



Curwensville and Clearfield Whitewater Parks

Feasibility Investigation and Conceptual Design

Clearfield County, Pennsylvania



October 2023

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318 McConnell Drive
Lyons, Colorado 80540

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October 5, 2023

Robert A. Swales
139 West Market Street, Suite 200
Clearfield, Pennsylvania 16830

Re: Clearfield Whitewater Park Feasibility Investigation and Conceptual Design

Mr. Swales,

S₂O Design and Engineering is pleased to present this feasibility investigation and conceptual design study for the proposed whitewater parks on the West Branch of the Susquehanna River in Clearfield County, Pennsylvania. We have enjoyed getting to know your community and we are excited about the opportunity to provide your community with another way to experience their natural resources and help expand recreational tourism by bringing whitewater parks to Curwensville and Clearfield.

The attached report provides information on whitewater parks, reviews the proposed project setting, analyzes the hydrologic and hydraulic conditions at the proposed site, presents conceptual design drawings, estimates project cost, and provides the outline for how to move forward to bring this project to life.

Please do not hesitate to contact us if you have any additional questions or require any clarifications.

Sincerely,

A handwritten signature in black ink, appearing to read "Scott Shipley".

Scott Shipley, PE
Principal Engineer

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1. Introduction

This feasibility investigation and conceptual design study for whitewater parks in Clearfield County, Pennsylvania was commissioned by Clearly Ahead Development. The proposed project sites are in the Borough of Curwensville and the Borough of Clearfield, along the West Branch Susquehanna River.

This project aims to remove the safety hazard presented by two low head dams- the dam at Curwensville's Irvin Park in failing condition and Raftsman Dam in downtown Clearfield with ongoing maintenance difficulties. An additional objective of the dam removal is to improve fish passage and aquatic habitat by removing hard barriers within the channel and installing recreation structures built primarily from natural material.

Another primary objective for this project is to provide a strong outdoor recreational attraction to serve the local community and draw in recreational tourism. The Curwensville and Clearfield Whitewater Parks would serve to expand the outdoor recreation culture that already exists in the immediate vicinity. Alongside the boating, fishing, hiking, and biking opportunities currently available, this project would provide an exciting recreational destination for locals and tourists alike to enjoy the beautiful West Branch Susquehanna River.

2. Whitewater Parks

2.1 Whitewater Parks Explained



Figure 1: The Hawea, New Zealand Surf Park is an in-stream surf park on a natural river.

Many cities and towns in the United States are considering constructing whitewater parks in their community. Once built to provide recreation for top-level kayakers in powerful rivers, whitewater parks have evolved to include features that are friendly for all levels of users. Through decades of iterative design, S₂O has worked to develop in-stream attractions in parallel with park amenities such as trails, parking, restrooms, and park space. These whitewater parks, surrounded by trails and recreational

areas, have not only achieved their original objective of attracting paddle sports enthusiasts, but have often exceeded expectations by becoming focal points for their communities and recreational destinations for outdoor tourism. Whitewater parks often host major events centered on slalom or freestyle competitions or host river festivals that feature local arts and culture. In addition, whitewater parks have a positive economic impact on the local community, as visitors spend money at local restaurants, lodging, and retail establishments. Cities with S₂O designed whitewater parks such as Durango, CO and Charlotte, NC have reported positive impacts on the local economy from tourism generated by the park that are on the order of millions of dollars per year.

In-stream 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 competition-level kayaking. 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 serve the community in multiple ways, providing streamside access for fishing, access to watch whitewater paddling for spectators, and spaces for the general public to gather and recreate on the banks and in the water.

In-stream parks are one of the two main categories of whitewater parks. The other type, pumped parks, are artificially created using pumps and purpose-built channels. These systems recirculate water in the same manner that theme parks or fountains draw from a single source, and do not rely on the flows of nearby rivers and streams.



Figure 2: The US National Whitewater Center is a pumped whitewater park that pushes water from the bottom pond to the top where it then flows by the force of gravity through four channel segments.



Figure 3: The US National Whitewater Center features commercial rafting and other outdoor adventure activities such as rock climbing, a ropes course, ziplining, mountain biking, jump platforms, whitewater and flatwater kayaking and stand up paddleboarding, yoga, and special events including food and music festivals.

2.2 Typical Economic Impacts of Whitewater Parks

Whitewater parks that have been built in similar Towns and Cities in the United States have become significant attractions. They bring enthusiasts and spectators alike to the residing communities and have significant economic impacts through increased property values, direct spending at the site, tourism dollars, and dollars spent at local restaurants, shops, and businesses. In-stream whitewater parks located in Colorado have had impacts as high as \$7-9 million dollars per year. Table 1, shown below, illustrates some typical economic impacts of these parks:

Table 1. Economic Impacts of Whitewater Parks (per year in US Dollars)

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

The impacts of these parks are based on regular usage at the whitewater park, instructional programs, competitions, festivals, and other community events. Freestyle events that occur in Colorado every year can bring millions of dollars into the local economy on a single weekend alone. For example, the GoPro Mountain Games in Vail, CO have a documented yearly economic impact of \$3.5 million dollars. In addition to creating economic impacts, these events also help to market a particular community as an outdoor town and whitewater destination.

3. Site Information

3.1 Site Location

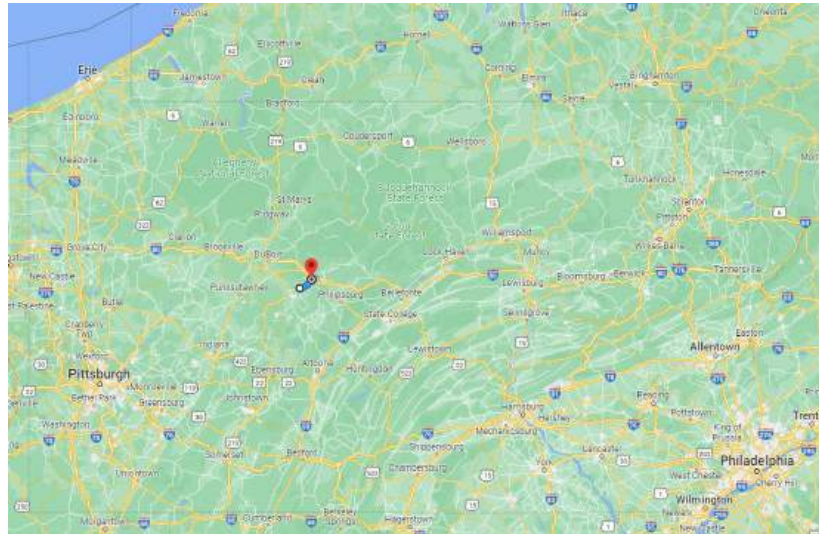


Figure 4: Site Location

The proposed projects are both located in Clearfield County, which lies in western central Pennsylvania. The Curwensville Borough is located within Pike Township. The Clearfield Borough is located within Lawrence Township.

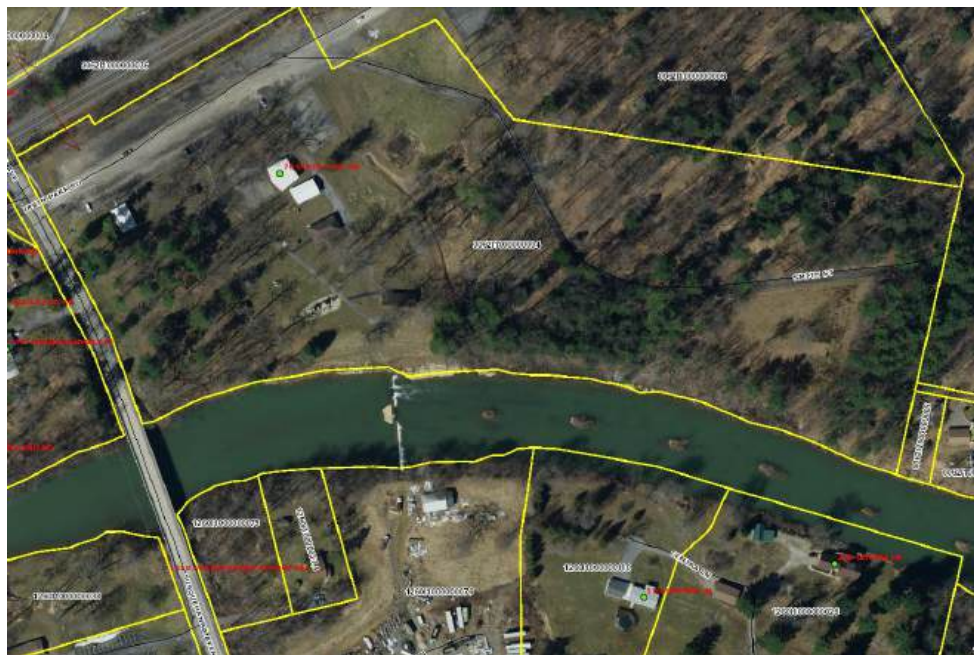


Figure 5: Site #1 Land Ownership

According to data obtained from Clearfield County GIS, the land on river left (0062I1000000004) is a 25-acre parcel owned by the Curwensville Borough. This land is in use as Irvin Park. The land on river right

(1260I1000000076) is a 6.36-acre parcel owned by Vincent Centra. This parcel appears to be a mixed-use, light industrial property, with 4 primary structures.



Figure 6: Site #2 Land Ownership

The land on river left (Parcels 0043K0821400014 and 0043K0821400011) are part of a strip of mixed residential and commercial use properties between Kelly Ave and River Road in downtown Clearfield. River Road is immediately adjacent to river left and provides public access at the current dam location. On the river right side, (Parcel 0041K0825200007), the long, riverside lot is owned by Grandview Terrace One, LP and currently in use as Buck's Pizza.

3.2 Site Considerations

Endangered Species

Federal

According to United States Fish and Wildlife Service maps available online, there are no critical habitats for species listed as endangered or threatened under the US Endangered Species Act that are located within or nearby the project area.

State

According to data obtained through the Pennsylvania Natural Heritage Program, there are no Natural Heritage Area Core Habitats, Natural Heritage Area Supporting Landscapes, or Conservation Easements located within or near either of the project sites. S₂O recommends consulting with local conservation authorities during design development to obtain site-specific information and recommendations.

Historic Structures

According to data obtained from the National Register of Historic Places, there are no designated historical structures near either of the project sites.

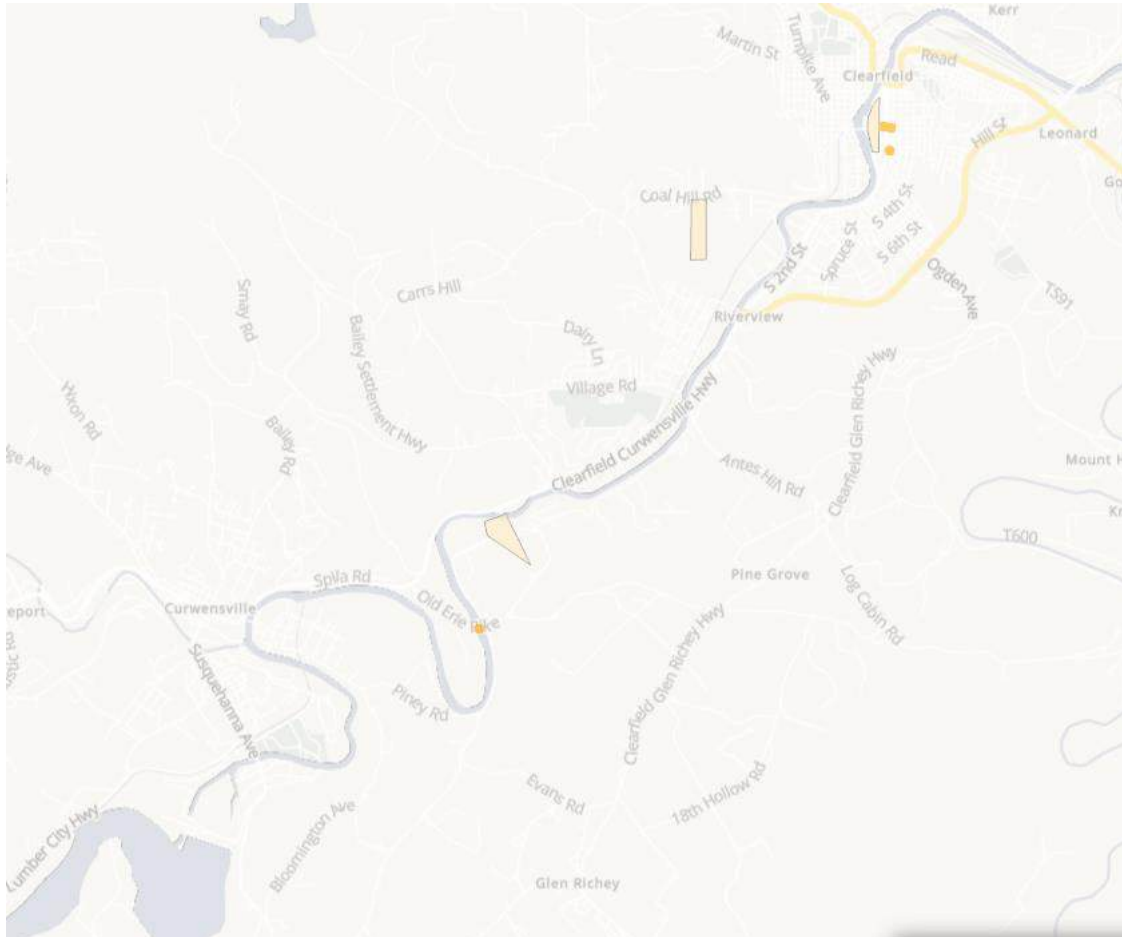


Figure 7: Curwensville and Clearfield do have listed entries for the Hogback Bridge, the Murray House, the Clearfield County Courthouse, and the Dimeling Hotel.

While there are no designated historical structures to be preserved on these project sites, the logging heritage of the area is still prominently visible within the river. There is a significant opportunity to highlight the cultural and industrial history of the area through interpretive experiences within the parks.

It has been reported that the open space in Irvin Park between Smith St and the West Branch Susquehanna River may have been the cabin location of William Bloom, the first recorded settler of Clearfield County. This area may have also had significance to the Native Americans living in the area.

3.3 Hydrologic and Hydraulic Conditions

The West Branch Susquehanna rises in western Pennsylvania, flows northeast through Curwensville and Clearfield, then continues east through central Pennsylvania before flowing south to join the Susquehanna River. The primary tributaries within the project reach are Anderson Creek, which joins the river in Curwensville; Montgomery Run, which joins above the Hyde Bridge; Moose Creek, which joins the river just below Raftsman Dam; and Clearfield Creek, which joins the river downstream of Raftsman Dam in Clearfield but upstream of the Shawville Dam.

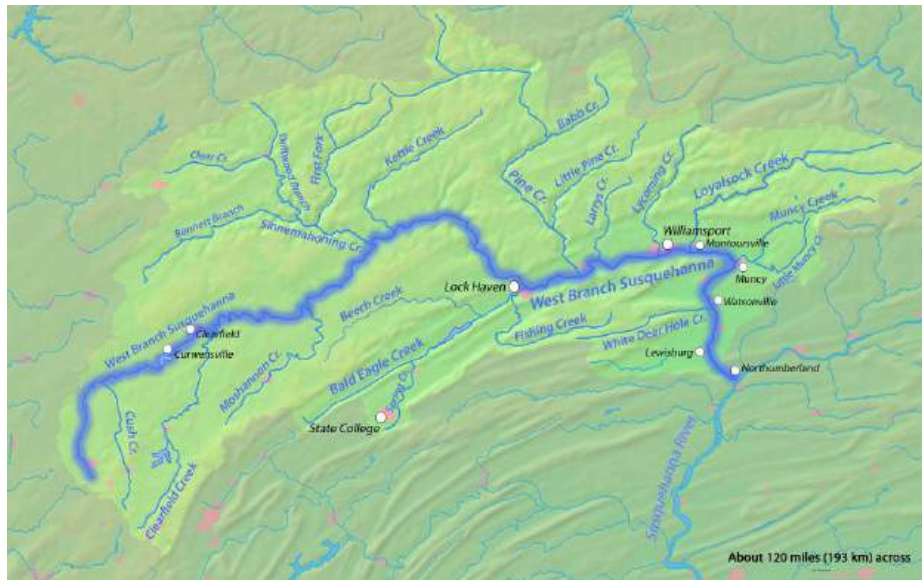


Figure 8: West Branch Susquehanna

Curwensville Lake and Dam

According to the United States Army Corps of Engineers (USACE):

Curwensville dam is an earthfill structure 2,850 feet long, rising 131 feet above the streambed, with a spillway and a gate-controlled outlet. The reservoir has a storage capacity of 119,467 acre-feet at spillway crest and extends 14 miles upstream when filled to that level. The project controls a drainage area of 365 square miles or 98 percent of the West Branch at Curwensville and 75 percent at Clearfield. The project reduces the flood heights along the West branch below the dam, and provides a lake for recreation. The Commonwealth of Pennsylvania coordinates the operation of George B. Stevenson Dam with the Corps' operation of Curwensville Dam, Alvin R. Bush Dam, and Foster Joseph Sayers Dam, in order to secure optimum flood control benefits through operation as a system.

The dam is operated by USACE, while the associated recreational facilities (beach, boat launch, pavilion, athletic fields, and campground) are operated and maintained by Clearfield County. As the design develops for the Curwensville and Clearfield Whitewater Parks, the USACE will be engaged as a stakeholder to explore the possibility of a recreational release schedule. There is interest in the community to move the releases from primarily the weekdays to primarily on the weekends, to allow for greater recreational use of flow.

Flow

Shortly downstream of Curwensville Lake and upstream of the proposed project site at Irvin Park, USGS maintains gauge 01541200.

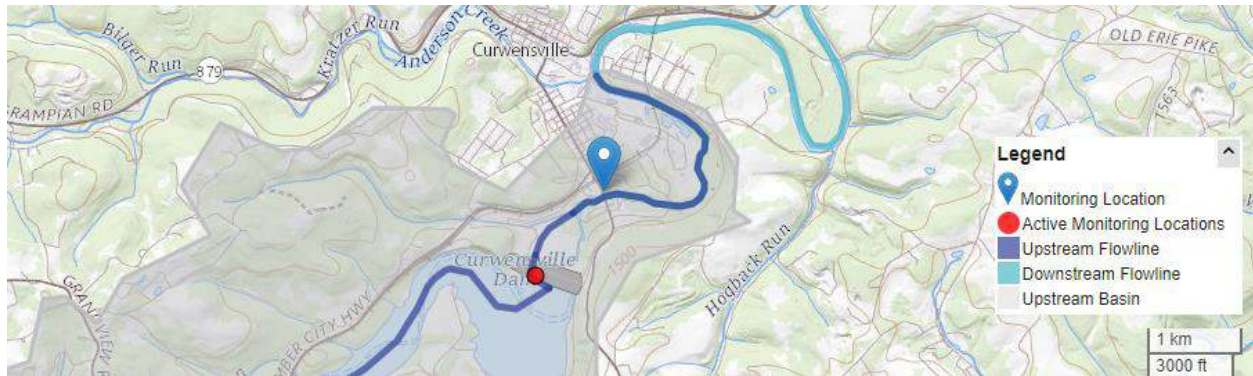


Figure 9: Location of USGS 01541200 in Curwensville

Shortly upstream of the proposed project site at Raftsman Dam, USGS maintains gauge 01541303 in Hyde.

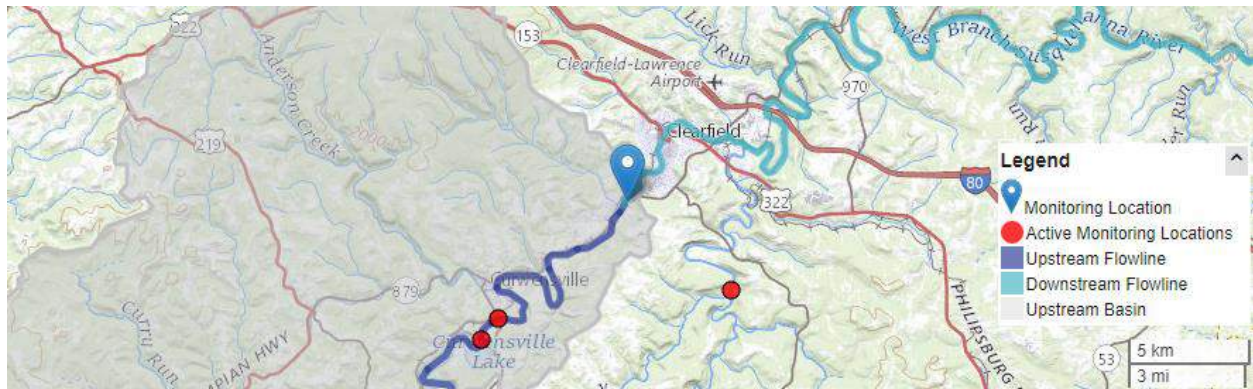


Figure 10: Location of USGS 01541303 in Clearfield

Flow data from these two USGS gauges for the last 10 years were analyzed to understand what flows can be expected at each of the proposed project sites. As seen in the figures below, these project sites both experience significant seasonality in flows- the most water is available in late winter/early spring, and the least water is available in late summer/fall.

Based on the average number of days per year with sufficient flow at the project sites, whitewater parks are feasible and will provide a substantial amount of user days throughout the year.

Both project sites experience a highly variable range of flow. To accommodate this variable flow, the whitewater parks will be designed with stepped whitewater structures to allow for both safe recreational use and fish passage at low, middle, and high flows. The size and character of waves at various flows will be predicted in later design phases by utilizing hydraulic modeling. In general, lower flows best suit tubing and fishing, intermediate flows suit the primary population of recreational canoeists and kayakers, and higher flows provide an exciting recreational experience for more experienced whitewater paddlers.

Curwensville

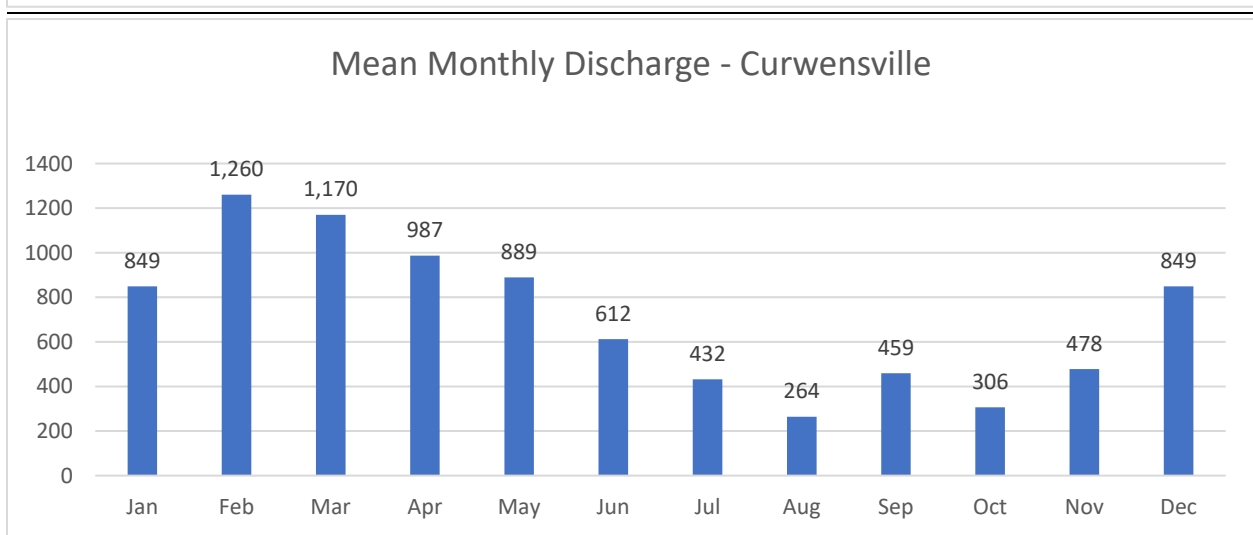
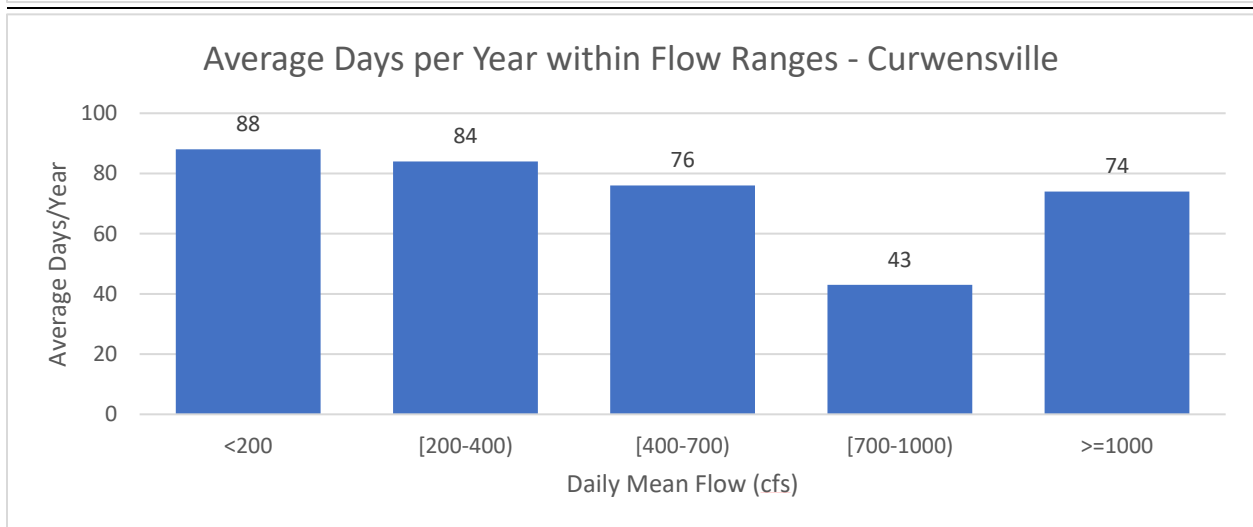
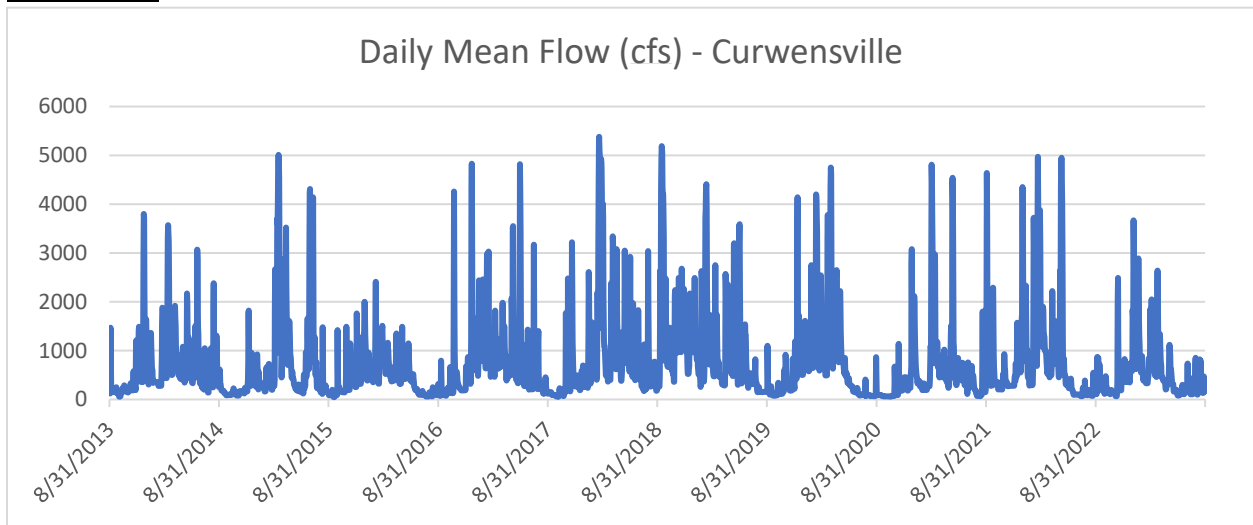


Figure 11: Curwensville flow data from 2013-2023 showing daily trends, average days/year at varying flows, and mean discharge by month.

Clearfield

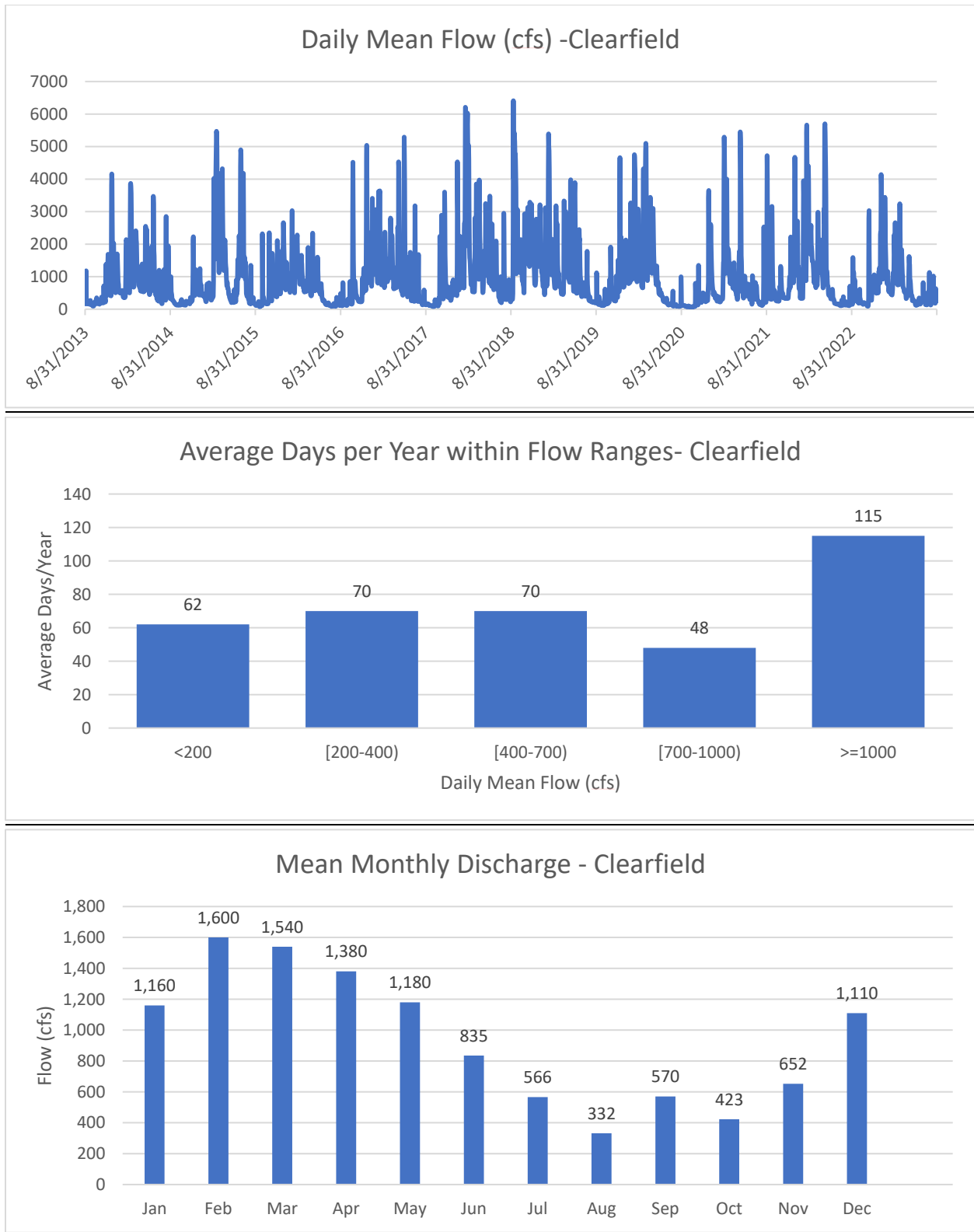


Figure 12: Clearfield flow data from 2013-2023 showing daily trends, average days/year at varying flows, and mean discharge by month.

Flood Impacts



Figure 13: Flood Maps obtained from Clearfield County GIS of both proposed project sites.

Current flood maps available through the Clearfield County GIS were reviewed to understand existing inundation boundaries and floodway limits through the proposed project sites. At the Curwensville site, the river and part of Irvin Park are within Zone A, which designates a 1% annual chance of flooding (also referred to as the 100-year flood) with no base flood elevations determined. At the downtown Clearfield site, the river and riverbanks are within Zone AE, which designates a 1% annual chance of flooding (100-year flood) with determined base flood elevations. The land adjacent to the river in downtown Clearfield is within a .2% annual chance of flooding zone (500-year flood).

As the design is further developed, the final wave structure geometry and channel modifications will be input into HEC-RAS software to complete 1-dimensional hydraulic analysis of the proposed improvements. This is both necessary for design development and a permitting requirement by regulatory agencies. If the project creates a rise in 100-year base flood elevations when compared to the baseline (effective) regulatory floodplain model, a Conditional Letter of Map Revision (CLOMR) may be required.

3.4 Outdoor Recreation

The existing outdoor recreational activities in the area present a unique opportunity to create a diverse flourishing culture of outdoor enthusiasts in Clearfield County with the addition of whitewater parks. In addition to the hiking, biking, boating, camping, and fishing offered at Curwensville Lake, residents and visitors in Clearfield County have access to valuable recreational programming.



Figure 14: The Susquehanna Greenway Partnership offers visitors maps and itineraries for hiking and biking on land trails, canoeing and kayaking on water trails, and visiting parks and river towns. Photos from SGP website. The Susquehanna greenway has 4 branches, with the West Branch passing through Curwensville and Clearfield.



Figure 15: There are multiple recreational community events held on the river, including a Dice Run and the pictured Clearfield Revitalization Corp- Anything That Floats Boat Regatta.

The creation of whitewater parks would attract visitors to the area, diversify the opportunities for the community to actively experience a historic and natural space, and solidify Curwensville and Clearfield as outdoor recreation destinations.

4. Site Visit

A site visit, followed by a stakeholder meeting, was conducted by S₂O engineers Riley Adams and Sarah Mosier on June 7, 2023. Multiple sites along the West Branch Susquehanna River were visited, as directed by CEO of Clearly Ahead Development, Rob Swales. Sequenced upstream to downstream, the following sites were visited:

1. Curwensville Dam



Figure 16: Dam at Curwensville Lake, owned and operated by US Army Corps of Engineers

2. Irvin Park



Figure 17: Irvin Park offers Curwensville residents an inclusive playground, pavilions, basketball and tennis courts, restrooms, a fishing area, and a canoe & kayak launch.



Figure 18: The failing low head dam is the subject of a conceptual design for removal and replacement with a whitewater structure.



Figure 19: Below the failing dam, flat bedrock along the bank offers a scenic gathering location for families. The historical man-made islands were constructed of local mountain stone and sunken timber and made up the Susquehanna Boom, used to sort and control the flow of logs from 1851 to 1909.



Figure 20: Photo taken from Irvin Park, looking upstream up at Susquehanna Ave Bridge. Alternate river access via the First Baptist Church is visible. The bridge has a sidewalk for pedestrian use.

3. Hand built Dam at Moose Lodge



Figure 21: Small rock dam near the Moose Lodge. The adjacent land is privately owned and the dam allows for navigability - no improvements are recommended at this site.

4. Former Howe's Leather Site



Figure 22: The former Howe's Leather site is a 26-acre parcel in the process of being redeveloped. This section of the river offers gorgeous scenic views.



Figure 23: East of the railroad track that divides the parcel has grassy, wooded and unwooded areas on natural terraces that could serve as campgrounds to increase the area's "stay and play" recreational tourism capacity. Smaller wooded areas could allow tent camping and the open field could host small cabins and/or RVs.



Figure 24: Concrete structure at Howe's Leather site that could be reconfigured to be a canoe/kayak launch or connected to trails at the planned camp ground. It is reported that this structure was a foundation from Susquehanna River's very first dam, created by "Irvin's Log Mill" to hold back logs as staging for the milling operation that was across river from the Anderson Creek Confluence. The concrete structure was later used for a raised steel tower/staircase that had a pedestrian suspension bridge tied into the hillside across the river, which was used by the factory workers at the mills and tanneries to walk from their homes to the factories.

5. Confluence of Anderson Creek



Figure 25: There are significant deposits at the point that Anderson Creek enters the West Branch of the Susquehanna. It is reported that most of this sediment came from a significant flood event in 2014. This is a natural process consistent with expectations of this geomorphologic feature. It is reported that with significant rain events, Anderson Creek features Class III rapids for a few weeks a year.



Figure 26: A feature downstream of the Anderson Creek Confluence that produces a small wave at some water levels.

6. Curwensville Community Center Put-In



Figure 27: The Curwensville Community Center Put-In, located shortly below the Bloomington Ave Bridge. The left bank of the river in this section is heavily armored and hosts a riverside section of the David S. Ammerman Trail.

7. Hogback Bridge Put-In



Figure 28: Hogback Bridge Put-In. This put in allows boaters to bypass the shallow section of the river and is near the rails-to-trails access.

8. Hubler Brothers Put-In

This site, located upstream of Swisher Concrete on river left, was not visited by the project team, but it was reported that launch access is being provided by the landowners through a partnership with Susquehanna Greenways.

9. Hyde Bridge Put-In



Figure 29: Upstream and Downstream Views at the Put-In Near the Washington Ave bridge in Hyde. This land is privately owned by Jimmy Collins. It is reported that the land may be donated to create a launch, parking area, and picnic area. The location is well-suited for additional recreational use; it is near the confluence of Montgomery Creek and has good visibility for passersby on the bridge and along the Curwensville/Clearfield Hwy, which is designated as a US scenic byway.

10. Lower Witmer Park



Figure 30: Current Canoe/Kayak Launch located in Lower Witmer Park, owned by Clearfield Borough. Across from the riverwalk, this highly visible put-in should be evaluated for accessibility improvements. The land, walkway, and parking lot to the right of the launch is owned by Clearly Ahead Development.

11. Raftsman Dam



Figure 31: The Raftsman Dam is the subject of a conceptual design for removal and replacement with a whitewater structure. It is constructed of large timber framing, filled with rocks, and covered with wooden boards. A 60-foot section of the dam broke off in 2016, and the dam presents an ongoing maintenance issue for the Borough.



Figure 32: The river left side of the dam features a manually operated sluice gate within a concrete structure.

12. Elliot's Park



Figure 33: Elliots Park is a small riverside grassy area that provides river access and gathering spaces.



Figure 34: (Left) There is significant erosion occurring at this site, which can be addressed through vegetating and stabilizing the bank. (Right) A sloped put-in allows boaters easy access to the river.

13. Shawville Access



Figure 35: There is a take-out location located shortly above the Shawville Dam on land owned by Mickey Moore. The access to the river is a sloped dirt path.

14. Shawville Dam



Figure 36: The Shawville Dam, owned by Gen On Energy, presents a dangerous and inconvenient portage. It is constrained by the power plant on river right and a steep embankment up to the highway on river left. Complete removal of this dam is recommended, for which a separate study is ongoing.

5. Proposed Improvements

5.1 Project Objectives

The objectives of this project address safety, fish passage and habitat, recreation, community, and economic development. These objectives include:

- Solve the ongoing repair issues associated with the 2 failing low head dams in Curwensville and Clearfield.
- Eliminate the inherent risk posed by low head dams by providing carefully designed recreational structures.
- Improve fish passage and connectivity.
- Improve fish habitat.
- Allow canoe and kayak navigation through this reach of river, which currently requires inconvenient and dangerous portages.
- Provide an enhanced recreational experience for residents to enjoy on the water.
- Provide a community gathering place for everyone to enjoy on and off the water.
- Increase visibility of Curwensville and Clearfield as outdoor recreation destinations by enhancing the recreational tourism experience.
- Provide attractions to draw in visitors for a “stay and play” experience to provide significant positive economic impact for the community.

This proposed project has the potential to attract and serve many user groups, including:

- Beginner kayakers
- Intermediate and advanced kayakers (at higher flows, with selected whitewater structures)
- Stand-Up paddlers, body boarders, and surfers
- Tubers
- Fishing Enthusiasts
- Spectators visiting the park to watch paddlers or simply spend time beside the river.
- Disabled users utilizing physical rehabilitation opportunities.
- Students engaging in physical education and water safety training.
- Swiftwater rescue training squads

5.2 Conceptual Design

Curwensville Conceptual Design 1: Whitewater Park

The following conceptual design was developed for the Curwensville location:

Curwensville Concept Design



Whitewater Wave Structure

Conceptual Design 1 features one whitewater structure, approximately located at the current failing low head dam adjacent to Irvin Park. This structure is designed to create a wave that provides varying recreational experiences at low, medium, and high flows. At lower flows, the drop structure would feature accelerated flow and a small hydraulic feature that could be used for tubing, paddleboarding, floating and beginner/intermediate kayaking. At higher flows, a larger wave hole is produced that would draw kayakers and surfers from the surrounding region to play and recreate while providing an attraction for spectators.



Figure 37: A similar Wave Feature at low flows in the S₂O designed Eagle Whitewater Park



Figure 38: This structure, dewatered and under construction, shows what S₂O designed whitewater structures look like under the water surface - the center low flow notch channelizes the river to get the most out of available flow, and interstitial spaces between boulders aid in fish passage through the structure at all water levels. The next "stair step" up is to accommodate medium flows, and higher flows rise along the grouted boulder slopes of the structure towards the banks.



Figure 39: A kayaker surfing in a designed wave in Eagle, CO at high flows.

Boulder Bank Terracing

On the river left side of the whitewater structure, on the banks of Irvin Park, the design features bank terracing with large boulders. This landscape element will be constructed out of locally sourced stone and serves as large steps to access the river on steeper bank slopes and provides a community gathering place to sit together and watch the river. This terracing will go all the way down the bank to tie into the whitewater structure, offering convenient access to the river at different water levels.



Figure 40: Terraced banks provide flood armoring, streamside seating, and river access.

Trails

Curwensville Conceptual Design 1 includes trail improvements to provide additional access throughout the park. Starting at the existing concrete pad southeast of the playground, one trail segment extends 400 feet to the east and down to the bank at the existing canoe/kayak launch. This launch is currently separated from the rest of Irvin Park, but the addition of this trail will provide launch users access to the existing restrooms, other existing park amenities, and the proposed whitewater feature. This trail will also allow in-stream users to run the whitewater drop multiples times by taking out at the existing launch and walking back upstream to do it again.

This design also features a riverwalk trail that extends approximately 600 feet to the west, meeting the bridge. This riverwalk trail is consistent with the Irvin Park Masterplan and will provide the community with an accessible way to view the river's beauty and watch paddlers in the wave.

Accessible Put-In

The existing canoe/kayak launch and the proposed trail will be configured to be ADA compliant to provide access to all users. Kayaking is an increasingly popular sport among wounded veterans of all abilities. Organizations such as The Wounded Warrior Project, and Team River Runner, with a mission "To provide all veterans and their families an opportunity to find health, healing, community purpose, and new challenges through adventure and adaptive paddle sports", have chapters all over the nation, getting thousands of veterans into boats every year.



Figure 41: Participants in Team River Runner's Outtasight Program at the US National Whitewater Center in Charlotte, NC. Photo and more information available at teamriverrunner.org

The Borough of Curwensville is already demonstrating exemplary commitment to equitable access to outdoor recreation through their existing playground at Irvin Park. Accessible paddling opportunities will further promote this brand and make Curwensville an accessible outdoor recreation destination to be enjoyed by all ages and abilities.

Curwensville Conceptual Design 2: Dam Removal

A second option for improvements in Curwensville would be to remove the dam without any recreational improvements. This option would mitigate the current safety risk posed by the failing dam and prevent future maintenance issues from reoccurring. Removal of the dam would also improve fish passage through this section.

Removing the dam will be less expensive than replacing the dam with a whitewater structure, though it is not expected to return any economic growth for the area.

Removal of the dam alone without the addition of a whitewater structure and associated recreational improvements will likely not achieve the recreational and economic objectives of the project that include branding Curwensville as an outdoor destination, bringing in visitors to stay and play, and providing a new opportunity for the local community and visitors to connect with the river.



Figure 42: The Existing Dam has not been repaired since its most recent failure, which occurred sometime between 2013-2015. The dam appears to be constructed of timber and rock with a concrete layer. Given the current condition and construction of the dam, it is unlikely that repairing the dam will serve as a sustainable solution that would meet the community's needs.

Clearfield Conceptual Design 1: Whitewater Park

The following conceptual design was developed for the Clearfield location:

Clearfield Concept Design



Whitewater Structures

Conceptual Design 1 for Clearfield features the replacement of Raftsmen Dam with two whitewater structures to provide recreation, improve fish passage, and maintain upstream water surface elevations similar to existing conditions. These whitewater structures will be constructed similarly to the previously described structure in Curwensville, with notched channels and sloping grouted boulders designed for low, medium, and high flow. As the design develops, physical data will be analyzed and the site will be hydraulically modeled, which may influence the park design to include a third whitewater structure.



Figure 43: The West Branch of the Susquehanna widens in this section, spanning about 300 feet wide at Raftsmen Dam. The Pueblo, CO Whitewater Park, pictured under construction on the left (Bryan Kelsen, 2007) and in use at higher flows on the right, shows what multiple structures on a wide section of river can look like.

In this concept design, the structures are located just downstream of the dam so that the dam can be utilized for water control during construction. If it is determined that elements of the existing dam are structurally sound, the first whitewater wave structure could be built from that structure.

Feature boulders will be placed around the whitewater structures to provide visual interest and an additional river feature for users to interact with.

Instream Bypass

A river left riffle is included in this design to allow boaters to bypass the whitewater features if they desire. It was reported to the design team that this section of river is part of a popular route for longer paddle trips, and not all crafts passing through this section will be well suited to run a whitewater wave. To accommodate these boaters, a rocky riffle will be constructed on the left side of the channel to gently lower the grade of the river.

The whitewater structures will tie into a boulder “island”, which will form the divider between the sections of river. Signage will be placed upstream of these features to indicate to boaters to select their desired route.



Figure 44: Riffle Bypass Feature at Eagle Whitewater Park.

Trails and Access

A riverwalk is proposed on the river right bank. The linear section of trail is approximately 600 feet long and features loops with access down to the river on both ends. The access down the steeper sloped banks will either consist of sets of boulder stairs with a trail at the bottom, as pictured, or a fully boulder terraced bank, like the proposed bank design for Curwensville.

Clearfield Conceptual Design 2: Dam Removal

A second option for Clearfield is to remove the dam without replacing it with whitewater structures. Fish passage would be significantly improved by the removal of this dam. It would also prevent the inconvenient portage for paddlers that is currently required, though the navigation of this section of the river may be ultimately impaired by insufficient water on low flow days.

Similarly to Curwensville, removing the dam will be less expensive than replacing the dam with whitewater structures, but it is not expected to return any economic growth for the area.

It is the design team's understanding that the water level in this section of the river is particularly important to the community. These sensitive areas through downtown Clearfield, particularly by the existing Riverwalk and Lower Witmer Park, will experience significantly lower water levels by removal of the dam without replacement by a whitewater structure.

Additional analysis on this dam removal alternative is available in the 2017 report by American Rivers examining the impact of Raftsman Dam on aquatic habitat.



Figure 45: In the September 2016 failure of the Raftsman Dam, a 60-foot section of the dam broke off. The dam appears to be timber framing filled with rocks and additional timber, with a concrete pad below. Photo from Courier-Express Article.

5.3 Additional Improvements

The following sites were identified in the site visit:

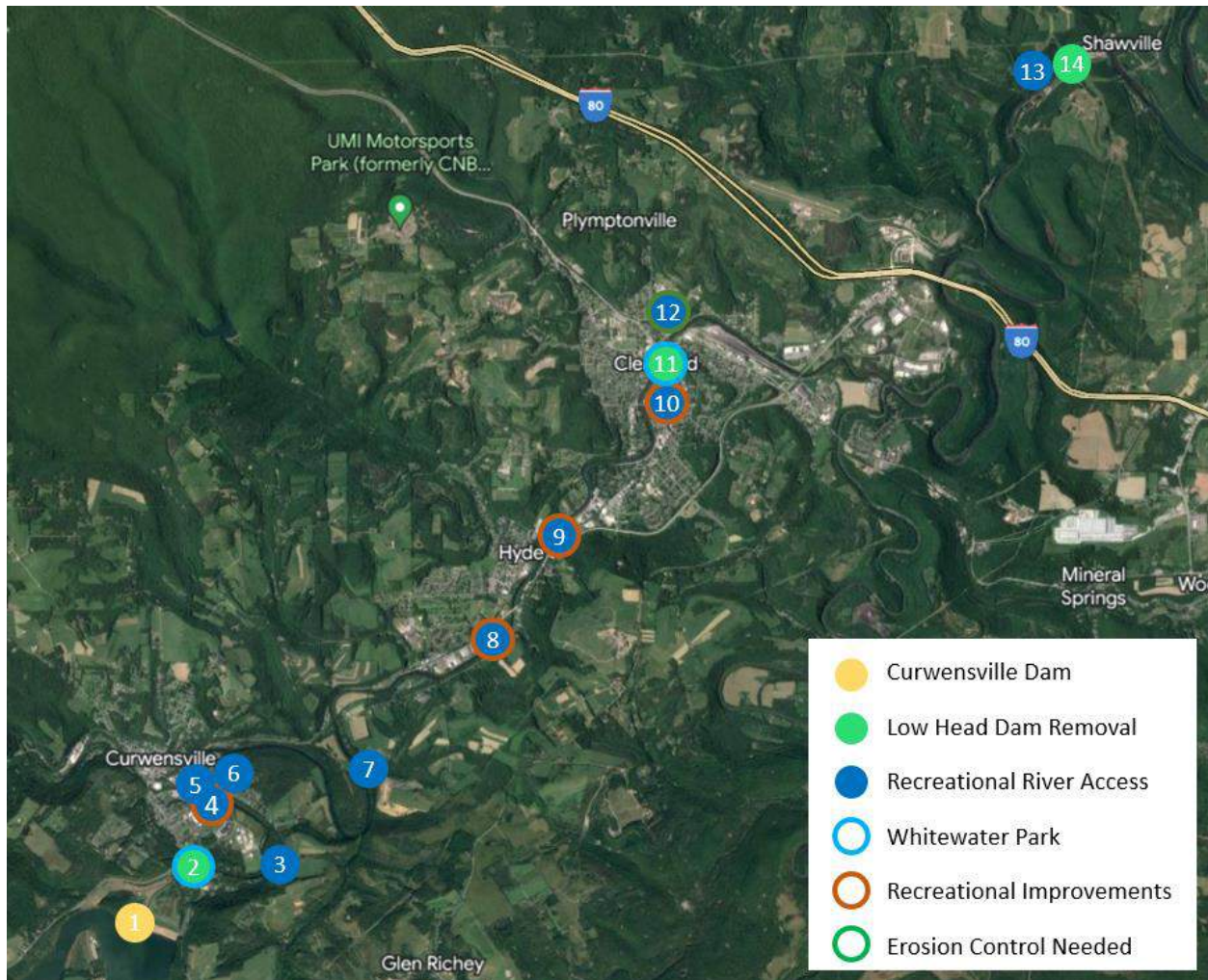


Figure 46: Recreational access points and identified areas of improvement along project reach. Site numbers correspond to numbers listed in Section 4, the site visit report.

The scope of this feasibility investigation and conceptual design focuses on the whitewater parks, but additional improvements throughout this river reach will be important to consider in future phases of design development as they relate to the recreational experience of the community and function of the river.

In addition to recreational improvements at put-in locations, there are other large projects in planning phases along this reach.

Irvin Park Master Site Development Plan

An Irvin Park Master Site Development Plan was completed for Curwensville Borough in fall of 2017. As the design for the whitewater park at Irvin Park develops, it should be integrated into a comprehensive plan with the existing and planned elements of the park.

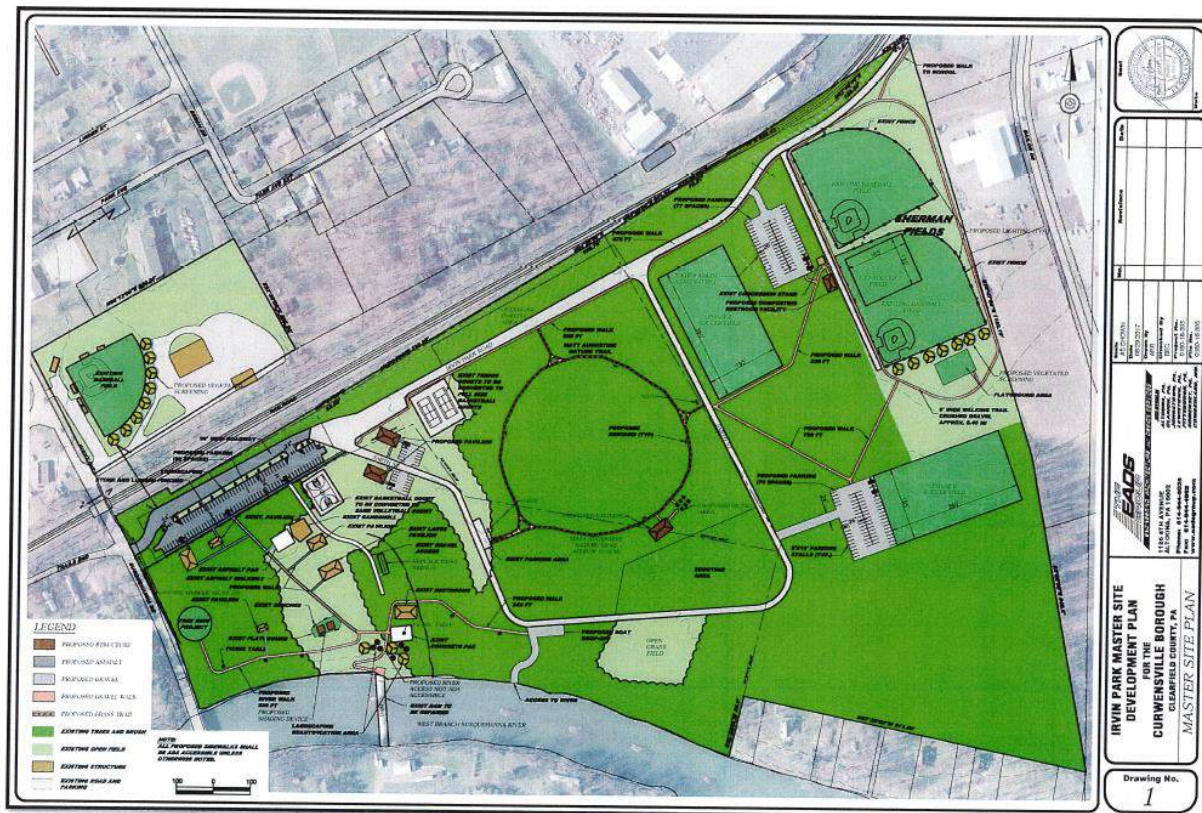


Figure 47: 2017 Irvin Park Master Plan

Former Howe's Leather Site

The Former Howe's Leather Site is located within Curwensville Industrial Park at 50 Cooper Road in Curwensville, PA. A conceptual design has been completed for the redevelopment of this site, which includes two canoe/kayak launches and a camping area, as pictured in the design below. There are also proposed trail networks extending from the site, increasing the accessibility of recreational opportunities.

The recreational components of this redeveloping site may be included in future design development of river access and opportunities in Curwensville and Clearfield.

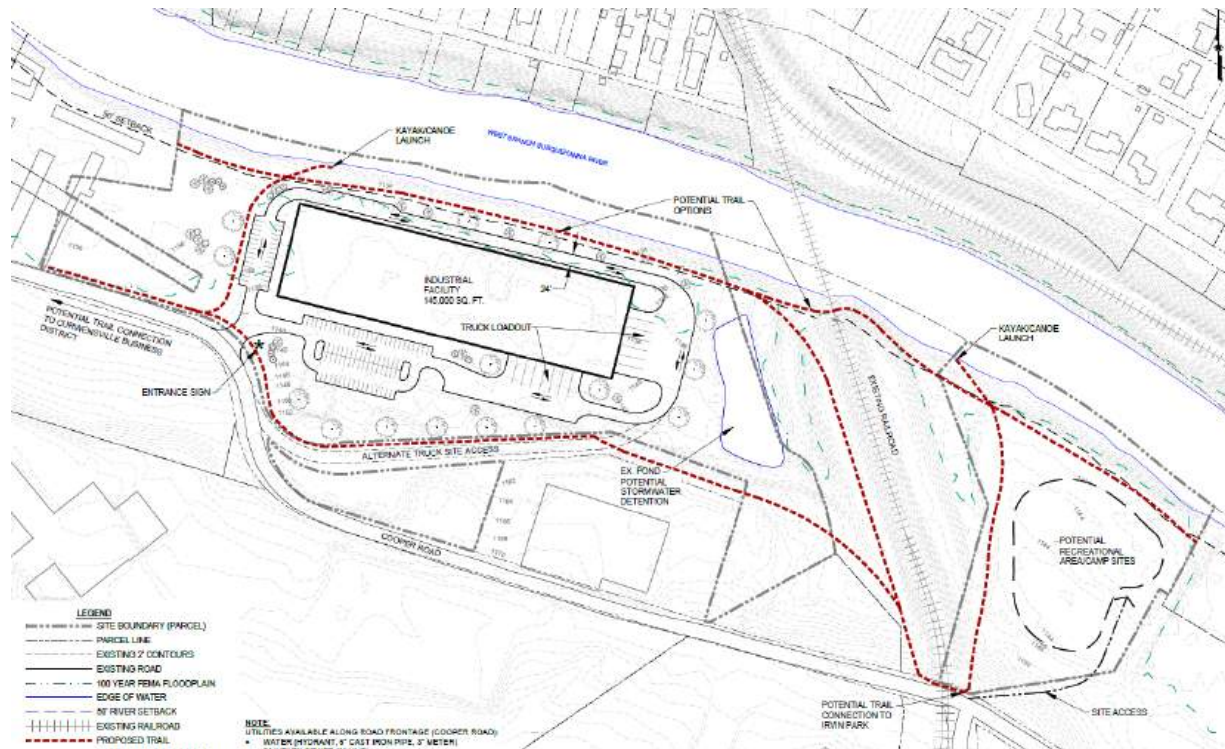


Figure 48: Conceptual Design for Former Howe's Leather Site

Shawville Power Plant Dam Removal

There is a feasibility study in progress for the removal of the Shawville Power Plant Dam, owned by Gen On Energy. It is being evaluated if the dam is necessary for the plant's withdraw requirements. The findings of this feasibility study should be considered in future design phases, and the projects may be able to be integrated for the benefit of the community.

5.4 Cost Estimates

The cost estimates presented are a preliminary cost opinion based on the conceptual designs. As the design develops in future phases, these cost estimates will be refined. Pricing for rock was provided by Russell Stone Products.

Curwensville Whitewater Park - Curwensville, PA
Opinion of Probable Cost - October 2023

Description	Quantity	Unit	Unit Cost	Cost
Hard Costs				
Site Set up, BMPs, Water Control			\$	164,834
Furnish & Install Protective Barriers & Fencing	600.0	LF	\$ 4.99	\$ 2,994
Furnish & Install Vehicular Tracking Pad	1.0	LS	\$ 3,000.00	\$ 3,000
Install & Maintain Best Management Practices	1.0	LS	\$ 10,000.00	\$ 10,000
Install Equipment Access Ramps & Roads	200.0	SY	\$ 19.20	\$ 3,840
Furnish & Install Water Control	1.0	LS	\$ 100,000.00	\$ 100,000
Operate & Maintain Water Control - Assume 2mo	2.0	MO	\$ 20,000.00	\$ 40,000
Reclaim Disturbed Areas to Include Native Seed Mix	1.0	LS	\$ 5,000.00	\$ 5,000
Trails			\$	71,514
Concrete Path (6' wide)	5850.0	SF	\$ 6.84	\$ 40,014
Bridge over Stormwater Channel	90.0	SF	\$ 350.00	\$ 31,500
Bank Terracing and Access			\$	105,251
Accessible Submerged Ramp	1.0	EA	\$ 30,000.00	\$ 30,000
Furnish & Install - 6-7' Diam Typ. Landscape Boulders	3.0	EA	\$ 1,900.00	\$ 5,700
Subgrade Prep and Compaction	300.0	SY	\$ 5.00	\$ 1,500
Furnish & Install Mirafi 180N Filter Fabric	300.0	SY	\$ 3.17	\$ 951
Furnish & Install Bedding Material (3-4" Clean Cobble) 12" thick	100.0	CY	\$ 50.00	\$ 5,000
Material and Delivery - 3ft Diam Typ. Boulders (4.5' thick)	330.0	CY	\$ 55.00	\$ 18,150
Material and Delivery - Riprap Toe Protection (18" D50, 4' Thick)	30.0	CY	\$ 55.00	\$ 1,650
Install Rip Rap and Boulders (18"and 3')	360.0	CY	\$ 90.00	\$ 32,400
Furnish & Install Concrete Grout (4000psi Placed As Directed)	49.5	CY	\$ 200.00	\$ 9,900
In-Stream Structure			\$	333,742
Excavate and Grade	622.5	CY	\$ 2.01	\$ 1,251
Furnish & Install Mirafi 180N Filter Fabric	827.8	SY	\$ 3.17	\$ 2,624
Furnish & Install Bedding Material (3-4" Clean Cobble) 12" thick	275.9	CY	\$ 50.00	\$ 13,796
Material and Delivery - 3ft Diam Typ. Boulders (4.5' thick)	1245.0	CY	\$ 55.00	\$ 68,475
Material and Delivery - Riprap Toe Protection (18" D50, 4' Thick)	651.0	CY	\$ 55.00	\$ 35,805
Install Rip Rap and Boulders (18"and 3')	1896.0	CY	\$ 90.00	\$ 170,640
Furnish & Install - 6-7' Diam Typ. In-Stream Feature and Toe Boulders	2.0	EA	\$ 1,900.00	\$ 3,800
Furnish & Install Concrete Grout (4000psi Placed As Directed)	186.8	CY	\$ 200.00	\$ 37,350
Dam Removal			\$	200,000
Removal of dam at Irvin Park	1.0	LS	\$ 200,000.00	\$ 200,000
Hard Costs			\$	875,341
Hard Costs with 15% Contingency			\$	1,006,642
Soft Costs				
Land Surveying	1	LS	\$ 10,000.00	\$ 10,000
Hydraulic Modeling	1	LS	\$ 35,000.00	\$ 35,000
Construction Bonding/Insurance	3%	%	\$ 875,340.58	\$ 26,260
Engineering Design	9%	%	\$ 875,340.58	\$ 78,781
Permitting	2%	%	\$ 875,340.58	\$ 17,507
Construction Monitoring	4%	%	\$ 875,340.58	\$ 35,014
Mobilization/Demobilization	4%	5	\$ 875,340.58	\$ 35,014
Soft Costs			\$	237,575
Soft Costs with 3% Contingency			\$	244,702
Total			\$	1,251,344

Clearfield Whitewater Park - Clearfield, PA
Opinion of Probable Cost - October 2023

Description	Quantity	Unit	Unit Cost	Cost
Hard Costs				
Site Set up, BMPs, Water Control				\$ 165,832
Furnish & Install Protective Barriers & Fencing	800.0	LF	\$ 4.99	\$ 3,992
Furnish & Install Vehicular Tracking Pad	1.0	LS	\$ 3,000.00	\$ 3,000
Install & Maintain Best Management Practices	1.0	LS	\$ 10,000.00	\$ 10,000
Install Equipment Access Ramps & Roads	200.0	SY	\$ 19.20	\$ 3,840
Furnish & Install Water Control	1.0	LS	\$ 100,000.00	\$ 100,000
Operate & Maintain Water Control - Assume 2mo	2.0	MO	\$ 20,000.00	\$ 40,000
Reclaim Disturbed Areas to Include Native Seed Mix	1.0	LS	\$ 5,000.00	\$ 5,000
Trails				\$ 23,256
Concrete Path (5' wide)	3400.0	SF	\$ 6.84	\$ 23,256
River Access				\$ 25,200
Boulder Canoe/Kayak Launches	1.0	EA	\$ 12,000.00	\$ 12,000
Boulder Stairs	3.0	EA	\$ 2,500.00	\$ 7,500
Furnish & Install - 6-7' Diam Typ. Landscape Boulders	3.0	EA	\$ 1,900.00	\$ 5,700
Two In-Stream Structures, Attachment to Bank, and Island				\$ 797,499
Excavate and Grade	1083.5	CY	\$ 2.01	\$ 2,178
Furnish & Install Mirafi 180N Filter Fabric	1444.4	SY	\$ 3.17	\$ 4,579
Furnish & Install Bedding Material (3-4" Clean Cobble) 12" thick	481.5	CY	\$ 50.00	\$ 24,074
Material and Delivery - 3ft Diam Typ. Boulders (4.5' thick)	2167.0	CY	\$ 61.00	\$ 132,187
Material and Delivery - Riprap Toe Protection (18" D50, 4' Thick)	2291.0	CY	\$ 61.00	\$ 139,751
Install Rip Rap and Boulders (18" and 3')	4458.0	CY	\$ 90.00	\$ 401,220
Furnish & Install - 6-7' Diam Typ. In-Stream Feature and Toe Boulders	15.0	EA	\$ 1,900.00	\$ 28,500
Furnish & Install Concrete Grout (4000psi Placed As Directed)	325.1	CY	\$ 200.00	\$ 65,010
Bypass Riffle				\$ 150,000
225 ft long in-stream riffle	1.0	LS	\$ 150,000.00	\$ 150,000
Dam Removal				\$ 400,000
Removal of Raftsman Dam	1.0	LS	\$ 400,000.00	\$ 400,000
Hard Costs				\$ 1,561,787
Hard Costs with 15% Contingency				\$ 1,796,055
Soft Costs				
Land Surveying	1	LS	\$ 10,000.00	\$ 10,000
Hydraulic Modeling	1	LS	\$ 50,000.00	\$ 50,000
Construction Bonding/Insurance	3%	%	\$ 1,561,786.80	\$ 46,854
Engineering Design	9%	%	\$ 1,561,786.80	\$ 140,561
Permitting	2%	%	\$ 1,561,786.80	\$ 31,236
Construction Monitoring	4%	%	\$ 1,561,786.80	\$ 62,471
Mobilization/Demobilization	4%	S	\$ 1,561,786.80	\$ 62,471
Soft Costs				\$ 403,593
Soft Costs with 3% Contingency				\$ 415,701
Add Alternative: CLOMR/LOMR				\$ 75,000
If the in-stream changes create a rise in base flood elevations, the CLOMR/LOMR process with FEMA will likely be required	1	LS	\$ 75,000.00	\$ 75,000
Add Alternative: Physical Modeling				\$ 125,000
In addition to computed 1D & 2D hydraulic modeling, a physical model can be designed to scale and built to provide the most accurate data	1	LS	\$ 125,000.00	\$ 125,000
Total				\$ 2,411,756

5.5 Process and Permitting

This Feasibility and Conceptual Design project is the first step of the design process but is not a fully vetted design. Detailed design and analysis are required to move the project from its current status to get it ready for construction. A typical whitewater park requires several stages of design, including:

- a) **Feasibility Investigation & Conceptual Design**—This is the current phase and determines whether a particular project is possible and, if so, how it could look and function. This stage is often very important for clients as it provides the material and preliminary information required to pursue funding and grants. The deliverable for this stage includes site information, preliminary flow and flood analysis, conceptual design drawings, a concept level cost estimation, and an outline of project process and anticipated permit requirements.

This report includes all the findings for the feasibility investigation and conceptual design for the Curwensville and Clearfield (C&C) Whitewater Parks project.

- b) **Preliminary Design**—The preliminary design phase often includes surveying, geotechnical investigation, preparing for permitting, creating baseline models, meeting with stakeholders and agencies to define constraints and objectives, and furthering the design documents to the permitting level. S₂O believes in a collaborative design process and will engage stakeholders at every step of the way, with significant input early in the preliminary design phase.

Stakeholders that will be engaged for the creation of the C&C Whitewater Parks may include:

- Clearfield Borough
- Curwensville Borough
- Curwensville Development Corporation
- Susquehanna Greenways
- Clearfield/Curwensville Rails to Trails Association
- Clearfield County Conservation District
- PA Wilds
- PA DCNR
- Visit Clearfield County
- Local Canoe&Kayak and Fishing Outfitters
- Squirrel Tails for Trout
- North Central PA Regional Planning & Development Commission
- Lumber Heritage Region
- Quehanna Industrial Development Corp
- PA Fish & Boat Commission
- US Army Corp. of Engineers
- Clearfield County Historical Society
- GenOn Energy

c) **Permitting**— The permitting process permeates many design phases. Typically, regulatory authorities will be engaged during the preliminary design phase to establish criteria and priorities for the project and permit applications will be submitted during the detailed design phase. Generally, the permits will be submitted by the design team on behalf of the project owners, which will be the Borough of Curwensville and the Borough of Clearfield. The C&C Whitewater Parks may require federal, state, and local permits. S₂O expects the project may require:

- US Army Corps of Engineers – Federal Clean Water Act 404/401 permit and certification.
- Environmental Review from PA DCNR.
- Permitting through PA Department of Environmental Protection (DEP) Stream and Wetland Regulatory Program.
- Wetland delineation
- Construction permits including dewatering and discharge, stormwater permits, and erosion control permits. These permits are typically secured by the contractor.
- Floodplain Development Permit. If a rise in floodplain due to the in-stream changes is determined, the CLOMR/LOMR process may be required through FEMA.

In the Preliminary Design Phase, the design team will submit the project for a DEP Permit Application Consultation, which will help determine which permits the project will require.

d) **Detailed Design**— Following the definition of the project and adaptation to constraints and stakeholder requests, the project will be ready to enter the detailed design phase, including detailed calculations and modeling. Whitewater parks remain a new phenomenon and typical design standards are just beginning to be created. The most comprehensive set of standards defined for Whitewater Parks was set by the Colorado Board of Professional Engineers. The Board found that the following items should be standard for whitewater park design:

Plans specifications:

- Existing and proposed topography
- Exact dimensions and proposed elevations/distances for any of the improvements
- Methods of water control and erosion control during construction

Calculations:

- 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.

Technical Specifications:

- Stability analysis
- Backfill
- Water control
- Erosion control
- Un-grouted rock/rip-rap or landscaping

- 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.

S₂O will work with the C&C Whitewater Parks stakeholders to produce these documents and help the project owner prepare to put it to bid.

- f) **Project Bidding and Construction**—the project is put to bid by the project owner and a contractor is selected and contracted.
- g) **Construction Oversight and Inspection**—In this phase the contractor and the design team work together to build the project to our exacting specifications. Often, S₂O has representatives in the field virtually full-time to ensure an accurate build that is aesthetically beautiful 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. Construction demobilization will take place after this phase.

6. Summary and Recommendations

S₂O recommends the selection of Conceptual Design 1 for both Curwensville and Clearfield.

For both communities, Conceptual Design 2, removal of the dams, would create positive impact by mitigating the current safety risk posed by the dams, alleviating the ongoing failure and maintenance problems with the dams, and improving fish passage. For Clearfield, removal of the dam would also achieve the goal of restoring canoe and kayak navigability. However, not all project objectives are achieved by this alternative. The significantly reduced water levels in Clearfield would affect aesthetics and navigation upstream of the existing dam, and a recreational and economic development opportunity would be missed. For Curwensville, Conceptual Design 2, the stand-alone removal of the dam, removes a historical community focal point without providing an alternative, and misses an opportunity to draw in visitors and residents as an accessible outdoor recreation destination.

For Clearfield, the development of a whitewater park in place of Raftsman Dam will open navigability, improve fish passage, provide an exciting whitewater experience for some boaters, provide a safe in-river passageway for other boaters, and draw in visitors and their associated economic development.

For Curwensville, the development of a whitewater park in place of the dam at Irvin Park will create an exciting in-water experience, further develop Curwensville’s brand as an outdoor recreation destination accessible to everyone, promote tourism and economic growth, and provide a community gathering place that honors the long history of community recreation at Pee Wee’s Nest.

7. References

- “Clearfield County Parcel Viewer 2.0.” *Clearfield County Parcel Viewer*, Clearfield County, clearfieldco.org/parcel_map_viewer/.
- Corcino , Jeff. “Raftmen’s Memorial Timber Dam Leaking.” *The Courier Express*, 15 Sept. 2016, www.thecourierexpress.com/news/local/raftmen-s-memorial-timber-dam-leaking/article_b07b87a7-7bee-5a42-9f9a-570e958afa9b.html.
- “Curwensville Lake .” *US Army Corps of Engineers*, US Army Corps of Engineers, www.nab.usace.army.mil/Missions/Dams-Recreation/Curwensville-Lake/.
- “DEP Permit Application Consultation Tool.” *DEP*, Pennsylvania Department of Environmental Protection, www.ahs.dep.pa.gov/PACT/.
- “National Agriculture Imagery Program (NAIP) 2019 for Pennsylvania.” *Pennsylvania Spatial Data Access*, US Department of the Agriculture, www.pasda.psu.edu/uci/DataSummary.aspx?dataset=3211.
- “National Register of Historic Places.” *National Parks Service*, U.S. Department of the Interior, <https://www.nps.gov/maps/full.html?mapId=7ad17cc9-b808-4ff8-a2f9-a99909164466>.
- “Outdoors in Clearfield County.” *Visit Clearfield County*, Clearfield County, www.visitclearfieldcounty.org/.
- “PEMA Orthoimagery - TIFF. 2018” *Pennsylvania Spatial Data Access*, Pennsylvania Emergency Management Agency, www.pasda.psu.edu/uci/DataSummary.aspx?dataset=5155.
- “Stream and Wetland Regulatory Program.” *Department of Environmental Protection*, PA Department of Environmental Protection, www.dep.pa.gov/Business/Water/Waterways/Encroachments/Pages/default.aspx.
- “USFWS Critical Habitat Map”, United States Fish and Wildlife Service, www.arcgis.com/home/webmap/viewer.html?url=https%3A%2F%2Fservices.arcgis.com%2FQVENGdaPbd4LUkLV%2FArcGIS%2Frest%2Fservices%2FUSFWS_Critical_Habitat%2FFeatureServer&source=sd.