



Rapid Creek Recreational Corridor Improvement Project

Feasibility Investigation and Conceptual Design

Rapid City, South Dakota



August 2024

S₂O Design and Engineering
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August 30, 2024

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Rapid Creek Recreational Corridor Inc
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Re: Rapid Creek Recreational Corridor Improvement Investigation and Conceptual Design

G. Black and J. Herreman,

S₂O-Calibre is pleased to present this feasibility investigation and conceptual design study for the proposed in-stream park on Rapid Creek, just upstream of Rapid City, South Dakota. 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 a river park to Rapid City, South Dakota.

The attached report provides information on in-stream recreational improvements, 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,



Scott Shipley, PE
S₂O Whitewater Division Manager
Calibre Engineering



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1. Introduction

This feasibility investigation and conceptual design study for an in-stream park in Rapid City, South Dakota was commissioned by the Rapid Creek Watershed Action Coalition. In this study, there are two possible project sites considered on Rapid Creek, both of which are located east of the city center, near the fairgrounds.

This project aims to provide a unique, exciting outdoor recreational attraction to complement the existing opportunities in the area. There is an ongoing effort to designate the Rapid Creek Watershed as a Recreational Area, which would provide federal protection to the Creek and associated watershed and prevent future mining uses.

Another primary objective for this project is to provide a strong attraction to serve the local community and draw in recreational tourism. The Rapid Creek In-Stream Park 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 in the community, this project would provide an exciting recreational destination for locals and tourists alike.

2. In-Stream Recreation and Whitewater Parks



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

The creation of in-stream recreation and whitewater parks are a growing movement in the United States. Many cities and towns in the United States have completed or are considering constructing these 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-Calibre has worked to develop in-stream attractions in parallel with park amenities such as trails, parking, restrooms, and park space. These 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-Calibre designed 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, stand up paddleboarding, yoga, and special events including food and music festivals.

2.1 Typical Economic Impacts of In-Stream Recreational Parks

In-stream 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 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 In-Stream Parks (per year in US Dollars)

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 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 a river town and an outdoor recreation destination.

3. Site Information

3.1 Site Location

Rapid City, known as the gateway to Mt. Rushmore, lies in western South Dakota just east of the Black Hills. With a population of 75,000, it is the second most populous city in South Dakota.



Figure 4: Rapid City is within Pennington County in western South Dakota.

Multiple sites in Rapid City were visited along 7 miles of Rapid Creek to determine the ideal location for an in-stream park. The two best sites, which both lie along Rapid Creek in the northeast portion of Rapid City, are near the Rapid City Fairgrounds. Site 1 begins at the existing low head dam that is adjacent to the Fair Arena. Site 2 is shortly downstream at the island in Rapid Creek, adjacent to the City-owned fields.



Figure 5: Both proposed sites are in northeast Rapid City, south of San Francisco St.

Land Ownership



Figure 6: Site 1 Land Ownership

The creek-adjacent land on the proposed Site 1 is a mix of city and county owned land. On river right, parcels 3806403001 and 3806403002 are owned by the City of Rapid City and designated as part of the Rapid City Greenway Tract. On river left, parcels 3806401001-3806401003 are owned by Pennington County and have permanent infrastructure for the Rapid City Fairgrounds. Site 1 is constrained on the southwest side by the railroad, parcel 380601004. There appears to be sufficient room to access the river up to the existing dam on the river right side, but this constraint will be considered during design and construction phasing.



Figure 7: Site 2 Land Ownership

The river land on either side of the river immediately upstream of the Site 2 improvements, parcel 3806276001, is owned by Pennington County. The large parcel that encompasses Site 2 improvements, 3806426002, is owned by Rapid City and designated as part of the Rapid City Greenway.

3.2 Site Considerations

Endangered Species

Federal

According to United States Fish and Wildlife Service (USFWS) Critical Habitat maps and NOAA's National Marine Fisheries Services (NMFS) Critical Habitat Mapper available online, there are no existing or proposed critical habitats for species listed as federally endangered or threatened under the US Endangered Species Act that are located within or nearby the project area.

State

Information on state endangered species was reviewed through the South Dakota Game, Fish, & Parks website. GIS maps or site-specific information did not appear to be available online but lists of endangered or threatened species were available by county. For Pennington County, the following list was most recently updated in 2016:

Pennington	Longnose Sucker	<i>Catostomus catostomus</i>	ST	LE = Federal Endangered
	Sturgeon Chub	<i>Macrhybopsis gelida</i>	ST	LT = Federal Threatened
	American Dipper	<i>Cinclus mexicanus</i>	ST	C = Federal Candidate
	Interior Least Tern	<i>Sternula antillarum athalassos</i>	FE, SE	PE = Proposed Endangered
	Osprey	<i>Pandion haliaetus</i>	ST	PT = Proposed Threatened
	Peregrine Falcon	<i>Falco peregrinus</i>	SE	SE = State Endangered
	Whooping Crane	<i>Grus americana</i>	FE, SE	ST = State Threatened
	Black-footed Ferret	<i>Mustela nigripes</i>	FE, SE	
	Northern Long-eared Bat	<i>Myotis septentrionalis</i>	LT	
	Northern River Otter	<i>Lontra canadensis</i>	ST	
	Swift Fox	<i>Vulpes velox</i>	ST	

In-stream construction is most likely to possibly impact aquatic species, which may include the state threatened Longnose Sucker and the state threatened Sturgeon Chub. Calibre recommends consulting with local conservation authorities during preliminary design development to obtain site-specific information regarding the presence of sensitive species. The state will also be engaged for recommendations if any sensitive species are present, which may include design recommendations to allow for upstream migration of aquatic life or construction windows to avoid disturbance during sensitive times.

Historic Structures

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

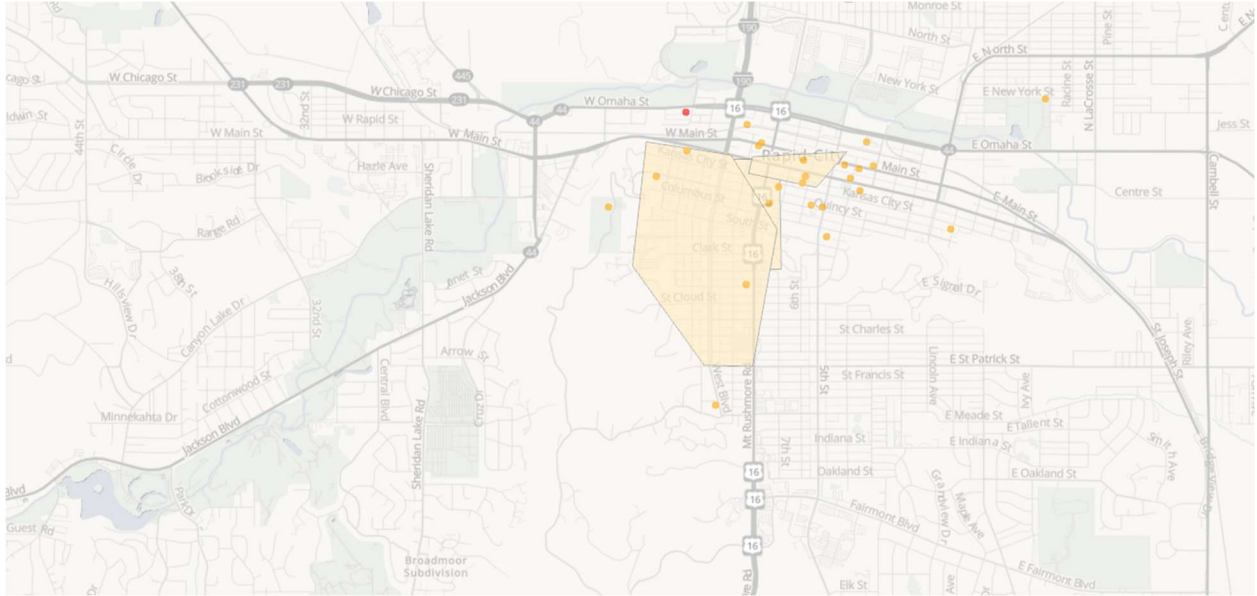


Figure 8: South of the creek, downtown Rapid City has multiple listed historic sites, and the West Boulevard Historic District.

3.3 Hydrologic and Hydraulic Conditions

Rapid Creek rises in southwestern South Dakota in the Black Hills then flows east through Rapid City, before joining the Cheyenne River, with a total length of 87 miles. Fifteen miles west of Rapid City, the Pactola Dam provides significant capacity and flood protection. On the western edge of Rapid City, the Canyon Lake Dam is owned by the City of Rapid City and provides a smaller capacity and additional flood protection.

These hydrologic conditions mean that Rapid Creek typically has low flow but is subject to extreme flows during flood events.

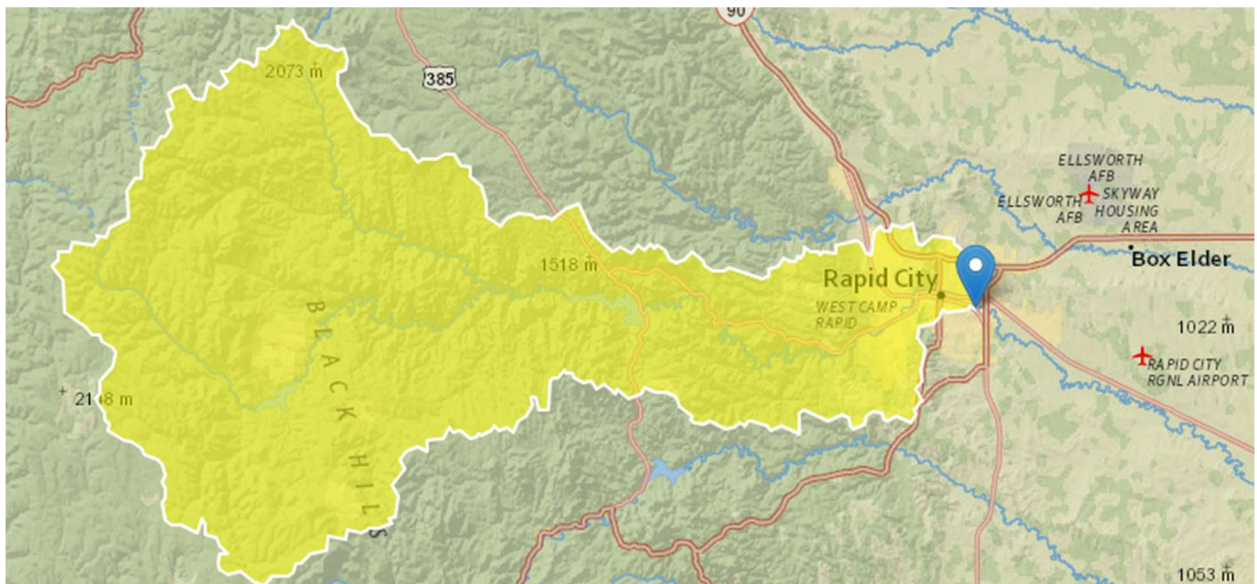


Figure 9: The upstream drainage area contributing to the creek's flow at Rapid City is approximately 420 square miles. Figure and basin characteristics obtained from USGS StreamStats.

1972 Flood

In June of 1972, Rapid Creek and the adjacent land in Rapid City were damaged by a large magnitude storm and a breach of the Canyon Lake Dam. According to the Association of State Dam Officials (ASDSO), the Canyon Lake Dam was a 20 ft high, 500 ft long earthfill dam that failed by overtopping. The flash floods from the upstream watershed caused debris to accumulate in the Canon Lake Reservoir, obstructing the spillway and causing the flow to overtop the dam. After 45 minutes of overtopping flows, the dam completely breached and sent an estimated 50,000 cfs floodwave toward Rapid City.

According to the USACE, the establishment of Rapid City's floodplain had already begun by 1972 following the National Flood Insurance Act of 1968 and subsequent floodplain delineation by the Soil Conservation Service. The relocation of residences from the floodplain and creation of the greenway were already underway when the devastation of the 1972 flood, which killed around 240 people, dramatically highlighted the need for this approach to development. Rapid City was awarded urban renewal funds for the creation of a six-mile greenbelt that would serve as floodways for the 100-year flood, which established nature areas and trails, a golf course, ballfields, and a memorial path.

Flood Maps

Current flood maps available through FEMA's National Flood Hazard Layer were reviewed to understand existing inundation boundaries and floodway limits through the two proposed project sites.



Figure 10: Site 1 and Site 2 Flood Map, accessed via FEMA's National Flood Hazard Layer Viewer

For both proposed project sites, both the instream and riverside improvements are within the regulatory floodway, as indicated by the red stripes in the Figure above. Adjacent land is also within Zone AE, which designates a 1% annual chance of flooding (100-year flood) with determined base flood elevations.

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 necessary for design development and is also 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. However, most in-stream parks are designed to meet a “no rise” condition which does not require a CLOMR/LOMR.

Flow

In northwest Rapid City, USGS maintains flow gauge 06414000 on Rapid Creek. This does not represent the exact flow conditions downstream at the project site but can be used as an approximation of flow patterns. Between the USGS gauge and Site 1, the Iowa Ditch diverts water from Rapid Creek. Downstream of Site 1, at the top of Site 2, the Hawthorne Ditch diverts water from the creek. Additional flow contributions to Rapid Creek are expected from stormwater runoff, but due to the outlets to these two ditches, flows at the project site are likely lower than at the USGS gauge.

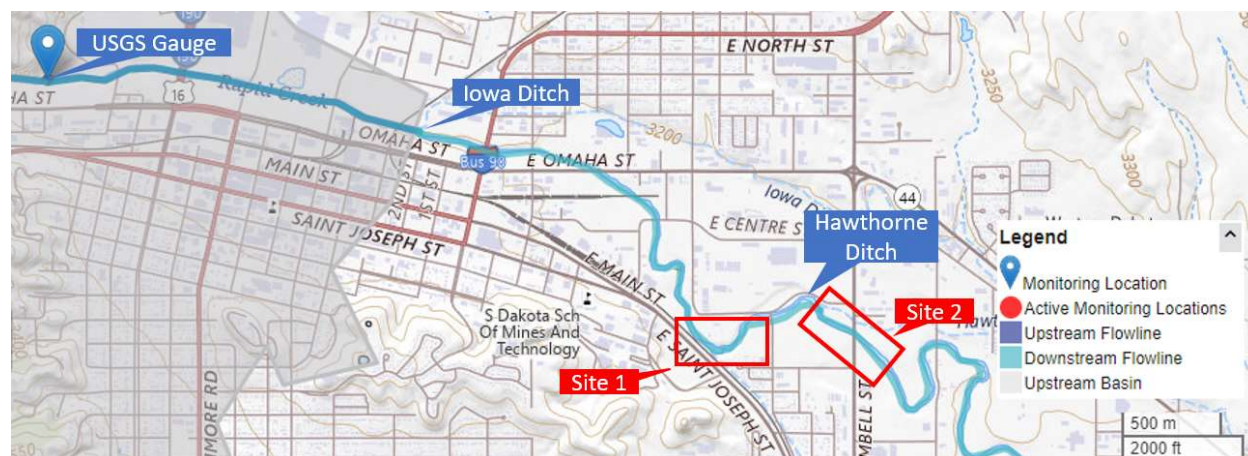


Figure 11: Location of USGS 06414000

Flow data from this gauge for the last 10 years were analyzed to understand what flows can be expected at the proposed project sites. As seen in the figures below, these project sites experience significant seasonality in flows- the most water is available May-July and the lowest flows are in the winter.

Based on the average number of days per year with sufficient flow at the project sites, an in-stream park is feasible, but will provide primarily lower-flow experiences that are best suited to tubing, swimming, fishing, and beginner kayaking.

To accommodate variable flow, the in-stream park will be designed with stepped wave structures that expand the structure’s capacity as the water rises to allow for both 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.

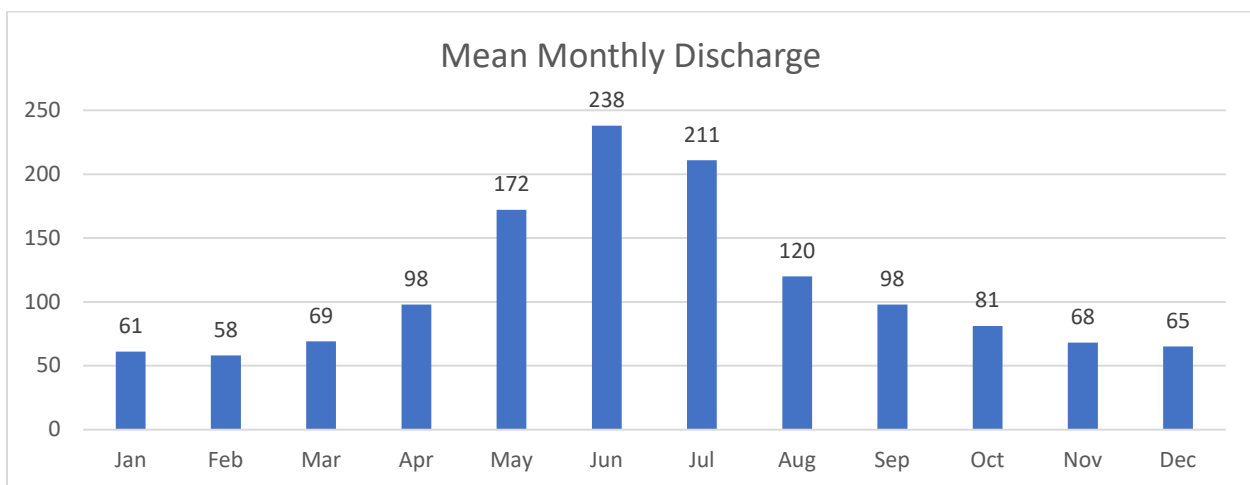
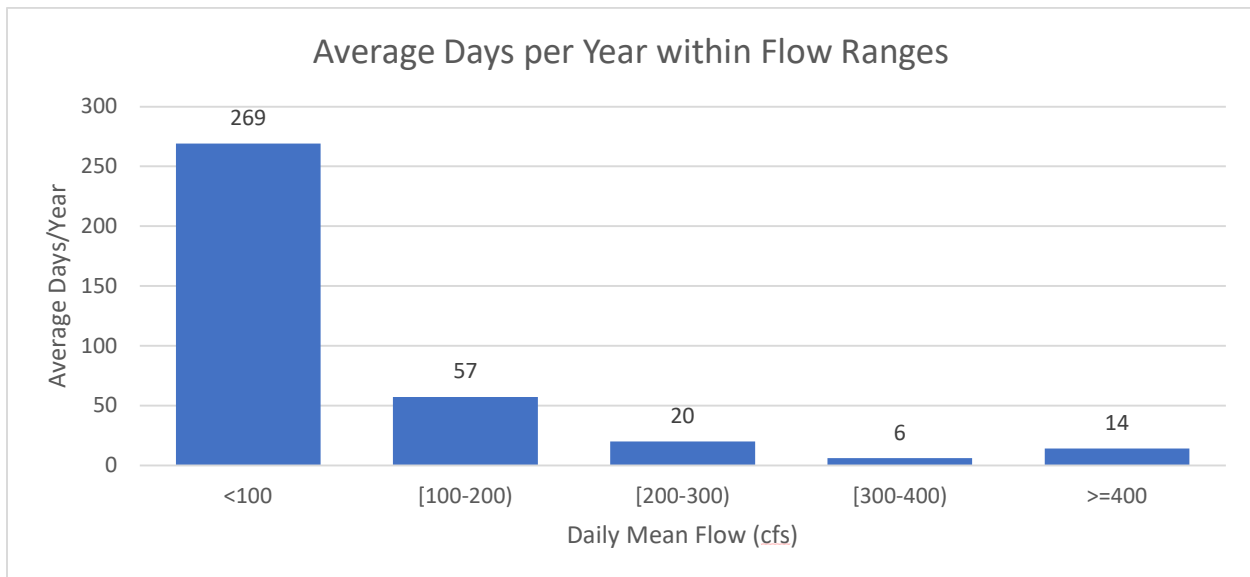
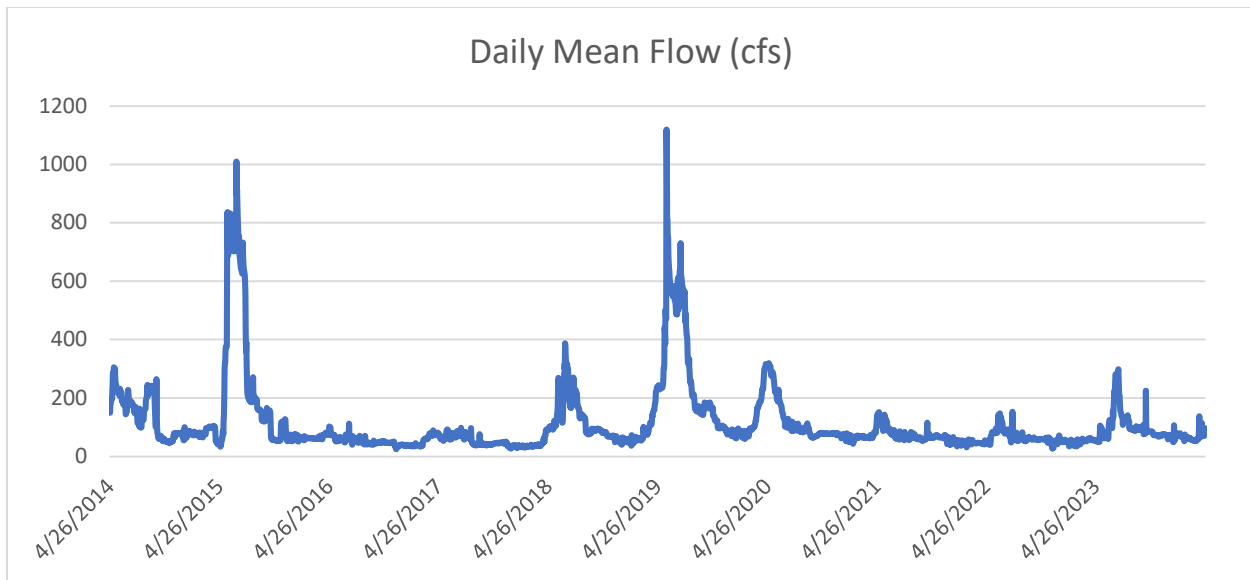


Figure 12: Flow data from 2014-2024 showing daily trends, average days/year at varying flows, and mean discharge by month.

4. Site Visit

A site visit was conducted by Scott Shipley on April 3, 2024. Multiple sites along 6.7 miles of Rapid Creek were visited to determine the ideal location for an in-stream recreational park. The sites visited extended from the Dam at Canyon Lake downstream through Rapid City, ending at Cambell St. Sequenced upstream to downstream, the following sites were visited:



Figure 13: A series of three dams are located at the outfall of Canyon Lake.



Figure 14: A small dam is located near the Meadow Brook Golf Course, shortly upstream of Jackson Blvd



Figure 15: Smaller diversion structures that can be a hindrance to navigation and a life-safety issue are in the reach.



Figure 16: Rapid Creek near the old City Water Treatment Plant/Sioux Park is highly developed with park land, a diversion structure with fish passage, and trails along the river.



Figure 17: Rapid Creek near Founder's Park has been restored and features fish habitat structures, a connected floodplain, and areas of wetlands. This area, with some restoration of decaying structures, could be ideal for run-of-the-river type float trips with a put-in and take-out within the park and utilizing the existing trail to float the reach. There are also restrooms and parking available as well as local businesses located to benefit from increased usage.



Figure 18: The area downstream of 15th St. extending past North St. is confined and relatively steep with deep eddies and areas of riffle conducive to in-stream park development.



Figure 19: There are numerous drop structures along the reach, some of which are fun to surf or kayak on at varying levels. However, some of these can also be dangerous in their existing condition depending on water levels.



Figure 20: Selected Site 1: A dam located in Rapid Creek near O'Harra Stadium creates an ideal location for an in-stream park. There is sufficient drop and access in this area for kayaking/tubing features, beach access to the scour pools, and a reach of paddling/tubing whitewater for users to enjoy.



Figure 21: Selected Site 2: A dam located near Cambell St. at the entrance to the Fairgrounds also creates an ideal location for a in-stream park with access, parking, room for park development, and sufficient drop and character in the river to create a waves and an accompanying kids play area.

5. Proposed Improvements

5.1 Project Objectives

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

- 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.
- Add a unique, valuable public amenity to an area of Rapid City that has historically been under-invested in.
- Improve access to creek.
- Increase visibility of Rapid City 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.
- Improve aquatic habitat.
- Stabilize the creek against future erosive events.
- Remove low-head dam at Site 1 to:
 - improve fish passage and connectivity.
 - allow boater and tuber navigation through this reach of river, which currently requires portage.
 - eliminate risk to human life posed by dam hydraulic.

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

- Kids coming to play in the stream
- Beginner kayakers
- Intermediate and advanced kayakers (at higher flows)
- Stand-Up paddlers, body boarders, and surfers
- Tubers
- Fishing Enthusiasts
- Spectators visiting the park to watch paddlers or simply spend time beside the river.
- Swiftwater rescue training squads

5.2 Site 1 Conceptual Design



The conceptual design for Site 1 includes the following elements:

Wave Structures



Figure 22: A Wave Structure is constructed of natural rock and grouted into place. The feature pictured is low flow through the structure at the Calibre-designed Eagle Whitewater Park

Five wave structures are proposed for Site 1, starting at the existing dam. The first structure may completely replace the dam or may utilize the existing crest, depending on the conditions of the dam evaluated in later design phases. The first four features are about 150ft apart from each other, and the fifth and final structure is about 250 ft downstream of the fourth, located around the creek bend. Topographic survey from 2023 accessed via Rapid City's GIS (RapidMaps) indicates a 5ft drop in water surface elevation (WSE) at the existing dam (feature 1), a 3 ft drop in WSE at the existing riffle (features 2-4), and an additional 2 feet of drop downstream at feature 5. As the design is developed, this 10 ft change in hydraulic height will be strategically redistributed throughout the reach to create a geomorphically stable channel with maximum recreational and habitat benefit.

The design of each individual wave feature will be based on site conditions, but all will have the same general configuration. The 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.

An in-stream recreational park on Rapid Creek will have low flow conditions for most of the days in the year.



Figure 23: A kayaker surfing in a designed wave in Eagle, CO at high flows.

Dam Removal and Fish Passage Connectivity

The creation of an in-stream recreational park at Site 1 would offer the dual benefit of creating a recreational amenity while addressing an existing safety hazard. It was reported to the design team that the dam is currently owned by the City of Rapid City and has outlived its useful life as an irrigation diversion dam.

By either removing the dam and replacing it with a wave structure or by modifying the dam structure to be a wave structure, both human and aquatic life will benefit. Recreational users floating or paddling the river will no longer have to portage this section, and the risk of users being caught in a potentially deadly hydraulic created by the dam will be eliminated.



Figure 24: Existing Dam

Fish passage will be restored so that upstream migration can occur, and the wave features will reestablish a pool-drop pattern to the river, improving aquatic habitat conditions. Low flow channels will be established to create habitat and passage opportunities at low flow conditions. Clusters of boulders and planned interstitial spaces will provide hiding, habitat, and resting opportunities for fish during high flow conditions.

Creek Access Improvements

The conceptual designs for both sites feature 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 wave structure, offering convenient access to the river at different water levels. These boulders also serve as bank stabilization, which is an essential component of the sustainable management of Rapid Creek.



Figure 25: Terraced banks provide flood armoring, streamside seating, and river access. Photo of Calibre-designed Durango Whitewater Park.

In the conceptual design for Site 1, terraced boulders are proposed on both sides of the creek from just above wave feature 1 to just below wave feature 4. This will allow easy spectating from either side of the creek, and convenient access in and out of the water. Feature 5 will also have access tied into the structure. Between features 4 and 5, a boulder toe for bank stabilization is proposed.



Figure 26: Steps made of slabs of stone offer convenient access and a natural appearance along the bank (Canon City Whitewater Park)

The conceptual design for Site 1 includes multiple river access points, extending above and below the wave features. In addition to access provided by boulder terracing, steps, ramps, and constructed boat launches can all be utilized to provide river access. During design development, each access point for Rapid Creek will be studied and designed based on site conditions. Ramps may be utilized in some locations to allow swiftwater rescue squads to access the river with boat trailers or facilitate ADA compliant access. The transition to the river will be considered based on the grade of each location, and existing or constructed velocity barriers will be used at all put-in locations to allow kayakers and tubers to enter the creek before entering the primary flow.

The wave structures tie into the boulder terracing and will allow non-boating river users, including fishing enthusiasts and spectators, to walk out onto the feature in moderate and low flow conditions for convenient access to Rapid Creek.

[Riverside Patio](#)

The conceptual design for Site 1 features an additional community gathering space. On the northern side of the creek (river left) at the location of the existing dam, park improvements including a gathering space are proposed. This feature will help to narrow the river at wave feature 1 from its previously over-widened condition due to the dam.

This could function as a riverside patio, an outdoor classroom, or a small event area. This will provide a larger, accessible space for the community to congregate by the river to watch kayakers, tubers, and other users in the wave feature or spend time by the river. The location of this space near the fairgrounds arena will help draw the public to the river and enjoy Rapid City's most beautiful natural asset.



Figure 27: Riverside Patio at the Calibre-designed Canon City Whitewater Park

Trails and Connectivity

Typically, in-stream recreational park users will navigate the features from top to bottom, then get out and walk up the river-adjacent trail to put back in at the top. Riverside trails are generally shaded from one or both sides, and offer a tranquil setting for walking, as well as access to the river.



Figure 28: Riverside Trail is used by in-stream users and pedestrians at Calibre-designed Poudre Whitewater Park.

The conceptual design for Site 1 has a riverside trail on the north (river left) side that connects with the existing greenway on both ends. This trail has multiple access points along the river, and connects to the riverside patio, the terraced banks between features 2 and 3, and provides access above and below feature 5. On the southern (river right) side of the creek, a trail extends from just above the first feature

to below the final feature, and continues east to provide an additional river access location near Cherry Ave.

Two parking lots are included in the conceptual design for Site 1. A 100-space parking lot is proposed in the field on river right, which would be accessed via Cherry Ave. A 40-space parking lot is proposed to replace existing buildings on river left near the upper end of the in-stream recreational park, which would be accessed via San Francisco St. Providing vehicle access near the river is important for users that are hauling and unloading boats, boards, and tubes.

5.3 Site 2 Conceptual Design



The conceptual design for Site 2 includes the following elements:

Wave Structures



Figure 29: Low flow conditions in Calibre-designed Meadow Park in Lyons, CO.

Four wave structures are proposed in the conceptual design for Site 2. At the upstream end of the park, the channel splits into two sections, with an island in between. The river left channel is currently dammed and feeds the inlet for the Hawthorne Ditch. It was reported to the design team that this ditch is currently used for irrigation by a sod farm, but alternative options may be utilized in the future. The proposed improvements for Site 2 will be designed to continue to efficiently supply water to the ditch at the same elevation and rating curve currently used. If the owner desires to no longer use that diversion in the future, the structure at the top of the channel can be modified, and the additional flow could continue downstream through the wave features.

The first 3 wave features are proposed at the top, middle, and bottom of the river right channel before the creek reconverges. A grade control structure will be utilized just downstream of the channel reconvergence to control the tailwater elevations within both channels. The fourth and final wave structure is proposed about 250 ft downstream of the channel reconvergence. Available topo indicates a 4-5 ft drop in WSE over the location of the four wave features.



Figure 30: Two wave features at Calibre-designed Poudre River Whitewater Park in Fort Collins, CO

Similarly to Site 1, Site 2 will experience primarily low flow days throughout the year, which are best suited to tubers, waders, fishing enthusiasts, and beginning boaters. The boulder deflectors proposed coming off the banks will create lateral scour pools and maintain a sinuous thread within the channel, which can help to make the creek more navigable at low flows.

Habitat Improvements

The proposed improvements at Rapid Creek will be designed to help to stabilize the stream and improve fish habitat.

Rapid Creek, like many urban streams, suffers from accelerated erosion and altered morphology due to the increased peak run-off associated with increased development. The proposed wave structures are channel-spanning grade control structures that can be designed to reduce bank erosion, maintain channel capacity, and maintain channel stability. In addition to the recreational enhancement provided by the increase in power in the center of the channel, the structures also reduce power and shear stress at the banks, which can improve water quality by reducing sediment loading in the channel caused by bank erosion.

Wave structures create a downstream scour pool, which provides habitat in the pool that is protected during high and low flows and provides favorable physical and velocity variability for aquatic life. The selection of bed material and boulder placement will be designed to provide beneficial habitat for aquatic life. Interstitial spaces are included in the channel design to provide habitat for benthic and other small fish species. Larger boulder clusters are typically utilized in the channel design to provide resting opportunities to help facilitate upstream fish passage during high flows. During the design development phase, Calibre engineers will work with regulators and local fish specialists to establish the aquatic species present in Rapid Creek, then use their unique habitat and passage needs to inform structure and channel design.

The wave structures also create “feeding lanes” for fish in the downstream scour pools at the boundary between the high and low energy flows. In-stream recreation parks are often heavily utilized for fishing due to their easy access into the stream, trail connectivity, and abundance of fish congregated at the feeding lanes.

In addition to the aquatic habitat enhancements provided by the proposed in-stream work, it is recommended that a wider riparian buffer is reestablished at the conclusion of in-stream construction. This buffer would be established between the creek and the mowed areas of the adjacent park and consist of selected native riparian vegetation. The defined access points, as proposed in the conceptual design, will encourage foot traffic to stay in defined access areas, and prevent trampling streamside vegetation. The establishment of riparian vegetation will both stabilize the banks to prevent further erosion and provide critical riparian habitat.

Kids Play Stream

Site 2 offers a unique opportunity to use the existing channel to create a play area within the creek for kids. The smaller channel on river left is well suited for these improvements, with easily accessible banks adjacent to the proposed riverside path.



Figure 31: Existing conditions at split channel (facing downstream). The smaller channel on river left is proposed for a kids play feature, while the right channel, which conveys most of the flow, is proposed to have wave features.



Figure 32: The Calibre-designed whitewater Park in Lyons, CO illustrates a dual channel design (facing upstream). The channel carrying the primary flow has a wave feature (with slalom gates hung), and the secondary flow channel is a constructed boulder riffle that changes grade gradually. This secondary channel was designed to offer fish passage and improved habitat but demonstrates a similar configuration to the dual channel for a play stream.

The play stream is proposed to include boulders placed throughout the channel, beach areas, and easy access in and out of the channel. This shallow area will offer a safer place for kids to explore and connect with nature. Sparking a natural tendency to build dams and experiment with hydraulics, this feature will

also offer a good location for interpretive signage about hydrology, hydraulics, and the history of Rapid Creek.



Figure 33: Calibre-designed play stream at Meadows Park in Lyons, CO. This channel runs through the park, while the proposed play stream in Rapid City would maintain a more natural look within the creek channel.

It is important to note that a designed shallow stream of this nature does not have sediment transport control, so it will likely need to be periodically maintained after flood events (clearing sediment, replacing boulders, etc).

[Creek Access Improvements](#)

Similarly to Site 1, the conceptual design for Site 2 includes terraced banks to provide river access, flood armoring, and streamside seating.



Terraced boulders are proposed on both sides of the right channel, adjacent to features 1-3. They are also proposed on the northern (river left) bank, to offer convenient river access and gathering space from the parking lot. Below feature 4, a line of terraced boulders along the southern (river right) bank allow boaters to easily get out of the river and use the trail to return to the top of the in-stream recreational park for additional runs.



Figure 34: Terraced boulders allow direct access to the river.

Trails and Connectivity

Similarly to Site 1, the trails for Site 2 are designed so that park users can navigate the features from top to bottom, then get out and walk up the river-adjacent trail to put back in at the top. On the south (river right) side of the creek, trails extend from the existing greenway at key locations, including above feature 1, below feature 3, and adjacent to the bank access below feature 4. On the north (river left) side of the creek, multiple new trails are proposed that will connect the top and bottom of the wave section, extend to the proposed parking lot at the top and bottom, and connect to San Francisco St.

There is a 100-space parking lot proposed on the north side of the creek, to be accessed via San Francisco St. Trails from the parking lot connect directly to the north side trail, to the Play Stream, and to the beach area proposed at the downstream end of the wave features.



Figure 35: A riverside path at the Calibre-designed Poudre River Whitewater Park

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 products was provided by Pete Lien and Sons.

The preliminary estimates magnitude of cost are \$3.1M for Site 1 and is \$2.7M for Site 2.

Rapid City Whitewater Park - Rapid City, SD**Site 1: Conceptual Design****Opinion of Probable Cost - June 2024**

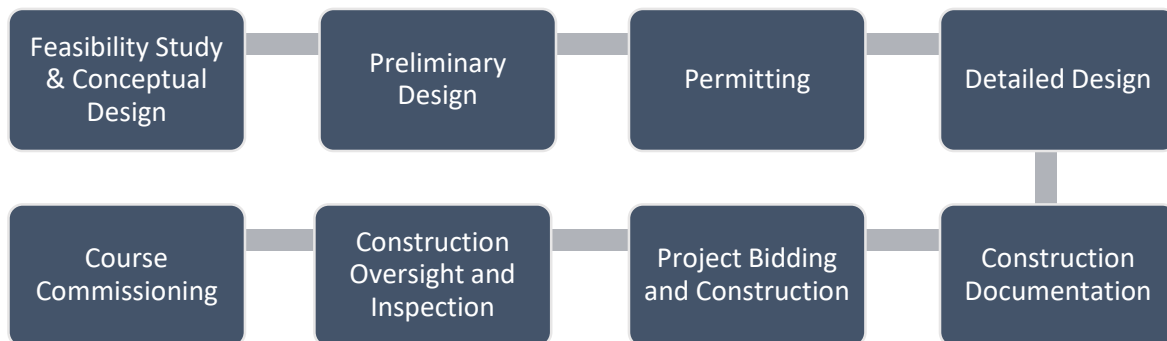
Description	Quantity	Unit	Unit Cost	Cost
Construction Costs				
Site Set up, BMPs, Water Control				\$ 184,600
Construction Mobilization	1.0	LS	\$ 50,000.00	\$ 50,000
Install Equipment Access Ramps & Roads	500.0	SY	\$ 19.20	\$ 9,600
Furnish & Install Water Control	1.0	LS	\$ 50,000.00	\$ 50,000
Operate & 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
Construction Demobilization	1.0	LS	\$ 30,000.00	\$ 30,000
Trails				\$ 130,753
Concrete Path (6' wide)	19116.0	SF	\$ 6.84	\$ 130,753
Bank Terracing and Access				\$ 901,416
Riverside Patio (2000 sf)	1.0	LS	\$ 30,000.00	\$ 30,000
Subgrade Prep and Compaction	1168.3	SY	\$ 5.00	\$ 5,842
3' Boulders (Furnish + Deliver) for Bank Terracing, Groynes, Steps	1752.5	CY	\$ 220.00	\$ 385,550
18" Riprap (Furnish + Deliver) for Bank Toe	379.5	CY	\$ 123.85	\$ 47,003
3-4" Cobble (Furnish + Deliver) for Bedding	389.4	CY	\$ 65.00	\$ 25,314
Install Boulders	1752.5	CY	\$ 100.00	\$ 175,250
Install Cobble and Riprap	769.0	CY	\$ 40.00	\$ 30,759
Furnish & Install Mirafi 180N Filter Fabric	1433.0	SY	\$ 3.17	\$ 4,543
Furnish & Install Concrete Grout (15% voids)	262.9	CY	\$ 750.00	\$ 197,156
Whitewater Structures				\$ 829,242
Existing Dam Modification (Concrete Removal)	1.0	LS	\$ 25,000.00	\$ 25,000
Excavate and Grade Native Materials (Assumes no bedrock excavated)	750.0	CY	\$ 22.00	\$ 16,500
3' Boulders (Furnish + Deliver) for Whitewater Structure	1500.0	CY	\$ 220.00	\$ 330,000
8' Boulders (Furnish + Install) Feature Boulders	15.0	EA	\$ 1,900.00	\$ 28,500
18" Riprap (Furnish + Deliver) for Scour Pools & Trench Backfill	368.3	CY	\$ 123.85	\$ 45,618
3-4" Cobble (Furnish + Deliver) for bedding, pools, and topping grout	460.4	CY	\$ 65.00	\$ 29,927
Install Boulders	1500.0	CY	\$ 100.00	\$ 150,000
Install Cobble and Riprap	828.8	CY	\$ 40.00	\$ 33,150
Furnish & Install Mirafi 180N Filter Fabric	566.7	SY	\$ 3.17	\$ 1,796
Furnish & Install Concrete Grout (15% voids)	225.0	CY	\$ 750.00	\$ 168,750
Parking Lots				\$ 114,500
100 Space Gravel Parking Lot (Eastern Lot)	30000.00	SF	\$ 1.50	\$ 45,000
40 Space Gravel Parking Lot (Western Lot)	13000.00	SF	\$ 1.50	\$ 19,500
Paved Entry Road to Eastern Parking Lot from Cherry Ave	12500.00	SF	\$ 4.00	\$ 50,000
Subtotal Construction Costs				\$ 2,160,511
15% Contingency				\$ 324,077
Construction Costs				\$ 2,484,588
Soft Costs				
Land Surveying	1	LS	\$ 25,000.00	\$ 25,000
Hydraulic Modeling (Assumes Physical Model not required)	1	LS	\$ 75,000.00	\$ 75,000
Engineering Design	1	LS	\$ 200,000.00	\$ 200,000
Permitting (Assumes no rise is met, CLOMR/LOMR not required)	3%			\$ 64,815
Construction Bonding/Insurance	3%			\$ 64,815
Construction Monitoring	4%			\$ 86,420
Subtotal Soft Costs				\$ 516,051
15% Contingency				\$ 593,459
Soft Costs				\$ 593,459
Total				\$ 3,078,047

Rapid City Whitewater Park - Rapid City, SD**Site 2: Conceptual Design****Opinion of Probable Cost - June 2024**

Description	Quantity	Unit	Unit Cost	Cost
Construction Costs				
Site Set up, BMPs, Water Control				\$ 357,000
Construction Mobilization	1.0	LS	\$ 50,000.00	\$ 50,000
Install Equipment Access Ramps & Roads	10000.0	SY	\$ 19.20	\$ 192,000
Furnish & Install Water Control	1.0	LS	\$ 40,000.00	\$ 40,000
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
Construction Demobilization	1.0	LS	\$ 30,000.00	\$ 30,000
Trails				\$ 89,878
Concrete Path (6' wide)	13140.0	SF	\$ 6.84	\$ 89,878
Bank Terracing and Access				\$ 729,745
Subgrade Prep and Compaction	960.6	SY	\$ 5.00	\$ 4,803
3' Boulders (Furnish + Deliver) for Bank Terracing, Groynes, Steps	1440.8	CY	\$ 220.00	\$ 316,983
18" Riprap (Furnish + Deliver) for Bank Toe	412.0	CY	\$ 123.85	\$ 51,031
3-4" Cobble (Furnish + Deliver) for Bedding	320.2	CY	\$ 65.00	\$ 20,812
Install Boulders	1440.8	CY	\$ 100.00	\$ 144,083
Install Cobble and Riprap	732.2	CY	\$ 40.00	\$ 29,289
Furnish & Install Mirafi 180N Filter Fabric	205.0	SY	\$ 3.17	\$ 650
Furnish & Install Concrete Grout (15% voids)	216.1	CY	\$ 750.00	\$ 162,094
Whitewater Structures and Play Stream				\$ 601,856
Excavate and Grade Native Materials (Assumes no bedrock excavated)	600.0	CY	\$ 22.00	\$ 13,200
3' Boulders (Furnish + Deliver) for whitewater structures and play stream	1200.0	CY	\$ 220.00	\$ 264,000
8' Boulders (Furnish + Install) Feature Boulders	10.0	EA	\$ 1,900.00	\$ 19,000
18" Riprap (Furnish + Deliver) for Scour Pools & Trench Backfill	180.6	CY	\$ 123.85	\$ 22,362
3-4" Cobble (Furnish + Deliver) for bedding, pools, and topping grout	194.3	CY	\$ 65.00	\$ 12,628
Install Boulders	1200.0	CY	\$ 100.00	\$ 120,000
Install Cobble and Riprap	374.8	CY	\$ 40.00	\$ 14,994
Furnish & Install Mirafi 180N Filter Fabric	212.2	SY	\$ 3.17	\$ 673
Furnish & Install Concrete Grout (15% voids)	180.0	CY	\$ 750.00	\$ 135,000
Parking Lots				\$ 95,000
100 Space Gravel Parking Lot (Eastern Lot)	30000.00	SF	\$ 1.50	\$ 45,000
Paved Entry Road to Eastern Parking Lot from San Francisco St	12500.00	SF	\$ 4.00	\$ 50,000
Subtotal Construction Costs				\$ 1,873,479
15% Contingency				\$ 281,022
Construction Costs				\$ 2,154,501
Soft Costs				
Land Surveying	1	LS	\$ 25,000.00	\$ 25,000
Hydraulic Modeling (Assumes Physical Model not required)	1	LS	\$ 75,000.00	\$ 75,000
Engineering Design	1	LS	\$ 200,000.00	\$ 200,000
Permitting (Assumes no rise is met, CLOMR/LOMR not required)	3%			\$ 56,204
Construction Bonding/Insurance	3%			\$ 56,204
Construction Monitoring	4%			\$ 74,939
Subtotal Soft Costs				\$ 487,348
15% Contingency				\$ 560,450
Soft Costs				\$ 560,450
Total				\$ 2,714,951

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 in-stream 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 Rapid Creek Recreational Corridor Improvement 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. Calibre 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 Rapid Creek In-Stream Park may include:

- Rapid Creek Recreational Corridor Inc
- City of Rapid City
- Pennington County
- Pennington County Conservation District
- South Dakota Department of Game, Fish, and Parks
- US Army Corp. of Engineers – Omaha District
- West Dakota Water Development District
- Local paddling community
- Black Hills Flyfishers

- 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. The Rapid Creek In-Stream Park may require federal, state, and local permits. Calibre expects the project may require:
- US Army Corps of Engineers – Federal Clean Water Act 404/401 permit and certification. The USACE may engage the South Dakota Department of Agriculture & Natural Resources for water quality certification. This may also require 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.
- 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 in-stream 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.

Calibre will work with the Rapid Creek In-Stream Park 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, Calibre 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.

Timeline

The design and permitting for an in-stream recreation park typically takes 1-2 years to complete. The longest critical path within that timeline typically is the USACE 404 permit, which can take up to a year to obtain. The total project duration, including planning, design development, permitting, and construction, is expected to take 3-5 years.

6. Summary and Recommendations

Rapid Creek is already a destination for outdoor recreation and enthusiasts- a reputation which will be complimented and highlighted with the addition of an in-stream recreational park. The selected area within Rapid City is well suited for a park due to the existing greenways, public land, and site accessibility.

This study presents two alternatives for in-stream recreation. Site 1 is steeper and has more power for the wave features, but streamside space is confined by both the railroad and the arena. Site 1 offers the dual benefit of dam removal as part of the project, which will eliminate a major life-safety hazard and reconnect fish passage in the area. Site 2 also has significant drop and allows for streamside park development and a unique kid’s wading and play area.

The selection of either concept design will add an exciting in-stream recreational opportunity, improve fish passage and habitat, and provide access opportunities to connect a wide variety of user groups within the Rapid City community to Rapid Creek.

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