AECOM
1360 Peachtree Street, Suite 500
Atlanta, GA 30309
aecom.com

To: DeKalb County Public Works Department
Roads and Drainage Division

DRAFT

From: AECOM

Date: July 9, 2020

Subject: Twin Brothers Lake Dam Alternatives Analysis

Memorandum

In accordance with the approved scope of work for the Twin Brothers Lake Dam project, AECOM Technical Services, Inc. (AECOM) has prepared a technical analysis of design alternatives for the modification of the Twin Brothers Lake Dam site (dam site) in Tucker, Georgia. This memorandum documents the work completed to further investigate the identified deficiencies at the site, develop design alternatives, and analyze the costs and benefits of each alternative. This memorandum builds on previous work by AECOM, including

- *Pre-Acquisition Safety Inspection Memorandum* (October 17, 2018)
- Bathymetric and Topographic Survey (Accura Engineering and Consulting Services, Inc. – February 2019)
- Lake Volume and Watershed Memorandum (March 1, 2019)
- Interim Corrective Measures for Spillway Stabilization (May 3, 2019)

Scope of Work

The work completed to date and this memorandum are based on the scope of work (scope) prepared for this project by AECOM (*Twin Brothers Lake Dam Rehabilitation Phase II – Alternative Analysis, Design Report, and Construction Documents*) and authorized by DeKalb County, Georgia (County) on February 10, 2020. This memorandum represents a key deliverable of Task 3 of the scope and includes the deliverables required of Subtasks 3.1, 3.2, 3.3, and 3.4. A separate technical memorandum is submitted to document the existing and proposed hydrologic and hydraulic analyses and is included with this technical memorandum as **Attachment 1**.

Site History and Context

The Twin Brothers Lake Dam is located east of Interstate Highway 285 and southeast of Stapp Drive in City of Tucker, DeKalb County, Georgia. Based on the review of records available, the dam site was constructed more than 60 years ago in the 1950s to create a small lake for fishing.

The dam site consists of two earthen dams and their impounded lakes; the Upper dam impounds the Upper lake and the Lower dam impounds the Lower lake. The Upper lake's normal pool elevation is elevation 989.0 feet above mean sea level (ft-MSL), has a surface area of approximately 1.6 acres, and contains 3.2 acre-feet of

water. The Upper lake is oriented in a northwest-southeast direction. The Upper dam is approximately 190 feet long with a crest low point elevation of 992.0 ft-MSL and toe elevation of 984.0 ft-MSL. A 15-inch corrugated metal pipe (CMP) connects the Upper lake to the Lower lake through the Upper dam; however, this CMP has collapsed and is no longer functioning.

Figure 1. Twin Brothers Lake Dam, 1955 aerial photo.

The Lower lake's normal pool elevation is 985.0 ft-MSL. At the normal pool the Lower lake's surface area is approximately 4.6 acres and contains 14.5 acre-feet of water. The Lower lake is oriented in a north-south direction with the Upper dam at the northwest end and the Lower dam at the south end. The Lower dam is 220 feet long with a crest elevation of 987.5 ft-MSL and toe at elevation of 978.0 ft-MSL. The upstream side of the Lower dam includes a 12-inch wide concrete retaining wall and the top elevation of the concrete wall is 987.5 ft-MSL. There are two pipes that run through the dam; a 24-inch CMP that runs from elevation 985.0 ft-MSL to 975.5 ft-MSL and a 12-inch reinforced concrete pipe (RCP) that runs from elevation 985.76 ft-MSL to 985.42 ft-MSL. The 24-inch CMP is believed to have served as the principal spillway but was observed during a prior inspection to be partially crushed and therefore is only assumed to operate at approximately one-half of its original capacity. The 12-inch RCP is believed to have been installed later to help discharge water from the lake.

There is a drainage channel that runs from the left abutment of the Upper dam, around the north end and east side of the Lower lake, and discharges into the stream channel downstream of the Lower dam. No flow from this bypass channel is directed into the Lower lake. As the Upper dam was originally constructed with a principal spillway conduit, it is likely that this bypass channel was only intended to convey discharge from infrequent rainfall events and not all discharges from the Upper dam as it appears to currently.

Site Deficiencies

AECOM observed several deficiencies during the September 14, 2018 inspection and subsequent site visits during 2019 and 2020. Both sides of the Upper dam and the downstream slope of the Lower dam were heavily overgrown with vegetation, with the latter covered with hardwoods as large as 24 inches in diameter. Free water was evident at the downstream toe of the Lower dam across most of the width of the dam, indicative of seepage. Hand probing of the soils during a geotechnical assessment of the site of the downstream embankment indicated that the soils were wet, of loose/soft consistency.

Principal spillway conduits at the Upper and Lower dams both appear to be non-functional. The Upper dam spillway conduit appears to have collapsed while the lower spillway conduit appears to be blocked.

The bypass channel, previously described, that parallels the eastern edge of the Lower lake and extends from the Upper dam past the left abutment of the Lower dam to discharge downstream was also observed during the inspection. The bypass channel is unlined and unbraced and is approximately 10 to 20 feet in width over the length of the dam and as deep as 18 feet in some areas with steep slopes and signs of significant erosion.

AECOM completed a hydrologic and hydraulic analysis of existing conditions of the site. The analysis confirmed that the bypass channel has been conveying most of the discharge from the watershed around the Lower lake and discharging downstream. As a result, it has become severely eroded creating a steep, highly incised channel that presents a potential public safety issue. The County has placed warning tape along the channel for safety precaution for walkers and visitors of Twin Brothers Lake.

Proposed Design Alternatives

To address identified deficiencies related to the dam site, AECOM has identified two design approaches.

- **Alternative A** - Rehabilitate both the Upper and Lower dams to return them to hydraulic functionality and to comply with current dam safety regulations.
- **Alternative B** - Decommission the dams by removing a significant portion of each of the embankments and re-establish the stream channel through the Upper and Lower lakes.

Each alternative is described in detail below.

Alternative A – Dam Rehabilitation

Alternative A, as seen in Figure 2, consists of regrading both the Upper and Lower dams as well as filling in the bypass channel. The rehabilitation alternative will involve replacing the non-functional principal spillway conduits at the Upper and Lower dams with new spillways. At the Lower dam, a concrete weir wall approximately 90 feet long will be constructed to act as its primary and auxiliary spillway. The Lower dam will also have its crest elevation raised approximately six inches to provide sufficient freeboard over the 100-year peak water surface elevation. The embankment will be re-constructed as the excavation for the concrete weir wall structure is backfilled and toe drains will be installed to address seepage concerns identified during the previous inspection. The final dam geometry is proposed to have a 12-foot wide minimum crest width with 3H:1V upstream and downstream side slopes which will enable mowing.

At the Upper dam, an articulated concrete block (ACB) spillway will provide discharge conveyance from the Upper lake to the Lower lake. The openings in the ACBs will be backfilled with topsoil and seeded with turfgrass to provide a more natural look. The dam embankment will be re-graded to have a 12-foot minimum crest width and 3H:1V upstream and downstream side slopes.

The existing bypass channel will be filled in since all discharge will now be directed into the Lower lake and through the Lower dam's spillway. Filling in the bypass channel will require that the existing wet area located

immediately to the north east of the Lower lake will need to be hydraulically connected to the Lower lake and that an existing storm drain outfall from Edinburgh Drive will need to be extended to outfall into the Lower lake.

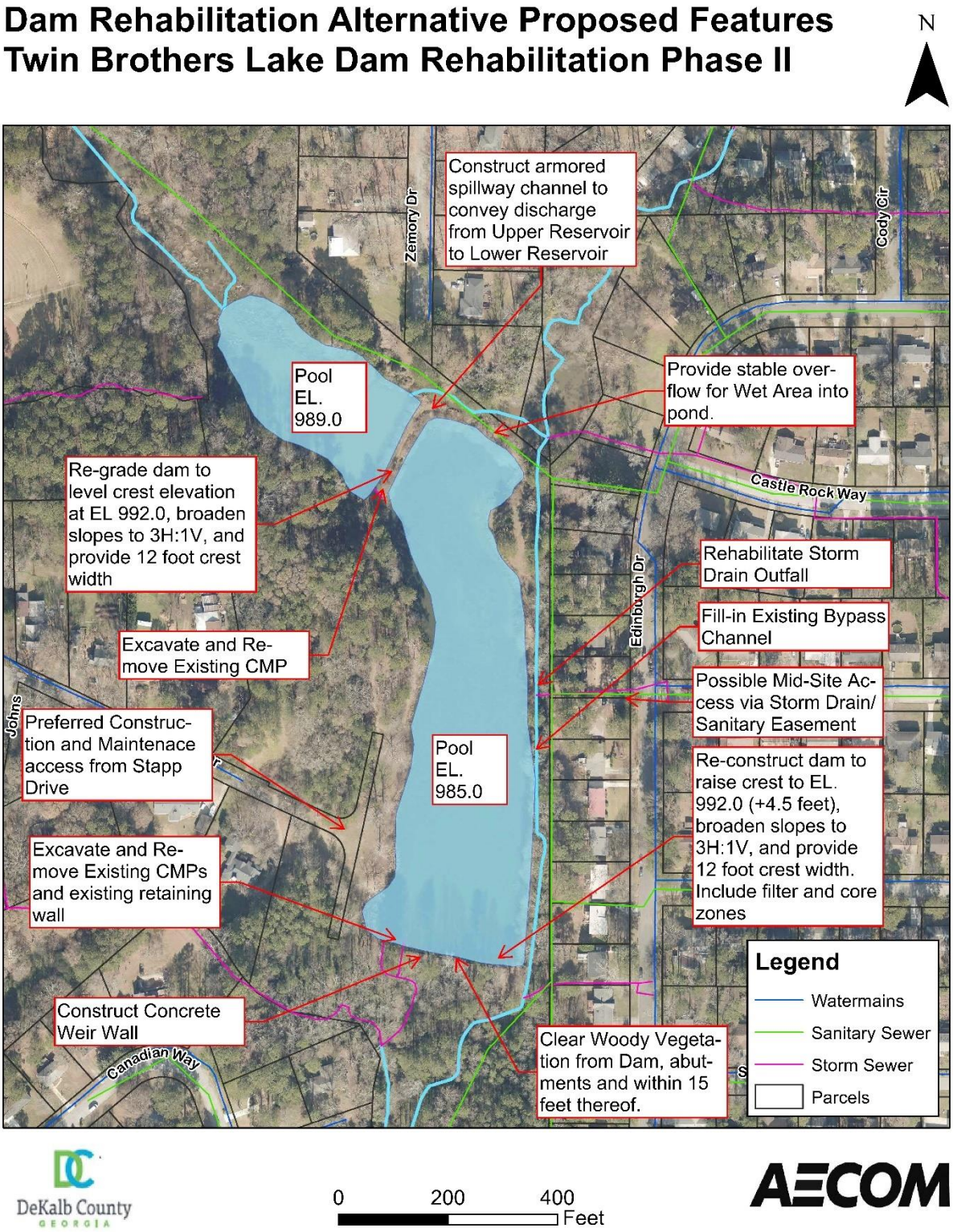


Figure 2. Alternative A scope map.

Alternative B – Dam Decommissioning

The dam removal option, as seen in Figure 3, involves the breaching of the Upper and Lower dams and restoring free flowing conditions through the former lakebeds. Site preparation will involve clearing and grubbing all vegetation from the dam and along the eastern dam embankment between the Lower lake and the bypass channel. The lakes will need to be pumped down to dewater. During the pumped drawdown, natural flow will be maintained in the existing bypass channel. After the lakes are drained, the Lower dam will be breached to design criteria and a new channel will be constructed to connect with the existing channel downstream of the Lower dam. A new stream channel will then be constructed through the lakebed. The size and shape of the channel will be designed using natural channel design principles. This design approach uses a 1.5 to 2-year return period storm event for channel sizing and includes a sufficient floodplain area along the channel corridor to meet overall design hydraulic requirements.

After the new channel is constructed through the Lower lake, the Upper dam will be breached to design criteria as well as eastern berm in the Upper lake to restore drainage from the East watershed to the new channel within the former lakebed. Once all channels are constructed and stabilized, flow will slowly be restored into the new channel and the bypass channel will be backfilled working upstream to downstream. During the backfilling of the bypass channel, the stormwater pipe extending from Edinburgh Drive will need to be extended to the west to discharge into the drained lakebed and the newly restored channel. Once the bypass channel is backfilled, the entire site will be stabilized.

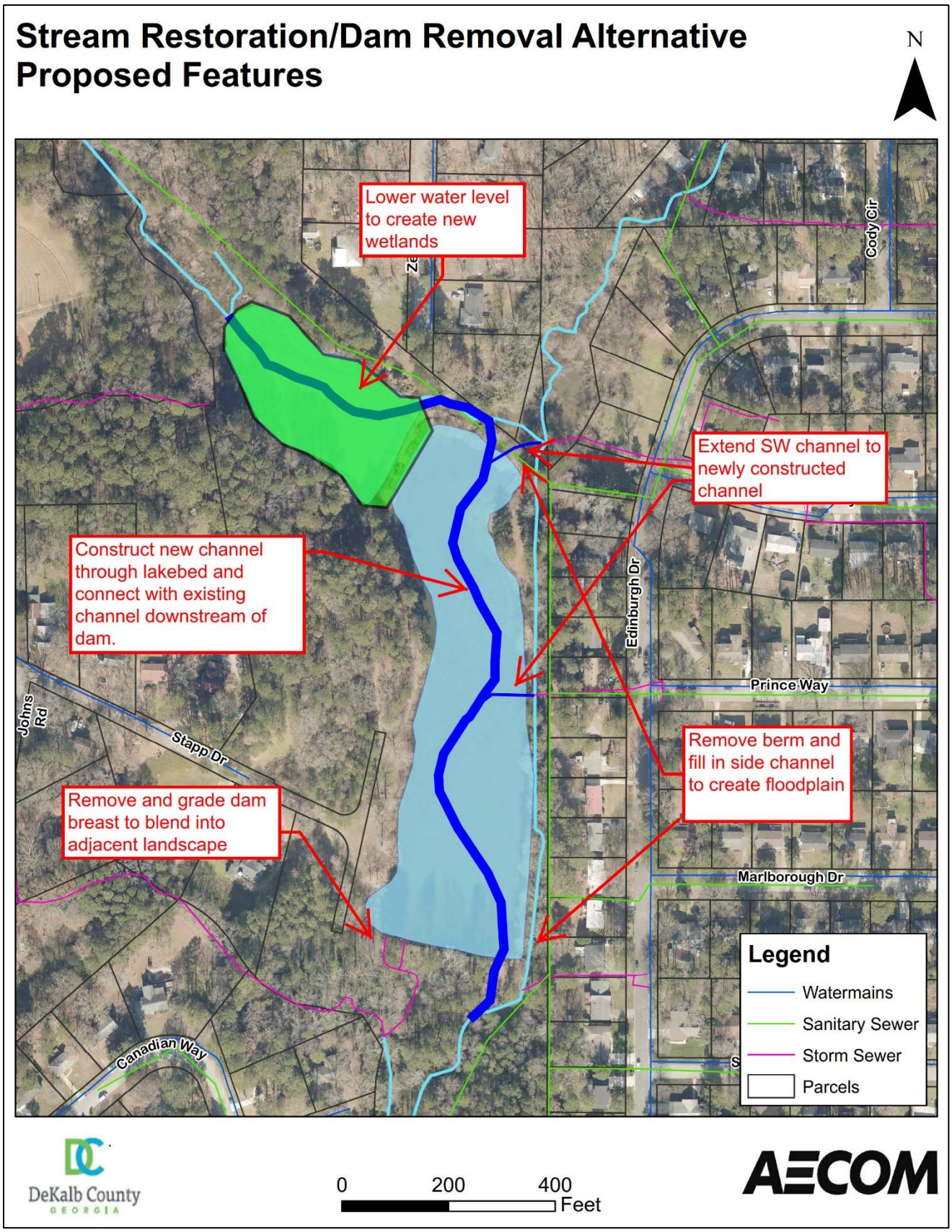


Figure 3. Alternative B scope map.

Recreation Alternatives

Based on the site visit and the analysis of GIS data, conceptual design for recreation alternatives also were developed to provide opportunities for environmental education and passive use recreation. The recreation concepts provide a framework and vision associated with the dam rehabilitation and/or stream restoration design alternatives. These proposed elements are conceptual in nature and are subject to change pending stakeholder and community input, further master planning and design activities. **Attachment 2** includes rendering for the recreational concepts developed for Alternatives A and B.

Alternative A involves rehabilitating the Upper and Lower dams. The recreation concept intends to preserve and celebrate the existing natural resources while simultaneously, improving the existing trail systems and supporting amenities. The missing links or gaps of the existing trail system will be reconnected. Alternative A includes the following potential improvement opportunities.

- Provide historic, cultural, and environmental education opportunities at the entrance from Johns Homestead park.
- Add wayfinding and educational signage next to key destinations such as the existing boardwalk, seating areas and overlooks.
- Add bird blinding to the existing hiking trail for bird watching activities.
- Repair and improve existing walking trails, including upgrade of the trail along the east side of the lake after the drainage channel is repaired.
- Connect missing links of the existing trail system and add supporting amenities such as benches or swing for resting. The trail will be extended downstream of the dam to access the trail on the east side of the Lower lake.
- Improve access to the Upper and Lower lakes from the existing meadow area.

Alternative B involves breaching of the Upper and Lower dams to restore the stream channel and habitats. Two layers of trail systems are proposed: a natural trail for family activities and an adventure trail for medium-intensive activities like hiking and jogging. These trails will connect three proposed entrances from the Lawrence Highway and Stapp Drive. Along the trail system, additional areas of interest identified for recreational activities include:

- Provide historic, cultural and environmental education opportunities at the entrance from the Johns Homestead Park.
- Add a series of multi-purpose areas for rest/picnicking for individuals or small groups along the southeast side of the trail system. A few meadow spaces were identified during the site visit along the trail system.
- Provide unpaved trails along the 75-foot stream buffer (based on the understanding that a stream buffer permit will be required unless the path accesses the water perpendicular to the buffer). Enhance the areas with riparian planting along with bank stabilization to restore the natural assets.

Optional for Both Alternatives

The County and the City can consider adding community and family activities areas at the entrance from Stapp Drive. Potential activities suitable for this area include movies-in-the-Park, performances, community gatherings, birthday parties, weddings, family reunions, employee celebrations, and health and wellness classes. In the proposed Great Meadow area, options include children’s playgrounds, exercise stations, small group sports, picnic and/or community gardens (see rendering in Attachment 2).

Alternatives Evaluation

The proposed alternatives were evaluated for a range of technical and non-technical parameters. A comparison of the alternatives based on each of these parameters is provided in this section.

Hydraulic Performance

ALTERNATIVE A

Rehabilitation of the dam, especially with the installation of properly sized spillway/weir structures, will allow the watersheds drainage to flow through the lakes instead of flowing through the severely eroded bypass channel to the east of the Lower lake. The Upper lake will be higher at elevation 992.0 ft-MSL and will prevent sedimentation accumulation in the larger Lower lake at water surface elevation 985.0 ft-MSL. Keeping the normal pool of the Lower lake at elevation 985.0 ft-MSL will not change the look of the existing lake area.

ALTERNATIVE B

The removal of the dam should restore the channel close to pre-dam conditions. All watershed drainage currently flows around the dam in the bypass channel. This channel is deeply entrenched and results in significant scour and erosion. Continued channel incision and erosion could likely result in failure of the eastern berm. The breaching of the dam and establishing a natural channel through the lakebed will restore natural stream functions and provide floodplain storage along the new channel. The existing bypass channel would be filled.

Maintenance Requirements

ALTERNATIVE A

Alternative A will require regular maintenance and periodic inspection of the dam structure. Basic recommended maintenance items are mowing the dam slopes and crest twice per year (spring and fall), annual visual inspection, clearing trash and debris from inlet and outlet points, and as it ages, making minor repairs to the concrete weir wall structure (parging spalls, filling cracks, etc.).

ALTERNATIVE B

Once the dam is breached, the habitats around the restored stream channel would be naturalized, or riparian planting can be done to speed up the process. Once the riparian landscape is established, maintenance will be minimal. There will be no maintenance required for the remainder of the breached earthen dams as they will not be required to meet dam safety criteria.

As the area would be managed as a park, regular maintenance could include mowing or landscaping, repair or replacement of amenities (such as picnic tables, benches, or playground) for both alternatives.

Construction Considerations

BOTH

Construction access is anticipated from public right-of-way at the eastern end of Stapp Drive and, if possible and acceptable, from the open parcels on Edinburgh Drive to access the northern part of the site. The County currently owns several parcels in this area that had experienced previous flooding. Staging areas at these access points are adequate for the scope of work described. Both alternatives will include frequent construction traffic in and out of the site to deliver and haul out equipment and materials. Maintenance of traffic provisions (signage, flagger, etc.) may be required for the access point on Edinburgh Drive. The County may also need to use the easement for the sanitary sewer for the backfill of the bypass channel.

ALTERNATIVE A

The dam rehabilitation will be a considerable construction project with the entire site requiring to be cleared and grubbed in addition to the lake being pumped down. The regrading will require heavy construction equipment to be able to maneuver around the site. In addition, an estimated 750 cubic yards of concrete will be required for the weir wall construction. The total estimated earth work volumes are 4,350 cubic yards of excavation and 6,650 cubic yards of earth fill.

ALTERNATIVE B

The alternative will require the lake to be pumped down. The dam and berm between the Lower lake and the bypass channel would need to be cleared of all woody vegetation. A channel from the eastern watershed would need to be constructed to connect with a newly constructed channel in the lakebed. The stormwater drainage from Edinburgh Drive would need to be extended into the former lakebed to connect with the newly constructed stream channel. A new channel will also need be constructed through the dam breach to connect with the natural drainage course downstream of the dam.

Permit Requirements

ALTERNATIVE A

Rehabilitating the dam could be permitted under a U.S. Army Corps of Engineers (USACE) Nationwide Permit (NWP) 3 for Maintenance of an Existing Serviceable Structure. Repairs to the dam and bypass channel would be authorized to prevent further damage of the properties along the bypass channel and to prevent catastrophic failure of the dam structure.

Currently, the bypass channel receives drainage from most of the watershed above the dams and wetland adjacent to the dam site. It is presumed this watershed originally flowed into the stream that was dammed to form the Lower lake. The bypass channel now flows parallel to the Lower lake and continues over 300 feet downstream of the dam before its confluence with the main channel which flows from the outfall of the Lower dam. It is possible the USACE would consider this channel to be a perennial stream.

The improvements to the spillway channel would require the loss of flow in this channel and may require compensatory mitigation for the loss of Waters of the U.S. A site visit and discussion with the USACE to assess the existing conditions on the site would be required. In order to work under this NWP, a preconstruction notification (PCN) document would be required to be submitted to the USACE and Georgia Environmental Protecting Division (GAEPD). Once the PCN is received and is deemed completed by the USACE, they have 45 days to authorize or deny the work under the NWP program.

For both activities, it is possible the USACE could require an Individual Permit. This is a lengthier application process and would require a public comment period. It is imperative the USACE is considered a stakeholder in this decision process. AECOM is scheduling a site visit with the USACE for review of the existing conditions and to solicit their input on the permitting process in order to allow the City and County to make an informed decision.

ALTERNATIVE B:

This activity could be permitted under NWP 27 for Aquatic Habitat Restoration, Enhancement, and Establishment Activities. Per the requirements for this permit, in order for the activity to be authorized, the aquatic habitat restoration, enhancement, or establishment activity must be planned, designed, and implemented so that it results in aquatic habitat that resembles an ecological reference. An ecological reference may be based on the characteristics of an intact aquatic habitat or riparian area of the same type that exists in the region. An ecological reference may be based on a conceptual model developed from regional ecological knowledge of the target aquatic habitat type or riparian area.

By removing the dam, and restoring this area to a natural stream channel, this project would be considered a habitat restoration. Compensatory mitigation is usually not required for restoration activities, as the long-term results of the activity function as mitigation for any temporary impacts incurred during the construction of the project. As noted above, the USACE would have to approve the plan prior to its implementation.

A site visit and discussion with the USACE to assess the existing conditions on the site would be required. In order to work under this NWP, a PCN document would be required to be submitted to the USACE and GAEPD. Once the PCN is received and is deemed completed by the USACE, they have 45 days to authorize or deny the work under the NWP program.

Environmental Impacts

ALTERNATIVE A

The Upper lake and dam will provide sediment trapping capability to help reduce turbidity downstream. The rehabilitation of the Lower dam will allow for the continued use of the lake for fishing and recreational activities. Erosion and sedimentation occurring in the bypass channel would be eliminated.

ALTERNATIVE B

The removal of the dam and construction of a new stream channel through the former lakebed will improve water quality. Erosion and sedimentation occurring in the bypass channel would be eliminated. Construction of new natural channel will restore natural stream functions and likely result in some flood storage and creation of new wetlands. Habitat diversity will increase.

Recreation Opportunities

ALTERNATIVE A

The conceptual design will enhance existing experience by adding wayfinding and educational signage next to key destinations such as the existing boardwalk, seating areas and overlooks. Bird blinding to the existing hiking trail will encourage bird watching activities. Access will be improved to the lake from the existing meadow area.

ALTERNATIVE B

The conceptual design aims to expands the existing trail system with opportunities for a wide variety of recreational activities. Breaching the dams will eliminate recreational opportunities associated with open water like fishing or paddle boarding. Additional green space gained from elimination of the lake will increase activities in a series of potential meadow areas for children’s playgrounds, exercise stations, small group sports, picnic and community gardens. In addition, the riparian buffer through proposed planting and bank stabilization will restore the natural stream habitats.

Site Safety

BOTH

Both alternatives will result in removal (backfilling) of the existing incised bypass channel and thus remove a major safety issue on the site.

ALTERNATIVE A

The rehabilitation of the dam would improve the safety of the dam by providing safe conveyance of flood flows up to and including the 100-year return period storm event, mitigating the seepage at the Lower dam, and improving slope stability of the Upper and Lower dams.

ALTERNATIVE B

The removal of the dam would eliminate any liability associated with open water activities (drowning) as well as significant damage resulting from a sudden breach and downstream flooding.

Budget Considerations

ALTERNATIVE A:

The recommended budget to rehabilitate the dam is $1,650,000 plus $441,000 for recreational improvements which includes a 20% contingency. Major drivers of the budget are earth work ($348,600) and construction of the concrete weir ($720,000).

ALTERNATIVE B:

The recommended budget to breach the dam and restore a channel through the lakebed is $570,000 plus $1,088,000 for recreational improvements which includes a 20% contingency. The major driver of the budget is earth work ($180,000).

Planning level cost estimates were developed for basic recreational/landscaping design for both alternatives. The recreation/landscape budget can vary significantly based on features desired by the community. The future improvements can be phased if budget is a concern.

Table 1 summarizes the estimated budgets. More detailed budget estimates are provided in **Attachment 3**. Cost for potential mitigation required for Alternative A is not included below.

Table 1. Alternatives Budget Comparison

Alternative	Description	Engineering Budget Estimate	Recreation Budget Estimate	Mitigation Cost	Major Budget Drivers
A	Dam Rehabilitation	$1,650,000	$441,000	Required TBD	Earthwork ($348,600) Concrete Weir ($720,000)
B	Stream Restoration	$ 570,000	$1,088,000	None	Earthwork ($180,000)

Summary

The Twin Brothers Lake Dam site is a unique opportunity to improve an existing dam/lake system with significant identified deficiencies and combine those modifications with major recreational upgrades for the adjacent park. The existing Upper and Lower dams both have hydraulic capacity issues and failed spillways while the Lower dam also exhibits potentially seepage issues and downstream slope stability problems. Two alternatives are presented in this memorandum. Alternative A considers rehabilitating the dams while Alternative B considers removing the dams and restoring the contributing stream system through the abandoned lakebed. Considerations for each alternative are provided for hydraulic performance, maintenance, construction considerations, recreation opportunities, permitting considerations, environmental effects, site safety, and budget.

Associated recreational concepts are presented that accentuate each of the alternatives. Recreational improvements include improved entrances, trail systems, and signage to enhance the use of the park.

Attachments:

1 – Memorandum - Twin Brothers Lake Dam Hydrologic and Hydraulic Analysis

2 – Rendering of Recreational Concepts

3 – Alternatives Budget Estimates

Attachment 1: Memorandum - Twin Brothers Lake Dam Hydrologic and Hydraulic Analysis

AECOM
1360 Peachtree Street, Suite 500
Atlanta, GA 30309
aecom.com

To: DeKalb County Public Works Department
Roads and Drainage Division

DRAFT

From: AECOM

Date: July 2, 2020

Subject: Twin Brothers Lake Dam Hydrologic and Hydraulic Analysis

Memorandum

In accordance with the approved scope of work for the Twin Brothers Lake Dam project, AECOM Technical Services, Inc. (AECOM) has prepared a hydrologic and hydraulic analysis pertaining to the modification of the Twin Brothers Lake Dam site (dam site) in Tucker, Georgia. This memorandum documents development of the hydrologic model and the hydraulic models for existing conditions and proposed conditions for the dam rehabilitation alternative under consideration. This memo builds on previous work by AECOM including:

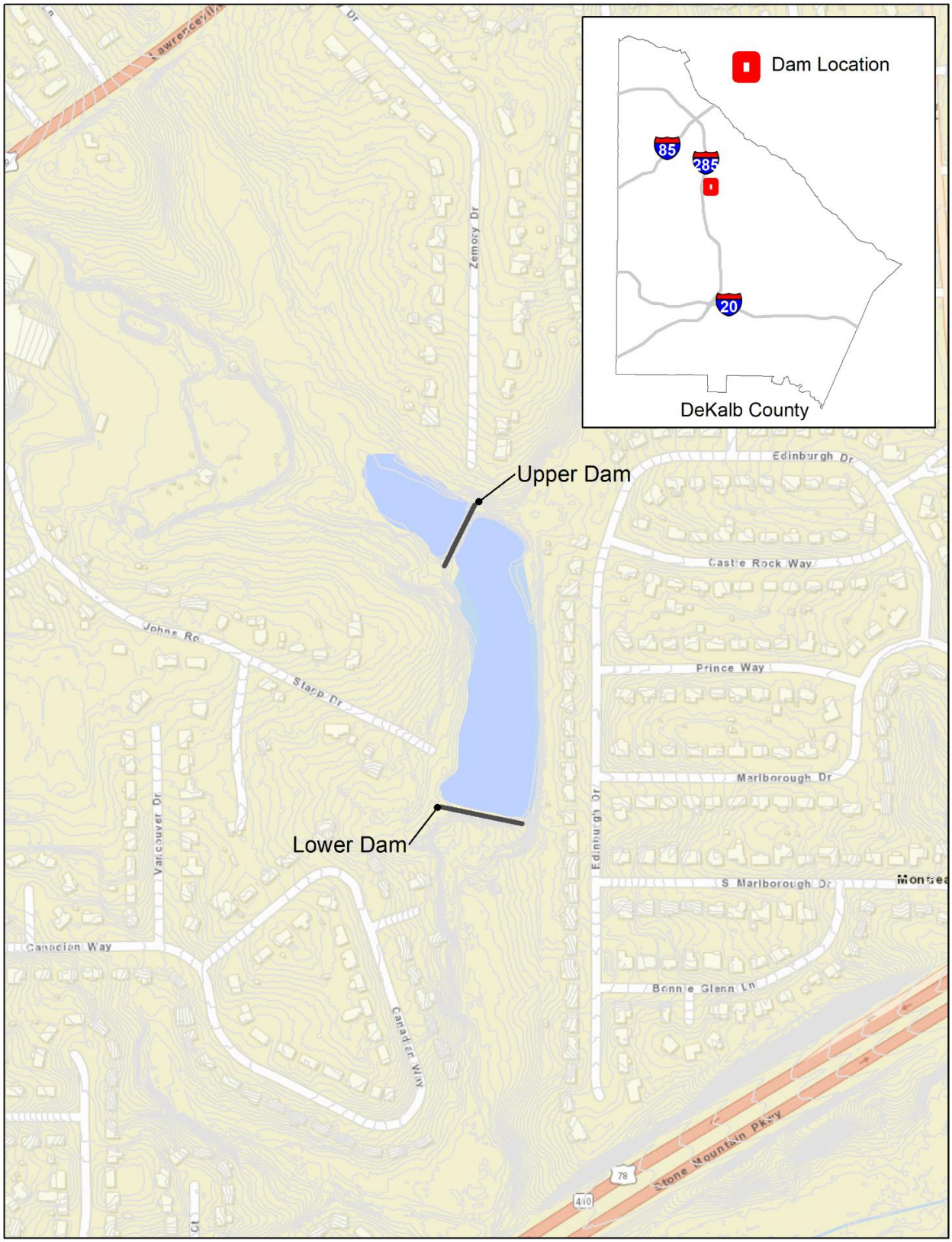
- *Pre-Acquisition Safety Inspection Memorandum* (October 17, 2018)
- Bathymetric and Topographic Survey (Accura Engineering and Consulting Services, Inc. – February 2019)
- Lake Volume and Watershed Memorandum (March 1, 2019)
- Interim Corrective Measures for Spillway Stabilization (May 3, 2019)

Background

AECOM produced a Safety Inspection Memo for DeKalb County (County) Department of Public Works, Roads & Drainage Division dated October 17, 2018 indicating the Twin Brothers Lake Dam is at risk of failure. This memorandum documents evaluation of the dam and outlet structures under existing conditions and proposed conditions considering a rehabilitation of the dams. AECOM completed an alternatives analysis to evaluate options to either rehabilitate the dam or decommission (remove) it. That analysis is documented in a technical memo that is being submitted separately.

The Twin Brothers Lake Dam is located east of Interstate Highway 285 and southeast of Stapp Drive located in the City of Tucker, in DeKalb County, Georgia. The site is owned by the City of Tucker, since it became a city in 2016; however, the dam and stormwater infrastructure are currently maintained by the County's Roads and Drainage Division based on an intergovernmental agreement between the City and the County. Based on the review of records available, the site was constructed more than 70 years ago to create a small lake for fishing. Figure 1 shows the vicinity area of Twin Brothers Lake with its two earthen dam embankments, the main lower dam (Lower) and the upper dam (Upper). The lakes are located within the South Fork Peachtree Creek watershed in the Upper Chattahoochee River Basin.

Figure 1 Twin Brothers Lake Vicinity Map

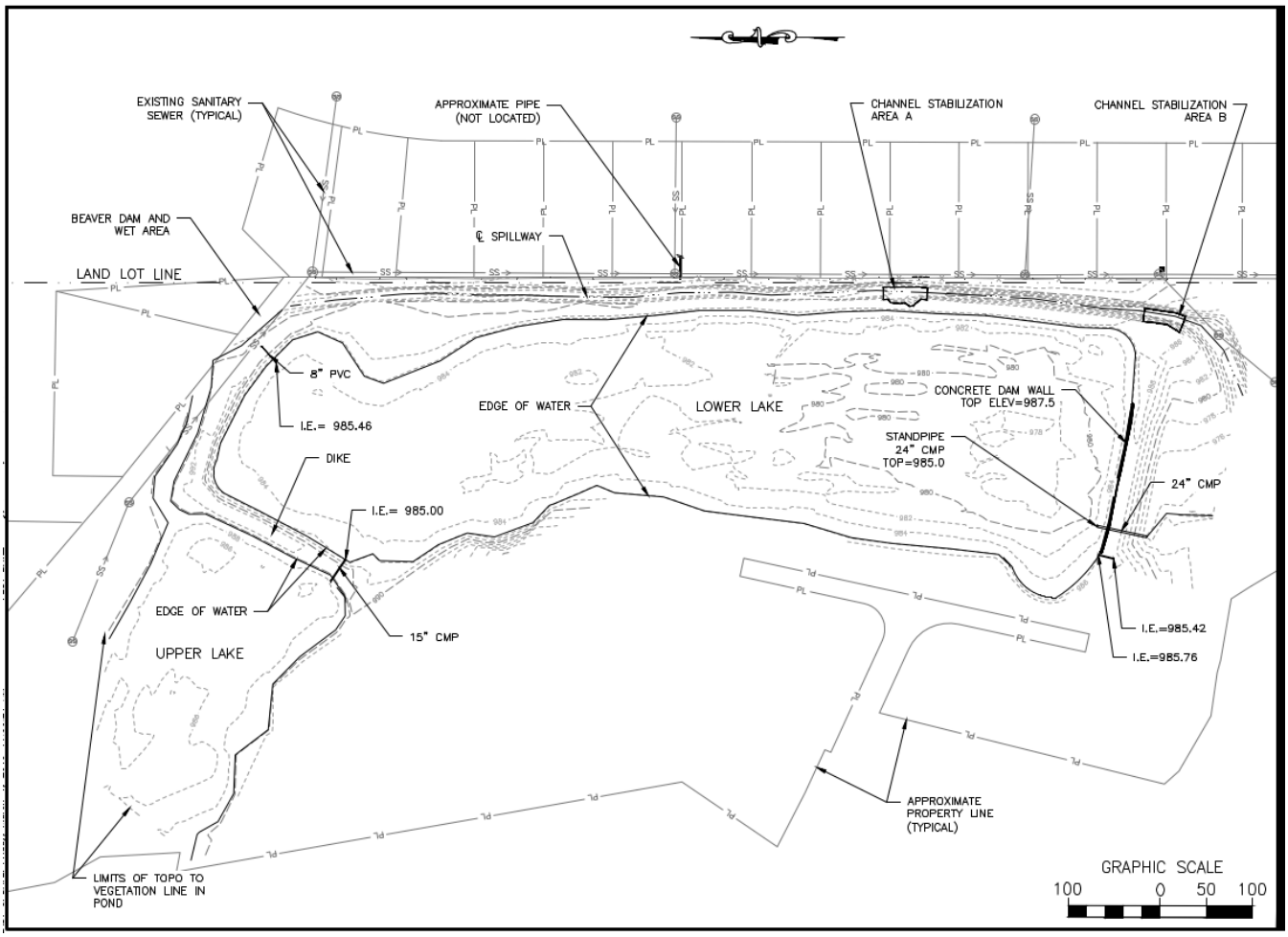


Survey and Observed Issues

Accura Engineering and Consulting Services, Inc. (Accura) completed the bathymetric and topographic survey in February 2019 (2019 Survey). Both the Lower and Upper dams are earthen embankments. The Lower dam has a concrete retaining wall on the upstream side of the dam. Figure 2 presents the current conditions of the dam from the 2019 Survey. Outlet pipes for both dams were located during the survey. A 15-inch corrugated metal pipe through the Upper dam was designed to provide drainage between the Upper and Lower reservoirs; however, this pipe appeared collapsed and it is unclear it any water can flow through the pipe. A 24-inch standpipe is located north of the Lower dam and was designed to control the lake level. This pipe also appeared clogged as water was observed to only trickle through the downstream side of the pipe. On the day of the survey in 2019, water surface level was recorded to be one foot above the top of the pipe.

Because the majority of the water from the East and Upper watersheds drains toward the former emergency spillway, this “bypass” channel has become severely eroded. This channel is unsafe for various reasons including exposing existing utilities, embankment instability, and continued head-cutting. Although this was likely originally intended to be a shallow swale but has eroded considerably and could cause issues for both compromised utility lines and public safety if it was kept.

Figure 2 Lake Bathymetry and Embankment Survey



Existing Condition Hydrologic Analysis

Analysis Methodologies

The hydrologic and hydraulic model was developed using the U.S Army Corps of Engineers' (USACE) Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) version 4.3 software and included parameters from the following categories: watershed area, precipitation losses, unit hydrograph transform, precipitation depth, precipitation distribution, spillway discharge rating, and reservoir storage rating. The following subsections document how the data was applied and the procedures used to develop and incorporate these parameters. Parameters were generally developed using methodologies and guidance from the Natural Resource Conservation Service (NRCS) National Engineering Handbook. Specific references for source data and methodologies are provided in the sections below.

Hydrologic Input Parameter Development

Watershed Delineation

The total drainage area to the Twin Brothers Lake dams consists of three watersheds: the Upper watershed and the Lower watershed which drain to the Upper and Lower reservoirs respectively, and the East watershed which drains directly into bypass channel which bypasses the Upper and Lower dams. Table 1 provides the watershed areas and

Figure 3 illustrates their location.

Table 1 Watershed Area

Watershed Name	Area (Acres)
Upper	142.6
Lower	10.1
East	137.3
Total	290.0

Figure 3 Watershed Delineation

Precipitation Losses

Precipitation losses for the hydrologic model were estimated using the Natural Resources Conservation Service's (NRCS) Runoff Curve Number method. The runoff curve number (CN) is an empirical parameter that provides an indication of storm runoff potential over an area based on land cover, underlying soil type, and hydrologic condition. Higher CN values indicate a quicker watershed response time and an increase in runoff. These values were determined using ArcGIS Version 10.6 and the following methodology:

- Watershed land use (Figure 4) was obtained from LandPRO 2012, created by the Research and Analytics Division of the Atlanta Regional Commission. The watershed is relatively developed and the predominant land use is medium density residential (equivalent to NRCS land use type Residential ¼ Acre). It is not anticipated that future land use change will cause a significant change in stormwater runoff volumes, based on the City of Tucker's 2018 Comprehensive Plan.
- Soils data from the United States Department of Agriculture Web Soil Survey v.3.3.2 program for Dekalb County, Georgia was obtained and a hydrologic soil group (HSG) was assigned to each soil type. HSG's are defined as follows:

  - Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.
  - Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
  - Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.
  - Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

  Figure 5 depicts the HSG values within the watershed.

- The soil and land use data were combined within ArcGIS and the resulting dataset was clipped to the watershed.
- A custom CN lookup table was developed by determining a relationship between the land use data and the HSG using values published by the NRCS in the National Engineering Handbook, Part 630 – Hydrology, Chapter 9 *Hydrologic Soil-Cover Complexes* (NRCS, 2004) to assign curve number values assuming an Antecedent Runoff Condition (ARC) of II. This table is provided as Table 2.
- Area-weighted composite curve numbers were calculated for the watersheds by cross-referencing the soil and land use data with the lookup table values. Composite curve numbers are provided in Table 3.

Figure 4 Land Use Map

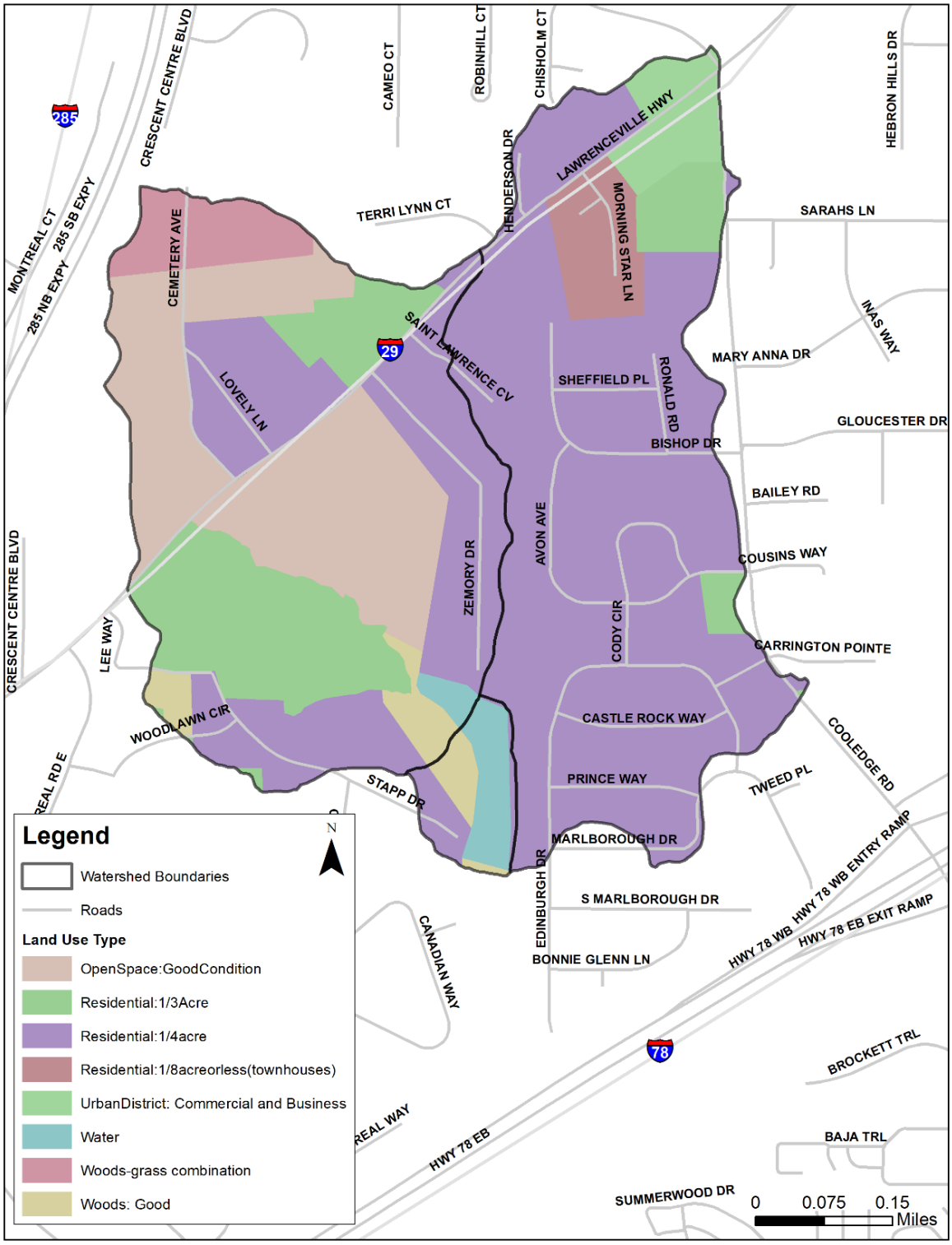


Figure 5 Hydrologic Soil Group Map

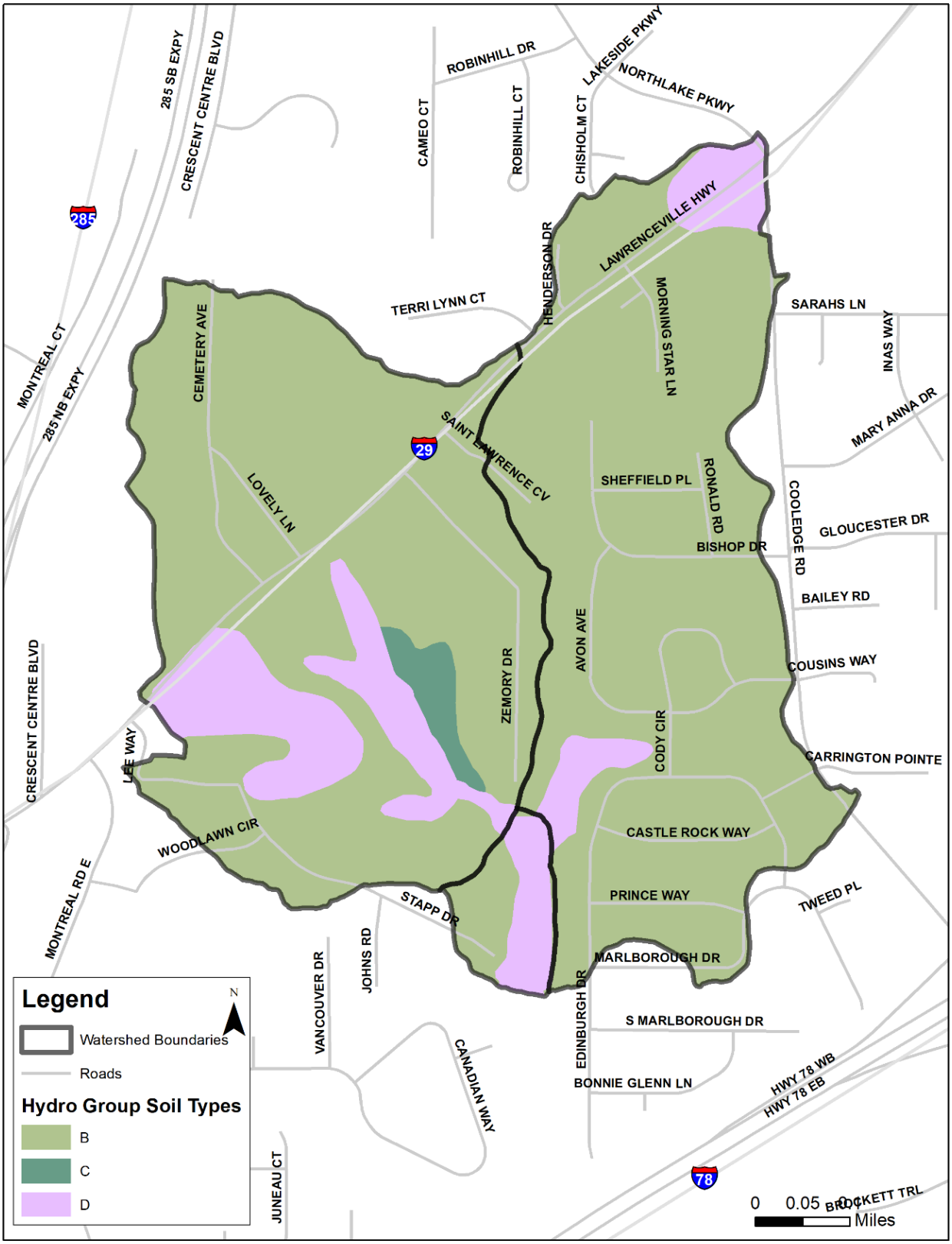


Table 2 NRCS Land Use and Curve Number Assignment

Land Pro Land Use	TR-55 Equivalent Land Use	Curve Number A	B	C	D
INST_INTENSIVE	Residential:1/3Acre	57	72	81	86
RES_MED	Residential:1/4acre	61	75	83	87
CHURCH	Residential:1/3Acre	57	72	81	86
TRANSITIONAL	Woods-grass combination	32	58	72	79
CEMETERIES	OpenSpace: Good Condition	39	61	74	80
PARK_LANDS	OpenSpace: Good Condition	39	61	74	80
RESERVOIRS	Water	100	100	100	100
FOREST	Woods: Good	36	60	73	79
RES_MULTI	Residential:1/8 acre or less (townhouses)	77	85	90	92
COMMERCIAL	Urban District: Commercial and Business	89	92	94	95

Table 3 Weighted Curve Number

Upper Watershed	Lower Watershed	East Watershed
70.8	84.5	77.0

Curve Numbers represent Antecedent Runoff Condition II (ARCII) as required by the Georgia Department of National Resources Environmental Protection Division Watershed Protection Branch Safe Dams Program 2015 Edition Version 4.0

Unit Hydrograph Transform

To convert excess precipitation into surface runoff, the SCS Unit Hydrograph Transform Method was employed within HEC-HMS basin model. The inputs for this method include graph type and a watershed lag time. The Standard graph type with peak rate factor of 484 was selected for this analysis. The lag time is defined as the length of time between the centroid of precipitation and the peak of the resulting hydrograph. Lag time can be estimated as 60% of the time of concentration (T_c). T_c, as defined in *NEH, Part 630, Chapter 15: Time of Concentration*, is the time for runoff to travel from the hydraulically most distant point of the watershed to the watershed outlet (NRCS, 2010).

The longest flow paths for the watersheds are illustrated in

Figure 6. These lengths along with the resulting curve numbers (for an estimation of the maximum potential retention), and watershed slope, were used to estimate the lag time. Table 4 summarizes lag times estimated using the NRCS lag time equation (NRCS, 2010). Average watershed slope was estimated using the DeKalb County LiDAR two-foot interval contours.

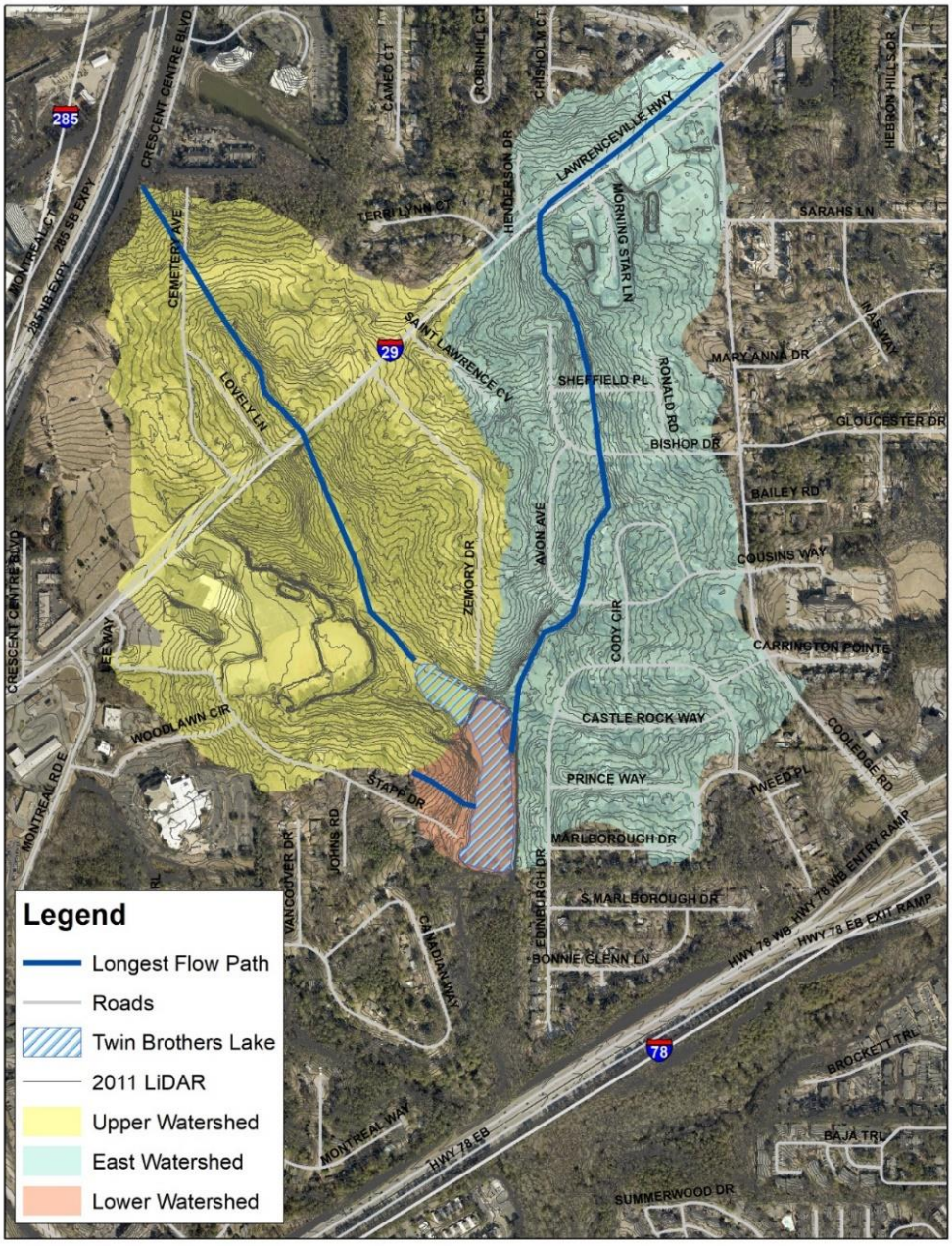
Table 4 Lag Time Computation Parameters

Drainage	I – Longest Flow Path (feet)	S – Maximum Potential Retention (inches)	Y – Average Watershed Slope, (%)	L – Lag Time (Minutes)
Upper Watershed	3,223	4.1	6.1	25.6
Lower Watershed	490	1.8	6.6	3.6[1]
East Watershed	4,767	3.0	5.5	31.1

Note: Lag Time Equation - L(hours)=(I^0.8((S+1)^0.7))/(1900*Y^0.5)*

1. *3.6 minutes was increased to 5 minutes in the model*

Figure 6 Longest Flow Paths



Precipitation Depth and Distribution Data

Five frequency storms were used in the analysis to estimate peak flow rates and evaluate the performance of the dams. Table 5 below presents the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Volume 9 Version 2 depth-duration-frequency (DDF) values for Twin Brothers project area. Other storm inputs include the following:

- Input type = partial duration storm event
- Output type = annual duration
- Intensity Duration = 5 minutes
- Storm Duration = 1 day

- Intensity Position = 50%
- Storm Area = blank for areas less than 10 square miles
- Curve = Uniform for all watersheds.

Table 5 Rainfall Depth by Frequency Storm

Duration	Depth of Precipitation by Recurrence Interval (Inches)				
	2-Year	10-Year	25-Year	100-Year	500-Year
5 Minutes	0.47	0.65	0.78	0.97	1.21
15 Minutes	0.83	1.17	1.39	1.74	2.17
1 Hour	1.51	2.12	2.53	3.21	4.06
2 Hours	1.83	2.58	3.09	3.94	5.04
3 Hours	2.04	2.85	3.42	4.38	5.66
6 Hours	2.47	3.39	4.05	5.20	6.74
12 Hours	3.04	4.10	4.85	6.14	7.88
24 Hours	3.68	5.01	5.90	7.39	9.29

NOAA Atlas 14 Volume 9 Version 2 ; Location Name Georgia: Latitude 33.8263 ° Longitude: -84.2419°

Existing Conditions H&H Modeling

Elevation-Area Rating

The bathymetric survey and the DeKalb County LiDAR and corresponding contours were used to develop the elevation-area ratings for the Upper and Lower reservoirs. The volume below the normal pool water surface elevation was estimated based on bathymetry collected during the 2019 Survey and the volume above the normal pool estimated based on LiDAR data from the Department of Watershed Management, DeKalb County February 2011 (2011 LiDAR).

Table 6 Upper and Lower Dam Key Elevations6 presents the critical elevations of the Upper and Lower dams. The 2019 survey indicated the normal pool water surface of the Upper reservoir is 989 ft-MSL and the Lower reservoir is at 985 ft-MSL. Table 7 details the elevation-area curve data.

Table 6 Upper and Lower Dam Key Elevations

Location	Bottom (ft-MSL)	Normal Pool (ft-MSL)	Top of Structure (ft-MSL)
Upper Dam	984.0	989.0	992.0
Lower Dam	978.0	985.0	987.5
East Embankment	--	--	988.0

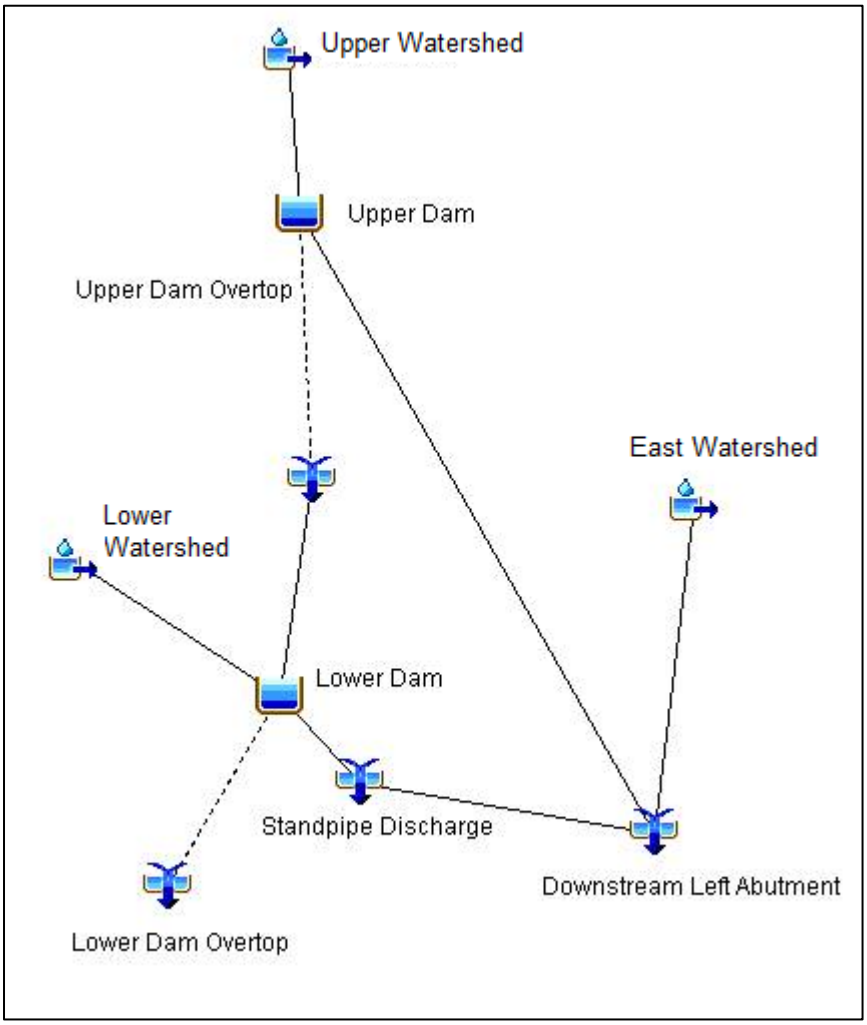
Table 7 Twin Brothers Elevation-Area Curves

Upper Reservoir		Lower Reservoir	
Elevation (ft-MSL)	**Area (Acres)**	**Elevation (ft-MSL)**	**Area (Acres)**
984.0	0.00	978.0	0.21
985.0	0.02	979.0	0.42
986.0	0.27	980.0	0.98
987.0	0.82	981.0	1.35
988.0	1.27	982.0	2.15
989.0	1.59	983.0	3.04
990.0	2.05	984.0	4.16
992.0	2.93	985.0	4.58
994.0	4.00	986.0	4.99
--	--	988.0	5.34
--	--	990.0	6.41
--	--	992.0	6.81

HEC-HMS Basin Model Schematic

Because of the collapsed 15-inch drainpipe, the Upper reservoir currently drains directly to a bypass channel that flows along the east side of the Lower reservoir and discharges to the receiving stream downstream of the Lower dam. This channel may have intended to be the emergency spillway for the Upper dam when the Twin Brothers Lake was initially constructed. Currently, little flow is directed towards the Lower reservoir other than a small watershed immediately west of the lower lake. The existing conditions model schematic, presented in Figure 7, was arranged to reflect these existing hydraulic conditions. The existing conditions hydraulic routing parameters for each dam were developed as described in this section to create the existing conditions model.

Figure 7 Twin Brothers Existing Condition Model Schematic



Outflow Structures

To estimate flow through and over the dam, features of each structure were defined in the HEC-HMS model. The following section presents the features that were modeled and the selection of the geometric inputs.

Upper Dam Discharge to Bypass Channel

Although a low level outlet conduit exists, it is currently clogged, and flow is routed first toward the bypass channel in the left abutment and second over the dam crest. The entrance to the bypass channel was modeled as a non-level overflow section having a weir coefficient of 2.9. The eight-point cross-section used to define this outlet is provided in Table 7.

Table 7 Geometry Coordinates of Upstream Entrance to Bypass Channel

Station (ft)	Elevation (ft-MSL)
2.6	992.0
25.7	991.2
38.5	989.6
51.3	988.3
63.9	988.2
76.4	988.4
89.2	989.4
106.9	992.0

Upper Dam Crest

The Upper dam crest is approximately 190 feet long with a low point elevation of 992 ft-MSL. This feature is modeled as a level overflow having a weir coefficient of 2.8. The dam top will not activate unless the volume of water is above 992 ft-MSL.

Lower Dam Standpipe

The current conditions of the Lower dam were also modeled in the HEC-HMS model. Flow goes through either the partially clogged standpipe, a 24-inch CMP or over the Lower dam crest. This feature was modeled as an orifice outlet. However, it was noted that the structure is partially clogged during the survey, so the area was modeled at one half of its capacity to simulate the existing condition.

Lower Dam Crest

The Lower dam crest is approximately 220 feet long with a low point elevation of 987.5 ft-MSL. This feature is modeled as a level overflow having a weir coefficient of 2.8. The dam top will not activate unless the water surface elevation is above 987.5 ft-MSL.

Model Results

The resulting peak flows for the HEC-HMS model elements for the five modeled frequency storm events are provided in Table 8. The model results yielded the following findings:

- The flow from the East watershed does not enter either dam but rather completely bypasses both structures via the bypass channel.
- The Upper dam receives considerable inflow, estimated at a peak flow rate of 375.0 cfs for the 100-year event. Due to main discharge towards the bypass channel, the Upper dam currently does not overtop and may appear to be functioning adequately. However, as the discharge from this structure was never designed to exit in this manner, the function of this non-engineered exit location should be addressed in the concept design phase.
- The Lower dam has a small contributing watershed and therefore proportionally lower inflow, estimated at a peak flow rate of 75.9 cfs during the 100-year event. This dam also does not overtop in any of the modeled storm events because of the small inflow rates and the available discharge capacity slowly through the partially clogged standpipe. If the dams were configured in series, however, the Lower dam would require a much larger engineered spillway to safely pass the combined flow from the Upper dam discharge and the Lower and East watersheds. For example, during the 100-year event the inflow would increase from the 75.9 cfs in Table 3 to over 700 cfs. These flowrates on this size structure are too large to safely convey with a low-level outlet, such as a siphon or other riser/pipe-style principal spillway.

- Because of the direction of discharges from the Upper and East watershed to the bypass channel, the bypass channel must convey approximately 90 percent of the discharge that runs through the Twin Brothers Lake Dam site. Only approximately 10 percent is routed through the Lower dam. It is possible that the bypass channel was not intended to convey this much discharge and the fact that it could be contributing to its erosion over time.

Table 8 Existing Conditions Results

Parameters	2 Year	10 Year	25 Year	100 Year	500 Year
Upper Dam					
Upper Dam Inflow (cfs)	96.4	188.6	256.5	375.1	530.7
Discharge to Bypass Channel (cfs)	86.1	177.4	245.1	357.9	511.3
Upper Dam Overtopping Discharge (cfs)	0.0	0.0	0.0	0.0	0.0
Water Level (Top of Dam 992 ft-MSL)	989.2	989.7	990.0	990.4	990.8
Lower Dam					
Lower Dam Inflow (cfs)	28.6	45.8	57.3	75.9	98.8
Lower Dam Standpipe Discharge (cfs)	2.3	3.1	3.5	4.2	4.9
Lower Dam Overtopping Flow (cfs)	0.0	0.0	0.0	0.0	0.0
Water Level (Top of Dam 987.5 ft-MSL)	985.2	985.3	985.4	985.5	985.8
Immediately Downstream at Confluence with Bypass Channel					
East Watershed (cfs)	116.2	204.8	268.0	375.9	514.4
Downstream Study Point (cfs)*	203.3	385.2	516.3	736.6	1030.4

*Downstream study point includes discharges from the Upper, Lower, and East watersheds.

Proposed Conditions H&H Modeling

Due to the existing condition dam configuration and safety concerns noted for the continued functioning of the side bypass channel, this project considers two design alternatives for Twin Brothers Lakes Dam.

Alternative A is to rehabilitate both the Upper and Lower dams and to reroute flows from the contributing watershed through the reservoirs. A proposed conditions HEC-HMS model was developed to simulate the proposed operation in Alternative A as described in this following section.

Alternative B is to decommission the Upper and Lower dams and restore the stream channel. Under this alternative, the peak discharge through the site would be similar to that determined at the downstream study point referenced in Table 9, approximately 737 cfs for the 100-year event. This would be the case since runoff from the Upper, Lower, and East watersheds would combine in the location of the decommissioned Upper and Lower dams.

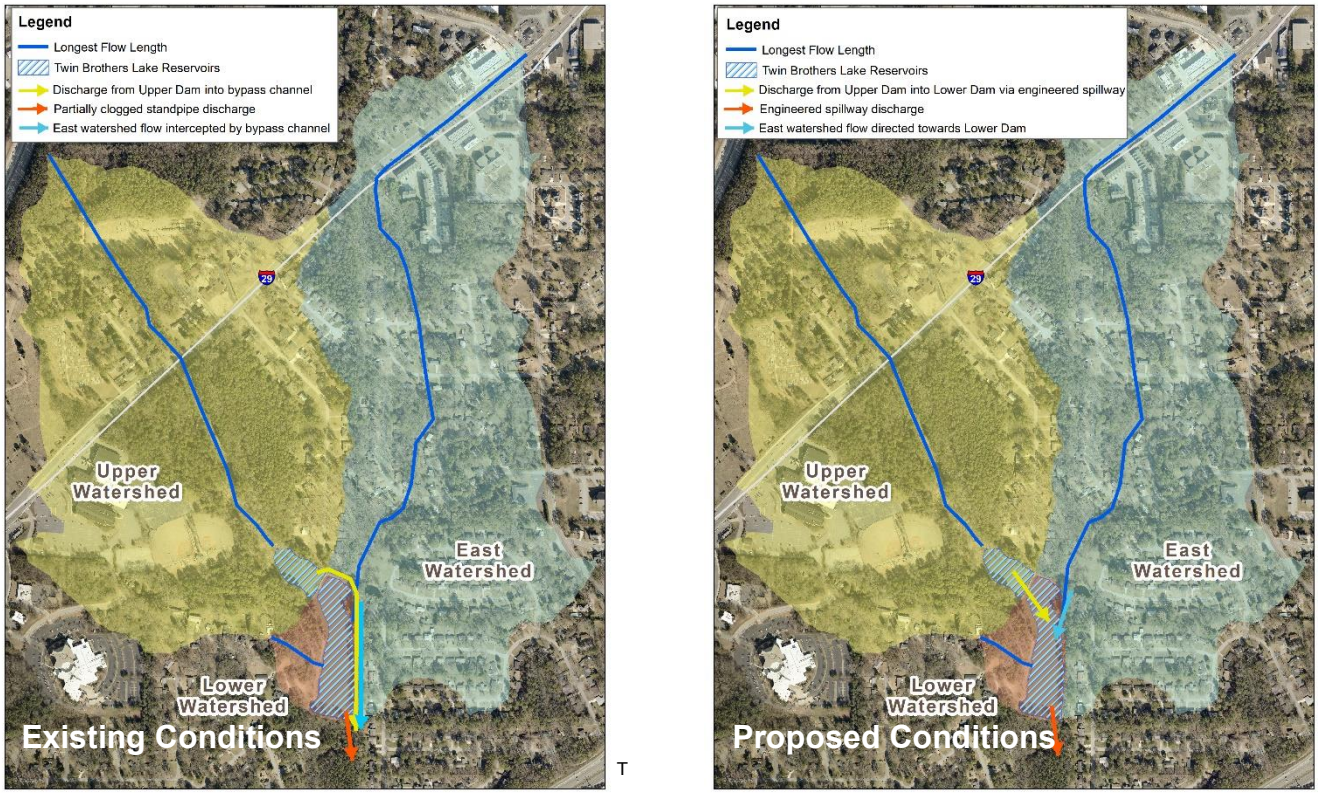
The following section focuses on the simulation of Alternative A for evaluation of the proposed conditions and outlet structures.

Overview of Alternative A - Proposed Conditions

One main alteration for the dam rehabilitation alternative is to abandon the bypass channel that currently conveys water from the Upper and East watersheds around the Lower dam. As indicated earlier, this channel was likely originally intended to be a shallow swale as an emergency spillway for the Upper dam but has eroded considerably and could cause issues for both compromised utility lines and public safety if it was kept. Therefore, the bypass channel is proposed to be abandoned by backfilling the channel; all flow from the Eastern watershed and Upper dam discharge will be directed towards the Lower dam.

Eliminating this channel will change the operation of the Twin Brothers Lakes Dam system. Currently the Lower reservoir receives only flow from a small contributing watershed (the 10.1-acre Lower watershed), and that there are approximately 280 acres that do not flow directly to or are routed through the Lower dam. Eliminating the bypass channel will require that all drainage from the Upper, Lower, and East watersheds will be directed towards the Lower dam. Figure 8 shows a comparison of existing and proposed conditions drainage patterns.

Figure 8 Existing vs. Proposed Flow Patterns at Twin Lakes Dam



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Design Constraints and Spillway Type Selection

The design of the proposed condition was constrained by the following considerations:

- Preference to maintain normal pool in both structures for neighborhood aesthetics and environmental benefits
- Spillway-type efficiency
- Need to maintain the structure as a low hazard dam.

For this design, the spillway design flood (SDF) was selected as be the 100-year, 24-hour flow event. Peak flow rates for the SDF are too large to pass through the dam via smaller diameter conduit-type spillways, such as drop spillways or siphons. The capacity of any single conduit or series of conduits will not be enough to safety convey the design flood without overtopping of the dam. Therefore, they were eliminated from consideration in favor of open section spillways.

At the Upper dam, flows will be passed through the dam via an open channel spillway cut into the left abutment of the dam. The spillway will follow the approximate alignment of the existing bypass channel until just beyond the dam when it will be aligned to discharge flows into the Lower reservoir. Due to expected high velocities during the SDF, the spillway will be armored with articulated concrete block mats to prevent erosion of the spillway.

At the Lower dam, flows will be passed through the dam over a concrete weir wall installed in the approximate center of the embankment. The concrete weir wall will include an earth retaining wall to retain the dam embankment on either end of the weir wall and train flows to pass over the weir. The area on the downstream side of the wall will be armored with riprap to prevent erosion and scour from water falling from over the weir wall crest.

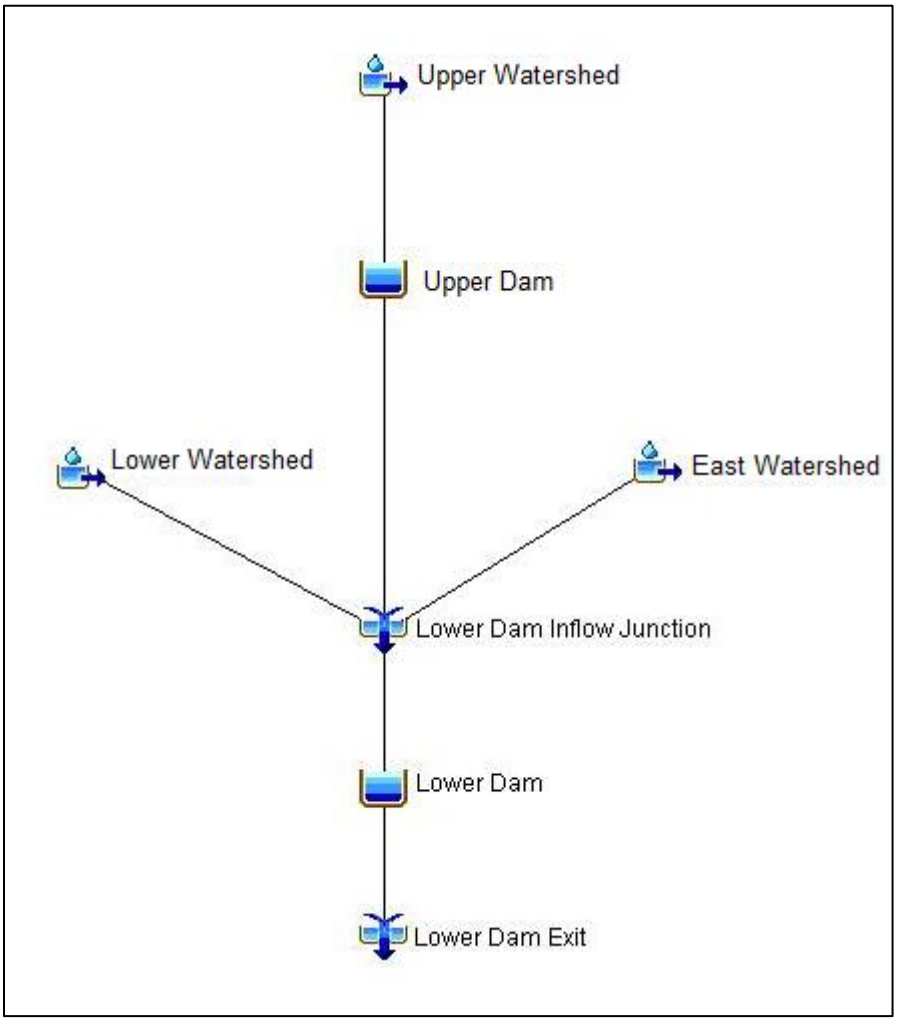
Elevation-Area Rating

No changes are proposed to the reservoir storage capacity and therefore, the elevation-area ratings developed for existing conditions model were applied to the proposed conditions model.

HEC-HMS Basin Model Schematic

The proposed conditions parameters for each dam's outlet structures were developed as described in this section to create the proposed conditions model. The proposed conditions model schematic is presented in Figure 9.

Figure 9 Twin Brothers Alternative A Model Schematic



Outflow Structures

To estimate flow through and over the dam, features of each structure were defined in the HEC-HMS model. The following section presents the features that were modeled and the selection of the geometric inputs.

Upper Dam Open Channel Spillway

The proposed conditions of the Upper dam were incorporated into the HEC-HMS model. The primary spillway is an open channel spillway proposed to run through the left abutment. An elevation-discharge rating for this spillway was developed in accordance with NRCS guidance and methodologies and the result is provided in Table 9Table 7.

Table 9 Upper Dam Open Channel Spillway

Elevation (ft-MSL)	Discharge (CFS)
989	0
990	57
991	196
992	403

Upper Dam Crest

The Upper dam crest elevation is not proposed to change from existing conditions. The Upper dam crest should not activate in the proposed design, as all discharge will safely pass through the engineered spillway. This feature is therefore not required in the Alternative A HEC-HMS model because all discharge will safely pass through the engineered spillway.

Lower Dam Weir Structure

The proposed conditions of the Lower dam were incorporated into the HEC-HMS model. The primary spillway is a concrete weir wall structure proposed to be located in the center of the dam embankment. The weir crest is proposed to be 90 feet long with a crest elevation equivalent to the existing normal pool elevation of 985 ft-MSL. An elevation-discharge rating for this structure was developed and is provided in Table 10.

Table 10 Lower Dam Weir Wall Discharge Rating

Water Surface Elevation (ft-MSL)	Discharge (CFS)
985	0
986	279.0
987	789.1
988	1449.7

Lower Dam Crest

The Lower dam crest is proposed to be raised by six inches from a low point elevation of 987.5 ft-MSL to 988 ft MSL. This feature is not required in the Alternative A HEC-HMS model because all discharge will safely pass through the weir structure described in the previous section.

Model Results

The resulting peak flows for the HEC-HMS model for the 100-year event are provided in Table 11.

Table 11 Proposed Conditions

Parameters	100 Year
Upper Dam	
Upper Dam Inflow (cfs)	375.1
Water Level (Top of Dam 992 ft-MSL)	991.7
Lower Dam	
Lower Dam Inflow from Combined Upper Dam Discharge, East Watershed, and Lower Watershed	716.4
Water Level at Lower Dam (Top of Dam 988 ft-MSL)	986.9
Lower Dam Discharge	715.3

Summary and Conclusions

Twin Brothers Lake Dam in Tucker, Georgia consists of two reservoirs and dams (Upper and Lower) as well as a bypass channel that conveys drainage from the Upper dam as well as an additional East watershed around the Lower dam and discharges immediately downstream of the Lower dam. Visual inspections have identified significant safety and stability issues with the bypass channel as well as with the Upper and Lower dams. These include significant erosion and slope instability.

Two modification alternatives are considered for Twin Brothers Lake. Under Alternative A the Upper and Lower dams will be rehabilitated and the bypass channel will be abandoned. This will require drainage from all watersheds to the site to be routed through the Lower dam. To accommodate this, the Upper dam will have an armored open section spillway installed in the left abutment of the dam and the Lower dam will have a concrete weir wall structure installed in the approximate center of the dam. Existing spillways and conduits will be removed. With Alternative A, the Lower dam will safely pass the 100-year flood event with greater than one foot of freeboard measured to the dam crest. The system is also estimated to reduce the 100-year flood discharge by approximately three percent when assessed at the study point downstream of the site.

Alternative B is to decommission the dam in which case the stream channel will be restored through the lakebed and decommissioned dam areas. The bypass channel will also be abandoned. Under this alternative, the hydrologic regime is expected to be similar to that of existing conditions with flows from the bypass channel now being conveyed through a restored stream system.

Attachment 2: Rendering of Recreation Concepts

Floral Hills Memory Garden

Rehoboth Baptist Church

Lawrenceville Hwy

Stapp Dr

US Highway 78 / Stone Mountain Hwy

3 Existing Hiking Trail

Design Strategies
1 Environmental Education
2 Consider Wayfinding Signage
3 Proposed Bird Blind

1 Existing Entrance

Design Strategy 1 Environmental Education

2 Existing Seating & Boardwalk

Design Strategies
1 Environmental Education
2 Consider Wayfinding Signage

6 Existing Meadow

Design Strategies
2 Consider Wayfinding Signage
6 Potential Access to Lake

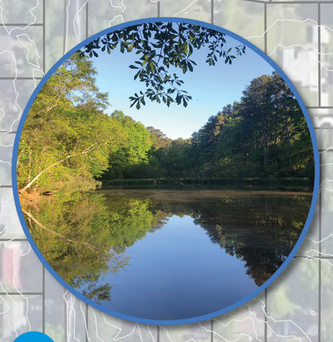
* Optional Amenities for:
- Children's Playgrounds
- Exercise Stations
- Small-group Sports
- Picnic
- Community Gardening

Repair Existing Dam - Concrete Weir Wall Spillway Structure

Proposed Limits of Lower Dam

Repair Existing Dam - New Spillway from Upper Basin to Lower Basin

Proposed Limits of Upper Dam



4 Twin Brothers Lake Dam

Design Strategies
4.1 Repair Upper Dam - New Spill-way from Upper Basin to Lower Basin
4.2 Repair Lower Dam - Concrete Weir Wall Spillway Structure

5 Eroded Area along Eastside

Design Strategies
5 Repair and Fill in Eroded Areas
7 Restore and Extend the Trail

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LEGEND

- Project Limits
- Twin Brothers Lake
- Low-lying Wet Area
- Meadow
- Johns Homestead
- Existing Parking Lot
- Existing Building
- Existing Sidewalk
- Existing Boardwalk
- Proposed Boardwalk/ Bridge
- Existing Trail
- Existing Entrance
- Existing Seating Area
- Proposed Bird Blind
- Sight Line

Opportunities
1. Existing Entrance
2. Existing Seating & Boardwalk
3. Existing Hiking Trail
4. Twin Brothers Lake Dam
5. Eroded Area along Eastside
6. Existing Meadow

Constraints & Design Strategies
1. Environmental Education
2. Consider Wayfinding Signage
3. Proposed Bird Blind
4.1 Repair Upper Dam - New Spillway from Upper Basin to Lower Basin
4.2 Repair Lower Dam - New Concrete Weir Wall Spillway
5. Repair and Fill in Eroded Areas
6. Potential Access to Lake
7. Restore and Extend the Trail

DeKalb County GEORGIA

TWIN BROTHERS LAKE DAM REHABILITATION PHASE II
RECREATION CONCEPTUAL RENDERING
ALTERNATIVE A - DAM REHABILITATION

0 100 200 400 ft

N

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Proposed Boardwalk/ Bridge
• A perpendicular crossing helps to minimize impacts on the restored stream and its ecologically sensitive areas.
Proposed Bird Blind
Proposed Nature Trail
• Jogging and Walking
• Family Activity
• Birdwatching
• Environmental Education
LEGEND
Project Limits
Johns Homestead
Existing Parking Lot
Existing Building
75' Stream Buffer
Proposed Meadow
Proposed Wayfinding Signage
Proposed Nature Trail
Proposed Adventure Trail
Proposed Primary Restored Stream Alignment
Proposed Restored Drainage into the Restored Stream
Existing Sidewalk
Existing Boardwalk
Proposed Boardwalk/ Bridge
Proposed Bird Blind
Proposed Outlook
Proposed Entrance
Proposed Resting Area
Proposed Stormwater Pipe
Floral Hills Memory Garden
Lawrenceville Hwy
Rehoboth Baptist Church
*Improve and adopt this part of the existing trail as the proposed adventure trail.
Proposed Restored Drainage into the Restored Stream
Proposed Primary Restored Stream Alignment
Stormwater pipe to be extended to the streambed
Proposed Meadow
• Multi-purpose Open Space
75' Stream Buffer
• Bank Stabilization
• Riparian Planting
• Unpaved Trail is Allowed
Stapp Dr
Proposed Adventure Trail
• Bird-watching
• Intermittent fishing opportunities
• Relaxation
• Jogging and Running
Proposed Trail Entrance
• Movies-in-the-Park
• Performances
• Community Gatherings
• Birthday Parties
• Weddings
• Family Reunions
• Employee Celebrations
• Health and Wellness Classes
• Environmental Education
Proposed Great Meadow
* Optional Amenities for:
• Children's Playgrounds
• Exercise Stations
• Small-group Sports
• Picnic
• Community Gardening
Castle Rock Way
S Marlborough Dr
Bonnie Glenn Ln
Edinburgh Dr
Vancouver Dr
Canadian Way
US Highway 78 / Stone Mountain Hwy
TWIN BROTHERS LAKE DAM REHABILITATION PHASE II
SITE ANALYSIS - BUBBLE DIAGRAM
TWIN BROTHERS LAKE DAM REHABILITATION PHASE II
EXISTING CONDITIONS- SLOPE ANALYSIS
Slope
0 - 2.0%
2.1% - 5.0%
5.1% - 8.0%
8.1% - 10.0%
10.1 - 15.0%

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TWIN BROTHERS LAKE DAM REHABILITATION PHASE II
RECREATION CONCEPTUAL RENDERING
ALTERNATIVE B - DAM REMOVAL AND STREAM HABITAT RESTORATION

0 100 200 400 ft N

AECOM

Attachment 3: Alternatives Budget Estimates

AECOM

By: AL Date: 6/18/2020
Checked: JB Date: 6/23/2020
Project: Twin Brothers Lakes
Phase: Alternative A - Dam Rehab

Engineer's Estimate of Construction Cost					
Line Item ID	**Description**	**Units**	**Quantity**	**Unit Cost**	**Total Cost**
	Clear and Grub	LS	1	$ 60,000	$ 60,000
	Remove CMP Conduit	LF	110	$ 20	$ 2,200
	Remove Concrete Retaining Wall	LF	170	$ 30	$ 5,100
	Excavation and Stockpile	CY	4350	$ 20.00	$ 87,000
	Embankment Backfill (Import)	CY	2500	$ 55.00	$ 137,500
	Channel Backfill (On-Site)	CY	4000	$ 15.00	$ 60,000
	Channel Backfill (Import)	CY	150	$ 40.00	$ 6,000
	Concrete Weir Wall	CY	750	$ 800	$ 600,000
	Articulated Concrete Block	SF	3100	$ 13	$ 40,300
	Coarse Aggregate	CY	120	$ 65	$ 7,800
	Fine Aggregate	CY	35	$ 120	$ 4,200
	Geotextile	SY	350	$ 5	$ 1,750
	Perforated Conduit	LF	100	$ 20	$ 2,000
	Extend Storm Drain Conduit	LF	40	$ 75	$ 3,000
	Storm Drain End Wall	EA	1	$ 2,500	$ 2,500
	Riprap	SY	350	$ 50	$ 17,500
	Beaver Area Rehabilitation/Connection to Pond	LS	1	$ 50,000	$ 50,000
	Topsoil	SY	21000	$ 8	$ 168,000
	Permanent Stabilization	SY	21000	$ 1	$ 21,000
	Construction Line Item Subtotal				**$ 1,215,850**
	Erosion/Sediment Control and Care of Water	%	1215850	5%	$ 60,793
	Mobilization/Demobilization	%	1215850	8%	$ 97,268
	Construction Total				**$ 1,373,911**
	Contingency	%	1373910.5	20%	$ 274,782
	Budget Total (nearest $10,000)				**$ 1,650,000**

Statement of Limitations: The work presented in this document has been carried out in accordance with reasonable and accepted engineering practices and standard of care. No warranty or guarantee, either written or implied, is applicable to this work.

AECOM

By: YZ Date: 7/9/2020
Checked: TS Date: 7/9/2020
Project: Twin Brothers Lakes
Phase: Recreation Alternative A

Engineer's Estimate of Construction Cost					
Line Item ID	**Description**	**Units**	**Quantity**	**Unit Cost**	**Total Cost**
	Boardwalk	SF	960	$55.00	$ 52,800
	Birdblind	EA	1	$5,200.00	$ 5,200
	Kiosk	EA	4	$2,000.00	$ 8,000
	Bench	EA	3	$3,000.00	$ 9,000
	Trash Receptacle	EA	3	$1,200.00	$ 3,600
	Crushed Slate Surface (Resting Area)	SF	1600	$4.50	$ 7,200
	Hardwood Mulch with Binder (4-inches)	SY	4197	$4.50	$ 18,887
	Geotextile	SF	36166	$0.50	$ 18,083
	Graded Aggregate Base (4-inches)	TN	905	$30.73	$ 27,811
	Groundcover	EA	14326	$8.50	$ 121,771
	Sod	SY	763	$7.50	$ 5,723
	Landscape Mulch (3-inches)	SY	1532	$3.60	$ 5,515
	Topsoil (4-inches)	CY	255	$ 50	$ 12,623
	Construction Line Item Subtotal				**$ 296,211**
	Erosion/Sediment Control and Care of Water	%	296211	10%	$ 29,621
	Miscellaneous	%	296211	1%	$ 2,962
	Grading	%	296211	13%	$ 38,507
	Construction Total				**$ 367,302**
	Contingency	%	367302	20%	$ 73,460
	Budget Total (nearest $1,000)				**$ 441,000**

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AECOM

By: BW Date: 6/18/2020
Checked: JB Date: 6/23/2020
Project: Twin Brothers Lakes
Phase: Alternative B - Dam Removal

Engineer's Estimate of Construction Cost					
Line Item ID	**Description**	**Units**	**Quantity**	**Unit Cost**	**Total Cost**
	Clear and Grub	LS	1	$ 60,000	$ 60,000
	Remove CMP Conduit	LF	110	$ 20	$ 2,200
	Remove Concrete Retaining Wall	LF	170	$ 30	$ 5,100
	Excavation and Stockpile	CY	8000	$ 20	$ 160,000
	Backfill and Grading	LS	1	$ 20,000	$ 20,000
	Channel Restoration through Dam	LS	1	$ 50,000	$ 50,000
	Extend Storm Drain Conduit	LF	40	$ 75	$ 3,000
	Storm Drain End Wall	EA	1	$ 2,500	$ 2,500
	Beaver Area Rehabilitation/Connection to Stream	LS	1	$ 80,000	$ 80,000
	Tree Planting	LS	1	$ 10,000	$ 10,000
	Permanent Stabilization	SY	43000	$ 1.50	$ 64,500
	Construction Line Item Subtotal				**$ 397,300**
	Erosion/Sediment Control and Care of Water	%	397300	10%	$ 39,730
	Mobilization/Demobilization	%	397300	10%	$ 39,730
	Construction Total				**$ 476,760**
	Contingency	%	476760	20%	$ 95,352
	Budget Total (nearest $10,000)				**$ 570,000**

AECOM

By: YZ Date: 7/9/2020
Checked: TS Date: 7/9/2020
Project: Twin Brothers Lakes
Phase: Recreation Alternative B

Engineer's Estimate of Construction Cost					
Line Item ID	**Description**	**Units**	**Quantity**	**Unit Cost**	**Total Cost**
	Boardwalk	SF	2520	$55.00	$ 138,600
	Birdblind	EA	1	$5,200.00	$ 5,200
	Overlook	EA	1	$30,000.00	$ 30,000
	Kiosk	EA	6	$2,000.00	$ 12,000
	Bench	EA	3	$3,000.00	$ 9,000
	Trash Receptacle	EA	3	$1,200.00	$ 3,600
	Crushed Slate Surface (Resting Area)	SF	1600	$4.50	$ 7,200
	Hardwood Mulch with Binder (4-inches)	SY	10522	$4.50	$ 47,349
	Geotextile	SF	93088	$0.50	$ 46,544
	Graded Aggregate Base (4-inches)	TN	2328	$30.73	$ 71,539
	Groundcover	EA	19206	$8.50	$ 163,251
	Sod	SY	12226	$7.50	$ 91,695
	Landscape Mulch (3-inches)	SY	2054	$3.60	$ 7,394
	Bioretention/Wetland Plantings (4-inch pots)	EA	19510	$ 5	$ 97,550
	Construction Line Item Subtotal				**$ 730,923**
	Erosion/Sediment Control and Care of Water	%	730923	10%	$ 73,092
	Miscellaneous	%	730923	1%	$ 7,309
	Grading	%	730923	13%	$ 95,020
	Construction Total				**$ 906,344**
	Contingency	%	906344	20%	$ 181,269
	Budget Total (nearest $1,000)				**$ 1,088,000**

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AECOM

By: YZ Date: 7/9/2020
Checked: TS Date: 7/9/2020
Project: Twin Brothers Lakes
Phase: Recreation Alternate Bid Items

Engineer's Estimate of Construction Cost					
Line Item ID	**Description**	**Units**	**Quantity**	**Unit Cost**	**Total Cost**
	Outdoor Composting Toilets	EA	2	$35,000.00	$ 70,000
	Playground	LS	1	$75,000.00	$ 75,000
	Picnic Table	EA	3	$2,000.00	$ 6,000

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