws that affect wetlands, the Clean Water Act (CWA) is the main regulatory tool. There are two sections of the CWA that are of particular significance:

Section 404 of the Clean Water Act enables the USACE to grant permits for certain activities within waterways and wetlands. Construction projects affecting wetlands in any state cannot proceed until a §404 permit has been issued. In deciding whether to grant or deny a permit, the Corps must follow certain guidelines, which are discussed below.

Section 401 of the Clean Water Act gives EPA the authority to prohibit an activity, including a construction project, if it can adversely impact water quality or have other unacceptable environmental consequences. For most states, EPA has delegated this authority to state environmental agencies. In Oregon, the Department of Environmental Quality (DEQ) is the state agency responsible for issuing 401 water quality certifications (WQC). When the state issues a 401 certification (which is required for any federally permitted or licensed activity that may result in discharge to waters of the U.S.), this certifies that a given project will not degrade Waters of the State or violate State water quality standards. (Oregon Department of Environmental Quality, 2015)

Whitewater Parks typically require an individual (404) permit which can be a lengthy review process that includes review of all impacts of the park to the environment including both in-stream and riparian zone as well as impacts to affected stakeholders. It would be typical that other departments, such as the Water Resources Department, fish and wildlife, tribal representatives, and others would be consulted as a part of the process.

State of Oregon

The 404 Permitting process is actually a joint application process with the State of Oregon making this a federal and state application. According to the State's website:

> *The Department of State Lands (DSL) and the U.S. Army Corps of Engineers, Portland District (Corps), released a revised Joint Permit Application (JPA) form for immediate use for removal-fill applications. DSL and the Corps both administer wetland and waterway regulatory programs in Oregon, and the joint form provides efficiencies for both applicants and the agencies.* (State of Oregon, 2015)

Additionally, a water right may be required. If water is going to be diverted into a channel in a manner other than natural flow, a water right will need to be attained either by transfer or claim.

Clackamas County

Clackamas County does not have permit authority over City of Oregon City lands.

City of Oregon City:

Any development on the Falls Legacy Site will require a Type III review by the City of Oregon City's planning division. A brief description of the requirements of this process is included in this report. Additional information is available from Oregon City.

Conclusion

Figure 44: Spectators watching rafters surf the wave.

A whitewater park has been proposed near Willamette Falls on the Willamette River in Oregon City. Site investigations reveal that there is potential to create either an in-stream or bypass feature at the Falls Legacy Site. This 22 acre site features a number of abandoned industrial facilities but is slated for redevelopment. The owner has shown interest in the possibilities of creating a whitewater attraction on the property.

The study proposes four different concepts that might be adopted for further investigation. One of the options, the in-stream concept, utilizes an existing ravine that would be fed with water from a former generating facility located in the Falls themselves. This type of amenity would provide recreation for avid kayakers and rafters but may not be very accessible for usage by the general public.

The other three concepts are bypass channels that would be created within the Falls Legacy Site's redevelopment project. While these channels do take up real-estate within the venue they can also be operated profitably as a commercial operation. Three concepts were proposed:

- The Riverwalk Concept would be built into a grade along the river's bank and would function as a retaining wall for the remainder of the site. This would decrease the instance that water would flood into the venue and would provide a recreational attraction in its own right while also providing a platform for the Riverwalk as well as a large common space in the center of the venue.
- The Grand Plaza Concept creates a central attraction out of the whitewater channel. This attraction, like the Riverwalk concept, could provide demonstration power generation as well as, or alternately, a waterfall in the central redevelopment site. Both the Riverwalk and Grand Plaza concepts could be provided with demonstration fish passage channels as well.
- The Perimeter Channel Concept is a much longer channel that meanders around the perimeter of the site. This channel would provide the most whitewater recreation and would also provide a continuous fluid connection between the upper basin and the river below, providing for fish passage up the waterfall.

The varying concepts have different benefits and weaknesses but provide a starting point for further refinement as design on the site progresses.

Appendix A: Willamette Falls Downtown District Policies and Design Guidelines

The District Policies and Design Guidelines are mandatory for future development within the Willamette Falls Downtown District, and will be applied during detailed development plan review.

Purpose. The plan policies and design guidelines promote development of high-quality buildings and open space that reinforce the four core values of the site: public access, economic development, healthy habitat, and cultural and historic interpretation. The guidelines are also intended to promote compatibility with the historic character of the district, while allowing contemporary interpretations of the historic patterns.

Guideline 1. Enhance the Special Character of the Willamette Falls Downtown District.

Principles:

Unique setting. Buildings and landscape elements should establish an aesthetic that considers the site's natural setting and industrial history, and promotes permanence and quality. Design elements to consider are materials, massing, views and viewing areas, building transparency, orientation to public and semi-public spaces, and landscaping.

Celebrate the river and falls. Where appropriate, the unique natural setting of the site should be celebrated by building and open space design. Integrate the experience of the river and the falls through site design. Special attention should be paid to development at the river's edge.

Streets. Re-establishment of the historic street grid is fundamental to the new district. Buildings and open spaces should orient themselves toward or open up to these streets. Special care should be taken for the design of ground floor, street-level uses.

Views. Take advantage of views toward the river and falls. Step structures down to follow natural change in elevation from the basalt bluffs to water's edge. Open up views toward Canemah down Main Street, and toward river from future 3rd and 4th Streets and the Riverwalk.

Materials. Building materials should reflect the industrial character of the site. Proposed materials must be high quality and express a sense of permanence fitting for the industrial history of the site. The first two floors of development especially should use materials that reinforce the high-quality, comfortable pedestrian environment.

Guideline 2. Design for the Comfort and Safety of Pedestrians.

Principles:

Network. Incorporate the pedestrian network that accompanies the street grid and public pedestrian ways into the design of buildings and open spaces. Link pedestrian paths in open space areas to public sidewalks and building entrances. Incorporate main entrances that orient to Main Street.

Visual Interest. Establish areas of visual interest on the ground floor of buildings where they face main streets. Incorporate seating and viewing areas in front of buildings and in open space areas where appropriate.

Natural setting. Locate and design buildings and open space areas to consider effects of sunlight, rain, shadow, wind, and views of the river and the falls. Maximize the amount of direct and indirect sunlight to adjacent public spaces.

Signs. Use pedestrian-scaled signage within the district that offers clear direction into and around the site. Private commercial signage should reflect the pedestrian character of the district and reflect the history of the site. Signage should not obscure or detract from views toward the water or the falls. Conversely, larger publicly-oriented and gateway signage is encouraged when appropriate and complementary to the district.

Lighting. Place and direct outdoor lighting to ensure that the ground level of the building and associated outdoor and pedestrian areas are well lit at night. Integrate exterior lighting so that it does not detract from the uses of adjacent areas. Lighting should be Dark Sky compliant.

Guideline 3. Maintain Downtown Character

Principles:

Continuity. The Willamette Falls District is an extension of the historic downtown. At the same time, the scale of buildings and industrial history of the district should create a different feeling. Buildings and open space areas should pay special attention to existing heights and the transition between the two downtown districts. New development should consider architectural patterns and materials existing in downtown, and also create a new sense of place.

Block Structures. Respect the block structures of the historic downtown. The pedestrian and vehicular experience of streets and sidewalks should be continuous across the barrier of 99E.

Parking. Locate parking to minimize impact on building appearance, streetscape, and pedestrians. Plan for the primary method of car storage to be within structures. Show that parking can flexibly serve different users, times of day, and could be reconfigured for other purposes. Develop, orient and screen structured parking to complement adjacent buildings. Reduce automobile/pedestrian conflicts around parking areas and support the pedestrian environment.

Guideline 4. Re-Use, Rehabilitate, Restore and Interpret Buildings and Structures

Principles:

Key structures. Preservation or rehabilitation of key structures should be a priority in the design of new buildings and open space. Highest value is placed on the following structures: De-Ink Building, #4 Paper Machine, Mill O, Hawley Building, and the Woolen Mill Foundation. If any these key structures must be removed, the applicant must document the specific reason for doing so, and propose mitigation to compensate for the loss of site character.

Other structures. Incorporate remnants, key features or other significant portions of existing structures into project design. The district’s 150-year history as a mill site (flour, wool, paper) and a manufacturing center should be celebrated and recognized when new buildings and uses are established.

Archaeology. Incorporate pre-colonial history of the site into new development where appropriate. Monitor archeology when disturbance of native soil is proposed.

Interpretation. Weave interpretive elements throughout the site to provide multiple and diverse opportunities to learn and reflect on the site’s history.

Guideline 5. Build for Long-term Use

Principles:

Future development. Locate buildings to allow for infill on adjacent vacant or underdeveloped parcels. Design compatible transitions between buildings and open spaces. Promote visibility and accessibility between open spaces and adjacent uses.

Quality materials. Promote permanence and quality in new development through the use of substantial and attractive building materials. Re-use existing industrial materials where appropriate.

Guideline 6. Incorporate Ecology into Design

Principles:

Riparian edge. Promote healthy habitat when designing new buildings and open space at river's edge. Take advantage of natural resource enhancement opportunities along the riverbank.

Landscape. Integrate and juxtapose ecological landscape elements with the intense urban and industrial history of district. Create continuous canopy of street trees, where practicable. Integrate innovative stormwater treatment systems with the overall site and development site design.

Buildings. Incorporate sustainable building practices into site and building design. Bring features of the site's natural setting inside buildings as a means for better integrating buildings with significant site elements. Consider shared utilities (eco-districts).

Guideline 7. Create a World-Class Riverwalk

Principles:

Riverwalk design. Establish permanent, prominent and breathtaking public access along the riverfront to structures, water, cultural history, and the falls. The riverwalk should be inviting to a wide range of people, including families and children. Allow for multiple, creative and unexpected opportunities to physically and visually connect to the river.

Integration. Integrate riverwalk with private development as it moves through the site, yet maintain its prominence along the river frontage. Reflect unique aspects of the place with unifying design elements integrated throughout and connects people physically and emotionally with the river

Views. Emphasize diverse scenic views of the falls and river from the riverwalk. Include views of the falls that reveal themselves as one proceeds along the riverwarlk.

Guideline 8. Create Quality Public Spaces

Principles:

Access to public space. Emphasize arrival by foot, bike or transit while accommodating the automobile. Public spaces should accommodate different ability levels.

Flexibility. Invite flexible programming through site design, rather than being designing for single use. Design for use in multiple ways by many different groups, on seasonal and daily basis. Public space should work at different times of day, weather conditions, and for different users.

Relationship to surroundings. Capitalize on adjacent buildings or natural features to create interesting visual experiences or vistas. Integrate design with adjacent private development. Reflect local character and personality.

Appendix B: 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 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).

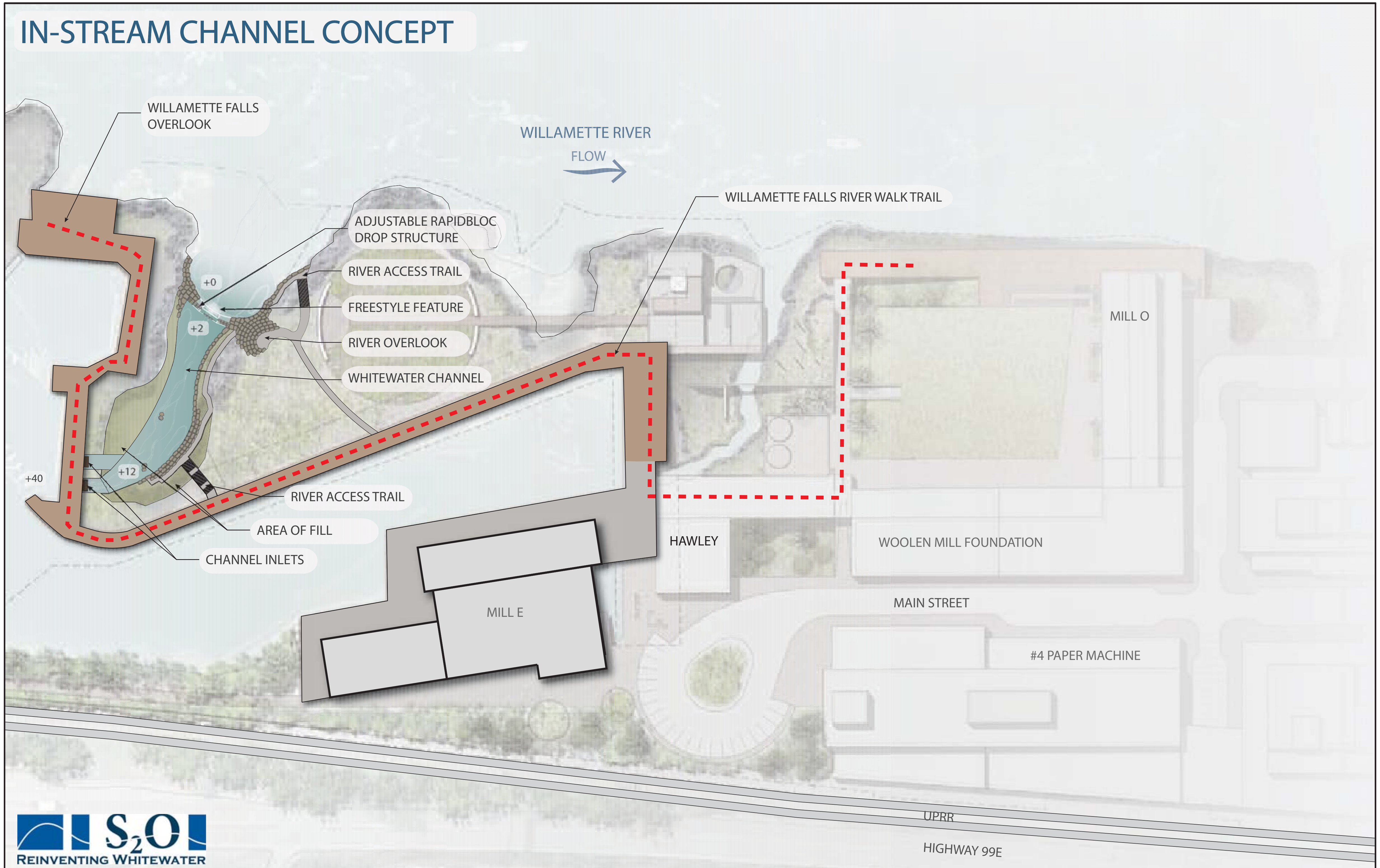
Swift water Rescue Park: a park designed specifically to help train rescue authorities in swift water rescue. These parks can hold cars, trees, and platforms in the main flow and can be turned off in an instant if a rescue or scenario becomes dangerous.

White water 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 C: Concept Design Renderings



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Client:
WE LOVE CLEAN RIVERS

Project Name:
WILLAMETTE FALLS, OREGON CITY

Status:
CONCEPT DESIGN

Drawing Name:
IN-STREAM CONCEPT

Revisions:
-

Drawn By:
CHRISTINE CLARK

Checked By:
Scott Shipley

Date:
2/26/2015

Stamp:

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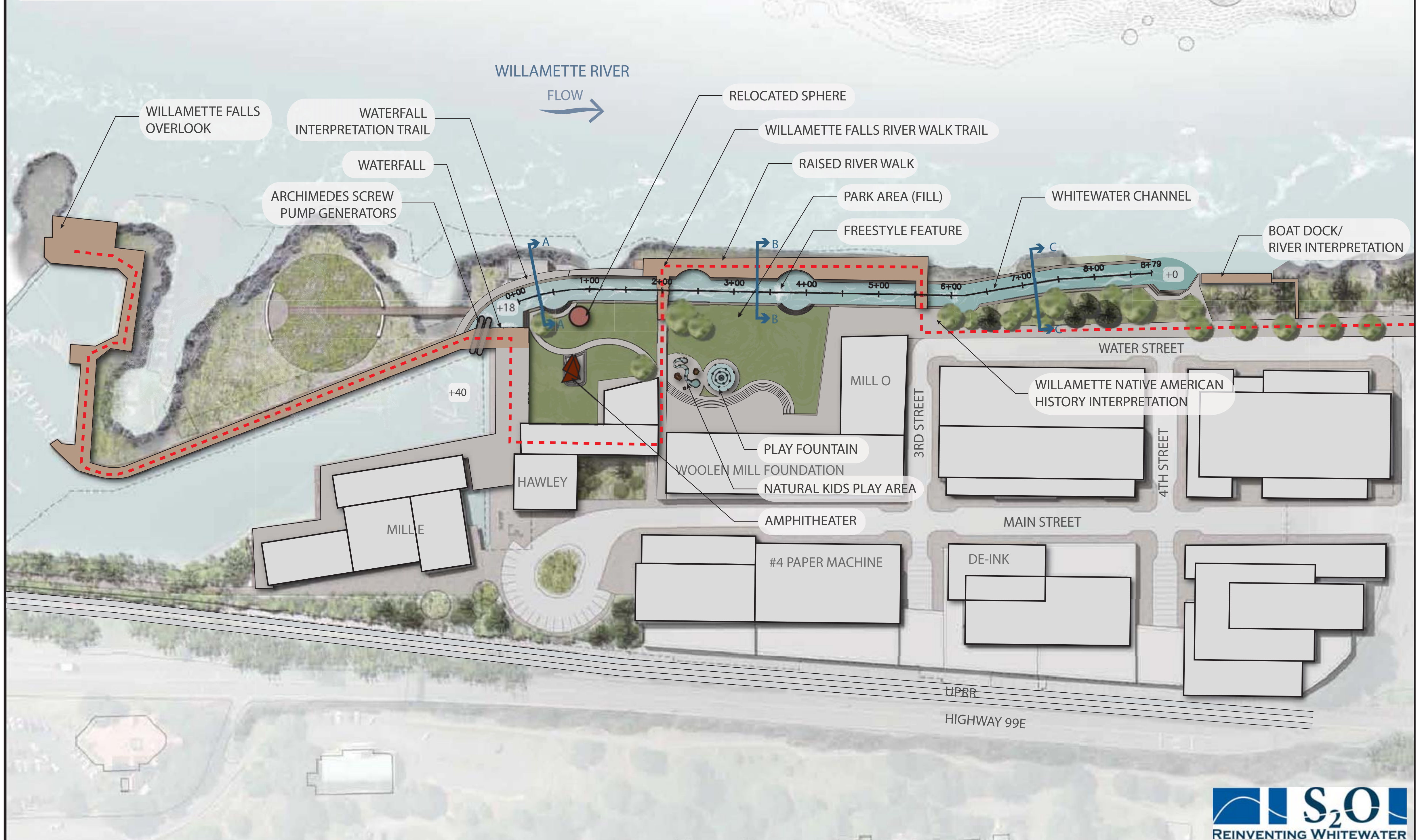
RIVERWALK CHANNEL CONCEPT



S2O
REINVENTING WHITEWATER

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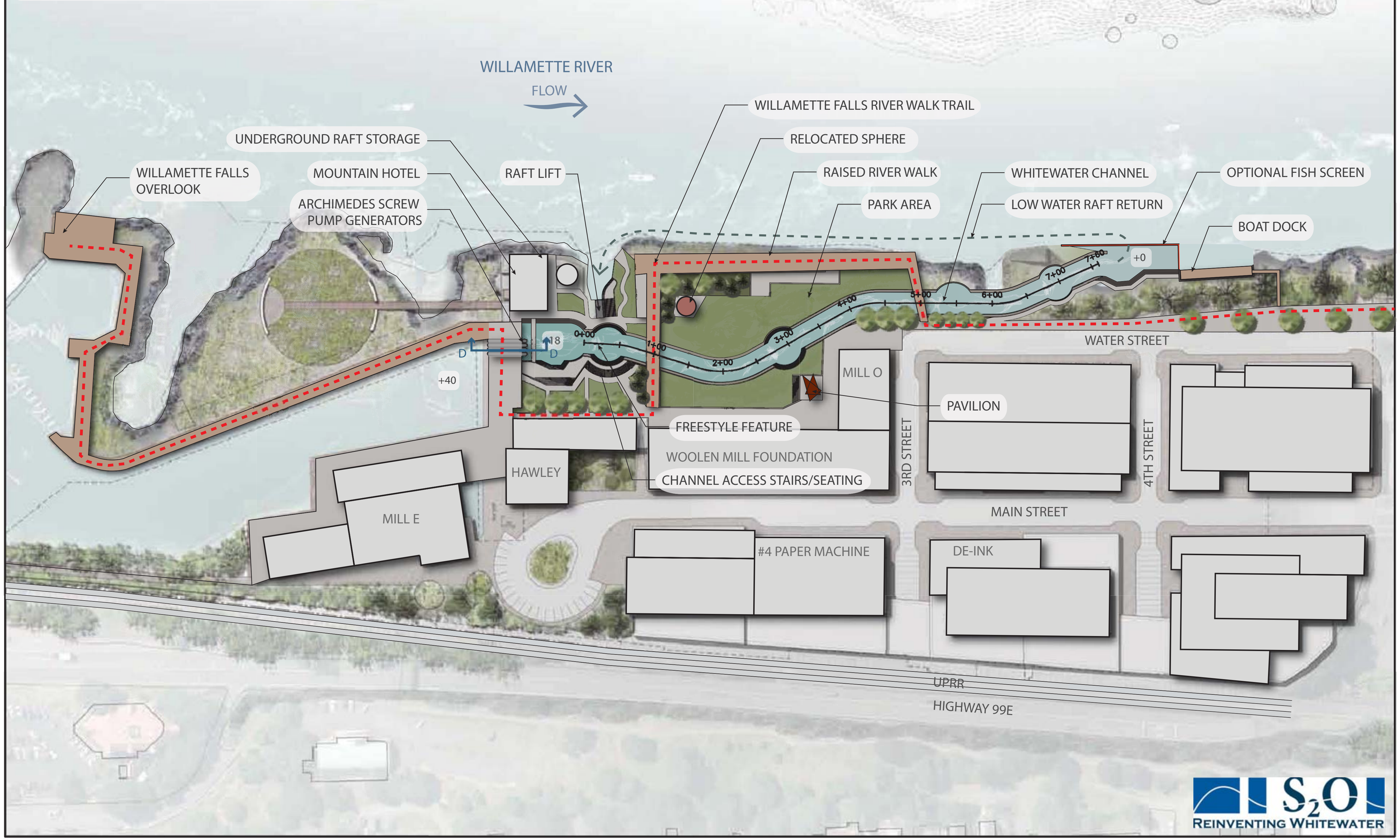
GRAND PLAZA CONCEPT



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Project Name:
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Status:
CONCEPT DESIGN

Drawing Name:
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Revisions:
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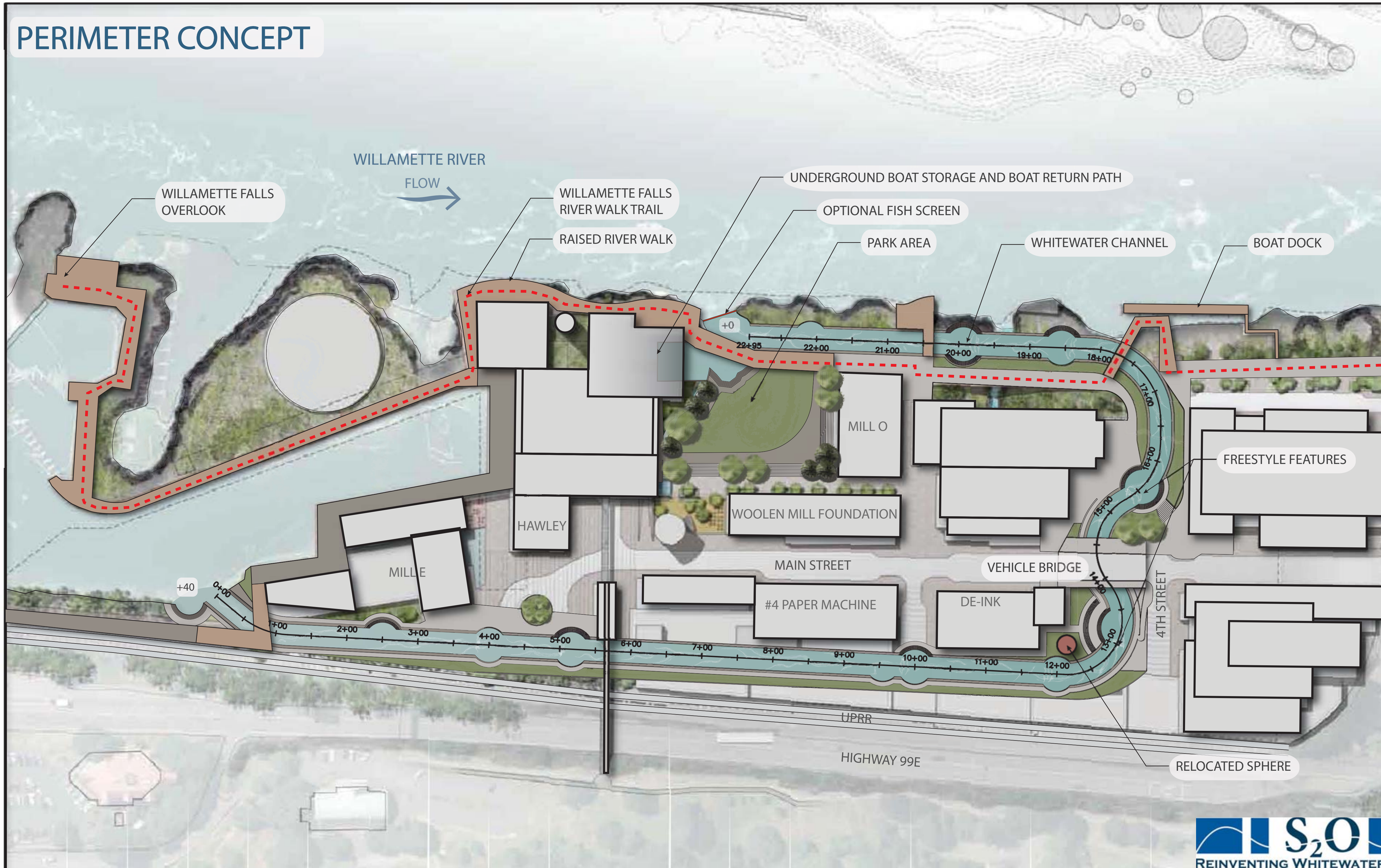

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CONCEPT DESIGN

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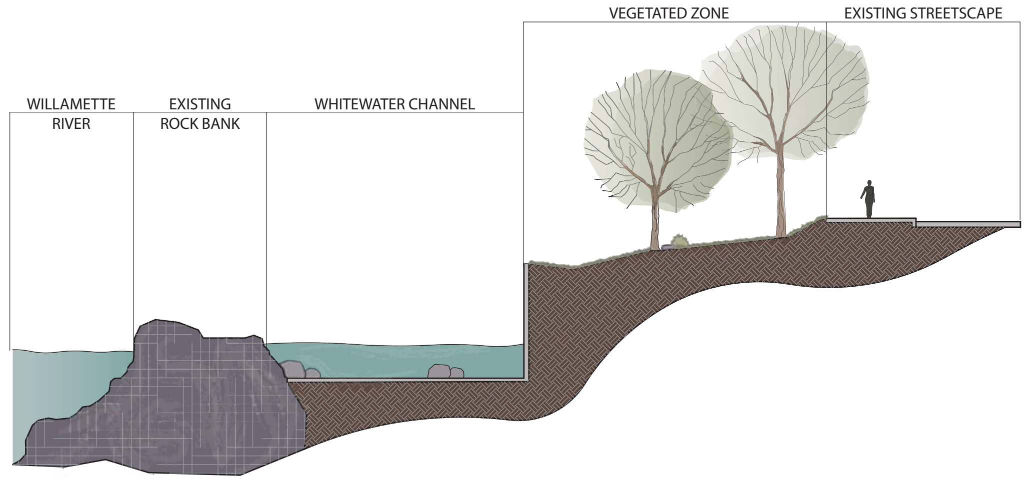

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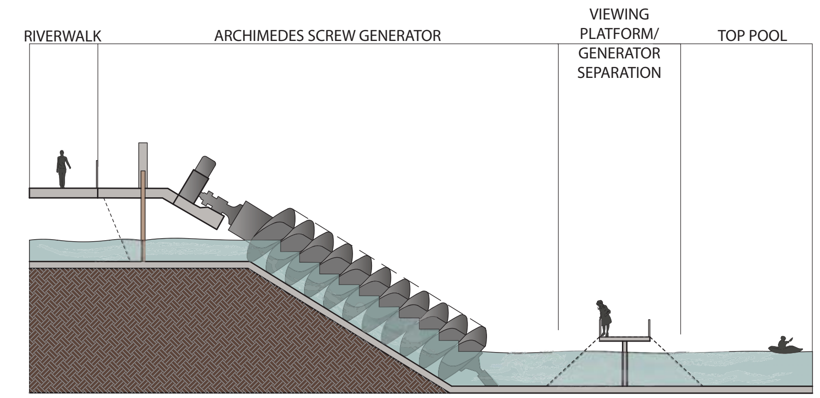

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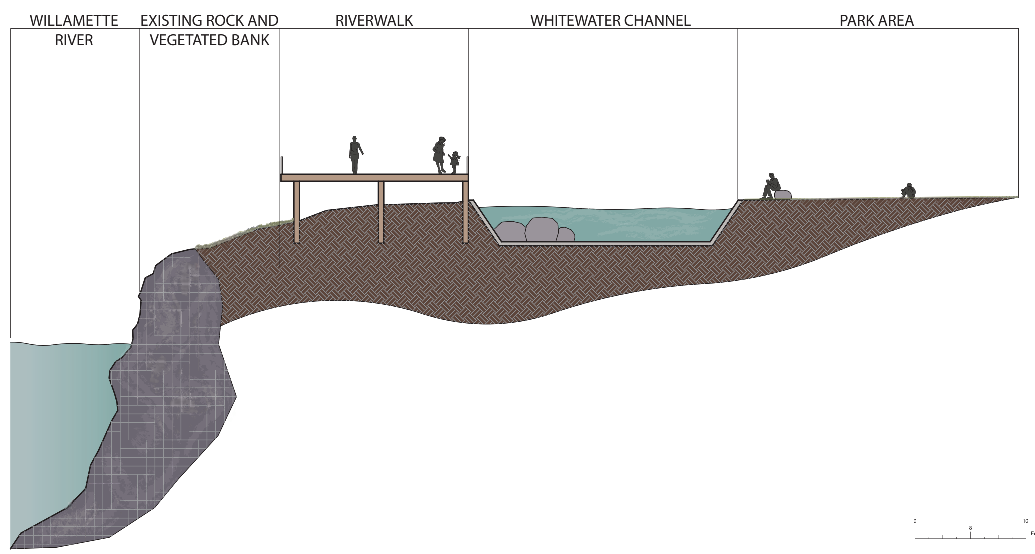

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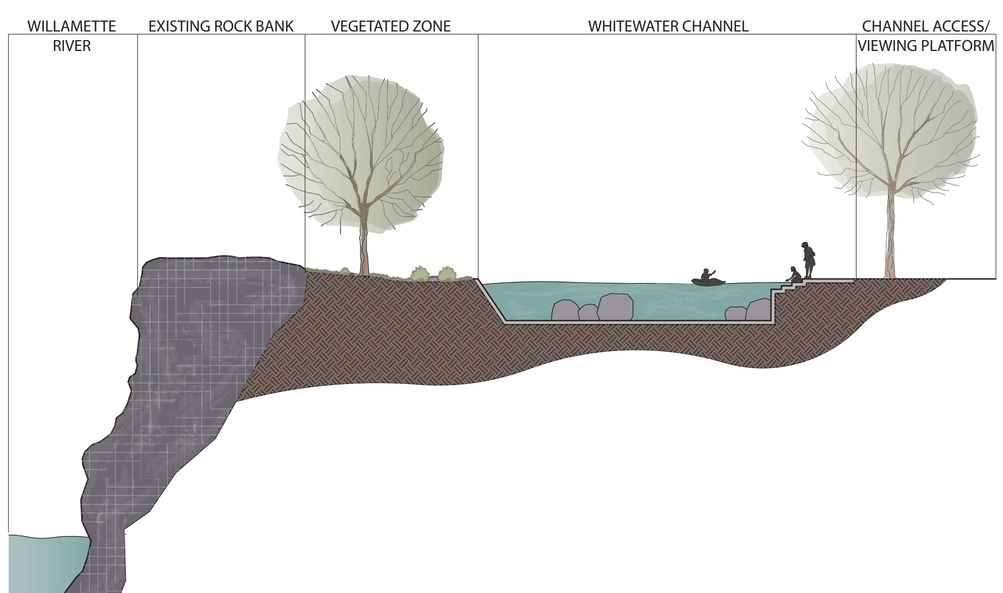

SECTION A

S2O REINVENTING WHITEWATER

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Drawing Name:
SECTIONS

Revisions:
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Bibliography

Clackamas County Assessor's Office. (2015, March 23). *Assessment and TAxation*. Retrieved from Clackamas County: http://www.clackamas.us/at/

Clackamas County Board of Commissioners. (2014, March). *Clackamas County Congressional Briefing*. Retrieved from Clackamas County: http://www.clackamas.us/pga/documents/legislative2014fed.pdf

Clean Water Act, Section 404. (n.d.). Retrieved from United States Environmental Protection Agency: http://water.epa.gov/lawsregs/guidance/wetlands/sec404.cfm

FEMA. (2015). *Flood Insurance Study*. Retrieved from Fema.gov, as seen with .kmz in google earth: https://www.fema.gov/floodplain-management/flood-insurance-study

Floodway. (n.d.). Retrieved from FEMA: https://www.fema.gov/floodplain-management/floodway

Google. (2015, February 11). *Google Maps*. Retrieved from Google.com: https://www.google.com/maps/place/Asheville,+NC/@35.5902946,-82.5731198,474m/data=!3m1!1e3!4m2!3m1!1s0x88598ca93c0f6f09:0x94ef31c106343a5d

Greenplay, LLC. (2008). *City of Oregon City, Oregon, Parks and Recreation Master Plan Update.* Brooomfield, OR: Greenplay.

Landre, L. (2015, January). US Army Corps of Engineers Representative. (S. D. Scott Shipley, Interviewer)

Moosbrugger, K. (2015, March 23). City Planning Staff. (S. Shipley, Interviewer)

North Caronlina Division of Environment and Natural Resources. (2014, November 17). *Division of Water Resources*. Retrieved from NCDENR-Frequently Asked Questions: http://portal.ncdenr.org/web/wq/swp/ws/401/certsandpermits/faqs

Oregon Water Resources Department. (2015, March). *Oregon Water Resourceds Department Water Rights Mapping Tool*. Retrieved from Oregenon Water Resources Department: http://apps.wrd.state.or.us/apps/gis/wr/Default.aspx

Pierceall, J. (2015, 3 19). Reprentative--Oregon Department of Water Resources Water Rights Mapping Division. (S. Shipley, Interviewer)

R. Goodman, G. P. (1994). The Design of Artificial Whitewater Canoeing Courses. *Instn. Civ Engnrs Mun. Engr*, 191-202.

Simpson, E. (2001). *Willamette Water Use*. Retrieved from Willamette.edu: http://www.willamette.edu/~karabas/courses/envr327w/projects/2001proj/UntitledFrame-3.htm

State of Oregon. (2015, March 25). *New Joint Permit Application*. Retrieved from Oregon.gov: http://www.oregon.gov/dsl/Pages/New-Joint-Permit-Application.aspx

Urban Drainage Criteria Manual. (2013, August). Retrieved from Urban Drainage and Flood Control District: http://www.udfcd.org/downloads/down_critmanual_volIII.htm

US Army Corps of Engineers. (2007). Engineering and Design: Structural Design of Concrete Lined Flood Control Channels. Washington DC, District of Columbia, United States.

USGS. (2015). *usgs surface water monthly statistics for the nation*. Retrieved from waterdata.usgs.gov: http://waterdata.usgs.gov/nwis/monthly/?referred_module=sw&site_no=14211010&por_14211010_2=1819541,00060,2,2001-06,2014-10&start_dt=2001-06&end_dt=2014-10&format=html_table&date_format=YYYY-MM-DD&rdb_compression=file&submit

Walker Macy, e. a. (2014). *A Vision for the Willamette Falls Legacy Project.* Portland, Oregon.

Wikipedia. (2014, December 2). *National Register of Historic Places Listings in Buncombe County, NC--Wikipedia*. Retrieved from www.wikipedia.com: http://en.wikipedia.org/wiki/National_Register_of_Historic_Places_listings_in_Buncombe_County,_North_Carolina

Wikipedia, various authors. (2015). *Oregon City, Oregon*. Retrieved from Wikipedia: http://en.wikipedia.org/wiki/Oregon_City,_Oregon

Appendix D: Site Review of the Willamette Locks

The Willamette Falls Site

Figure 45: The Willamette Falls Locks.

A site visit was conducted by S2o representatives on the 2nd of February, 2015.   S2o toured the Locks site initially. The Locks Site is owned by USACE and adjacent to West Linn Paper and PGE Sullivan Hydropower facility in City of West Linn. The locks are a canal with four vertical navigation locks that is located on the Northwest side of Willamette Falls. The Locks are currently federally owned. The locks were opened in January of 1873 as the first multi-lift navigation locks in the United States and were in continuous use until 2008. The Locks are currently operated by the Army Corps of Engineers and are registered in the national register of historic places (Wikipedia, various authors, 2015).

It should be said at the outset of this discussion that the Locks are currently, and were at the time of the site visit, an unlikely location for a whitewater park despite the fact that they physically match the requirements for a whitewater park. There is currently an effort underway to restore the locks to operating condition which would prevent the creation of a whitewater park at this location.

The canals were excavated into basalt rock and, though in need of repair to operate as locks, appear stable and robust. The canals are visually deep and of sufficient width to support a whitewater park. When in operation water depths were between 6 and 8 feet at the bottom sill and five feet in the upper canal. An average whitewater park is roughly 6 feet deep with water depths between 1.5 and 6 feet that average approximately 4 feet deep. Given the amount of drop in the canal and the length of the canal, the locks provide an ideal venue for a whitewater park. However, there are some obstacles.

Figure 46: The Willamette Locks are historic and feature an operating paper plant that spans both sides of the locks.

The West Linn Paper Company currently operates on both sides of the existing lock and it owns the majority of the parking areas and excess land adjacent to the site. The proximity of this industrial usage to the locks provides a design challenge that may be insurmountable as a whitewater park would surely need access and staging areas on both sides.

Additionally, there is an effort, supported by Clackamas County (Clackamas County Board of Commissioners, 2014), to protect, restore, and preserve the Locks as operating Locks. This effort would fundamentally oppose transformation of the locks into another purpose such as whitewater boating. These two facts present significant hurdles to moving the project forward in this location. The primary purpose of surveying the site was to determine physical feasibility.

Site Ownership:

Site ownership at the Locks site is shown below in Figure 47:

Figure 47: The locks are a single lot with adjacent land a mixture of ownership including West Linn Paper and PG&E (Clackamas County Assessor's Office, 2015)

Land ownership at the Locks is not available on the Assessor's website (Clackamas County Assessor's Office, 2015), but lot lines are. Based on discussions with USACE representatives (Landre, 2015)the Locks and directly adjacent lands are property of the Federal Government. Adjacent properties are a mixture including properties owned and operated by PG&E as well as the West Linn Paper Company. Access to the site is limited and inappropriate to the general public given the manufacturing that currently takes place along the canal.