

Recreation Engineering and Planning
Conceptual Master Plan
Whitewater Course

**CONCEPTUAL PLANNING REPORT
CONCEPTUAL MASTER PLAN
WHITEWATER COURSE
BARREN RIVER
BOWLING GREEN, KENTUCKY**



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Abstract



This report evaluates opportunities for a whitewater park in Bowling Green, Kentucky on the Barren River. The report includes a) a brief site profile that includes a synopsis of the current site status, flows and hydraulic issues in the Barren River as well as planning and safety issues. The report also includes b) a brief overview of uses and users of the whitewater park and the constraints associated with these users as they apply to the plan of a whitewater park. Finally, this report includes c) a conceptual plan and cost estimate that represents a feasible solution for the Bowling Green Whitewater Park as defined by the constraints identified in a and b above.

Introduction

Whitewater sports are among the fastest growing recreational activities in North America. The recent trend among some cities to create whitewater parks has brought this sport from its traditional remote location to a more urban environment. Numerous whitewater parks have been constructed in North America and these parks, surrounded by trails, picnicking and recreational areas, have surpassed their original objective of attracting paddle sports enthusiasts and have become focal points for their communities. These parks attract visitors and locals alike and often play host to major events centered around slalom or freestyle kayaking competitions. Some towns, like the City of Golden, Colorado, have reported millions of dollars worth in impact on the local economy due to tourist activity attracted by their whitewater park.

The purpose of this project is to develop a Conceptual Master Plan for a whitewater park along the waterfront development of the Barren River in Bowling Green, Kentucky.

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This whitewater park would take advantage of the head and flows available at the Bowling Green Municipal Utilities (BGMU) Dam at the waterworks facility. The Conceptual Master Plan would integrate the Barren River with the city's waterfront by making a strong connection between people, the city neighborhoods and the downtown waterfront. The Barren River whitewater park would be an integral part of the fabric of the community and would become a citywide resource and attraction that is linked to the daily work, recreation and leisure life of both the inhabitants and visitors to Bowling Green. The primary vision is that the river would become an important asset and shared recreational, economic and environmental resource to the fullest extent possible.

The planning process is then tasked with three primary objectives during this conceptual phase. The first objective is to gather sufficient information to understand site constraints associated with a whitewater park at this location. These constraints include access, hydrology, layout, and other physical constraints associated with the site. Also included in this task will be any constraints associated with other current uses of the river. The second phase involves identifying community constraints associated with this project. These include a complete understanding of the potential users and uses of the proposed whitewater park. Finally, the third objective of this document is to propose a conceptual planning solution that best provides for the constraints identified in this report.

Site Profile: Bowling Green Municipal Utilities Waterworks Dam Site



Bowling Green is located in South Central Warren County, Kentucky. The area of study is located along the Barren River at River Mile 37.6 from its confluence with the Green River. The importance of this corridor as a recreational and natural resource has been enhanced with the establishment of the River Walk at Mitch McConnell Park, which parallels a majority of the corridor length.

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The river channel at this location features high banks with selected access points and, at some levels, trail access along the river by way of a trail on river right. The river channel features earthen and loose sandstone banks that are, for a large part of the reach, armored with small riprap at lower levels and are largely eroded above the low water line. The upper banks of the river feature regions that are steep embankments as well as other regions that are thickly forested. The streambed is sandy with some rocks and downed trees as well as numerous remnants of past in-stream development.



The most prevalent of these remnants is the Waterworks Weir Structure at the head of the reach. This Structure is constructed of loose rock with an apparent (by inspection) d_{50} of roughly 1-1.5 ft. The dam features a static drop of approximately 10 feet. Upstream of this Structure is the City's municipal intake which, presumably, suffers from the decreased head caused by the erosion of the current dam structure. The reach also features three bridges of significance. Two hundred fifty feet downstream of the dam is the KY 3225 Old Louisville Road Bridge. This bridge rests on three pylons that are in the river channel. Eight hundred feet downstream of the dam, the second bridge is the Historic College Street Bridge that has now been converted into a pedestrian crossing. The bridge sits on a single mid-stream pylon and provides direct trail access to Mitch McConnell Park. Fifteen hundred feet downstream of the waterworks dam is the US 68 Louisville Road/ N/X Corridor Bridge, which sits on

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two pylons. The last bridge is 1,650 feet downstream of the dam. This is a single track CSX Railroad bridge.

Access to the site is prevalent, but is made difficult by the elevation difference between the river and the City, which sits high on the Barren River's steep banks. At present, there is a greenway and the aforementioned park directly adjacent to the selected reach of the river. Additionally, current master plans call for dramatic enhancement of the river's banks on the river right side. This enhancement would create open access directly to the water's edge. One of the key elements of the proposed whitewater course would need to be integration of the proposed whitewater park with the current master plan for this property.

There are several physical constraints associated with this reach of the river. The existing dam provides head for the City's water works. This head elevation would need to be maintained at all flows in order to ensure ample flow depth for this facility. Additionally, there are, as mentioned above, several bridge pylons within this reach. Planning of the water park would need to include scour analysis of the final plan in order to ensure the continued stability of these pylons. Additionally, the shape of the pylons and the direction of the flow would need to be tailored such that the pylons do not create an in-stream hazard to the boaters who visit the park.

Flow Characteristics

Peak flows for the Barren River in Bowling Green, Kentucky are shown in Figure 1. Analysis of available peak streamflows, shown in Figure 1, suggests that peak flows in the Barren River are extremely high. While an upstream dam acts to somewhat dampen flooding, the estimated 100 year flood level for this reach is 62,300 cfs¹. This is an extremely high flood flow. Planning and modeling would need to account for both flood elevations and flood power.

¹ Source: Jamie Blanton, USACE, Louisville District. Study dated 1994 based on flows from 1940-1994. Estimated flood discharge adjusted to include effects of dam.

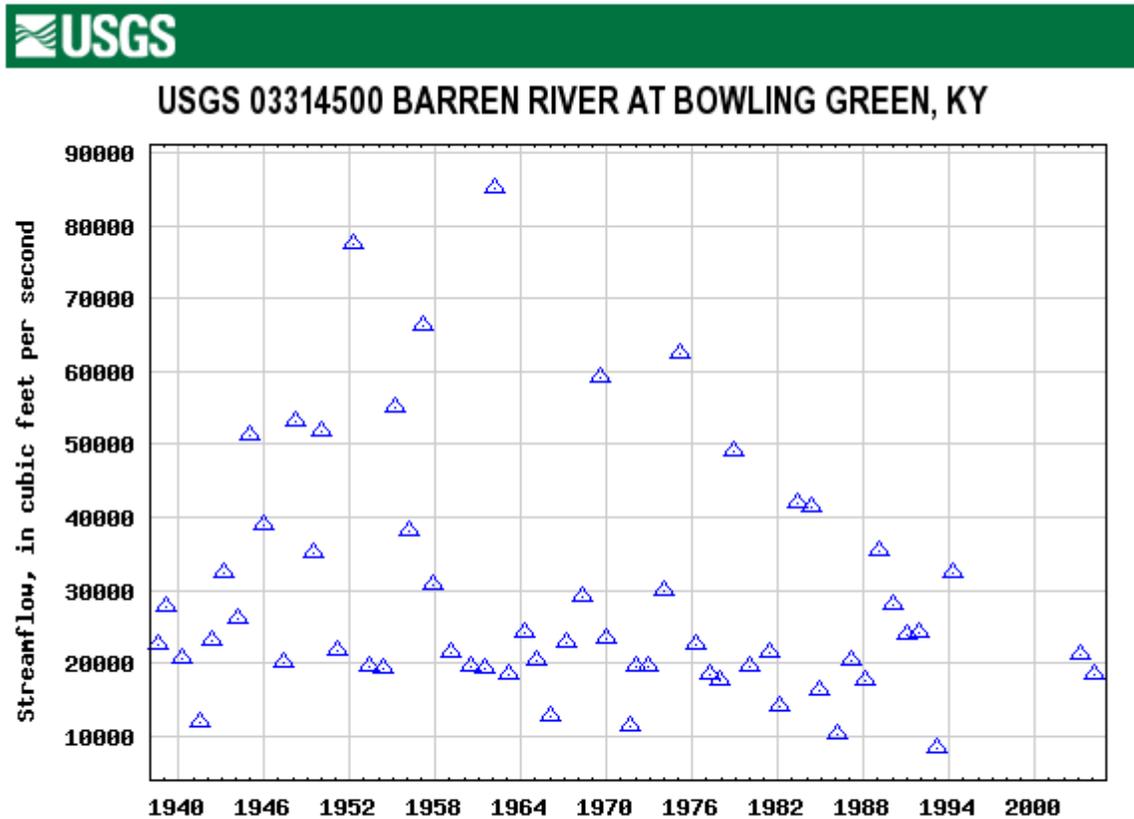


Figure 1. Peak stream flows for the Barren River in Bowling Green (Source, usgs.gov)

Average flows, however, are much more manageable. Peak average flows occur in the winter months and can reach, on average, levels in the 5-6000 cfs range. Low average flows occur in the summer and can be as low as 800-1000 cfs on average. Figure 2 shows the average mean of monthly streamflows for the Barren River in Bowling Green, Kentucky (source: USGS gauge 03314500).

Average Mean of Monthly Streamflows

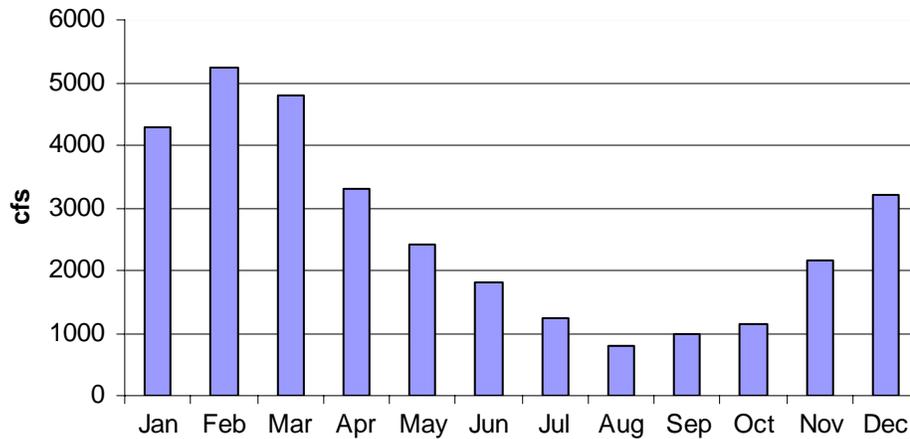


Figure 2. Average Mean of Monthly Stream flows for Barren River in Bowling Green.

Figure 2 illustrates the average mean of monthly streamflows. It should be noted that these flows are substantial and, in combination with the gradient seen at the sites listed above, can be used to create a very attractive whitewater park. Minimum flows commensurate with the summer levels should be used to tailor the width and depth of low flow channels. The summer season can be expected to be the height of the tourist season so special consideration should be given to tailoring attractive whitewater features to these levels.

Ideal levels are difficult to target given the large month to month variability of flow levels. Plans should be created that are extremely versatile with respect to flow rates, thus taking advantage of the low summer flows while still providing play attractive play features during the winter months.

Project Planning

Project planning for this type of whitewater park is a key element of the planning process. It is necessary to have a complete understanding of the project, its users, and the city's intended objectives before planning begins.



The park is intended to be an open access facility that is integrated with the River Walk and Mitch McConnell Park expansion. The whitewater improvements are tasked with providing a downtown in-stream recreational amenity that is an attraction to local users as well as visitors and destination paddlers. The plan is further tasked with creating a facility that can host competitive and recreational events at a national level while still providing unintimidating recreation for all levels of boaters. The park should also serve as an aesthetic attraction and should provide streamside recreation, seating, and shade for non-boating visitors. A user analysis has been prepared in order to gain insight into the constraints associated with each of these types of users. A summary of these typical users is listed below:²

² This summary of users represents assumptions made with regard to a spectrum of typical users for whitewater parks throughout the world and was not created from a public process survey. Such a survey is not in the purview of this study.

Whitewater Park User Groups

From a planning standpoint, the “User Groups” include all of the entities that are involved in successfully implementing the operational model for the park. The following groups have been identified as likely users of the whitewater course:

- The City of Bowling Green;
- Local whitewater clubs;
- Rafters;
- Recreational boaters;
- Top-level boaters; and
- Spectators.

Amplifying information on these groups is presented below.

The City of Bowling Green, Kentucky

The City represents the initial owner and operators of the Barren River whitewater park. The City is seeking both a recreational amenity as well as a tourist attraction that would help drive the local economy. On the flip side, the City is seeking a facility that is both easy and cheap to maintain and does not create an increased flood risk. The City is very interested in seeing the plan of the park mesh seamlessly with the River Walk expansion in order to maximize their investment. Additionally, the City does not want to see any effect on their municipal operations.

Associated Planning Criteria:

- The whitewater park should serve as an amenity for both local and visiting users.
- Maintenance costs should be minimized.
- The whitewater improvements must not affect the City’s municipal operations.
- The site should be appropriate for competitive events that showcase the water park to the community on a local basis and the community to the Nation in the media and press.

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Local Whitewater Clubs

The local whitewater clubs and specialty shops (which include West Kentucky University's Physical Education and Recreation Department and Outdoor Recreation Adventure Center) also have an interest in the whitewater park. Perhaps the central and primary purpose of the park would be to provide an easy access centrally located park and play destination that can be accessed quickly from the town and provide top quality recreation with very little time commitment. These users are looking for a local recreational amenity as well as a venue to host competitive events. Furthermore, the park should help grow the sport in the local region by providing instructional facilities for beginners, clubs and classes as well as training facilities for developing athletes who wish to practice and compete at the site. Perhaps the central and primary purpose of the park would be to provide an easy access centrally located park and play destination that can be accessed quickly from the town and provide top quality recreation with very little time commitment.

Associated Planning Criteria:

- The course must provide world-class whitewater in an attractive setting.
- The course must provide a quality experience to as many users as possible.
- The course must accommodate informed as well as uninformed users through planning, operations, signage, and control.
- The course must have the ability to host large events.
- The course should promote whitewater boating in Bowling Green

Rafter

The moniker “rafter” is intended to describe all inexperienced inflatable traffic on the whitewater course. These users are composed of a large cross-section of the general community and can be characterized as such. This group is largely inexperienced in whitewater, knows little about the use of watercraft, is generally not knowledgeable in how to swim or self-rescue in whitewater, and needs instruction in every facet of equipping themselves and navigating a turbulent river. These users can also be considered to be not physically fit with respect to whitewater boating and as such not overly mobile on the water, not adept at ingress and egress, and needful of periodic rest points.

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Associated Planning Criteria:

- The user must be provided with an open access type of park that is appropriate for general use.
- Must be able to easily enter and exit the river at any point in case of panic or emergency
- Must be able to take-out at the appropriate stopping point regardless of ability.
- May require signage about appropriate usage and may require direct communication with regard to appropriate flows.
- Must be required to wear appropriate safety gear.

Recreational Boater

There would be a significant flow of knowledgeable boaters to the course. These people are generally experienced enough to manage for themselves once they reach the river but would still require rescue and safety at times. These users would typically transport a large amount of equipment to and from the course on a daily basis in the form of kayaks and gear. Users would stay at the course for extended periods of time and would use all available rapids. These users would dabble in slalom, freestyle and general recreational paddling and tend to arrive and paddle in groups. Users either are familiar, or quickly become familiar, with the tradition of providing right-of-way to less experienced and oncoming traffic. These users crave a variety of whitewater but also crave places to pull off the river and enjoy the experience, rest, and recuperate. Active and crowded eddies can cause significant agitation for this user group.

Associated Planning Criteria:

- Must have a variety of whitewater activities.
- Should have non-intimidating options for those users who are not interested in an extreme experience.
- Desires an uncrowded river environment.
- Requires functional access for getting equipment to and from the course.

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- Requires numerous eddies, pools and velocity breaks in order to rest, avoid impacts with other boaters, and get in and out of the boat.
- Requires access and ingress from any point on the river for safety and rescue reasons.



Top-Level Boater

This user group would quickly acquire expert knowledge of the course and its features. These users would typically not need rescue on the water nor guidance off the water. However, these users have high expectations for the whitewater that they paddle in. In order to host large competitive events these users need to have challenging and spectacular class 3-4 whitewater that is both unique, changeable, and provides a variety of options for differing experiences (changes in slalom features, a variety of play waves, and a variety of challenging maneuvers on the course).

Associated Planning Criteria:

- Must have quality whitewater that is appropriate for surfing, challenging boating and competitive events.
- Would like to have changeability of whitewater obstacles.
- Must have great play spots.
- Must have variety of paddling experiences to choose from.
- Must have a facility that contributes to the objectives of these users whether it is training for competition, recreational usage, or preparation for more difficult river running outside of the park.

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Spectators

Spectators—particularly at a site like the Barren River whitewater park, which is located next to a major city—would typically be the largest user group at a particular site. This user group would arrive on-site with little to no plans to take part in specific activities. This user constitutes a large cross-section of the general community and would have little or no understanding of the basics of turbulent whitewater. This user desires varying views of the course that are shaded from the hot sun and accommodate warm seating on cold days.

Users would typically mix eating with the day's outing and are expected to stroll and inspect the entire facilities in a day's excursion. These users would arrive and depart en-masse on event days.

Associated Planning Criteria:

- The site must have comfortable shaded seating.
- The site must provide alternative activities.
- The site must have adequate parking, strolling and seating amenities.
- These users desire complete trail access to the entire site.

In summary, the expected users associated with the park are varied and have varying priorities, needs, and wishes. The plan of the park must be tailored to best fit these desires as well as the physical constraints of the site.

Economic Impact



The City already possesses the infrastructure in the form of hotels, restaurants, and entertainment necessary to capitalize on the expected increase in whitewater visitors. Similar Cities, such as Vail, Breckenridge, and Vail have noted significant increases in local

economies due to these visitors. Economic impact studies show that whitewater parks in these towns have brought between one and two million dollars a year into the local economy. Bowling Green, which is located in a region that is relatively devoid of whitewater boating, stands to be a tremendous attraction to boaters who would otherwise have to travel great distances for reliable boating and large competitions.

Alternatives Considered

Alternative A

Based on the constraints identified above it can be concluded that the park should seamlessly mesh with the River Walk improvements while providing an easy access recreational amenity to all levels of users from those who wish to simply watch from the shore to those who are seeking top level whitewater competition. The whitewater plan should provide top level boating for expert users while maintaining navigability for all levels of users and providing recreational and instruction paddling opportunities throughout its length. Improvements should be low maintenance and should not affect the City's utility operations or create a flood risk. Furthermore, the facility should function to tie the downtown together with the river as well as create a recreational tourist attraction.

The proposed plan features four drop structures that would distribute the head of the existing Waterworks Dam. Each of the drop structures would drop between 1.5 and 2 feet and would create a surfable hydraulic at its base. These structures would operate at a variety of flows, allowing for freestyle kayaking throughout the year—even during the lower flow summer months. The drops structures would also control the depth and character of flow and to divert the faster flows away from the bridge abutments that line the river throughout this reach.

Additionally, four offset single rock deflectors have been added at the bottom of the reach. These deflectors would create eddy features, to deflect the flow, and, at higher flows, to create series of waves. This area is ideal for beginner instruction and for recreational kayaking.

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Alternative B

The second alternative is similar to the first but features six separate drop structures. Drop number four is, again, a split structure. The advantage of this plan is that it features our signature drop structure. This structure is our most popular and has been favored at other sites. This park has many advantages including:

- Pool and drop whitewater that provides dynamic surfing while also allowing for easy recovery.
- A large variety of surf waves that can be tailored to specific flow rates providing ideal playspots over a larger spectrum of flows.
- The ability to create varying difficulty at drops allowing developing boaters to “step” up through the varying features.

In addition to the whitewater, both alternatives mesh with the current development master plan on the parks banks.

The park features trail connections to several parts of the existing and planned park. The primary river trail parallels the river along the North bank. This trail extends throughout the reach of the park. Access from this trail is available to all of the drop structures, to the pedestrian bridge/Mitch McConnel Park and to the proposed River Walk improvements area. The upper structure would be hydraulically planned to provide a low and high flow chute that channels the water to create a hydraulic while, at the same time, maintaining current low and high water head levels for the City’s utilities. No pedestrian access would be provided to this area from the park area.

Preferred Alternative

The preferred alternative is similar to the first alternative. It consists of four drop structures and two offset connected double deflectors that create six pools. These structures would be constructed in a similar fashion to those in the first alternative. The structures would be composed primarily of large to medium sized grouted rock. The center of the structure would

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be lined with smooth grout. This grouted area is planned to be submerged even during low flow events. From the center of these low flow channels stepped wings (with no exposed grout) would extend to the banks. The stepped wings would be anchored into existing bedrock at the riverbank.

As stated above, the drop structures would distribute the head of the BGMU dam. Each drop structure would drop 1.5-2 feet to create a surfable hydraulic at the drop base. The structures would operate at a variety of flows, allowing freestyle kayaking throughout the year, including summer and fall months when streamflow levels are low. The drop structures would also control the depth and character of flow and would divert faster flows away from bridge abutments located within the project corridor.

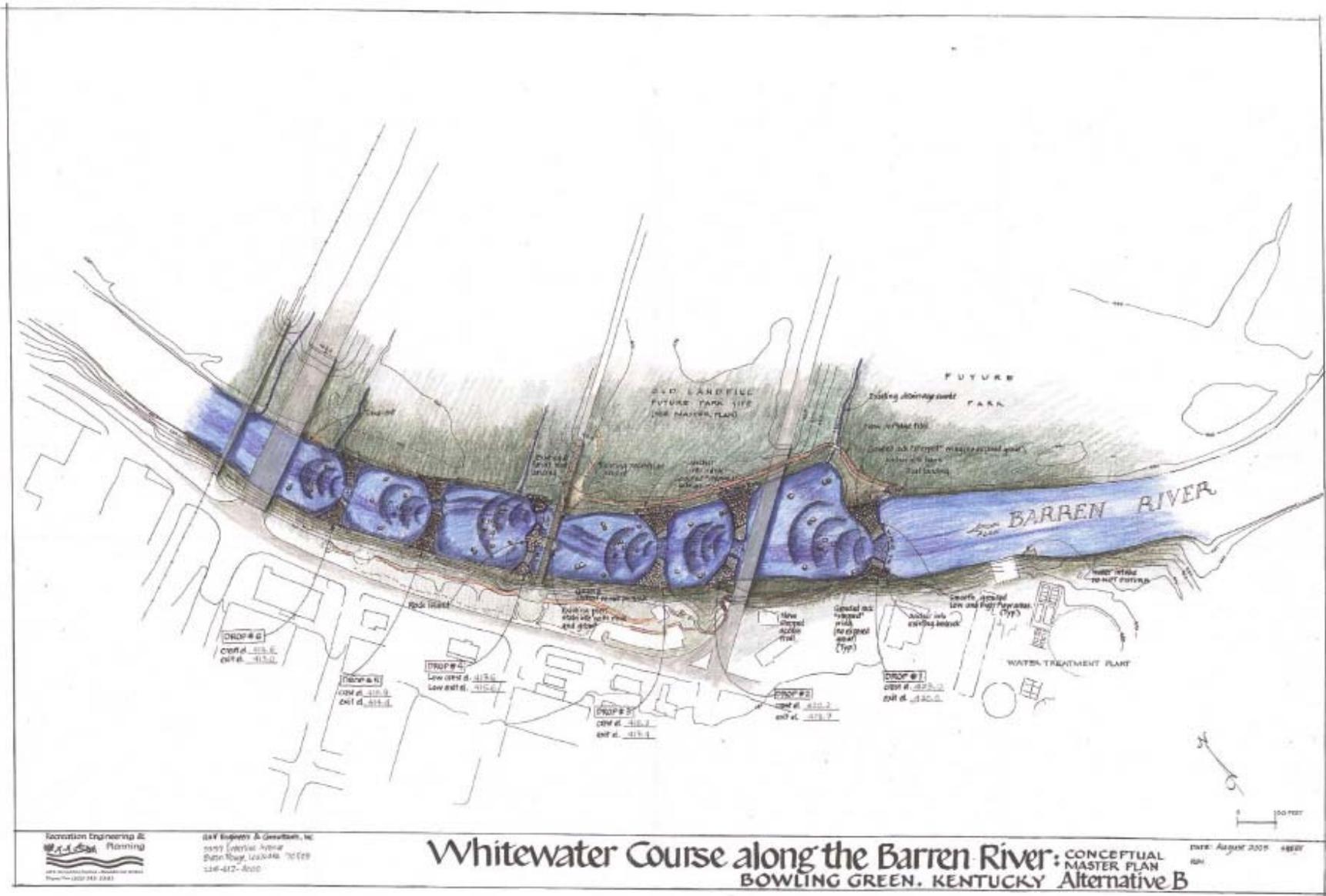
Drop number one, the easternmost drop structure, would utilize the remnants of the breached BGMU dam and would include a boat landing on the north bank of the river. Drop number four, the westernmost drop structure, would be connected to the existing pedestrian bridge. This drop structure would differ from the others in that a rock island would be constructed in the channel center; a smooth grouted high flow area would connect the island to the southern stepped wing, and a smooth grouted low flow area would connect the island to the northern stepped wing. A portage trail would begin at the boat landing on the north side of Drop number one and would proceed west along the riverbank to the proposed boat landing at the foot of the pedestrian bridge. A stepped access trail on the south riverbank would provide access to the southern stepped wing of Drop number two.

Structures five and six are offset connected double deflectors. As in the first alternative, the deflectors would also be constructed of grouted rock. The deflectors would create eddy features and pools, to deflect flow, and at high streamflow levels, to create series of waves. Unlike the first alternative, however, these deflectors would be connected and slightly elevated. The primary difference between the Preferred Alternative and the first alternative is the elevations of each drop.

A detailed conceptual plan has been included in Appendix 1.

Appendix 1

Barren River Whitewater Park Conceptual Plans

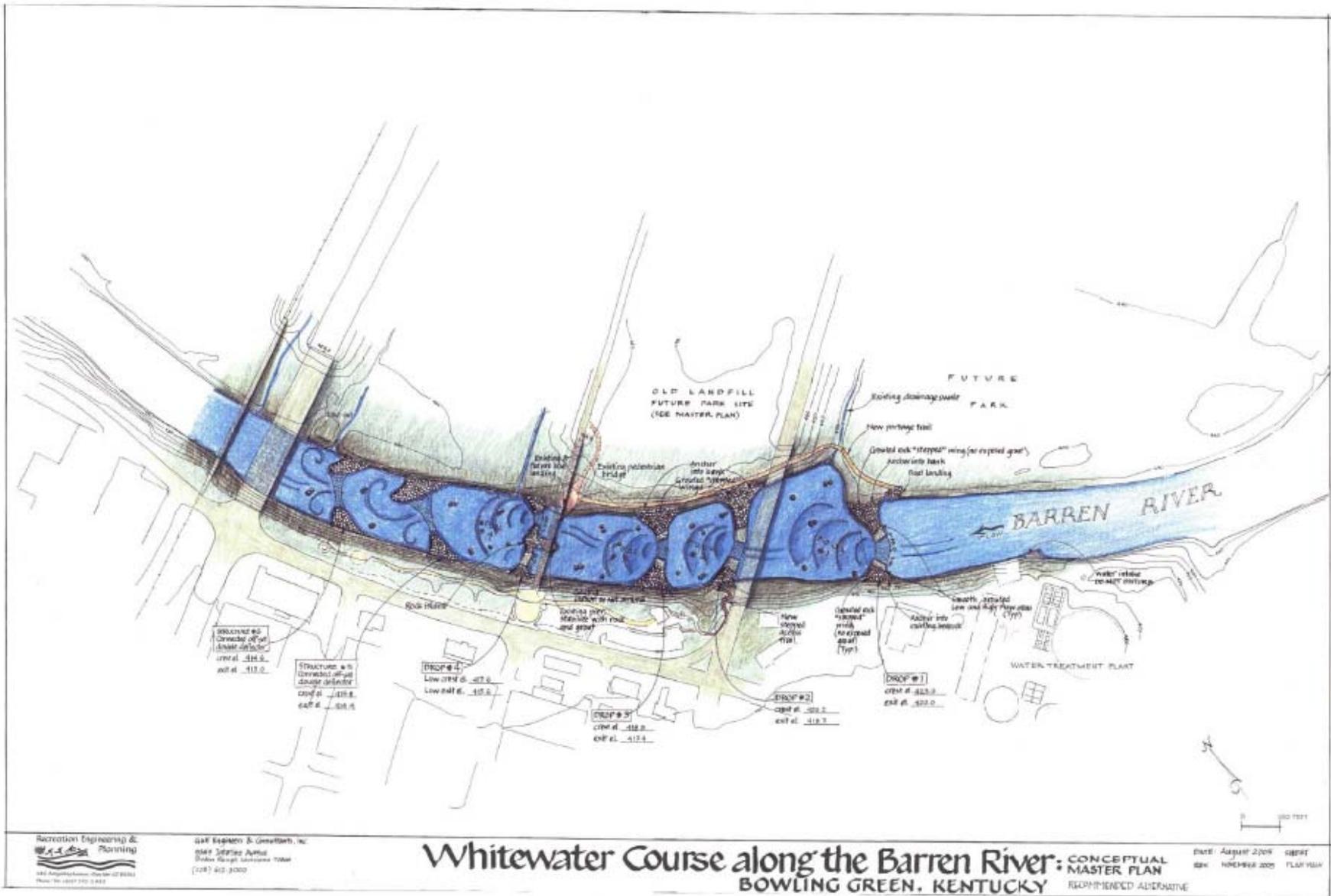


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Whitewater Course along the Barren River: CONCEPTUAL MASTER PLAN
BOWLING GREEN, KENTUCKY Alternative B

Date: August 2008 48827
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