AMERICAN RIVERS

May 19, 2026

This cover letter has been prepared for the Craggy Dam Removal Study Report of Findings: Conceptual Design and Energy Alternatives Analysis, publicly available at CraggyCoalition.org. All appendices and excel workbook attachment are available at request by email to; Craggy@americanrivers.org.

Between 2024-2025, American Rivers and the Buncombe County Municipal Sewerage Department (MSD) partnered on this report, funded by the North Carolina Wildlife Resources Commission, to investigate the costs, benefits, and feasibility of the possible removal of Craggy Dam. A final update, based on MSD Staff feedback in January 2026, was delivered in April 2026.

From the report, we've learned that no known constraints -- engineering, sediment, or regulatory -- make dam removal impossible. Dam removal is technically feasible and potentially fundable, pending full due diligence. We've also learned that there are significant benefits which would be realized in the case of dam removal.

This report also helps us to understand the scope and costs of Craggy Dam removal, if realized. The content of this report does not represent a complete design, nor does it determine or assign absolute value to either removing or retaining the Craggy Dam.

Conversations have now turned to investigating the value of Craggy Dam, should it be sold to partner organizations who would then in turn pursue dam removal and river restoration.

In the short term a public, transparent process will be needed to fully understand:

1. The fair value of Craggy Dam as an asset, and;
2. The public benefits and tradeoffs of dam removal, before foreclosing options or making irreversible capital commitments.

As of this writing, a broad coalition of local, regional, and national organizations -- including American Rivers, MountainTrue/French Broad Riverkeeper, RiverLink, Sierra Club, Southern Environmental Law Center, and American Whitewater -- supports continued exploration of the possibility of dam sale and ultimate removal.

Craggy Dam presents an extraordinary opportunity to balance fiscal responsibility, public safety, environmental stewardship, and community resilience. We are grateful for the partnership and leadership of MSD which has brought us to this point, and committed to continuing to seek a path forward which reflects the best long-term interests of MSD, its ratepayers, and the region.

Sincerely,

Anabel Winitsky,
American Rivers Associate Director, Southeast Conservation

Craggy Dam Removal Study
Report of Findings: Conceptual Design and Energy Alternatives Analysis

French Broad River Basin | HUC 06010105 | Buncombe County, North Carolina

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EXECUTIVE SUMMARY

The Craggy Dam Removal Study assesses the outcomes of a proposed river restoration project on the French Broad River; Removing Craggy Dam, a 120-year-old in-stream barrier and hydropower facility operated by the Buncombe County Metropolitan Sewerage District (MSD) in Woodfin, North Carolina (NC). The study explores environmental, social, and economic benefits, along with the existing and alternative energy solutions to replace hydropower production. American Rivers partnered with MSD on this study. Answers to questions from MSD that are not in the body of this report can be found in Appendix G.

Key Findings

Part A. The Benefits and Impacts of Dam Removal

Dam removal will benefit the Greater Asheville area through numerous avenues. These benefits include the following:

- Local Economy Growth: Dam removal supports tourism, outdoor businesses, and real estate value increases.
- Flood Reduction: Flood stages could drop by up to 10 feet, reducing flood risks to local infrastructure and buildings, improving resiliency along the river corridor.
- Job Creation: Dam removal and subsequent development projects would generate sustained and temporary employment.
- Recreation & Safety: There will be increased opportunities for paddling, fishing, and greenway development; plus, the elimination of safety hazards associated with the dam.
- Community Revitalization: There will be enhanced cultural and recreational amenities, aligning with Greater Asheville's outdoor recreation economy and identity.
- Environmental Restoration: Dam removal reconnects 1,460 downstream miles of river to the headwaters of the French Broad River for the benefit of native fish species, improves water quality, and creates more floodplain buffer.

Due to the many benefits of dam removal there is an existing local community of stakeholders and vested state and federal agencies in favor of Craggy Dam removal. A stakeholder/community group should be engaged prior to further development of dam removal plans.

However, there are several impacts to consider with the removal of the dam. A significant impact is the operational change to MSD, who would no longer produce hydropower which offsets cost of grid electricity used for their wastewater treatment facilities. Additionally, hydropower production has the lowest greenhouse gas (GHG) emissions per kilowatt-hour compared to other power production.

There will also be changes to the river system with dam removal. Some will be temporary impacts that are aesthetic and water quality based while others will be a permanent change such as the type of boating accessible before and after removal with a change from slack water to flowing water.

Part B. Site Conditions and Implementation of Dam Removal

The Study determined there are no physical, financial, or environmental reasons that prohibit the removal of Craggy Dam. There may be financial incentives to remove the dam given the anticipated need to repair, replace, or rehabilitate dozens of elements of the hydropower facilities over the next 10 years, as identified by the Hatch Report.

Several environmental assessments and studies are needed to develop dam removal plans. Additionally, there will be many steps in the regulatory process including working with both FERC and FEMA which may take up to three years to complete. All liability for the dam removal work including all structures associated with hydropower generation even if left standing or repurposed would be transferred to a new entity. Throughout the process of removal and forever after MSD would no longer be held to the operations, capital investments, maintenance, and liabilities associated with Craggy Dam.

The initial estimate of the cost to fully removal Craggy Dam and all the associated hydropower facilities is $6.3 million to $8.7 million. Estimated cost savings of $3.9 to $4.4 million can be found if portions of the hydropower system are left in place and the dam alone is fully removed. This second removal scenario would still provide all the benefits to the community and river listed previously.

Part C. Energy Analysis

Three energy future alternatives were identified and evaluated over a 27-year period, consisting of 2 years of planning and 25 years of operation. The 'Dam Remains' alternative leaves the existing hydro facility in place and invests in the hydro facility according to the Life Extension and Reliability scenario as described in the Hatch Report. The grid power alternative removes the hydro facility and relies on the regional grid for all electricity needs. The solar power alternative removes the hydro facility and replaces it with a nearby solar power facility sized to approximate a similar level of annual electricity production as the removed hydro facility.

Primary findings from the analysis are provided below, while a more detailed set of findings is presented in the main body of this document. The resulting present value cost refers to the costs associated with meeting total MSD energy demands over the full 27-year period under each alternative scenario.

- Dam Remains (*Scenario 1*): Present value costs are approximately $16.4 million.
- Grid Power (*Scenario 2*): Present value costs are approximately $21.0 million.
- Solar Power (*Scenario 3*): Present value costs are approximately $26.9 million to $32.3 million[1].

Conclusions and Recommendations

There are multiple benefits to the community, economy and environment associated with the removal of Craggy Dam. There do not appear to be any significant issues with existing infrastructure, sediment, or regulatory concerns that would prevent dam removal. Given the initial community and regulatory support and likely funding opportunities for dam removal we recommend the following actions:

- Evaluate the existing on-going grid power use and amount of usable hydropower production with duration of off-line facilities due to maintenance issues not fully captured in the Hatch Report.
- Develop and conduct a community outreach and engagement plan to gauge community and stakeholder perspective and long-term interests in investments, including solar power and recreation, around the French Broad River.
- Utilize the investigations in the Stantec and Hatch Reports as well as community input to inform future decision making by Buncombe County MSD board leadership regarding the future of Craggy Dam.

[1] The range of total present costs presented in this bullet reflects some uncertainty as to whether federal tax credits apply to the solar facility.

1 INTRODUCTION

1.1. Purpose of Study

The purpose of this study is to determine whether the removal of Craggy Dam is environmentally and economically viable. In doing so, this report recognizes both beneficial aspects as well as challenges of dam removal on the Buncombe County North Carolina Metropolitan Sewerage District (MSD) operations and the French Broad River.

Craggy Dam is a hydropower facility operated by MSD's wastewater treatment (WWT) facility. Craggy has stood for 120 years as the upstream most aquatic barrier on the mainstem French Broad River, separating the downstream network from its headwaters. Craggy Dam provides renewable power generation for MSD operations but also impacts the economic potential and ecological health of the river corridor. Craggy Dam is at a critical life-cycle point, as MSD must make significant investments in capital improvements and maintenance if effective hydropower operations are to continue. American Rivers partnered with MSD and contracted Stantec to investigate the feasibility of dam removal, evaluating the (A) impacts of restoring the natural river system, (B) developing conceptual design and cost estimate for dam removal, and (C) a practical evaluation of the economic and operational impacts for MSD given future scenarios with or without the dam.

Figure 1: Study Area

1.2. Background

Craggy Dam and WWT operations are in Woodfin NC, approximately four miles north of Asheville, NC. The dam is positioned across the French Broad River, in United States Geological Survey (USGS) 8-digit Hydrologic Unit Code (HUC) 06010105 with a 965 square mile (sq mi) watershed. The study area is approximately 364 acres and includes the hydroelectric facilities, MSD's property across Riverside Drive, and the adjacent property to the east (See **Figure 1**).

1.2.1. Site History

Craggy Dam and its original facilities, known as Weaver Dam, were built in 1904 by W. T. Weaver Power Company to provide power for their Asheville streetcar lines as well as residential and commercial customers (MSD 1983, Rhoades & Rhoades Jr. 1996, Bubenik 2023). The dam was acquired by Carolina Power and Light Company (CP&L) and operated until 1963 when it became uneconomical to continue production. MSD purchased the facilities in 1963, along with the adjacent property where MSD subsequently built the WWT facility. To allow for the construction of the WWT facility, and the related relocation of Riverside Drive (NC Hwy 251), the original power canal headrace (called a flume hereafter) was filled in for approximately two-thirds of its length. In 1983, MSD applied for a license exemption from the Federal Energy Regulatory Commission (FERC) to put the hydro-electric facilities back into production and provide power for the WWT facility (MSD 1983). From 1984 to 1986, the intake gates and flume were replaced with new structures and alignment; the left dam abutment was repaired; and the powerhouse, powerhouse access, tailrace, and associated river berm were rehabilitated (MSD 1983, MSD 1984, MSD 1985, Nisbeth n.d.). The structures have stayed in the resulting configuration to the current day.

1.2.2. Current Conditions and the Hatch Report

Two reports, hereafter referred to as the Hatch Report, were developed by Hatch Associates Inc as part of a Conditions Assessment for MSD for the stated purpose of assisting the management of the Client (MSD) in making decisions with respect to the planned condition assessment, recommendations for improvements, and the associated Capital Improvement Program for Craggy Dam. The reports include the Condition Assessment and Recommendations (Hatch 2024), and the Craggy Condition Assessment Capital Improvement Plan (Hatch 2025).

The Hatch Report's Condition Assessment and Recommendations reviewed the operations of the full hydropower facility including the flume, gatehouse, dam spillway, powerhouse and switchyard and transmission lines. The report describes several mechanical elements in poor condition including the powerhouse intake gates and the headgates and vibration issues with the two turbines. Electrical systems were in satisfactory condition but were noted to be nearing the end of their expected service life which means running equipment at risk of failure or replacement and modernization. Structures varied in condition and included ratings of poor at the headgates, fair at the spillway, and good for the flume wall powerhouse but include recommendation to monitor conditions, like leaks, spalling and powerhouse components.

The Hatch (2024) Report recommends over 40 minor and major items for repair, rehabilitation/overhaul, or replacement for general life extension, reliability, safety or environmental concerns within the next 10 years. In addition, dozens of elements for monitoring or completing a detailed engineering analysis for determination of additional operational needs are recommended.

The Hatch Report's Capital Improvement Plan provides a Life Extension and Reliability scenario, which includes 30-years of projections (FY2025-2055) of investment into major maintenance and life extension

and estimated annual power generation based on projected increases in project capacity. The resulting model's estimates of required investment schedule and increased power production are used as input assumptions for the financial model of the dam-remains scenario found in Part C - Energy Alternatives Analysis of this report.

For a more detailed accounting of the challenges associated with the incorporation of the Hatch Report's Life Extension and Reliability scenario into the Craggy Study see Appendix F. As discussed in Appendix F, many of the challenges regard defining baseline, the use of inflated versus constant dollars, and the approaches to dealing with uncertainty.

Power production at Craggy Dam has historically offset a proportion of the electric energy needs for MSD's WWT facility. Between September 2024 and August 2025, the hydropower facility went offline while MSD waited for a replacement part. However, due to the existing electric grid backup connection this does not hinder MSD's WWT facility capabilities and allows MSD to service equipment on a budgetary and workforce timeline that fits their needs.

1.3. Stakeholders and the Greater Asheville Community

Dam removal of publicly owned structures impacts a broad array of stakeholders due to the many significant benefits and changes to the community and river system. Therefore, community input is critical in measuring the social value of the river both with and without the dam, as well as assessing the effects of lost hydropower electricity generation. Hydropower dam removals require significant local, state and federal coordination. Early agency coordination supports process collaboration and efficiency. Additionally, local non-profits can provide value-added planning and visioning to a dam removal project. Equinox Environmental has been in touch with the Woodfin community and stakeholders of the Taylor's Wave project due to their involvement in the project. Several of the stakeholders were aware of this feasibility study and were in favor of the removal of Craggy Dam. These same groups/people would likely be stakeholders in the removal of Craggy Dam if it were to advance further. Potential stakeholders for determining the value of removal for Craggy Dam include the following:

Stakeholders with Vested Interest (directly adjacent, near the project site, or impacted to a higher degree than others):

- MSD staff and Board of Directors
- The Mill at Riverside; residential tenants, businesses, and owners
- French Broad River Academy Boys and Girls School
- Town of Woodfin
- Buncombe County
- Residents in proximity to the river
- Nantahala Outdoor Center
- French Broad River Outfitters
- MSD ratepayers, (including, but not limited to; service area recipients, individuals, businesses and government entities)
- Norfolk-Southern Railroad
- Other businesses up and downstream of the dam

Non-Profit Stakeholders:

- French Broad River Paddle Trail – Mountain True & French Broad Riverkeeper
- French Broad River Partnership
- Riverlink

- Asheville Greenworks
- FIND Outdoors
- Connect Buncombe
- Southern Appalachian Highlands Conservancy
- Mountain Bizworks – Made By Mountains
- Outdoor Business Alliance of WNC
- Mills River Partnership
- Great Trails State Coalition
- Trout Unlimited
- American Whitewater
- American Rivers
- Conserving Carolina
- River Management Society
- North Carolina Paddle Trails Association
- North Carolina Outdoor Recreation Coalition

Government Agency Stakeholders: (with a special emphasis on French Broad River Paddle Trail)

- Transylvania County: Parks & Recreation, Natural Resources Council, Soil & Water Conservation District
- City of Brevard
- Henderson County: Parks & Recreation, Soil & Water Conservation District
- Town of Mills River Parks & Recreation
- Buncombe County Parks & Recreation
- City of Asheville Parks & Recreation
- Madison County Parks & Recreation
- Town of Marshall
- Land of Sky Regional Council
- North Carolina Department of Natural & Cultural Resources: State Parks, State Trails
- North Carolina Wildlife Resources Commission
- North Carolina Department of Transportation
- North Carolina Department of Commerce: Outdoor Economy Office
- US Fish and Wildlife Service
- United States Forest Service: Pisgah National Forest, Cherokee National Forest
- Town of Montreat
- Town of Biltmore Forest
- Town of Weaverville,
- Woodfin Sanitary Water and Sewer District
- Cane Creek Water and Sewer District
- Town of Black Mountain

PART A – IMPACTS OF DAM REMOVAL

2. ECONOMIC IMPACTS OF DAM REMOVAL

Removing a dam is an intensive infrastructure endeavor that creates local construction, engineering, scientific, planning, and other related jobs. Dam removal projects support 12 to 15 jobs per $1 million invested (American Rivers 2023). Long stretches of free-flowing rivers not only enhance natural functions and ecological habitat, but they can also provide economically valuable recreational opportunities that impact local communities and the region. The feasibility of the Craggy Dam Removal must consider the comprehensive benefits and impacts to the French Broad River watershed especially as it relates to local economies and communities.

2.1. Recreation

Outdoor recreation is a cornerstone of the Greater Asheville regional and local economy, generating jobs, supporting entrepreneurship, cultivating outdoor communities, enhancing quality of life, and fostering environmental stewardship.

This analysis considers the major success of the French Broad River Paddle Trail, a 140-mile recreational watercraft trail between Rosman, North Carolina and Newport, Tennessee, and the existing recreation investments underway in the Town of Woodfin including the Woodfin Greenway & Blueway and the whitewater Wave (Taylor's Wave) at Riverside Park. The removal of Craggy Dam would promote additional opportunities for river-based recreation, parks, and greenways. Connected and continuous outdoor recreation access in the Craggy Dam corridor has the potential to generate compounded economic, community, social, and environmental benefits that will redefine the region and further solidify western North Carolina as the outdoor industry capital of the eastern United States.

2.1.1. Valuing the French Broad River

To support communities in building their case for outdoor-driven economic development, the Made By Mountains Partnership collaborated with Appalachian State University's Center for Economic Research and Policy Analysis to produce usable data for local officials and stakeholders (MADE x MTNS 2024). Their findings revealed first-of-its-kind data showcasing that outdoor recreation visitor spending generated **$4.9 billion** in revenue and supported **48,000 jobs** in 25 counties of western North Carolina in 2022. Local and visitor spending ripples through the economy directly and indirectly impacting numerous businesses and industries including:

- Gear: outfitters/rentals
- Food: restaurants, grocery stores, breweries, coffee shops
- Lodging: camping, glamping, hotels, bed & breakfasts, short-term rentals
- Transportation: gas and other travel spending
- Retail & Services: shopping and other services
- Activities: guided experiences

Additionally, in December 2021, the French Broad River Partnership published an economic impact study of the French Broad River (Ha 2021) produced by researchers from Western Carolina University. Their study narrowed in on the 8 counties that the river touches and revealed that the annual economic impact of the river and its tributaries was **$3.8 billion**. Other key findings revealed that the watershed

received **6.9 million river-influenced visitors**, who spent an average of **$1277 per visit**, resulting in **$2.7 billion in annual visitor spending** creating and sustaining **38,554 jobs**.

These findings illuminate the immense economic potential of continued investment in outdoor recreation assets within the French Broad River watershed and region.

2.1.2. French Broad Paddle Trail

When considering the geographic footprint of the French Broad River Paddle Trail, which in western North Carolina includes Transylvania, Henderson, Buncombe, and Madison counties, there is currently 75 miles of free-flowing river between Rosman and Riverside Park in Woodfin. Removing Craggy Dam would provide an additional 16 miles of continuous water-based recreation to Capitola Dam in the Town of Marshall. This outdoor asset provides ample opportunities for the beginner to the expert, diverse trip experiences, and connectivity to local businesses and communities further stimulating community and economic development.

In 2017, Summit Economics (Doedderlein and Binnings) evaluated the economic benefits of many years of restoration along the South Platte River and Cherry Creek in Denver Colorado and found that, on average, properties within a half mile of the rivers or greenways hold 36 percent higher value than other properties in the city. Dam removal is a primary and effective means of river restoration and when partnered with the recreational extension of greenways and blueways in the area it is anticipated that the property values along the French Broad River in near Craggy Dam will benefit as will Buncombe County with property tax revenue.

Over the last several years, Asheville, Woodfin, and the surrounding region have grown largely due to their investments in outdoor recreation assets that enhance quality-of-life and their proximity to pristine national forests containing numerous hiking and biking trails. In addition to the French Broad River Paddle Trail, which contains 40 access points and 20 riverside campsites, a 15-mile-long greenway has been envisioned and studied along the French Broad River corridor from the corporate limits of the City of Asheville north to the Buncombe/Madison County line, including an area within the Town of Woodfin and adjacent to Riverside Drive and the Craggy Dam. The greenway corridor along the French Broad River follows the route of an early transportation link between Tennessee and South Carolina known as the historic Buncombe County Turnpike. More recently, a section of this greenway was included as part of the Hellbender Trail, a regional trail approximately 18 miles in length connecting Asheville, Black Mountain, Brevard, Canton, Fletcher, Hendersonville, Mars Hill, and Waynesville.

Approximately 5 miles of the above referenced greenway that is part of the Woodfin Blueway Greenway project currently includes the MSD office. The greenway which connects multiple parks will be providing a major asset to the residents of the community and the county with Riverside Park & Taylor's Wave serving as a regional destination. Riverside Park & Taylor's Wave, the greenway, and Silver Line Park are key components of a $34 million dollar investment in the Woodfin Greenway & Blueway projects, which will rebrand the town as a mecca for outdoor recreation.

In summary, an interconnected greenway and blueway network would enhance quality of life and provide ample public health benefits. It would also provide an active transportation corridor and allow for diverse outdoor recreation experiences including:

- Paddling (kayaks, canoes, standup paddle boards) – multi-day adventures
- Tubing

- Walking, running
- Cycling
- Birding
- Fishing, angling
- Camping
- Picnicking
- Ecological education through interpretive signage.

2.1.3. Impacts on Existing Recreation Amenities

The whitewater kayaking feature developed with Taylor's Wave may be marginally impacted with dam removal, discussed in detail in **sub-section 4.2.1**. The Wave was designed to retain function with the dam removed. Still, stakeholders may find that a backwater structure may improve the Wave features following dam removal. There would be a cost associated with the installation of the structure, but its addition could create a backwater that better supports the Wave features than the backwater from Craggy Dam as currently designed.

Development opportunities may arise from removing the dam but stabilizing other elements of the facilities in place. For instance, leaving the flume intact as a site for potential greenway connectivity would allow for continued outdoor infrastructure investment in a localized recreation network. The pumphouse could also be repurposed as a historic marker and recreational waypoint with the building serving as a coffee house or snack station.

The reservoir produced by Craggy Dam currently creates deeper and calmer water than the up or downstream flowing portions of the French Broad River, an amenity which would be lost with the removal of Craggy Dam. This segment of river is approximately 3500 LF with a depth ranging from around 9 feet nearest the dam to around 4 ft at the upstream extent. However, due to safety postings near the dam paddlers cannot use the entire length without jeopardizing personal safety. The small length of reservoir takes only a few minutes going up or downstream in a kayak or canoe but will take longer on a standup paddle board. The reservoir length and safety risks for both fitness and casual paddling reduces the attractiveness for flat water paddling.

NC Wildlife Resources Commission (WRC) hosts an interactive online map for fishing locations in NC. Two non-WRC affiliated fishing locations are noted on the map that bracket Craggy Dam. Primary game fishing species from Riverside Park (upstream) and Ledges River Park (downstream) include the same four species: Muskellunge, North American Freshwater Catfishes, Redbreast sunfish, Smallmouth bass. Muskellunge are the only species stocked by NCWRC of those listed. Both locations are expected to retain the same game fishing opportunity after dam removal, potentially increasing habitat by connecting the up and downstream forage areas.

2.1.4. Safety Improvements

In-line dams like Craggy Dam present some inherent risks to recreationists on the water and have been colloquially labeled "drowning machines" for their ability to trap someone in the turbulent area directly below the dam during high flow conditions (Association of State Dam Safety Officials, 2025). During low flow conditions there are exposed boulders and overall rocky conditions. Both flow scenarios are life endangering situations if ever encountered by river uses.

Additionally, there is no legal river-level portage at Craggy Dam due to MSD operations and fencing related to the closed Buncombe County landfill downstream. Paddlers must exit the river at Riverside

Park and drive 4-miles downriver to Ledges Whitewater Park to re-enter. As more people recreate on the river, especially with the investment in Taylor's Wave at Riverside Park, there's a higher risk of personal injury given the proximity of the dam. The U.S. Fish and Wildlife Service has stated that dams pose a deadly risk to recreationists and families across the country due to the hydraulic forces imposed on the river.

MSD has reported no incidents at the dam and has implemented signage warning river-goers of the dam location. While the current safety strategy has not failed, increased river uses by recreational boaters and those not familiar with the downstream dam may reduce the strategy's success in the future. Removing the dam would provide a proactive measure to protect the health and safety of users and provide an easeful experience between Riverside Park and Ledges Whitewater Park, enhancing Woodfin as an outdoor recreation destination and eliminating the liability risk of MSD.

2.2. Flood Reduction

The French Broad River has a mapped 100-year FEMA floodplain, a mapped 500-year floodplain, and a mapped 100-yr floodway (Map Number: 3700973000J / Panel 9730, dated 1/6/2010). The dam removal was not modeled for this study, but a Flood Insurance Study was performed on the French Broad River in 2010, and profiles were produced for the 10-, 50-, 100-, and 500-year floods. Interpolating between the profiles downstream of the dam and those just above its influence suggests that removing the dam will reduce the flood stage at the dam location by approximately 10 ft in all storms; further, approximately 1000 ft upstream of the dam, flood stage will be reduced by approximately 8 to 9 ft in the 10-yr and 7 to 8 ft in the 100- through 500-yr storms. **Table 1** below shows the likely properties to experience a reduction in the extent of flooding in a dam removal scenario. **Figure 2** below shows a map of properties near to Craggy Dam, some of which are expected to benefit from dam removal by reduced impact on existing structures. See **Appendix A** for FEMA floodplain related information.

Table 1: Properties with likely reduced floodplain limits with dam removal

Landowner	ID #	Potential Flood Reduction Benefit
Buncombe County MSD Maintenance building	NA (2110 Riverside Dr)	Building and parking lot out of 500-yr and 100-yr events
Buncombe County MSD Main Office building and other buildings	NA (2028 Riverside Dr)	Building and majority parking lot out of 500-yr and 100-yr events
IMC Investments, LLC	5	The Mill at Riverside building out of 500-yr event Majority of parking lot out of 100-yr event
French Broad River Academy, Inc	11	Building is likely out of 100-yr flood event
Somers, Glen	1	Reduced extent of 500-yr and 100-yr events
NCDOT	NA	Riverside Dr out of 500-yr and 100-yr events
RR Right-of-way	NA	Tracks out of 100-yr event

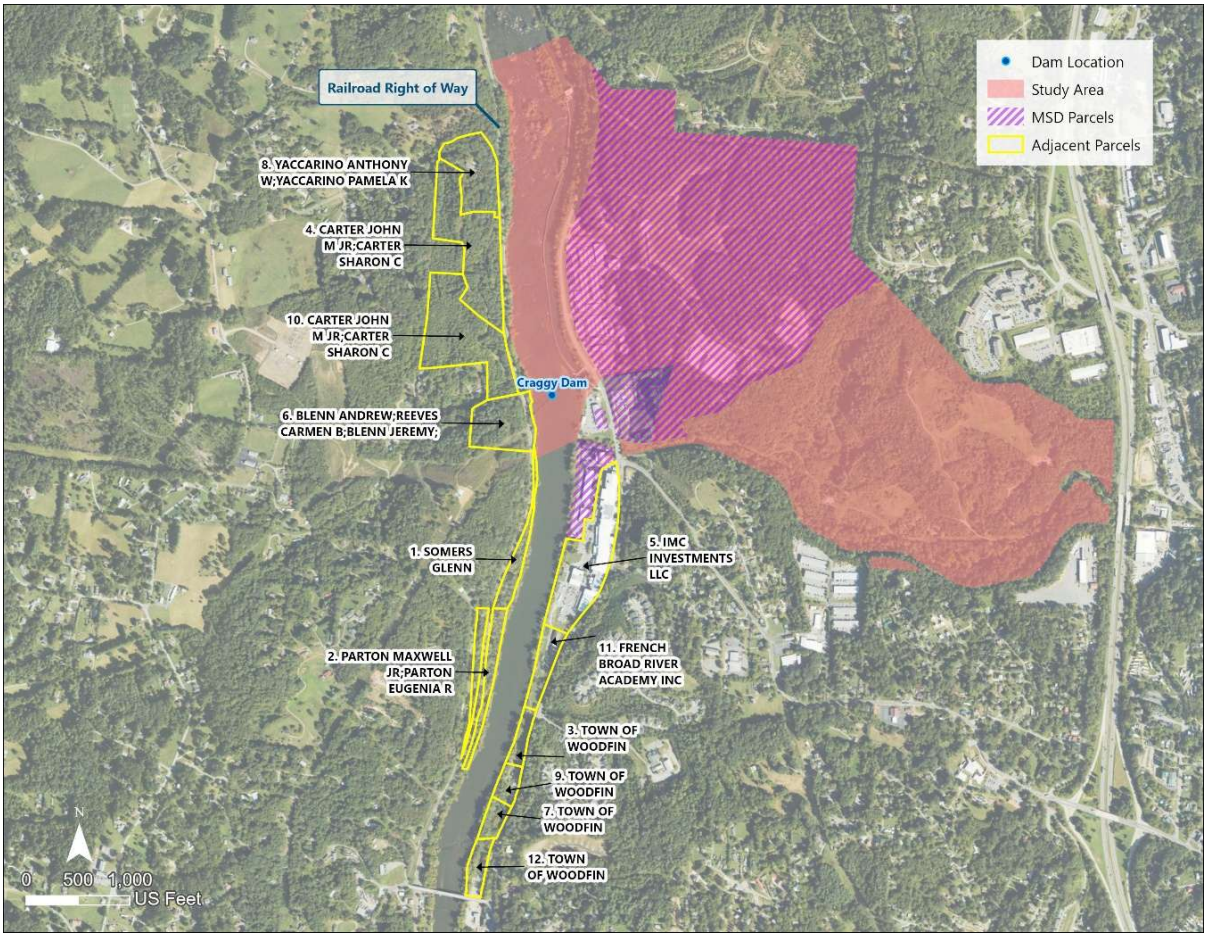


Figure 2: Adjacent Property Owners

2.3. Temporary Impacts Following Dam Removal

Upon drawdown of the impounded water in a dam removal project the exposed sediments will likely be an unaesthetic condition. This may temporarily affect the river viewing by community members at businesses upstream. It is common for sediment to need a few years, depending on the size of storms in the watershed, to fully evacuate the accumulated sediments. During this time new vegetation may develop along the riverbanks but will be low and herbaceous until larger trees can either be planted or naturally grow from existing seedbank deposition. It is anticipated that the riverbed will be rocky like the condition near and upstream of Old Leicester Hwy and of similar width to the existing channel. However, there are sand, silt and organic materials covering these rocks that will be exposed and take time to mobilize downstream. **Figure 3** shows the vegetation development along a dam removal site near Baltimore MD.

The upstream conditions will take a few years to equalize with sediment remobilization likely occurring with storms over a 5-year return period. During this time the downstream channel will also be temporarily affected. The remobilized sediments during Phase 1 **(See subsection 5.1.3)** will move downstream in a sediment pulse based on allowances determined in the permitting process. A study completed by Collins et al (2024) on the Bloede Dam removal near Baltimore MD showed that minor downstream sediment accumulation occurred with sand-sized and finer particles at existing point bars and some riffle features during Phase 1 but were remobilized during Phase 2 of the sediment remobilization. It is expected that the area downstream of Craggy Dam will incur some deposition, but

it also will be mobilized with a few months of its deposition with storm flows. Therefore, coordinating remobilization to work with time of year restrictions in this segment of the French Broad River will be necessary to limit the temporary sediment accumulation impacts downstream of the dam.

April 2018

July 2019

March 2021

April 2023

Figure 3: Bloede Dam removal site recovery process.

3. ENVIRONMENTAL IMPACTS OF DAM REMOVAL

3.1. Habitat Restoration and Biodiversity

Plants and animals with a federal classification of endangered or threatened are protected under provisions of Sections 7 and 9 of the Endangered Species Act of 1973, as amended. The USFWS Information for Planning and Consultation (IPAC) database review tool was consulted (accessed August 15, 2024), the list of threatened or endangered species potentially affected by activities in the location of the potential Craggy Dam Removal project includes gray bat (*Myotis grisescens*), northern long-eared bat (*Myotis septentrionalis*), tricolored bat (*Perimyotis subflavus*), bog turtle (*Glyptemys muhlenbergii*), Appalachian elktoe (*Alasmidonta raveneliana*), Monarch butterfly (*Danaus plexippus*), mountain sweet pitcher plant (*Sarracenia rubra ssp. jonesii*), and rock gnome lichen (*Gymnoderma lineare*).

In addition to the USFWS database, the NC Natural Heritage Program (NHP) GIS database was consulted to determine whether previously cataloged occurrences of protected species were mapped within one mile of the project site (August 15, 2024). Results from NHP indicate that there are four known occurrences of a state threatened or endangered species within the project area. Species include two bird species; the bald eagle (*Haliaeetus leucocephalus*) and warbling vireo (*Vireo gilvus*), one dragonfly; the mustached clubtail (*Hylogomphus adelphus*), and one fish species; the paddlefish (*Polyodon spathula*). However, after discussion with NC Wildlife Resources Commission (NCWRC) fisheries biologist Dylan Owensby (personal communication, June 10, 2025) the paddlefish has been extirpated from the French Broad River since the 1940's and would not be impacted or benefit from dam removal. However, NCWRC have reintroduced six native species to the French Broad River upstream of Asheville

that would benefit from the increased habitat range with the removal of Craggy Dam. These species include the following:

- Tangerine Darter (*Percina aurantiaca*)
- Freshwater Drum (*Aplodinotus grunniens*)
- Smallmouth Buffalo (*Ictiobus bubalus*)
- Black Buffalo, (Ictiobus niger)
- Smallmouth (Redhorse, *Moxostoma breviceps)*
- Gizzard Shad (*Dorosoma cepedianum)*

The proposed project offers some potential to improve or create suitable habitat for the Federal Species of Concern and NHP species. The riverbanks exposed with reduced water levels create more area for vegetation growth which can be customized to support the fauna identified.

3.2. Ecosystem Connectivity

Using the information provided by the National Aquatic Barrier Prioritization Tool for Craggy Dam instream habitat extent will be created with an upstream network of 3,747 miles connected to a downstream network of 1,460 miles, currently disconnected by Craggy Dam (National Aquatic Barrier Inventory & Prioritization Tool, 2025). These quantities include the length of the French Broad itself, as well as the creeks, tributaries and streams that flow into the river. Craggy dam is the upstream most dam on Mainstem French Broad, and removal would reconnect and benefit 16 miles of mainstem before reaching Capitola Dam downstream.

According to the U.S. Fish & Wildlife Service, more than half a million dams block our nation's rivers, and many are nearly invisible. They halt the free flow and exchange of fish, nutrients and sediments, and they pose a deadly risk to recreationists and families across the country. The U.S. Fish and Wildlife Service is dedicated to removing those dams that are unsafe, negatively impact the environment and serve no modern-day purpose. Removing unutilized dams has the potential to restore riverine ecosystems, reconnect wetlands and floodplains to allow for enhanced ecosystem services, improve water quality, and enhance aquatic biodiversity of fish habitats.

During a dam removal, thoughtful design and management of sediment transport is required by law through compliance with the Clean Water Act, but limited temporary impacts are anticipated and regulated during the construction phase. These temporary impacts to water quality and sedimentation are avoided if the dam remains in place by retention of the stored sediments and lack of construction disturbance.

3.3. Water Quality

Water quality data is available from the Environmental Quality Institute (EQI). EQI assigns metric-specific ratings based on a scale of "A" through "D", with "A" indicating good water quality and "D" indicating poor. There are two EQI sampling locations on the French Broad River in the vicinity of Craggy Dam – one 5.5 miles upstream near downtown Asheville, and one 4.3 miles downstream near Ledges Whitewater River Park – both of which have been collecting monthly data since 1990. EQI rates the turbidity of the French Broad as a "C" upstream of the dam and a "D" downstream. Further, EQI rates the total suspended solids of the French Broad as a B upstream of the dam and a "D" downstream. While these are not a substitute for proper sediment testing and modeling, they do indicate the water quality decreases due to unique inputs between the two sampling locations. These inputs are a combined effect from stormwater discharge, tributary inflow in developing watersheds, accumulated

sediment releases during rain events, and geomorphic changes causing turbulence and increasing turbidity.

3.4. Carbon Emissions

Hydropower utilizes water, a natural and renewable resource, to spin turbines thus generating power. When functioning, hydropower facilities are known for their reliability and ability to provide a constant supply of electricity. However, in the case of Craggy Dam where the upstream impoundment does not provide a consistent volume of water, power production is dependent on the consistency of daily river flow conditions. As such, seasonal variation or drought conditions reduce power production during portions of the year.

Hydroelectric power is known to have the lowest greenhouse gas (GHG) emissions per kilowatt-hour compared to other energy sources. Hydropower reduces greenhouse gas emissions by 96.2% per kilowatt-hour of natural gas, 92% by biomass, 61.5% by solar PV, and 51.3% by geothermal (Bayazit, 2021). These low GHG emissions contribute to efforts to combat climate change.

The largest source of GHG emissions associated with MSD electrical needs is the proportion of electricity needs sourced from the regional electricity grid. If Craggy Hydro is removed and no solar facility is built to replace the foregone electricity generation additional quantities of electricity will be required from the regional electricity grid and GHG emissions associated with grid electricity will increase. If Craggy Hydro is removed and the foregone electrical energy is replaced by a newly constructed solar facility, GHG emissions from the electricity grid will remain relatively similar. See more analysis regarding greenhouse gases specific to Craggy Dam removal in **Section 6.5**

PART B – PROCESS TO IMPLEMENT THE REMOVAL OF CRAGGY DAM

4. SITE CONDITIONS

The project study area was reviewed via field assessments and observations, conducted July 2024, and through document and GIS analysis prior to Hurricane Helene. All information conveyed below references the pre-Hurricane Helene conditions unless otherwise noted. Potential impacts on the existing conditions by Hurricane Helene are provided where possible. A photo log of the existing conditions, prior to Hurricane Helene, is provided in **Appendix B**.

4.1. Craggy Dam and Associated Structures

The dam and associated structures are a functioning hydroelectric facility which currently produces approximately 2,700 kilowatts (KW) of energy per year for MSD's WWT facility, approximately 45% of their power needs. The dam itself is a low-head, run-of-the-river type across the French Broad River and is roughly 13 feet (ft) high and 600 ft long. Design plans were not found for the dam, but from the original FERC exemption application and recent field investigations it appears to be constructed of stacked stone with a concrete cap. The dam is in acceptable to good condition based on observations made during the site assessment. There has been minimal maintenance to the dam since 1963. The left bank abutment was visible and showed some signs of scouring and cracking along the bank on the downstream side. See photos on page 7 of the photolog. Observations of the gatehouse were not made other than noting their closure and submergence during the field visit.

The dam connects to the flume through a concrete triple gated structure on river-right[2] with about a 90 ft by 20 ft footprint. The associated flume runs along the right bank of the river for about 2,750 ft. Plans were found for the flume wall, which showed that about 500 ft of that length is the original stacked stone flume wall, while the remaining is the newer concrete. Visual observations of the flume wall indicate it is in good condition and well maintained. However, there was significant sediment accumulation within the flume. Correspondence with MSD indicates this material is not regularly removed.

The flume conveys water to a powerhouse which has a footprint approximately 80 ft by 90 ft. There are three turbines with associated generators in the powerhouse. The powerhouse discharges water into a tailrace, confined to river-right by a dumped-boulder island approximately 560 ft in length at which point it reconnects with the river. MSD property adjacent to the hydroelectric facility includes WWT and accessory facilities, treatment wetland, and approximately 83 acres of forested land. Our site assessment did not include the interior of the powerhouse so no assessment of condition can be provided. However, observations were made of the stone wall along the right bank and a portion of wall perpendicular to flume flow damming and directing water into the powerhouse. This wall had multiple locations of leaking that appeared to have been marked, but the dedicated flow path that discharges to the tailrace indicates this is an ongoing issue. Photos of the leakage are provided on page 10 of **Appendix B.**

MSD has an existing workforce trained and skilled in the workings of the hydropower facility. The cost is built into the larger utility service of MSD and not born by the wastewater treatment facility that uses the hydropower produced at Craggy Dam. These aspects support price predictability controls by MSD.

[2] "Left" and "right" in this report are based on orientation facing downstream.

Hurricane Helene has impacted the production of hydropower in multiple ways. There was significant large debris, such as pipe sections and commercial propane tanks, deposited within the flume and debris loading at the headgates when flood waters receded. MSD staff removed all debris soon after the Hurricane. However, the powerhouse/power production remained offline. The facility experienced an unexpected and complete outage beginning in 2024, prior to Hurricane Helene, which persisted until August 2025 until a key part was replaced.

4.2. Adjacent properties

4.2.1. Upstream of Craggy Dam

Both riverbanks upstream of the dam were investigated for potential impacts from removing the dam. Upstream property ownership includes both private and public entities and is shown in **Figure 2**. Businesses and the Town of Woodfin own the right bank properties, while private ownership and a railroad right-of-way are along the left bank.

The assessment indicated that impacts will likely be limited to the right bank where there are multiple storm water or drainage outlets and river access points. Upstream impacts include reduced water surface elevation through lower water depth and lowered riverbed from stored sediment remobilization. Several small drains/stormwater outlets were identified along the right bank; all were at the water line or perched above it at the time of assessment. Some may require extensions, energy dissipation, or lowering to support long term bank stability after dam removal. The French Broad River Academy would need an extension to their boat ramp to maintain access to the river once the water surface elevation drops and riverbed conditions stabilize. Coordination with impacted properties should be incorporated into the Community Engagement and Stakeholder Collaboration as discussed in **Section 3**. A summary of the anticipated impacts is provided in **Table 2**.

Table 2: Landowners with affected infrastructure from dam removal

Landowner	ID #	Parcel PIN Number	Potential Impact
IMC Investments, LLC	5	973016137600000	3 pipe outfalls
French Broad River Academy, Inc	11	973005736300000	Boat ramp / river access
Town of Woodfin*	7 and 9	973004411700000	2 pipe outfalls and one river access point
NCDOT	NA	NA	Riverside Dr box culvert

*Riverside Park development location

Taylor's Wave

Our team contacted the designers of the Taylor's Wave project to determine how Craggy Dam was included in their analysis. The team at S_2O Design and Engineering (S_2O) evaluated Taylor's Wave design under existing conditions and in a dam removal condition. Their analysis indicated that the Wave would continue to function under a dam removal scenario, however, for improved function a grade control structure or other retrofit may need to be installed downstream of the Wave. No significant negative impact was identified during the assessment by S_2O.

4.2.2. *Railroad Right-of-Way*

The left bank up and downstream of the dam includes a railroad right-of-way. While no impacts are anticipated to the railroad, coordination and outreach with Norfolk Southern will be needed. Previous experience with railroads near projects indicates a Norfolk Southern representative will be required on-site when work is within 150 ft of the rail lines. This distance is within the range of work for the river-left dam abutment.

4.2.3. *Downstream of Craggy Dam*

Downstream property ownership is by MSD along the right bank and the railroad right-of-way along the left bank through the extent of the tailrace. Private properties are adjacent to the right of way but do not own the riverfront property.

Impacts on the downstream river reach are expected to be negligible with no impact on riverside property. Downstream river conditions will have some sediment accumulation, but it is expected to naturally flush through the river and have no lasting impacts. It is anticipated that Hurricane Helene mobilized and deposited significant amounts of sediment in the downstream river segment which will be processed over multiple years. Any release of sediments from Craggy Dam is expected to be within natural sediment transport rates (See detailed discussion in **subsection 5.1.3**) and be minimally noticeable compared to the sediment transport impacts of Hurricane Helene.

4.3. Accumulated Sediment

A preliminary field evaluation of accumulated sediment in the impoundment of the French Broad River upstream of Craggy Dam was conducted via probing within the impoundment from near the dam to the upstream Old Leicester highway bridge. This includes the area adjacent to Riverside Park and the proposed footprint of the Woodfin Wave. Probing was conducted with a 1-inch diameter steel rod. Depth of water was estimated with the rod before it was pushed into the sediment. The probing sediment depth was recorded. Occasionally the probing met refusal and was associated with rock or consolidated sand, other times the rod length was exceeded with the combined water and sediment probing without reaching refusal. The maximum length of the rod was 12 feet. Using sound and resistance vibrations during the probing general material identification was made during the probing. Nearest the dam a soft sediment layer likely primarily silt and detritus were over a sand layer, where probing ending by refusal or exceeding probing depth capabilities. Moving further upstream the silt and detritus layer disappeared or thinned, and the sand layer was predominant. Continuing to move upstream the sand layer became interspersed with gravels and boulders, eventually tapering out with boulder dominance. The change to minimal deposition in deep gaps between boulders coincided with moving water and outside the influence of the dam. The results of the field evaluation sediment assessment are shown in **Figure 4**.

While the results represent the best known information currently available, the evaluation took place prior to Tropical Storm Helene hitting Asheville in September 2024 and will need to be reconfirmed.

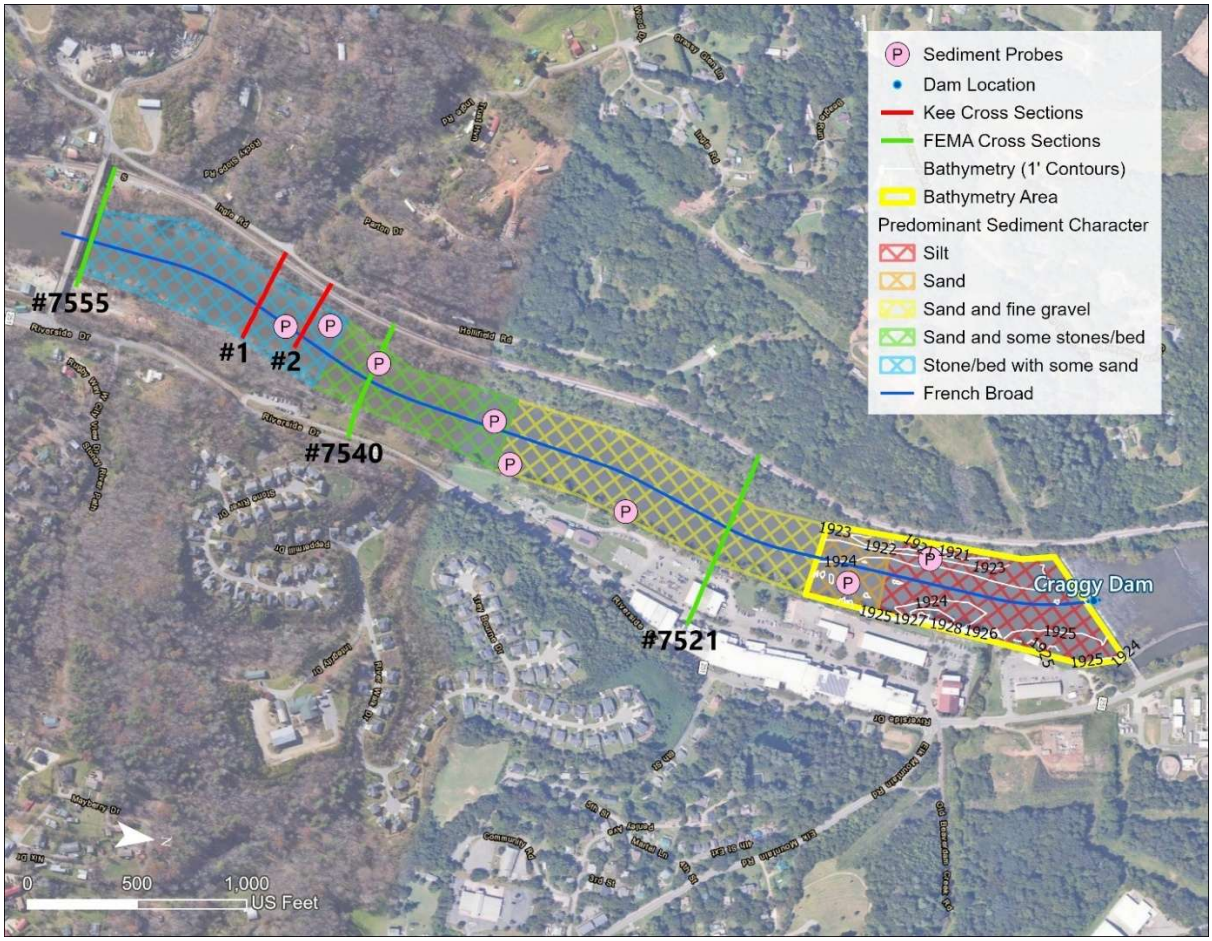


Figure 4: Sediment Probing and Facies Mapping

A wedge of accumulated sediment was identified upstream of the dam using the limited bathymetric survey conducted by RES for this assessment, and performed in June 2024, to approximately 1000 ft upstream of the dam, the sediment probing and evaluation of cross sections from Federal Emergency Management Agency (FEMA) (Kee Mapping and Survey, 2021) and two additional cross sections added for the Woodfin Wave project (S_20, 2023). The FEMA and added cross sections were used in the evaluation of the Woodfin Wave project and verified during that project by Kee Mapping and Surveying. These data, along with the dam and river dimensions, were used to predict a wedge of accumulated sediment upstream of the dam in the range of 120,000 to 216,000 cubic yards (yd^3) (**Figure 5**). The minimum assumes that the downstream-most FEMA cross section represents the non-mobile riverbed (approximately 1,650 ft upstream), while the maximum assumes that it represents the top of the deposited, mobile sediment with a wedge extending approximately 3,400 ft upstream.

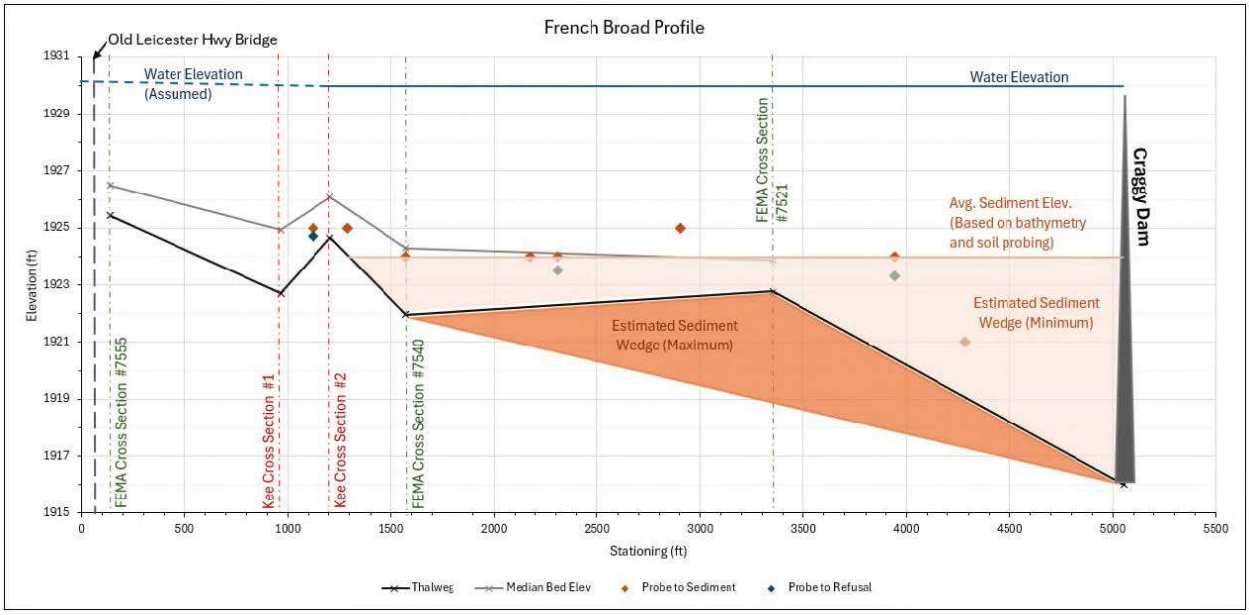


Figure 5: Accumulated Sediment Wedge Estimation

4.4. Utilities and Infrastructure

Nearby infrastructure including upstream and downstream crossings, the adjacent roadway and railroad, stormwater or other discharge pipes within the project limits and impoundment and other above and below ground utilities were investigated for potential impacts due to the project (**Figure 6**)

4.4.1. Transportation Structures

Plans for the nearest upstream bridge along the French Broad River, for Old Leicester Highway, were obtained from NC Department of Transportation (NCDOT). These indicated that the bridge footers are poured concrete pads and did not clarify whether these were tied into bedrock. However, field investigation, cross section and profile data obtained from FEMA, and survey data for Taylor's Wave Project suggest that the bridge is protected by a dense boulder bed. Further, the survey for Taylor's Wave Project indicated that there is a segment of bedrock just downstream of the proposed wave feature which would limit bed adjustment near the bridge. Taken together, the Old Leicester Highway bridge should not be impacted by the dam removal. However, more in-depth geotechnical investigations of the bridge foundation and coordination with NCDOT will be required prior to proceeding with dam removal. There are no downstream crossings for over 6.4 miles and no anticipated impacts to downstream bridges or utility crossings from removal of the dam.

Other transportation infrastructure that could be impacted by the Project include the NCDOT crossing for Riverside Drive over Beaverdam Creek, located approximately 900 feet upstream of the dam and 380 feet upstream of the confluence of the creek and the river, and a Norfolk Southern Railway, which runs along the left bank of the French Broad River. Plans were obtained for the NCDOT crossing, which showed that it was constructed using concrete box culverts with inverts approximately 1 ft below the normal water level of the existing impoundment. Based on bathymetric survey and preliminary riverbed elevation at the dam, the bed of Beaverdam Creek has the potential to drop 10 or more feet at its confluence with the river, as the accumulated sediment behind the dam is remobilized. The stability of the creek and crossing will need to be further evaluated, and the creek will likely require some level of stabilization. Stabilization could range from grade-control structure and bank grading if bedrock or

cascade elements are found to full replacement of the NCDOT culvert crossing if no stabilizing elements are identified and 10 ft of sediment mobilization is expected.

A rail line runs along river-left and is constructed on a rock berm, approximately 9 ft above the dam crest, and has boulder bank-protection near the dam itself. Additionally, the rail line is setback from the top of riverbank approximately 10 ft or more along the impoundment. The dam abutment ties into the left bank close to the rail line and could be left in place to bolster the bank integrity near the line. Impacts on the railway are not anticipated due to the dam removal or work because of these existing conditions and precautions.

4.4.2. Stormwater Outfalls

Several stormwater outfalls and other drains were identified during site assessment and data collection in the project area and along the impoundment upstream. A stormwater outfall for the drainage ditch for Riverside Drive, opposite the river, flows into the flume structure adjacent to the intake gates. The outfall is proposed to be extended to the new bed elevation post flume removal, or outlet protection would need to be installed to the new bed elevation. Five more outfalls were identified along the right riverbank between the dam and the upstream bridge for Old Leicester Highway, all of which are outside the proposed work areas, but may require extensions or dissipation pads.

4.4.3. Overhead Utilities

Overhead electric utilities near the dam include the powerlines along the flume wall, which transmit the power generated by the hydroelectric facility, and two Duke Energy powerlines, one which crosses the French Broad River approximately 180 feet upstream of the dam, and the other which crosses the river approximately 500 feet upstream (**Figure 6**). The lines associated with the hydroelectric facility would be removed along with the dam and other structures. The Duke Energy powerline closest to the dam crosses directly over the proposed staging area near the dam, and the height of equipment in the staging area would need to be monitored to ensure the safety of the crews. The powerline further upstream does not cross any of the proposed work areas and so should not affect or be affected by the Project.

4.4.4. Underground Utilities

There are multiple underground utilities near the dam and associated structures including a pressurized main and a gravity main which run along the right bank of the river next to Riverside Drive, a buried fiber optic cable that runs along Riverside Drive, an active outflow from MSD's WWT facility into the French Broad River, and an abandoned outflow from MSD's WWT facility into the river. A portion of MSD's 66-inch sewer interceptor crosses Beaverdam Creek near its confluence with the French Broad River. This interceptor conveys wastewater collected across MSD's serve area, approximately 21 million gallons per day. Surveys will need to be performed on this portion and incorporated into the modeling of bed adjustment for the creek to determine if it will become exposed by the removal of the dam, the results of which may indicate a need for additional structural analysis and possibly mitigation. Initial data collection also indicates that the pressurized main and the fiber optic cable run next to Riverside Drive within 20 to 30 ft of the flume intake gate structure. These will need to be located so work at the flume intake and adjacent riverbank can avoid impacting them. The active outflow from MSD's WWT facility connects to a splitter box within the flume structure with an extension to the river, which allows flow to be directed either into the flume or directly into the river. The extension and splitter box are proposed to be replaced with a new outfall as part of the flume removal and bank stabilization. The abandoned outflow is proposed to be removed as part of the Project.

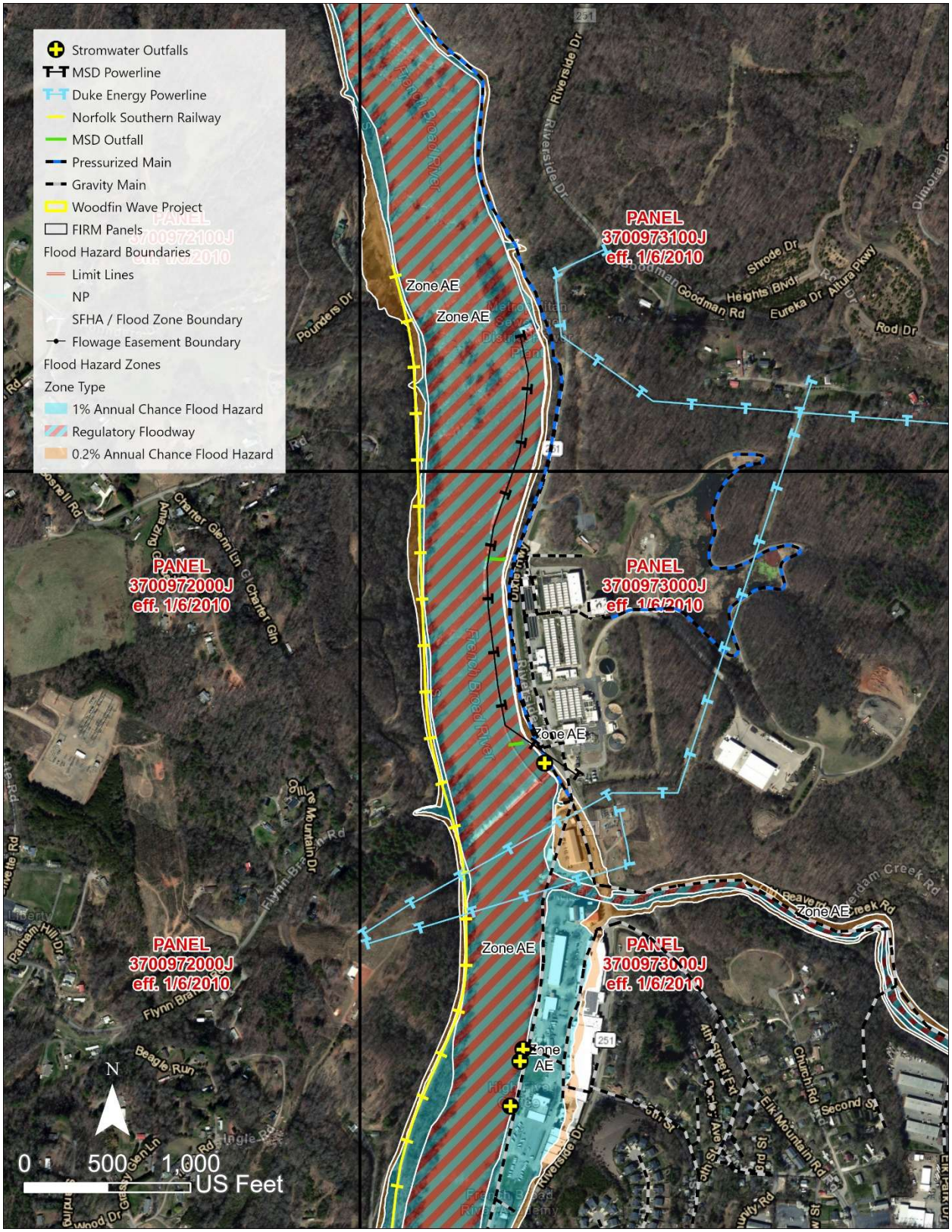


Figure 6: Project Constraints

4.5. Regulatory Coordination

In preparation for assessing the feasibility of the potential Craggy Dam Removal Project, our Team reached out to many relevant regulators to request feedback on the proposed project. During these calls, each regulator was in favor of dam removal and saw no obstacle to its removal. As a follow up to those discussions, RES sent a letter in August 2024 with project background and relevant resource information to state and federal agencies that may be involved in the regulatory approval process for the proposed project. Details of the early coordination for each of the agencies are described below and tabulated in **Appendix C.**

4.5.1. FERC

The FERC issued a license exemption for Craggy Dam, P-7497, to MSD on January 25, 1984. The exemption met the requirements for a small hydroelectric project (i.e., up to 5 Mw) built at an existing dam and exempts MSD's Craggy Dam from the requirements of Part I of the Federal Power Act. It is noted that license exemptions do not convey the right of eminent domain.

FERC license exemptions are issued in perpetuity but are still subject to mandatory terms and conditions set by federal and state fish and wildlife agencies and FERC. Standard Article 2, included in the Craggy Dam exemption, requires compliance with any terms and conditions that Federal or State fish and wildlife agencies have determined to be appropriate to prevent loss of, or damage to, fish and wildlife resources. Based on the terms and conditions required by the Federal and State fish and wildlife agencies, the environmental information in the application for exemption, other public comments, and FERC staff's independent analysis at the time the exemption was issued, FERC determined the license exemption order was not a major Federal action significantly affecting the quality of the human environment.

Craggy Dam Compliance History

Stantec researched FERC's publicly accessible database to review MSD's compliance with the terms and conditions of the FERC license exemption including fishery related issues of fish passage, turbine mortality, and minimum flows.

Although many of the project's documents are on microfilm due to the date the license was issued, some information addressing fish passage, turbine mortality and minimum flows was accessible and is summarized below. Documents on microfilm will require a formal request to FERC for copies.

- Fishery Related Issues - The license exemption does not state a minimum flow or prescribe fish protection or passage requirement. However, these would be covered by license Article 2 which requires compliance with any terms and conditions that Federal or state fish and wildlife agencies have determined are appropriate.
- Minimum Flow - FERC database revealed there were disagreements between MSD and some resource agencies over required minimum flow in the initial years of project operation. The issue was apparently resolved when the fishery resource agencies agreed to a habitat mitigation plan in exchange for lower minimum flows. A document dated 1996-11-13 under the mitigation measures had enhanced habitat for both macroinvertebrates and fish. The staff at NC wildlife commission did not recommend any additional measures.
- Turbine Mortality – The 1996-11-13 letter reported the turbine mortality study results were successful. There was no other documentation readily available with a copy of the study.
- Fish passage – The MSD application for Craggy Dam license exemption dated 1983-07-22 contains a record of consultation. A letter from the US Fish and Wildlife Service (USFWS) to MSD dated 1983-06-08 documents the USFWS agreed to hold fish passage in abeyance until

upstream fish passage was provided at the downstream Capitola and Marshall hydroelectric dams. As of 1997-02-18 the operators of Capitola were waiting for resolution of upstream fish passage at the downstream Marshall project.

- In present condition neither of the two downstream dams have fish passage systems.

In summary, there are no apparent outstanding issues with MSD's compliance with their license exemption. However, if the downstream dams were removed or upstream fish passage systems developed, this could change the requirement at Craggy Dam to provide fish passage.

Transfer of an Exemption and liability reduction for MSD

When FERC issues a license exemption, they approve both the hydropower project and the licensee. A licensee or exemptee may decide to transfer a hydropower license to another entity. Transfers of license exemptions are not required to be approved by FERC prior to the transfer. However, an exemptee must notify FERC of the transfer or sale of the exemption and must update the contact information. A transfer of exemption to another entity would removal liability from MSD for any of the resulting actions from the dam removal process. This includes any hydropower affiliated structures that are not removed and left within the river.

4.5.2. US Fish and Wildlife Service

Jurisdictional Waters of the US

According to the US Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) the French Broad River is listed as riverine, upper perennial, rock bottom, permanently flooded (R3RBH) below the dam and riverine upper perennial unconsolidated bottom, permanently flooded (R3UBH) above the dam (USFWS 2021). There are no other natural waters within the Project area. The NWI lists four occurrences within the Project area, but all are non-natural systems. Two of MSD's treatment pools are listed as freshwater ponds (PUBKx); and MSD's treatment wetland and the tailrace downstream of the powerhouse are also listed as freshwater ponds (PUBHh). None of the MSD pools or treatment wetlands would be affected by a dam removal project, while the French Broad River and downstream tailrace area will be temporarily impacted.

Endangered Species Act

The project would need to evaluate the potential impacts to species of concern and may require formal Endangered Species Act (ESA) Section 7 consultation with the USFWS. Since the proposed project would require federal permits and has the potential to impact endangered species, ESA consultation would be required and a Biological Evaluation/Biological Assessment (BE/BA) would need to be drafted. The USFWS was contacted for early coordination regarding the potential project and provided some guidance for developing the BE/BA, which is included in **Appendix C.**

4.5.3. US Army Corps of Engineers

Impacts to the French Broad River will be unavoidable, due to the dam removal activities proposed. These impacts are unavoidable and mostly temporary but the proposed project would result in an overall functional uplift of the stream system. The proposed project would require a permit under Section 404 of the Clean Water Act through the US Army Corps of Engineers (USACE). Based on proposed activities, the project may qualify under Nationwide permit (NWP) 27 for Aquatic Habitat Restoration, Enhancement, and Establishment Activities or NWP 53 for Removal of Low-Head Dams. Additionally, the project would require a Section 401 water quality certification issued by the State.

Our coordination with USACE determined that the removal of Craggy Dam may mean USACE is the lead federal agency or FERC may be the lead federal agency. The USACE representative recommended early coordination with USACE and FERC to discuss the proposed process when the intention is to remove a hydropower dam and make determinations of leadership related to permitting process.

4.5.4. North Carolina State Historic Preservation Office

Consultation with the North Carolina State Historic Preservation Office (SHPO) and Tribal Historic Preservation Office (THPO) are required for this project. The SHPO GIS Web Service database was reviewed to determine if any listed or potentially eligible historic or archeological resources occur in the proposed Project area. There is one known potential eligible historic site within the project area. The site includes the hydropower facility, i.e. powerhouse, and therefore would be impacted by the project which proposes to remove the facility. Since the proposed project would require federal permits and has the potential to impact historic properties, the proposed project would need to engage in National Historic Preservation Act (NHPA) Section 106 consultation. Additionally, the existing dam is more than 50 years old and may be eligible for listing on the National Register of Historic Places. In October 2024, the SHPO responded to our scoping letter stating that no archaeological investigation is recommended, however, they recommend a Historic Structure Survey to evaluate whether any buildings or structures within the project area are eligible for listing in the National Register.

If it is determined that there are no historic properties, or there are historic properties, but the project will not affect them, and the SHPO/THPO concurs, then no additional studies or coordination is necessary. If there is a finding of adverse effect, then the consultation process continues, and a Memorandum of Agreement or Programmatic Agreement will be necessary to describe how we will mitigate the adverse effect. Our Team recently went through this process on a similar project and some of the mitigation measures that were required included ground/lidar survey, preparation of a storymap, additional photo documentation, and some additional maps. Other projects have preserved a piece of the dam, often an abutment or other near bank feature and signage to document the location. At the Craggy Dam location, the old headgates are preserved along the bank just upstream of the currently used headgates and are an example of how to preserve parts of historic information. This step or leaving a portion of the flume wall, current headgates or powerhouse could all be items for mitigation with the removal of Craggy Dam.

Russell Townsend, the THPO officer for the Eastern Band of Cherokee Indians was contacted about the potential project but no response was received at the time of the report.

4.5.5. NC Department of Environmental Quality: Energy, Mineral, and Land Resources

The potential Craggy Dam Removal Project is subject to the NC Department of Environmental Quality (DEQ): Division of Energy, Mineral, and Land Resources (DEMLR) Erosion and Sediment Control Program. As such, the project will require a NCG01000 General Permit as part of the NPDES Construction Program. The project will also require an Erosion Control permit to meet the requirements of the Sedimentation Pollution Control Act of 1973. This permit will need to be obtained through DEMLR, if the project receives funding from public sources; otherwise, it will need to be obtained from the Buncombe County Soil Erosion and Sedimentation Control Division. Additionally, if MSD decided to surrender the existing FERC license, the Craggy Dam would automatically be under state jurisdiction due to its listing as high hazard in the state dam inventory. MSD could either apply for an exemption of state jurisdiction due to the small size of the dam or undergo dam safety review under the DEMLR dam safety program.

4.5.6. NC Wildlife Resources Commission

The NCWRC was contacted to see if they needed more details about the project. NCWRC indicated that they are already informed about the potential project and in favor of dam removal. No other information was requested at this time.

5. DAM REMOVAL IMPLEMENTATION PLAN

5.1. Project Phases

5.1.1. Community Engagement and Stakeholder Collaboration (6 months, ongoing)

Community engagement should begin as early as possible, inclusive of public input from the MSD service area prior to a final decision regarding the status of the dam and potential dam removal. Early community engagement avoids feelings of decisions being forced upon the community or decisions being made without community input. It also identifies those that are against removal and for removal to provide a forum for discussion.

There are also numerous stakeholders that should be involved in the reimagining, planning, and design process should the project move forward. To gain stakeholder feedback, the findings from this study should be made available as part of a comment period to solicit public and stakeholder input. This input could provide valuable information in the decision-making process and allow MSD and others to better and more fully understand the potential interest of the community they serve.

Community engagement and Stakeholder collaboration for dam removal projects begins before the designs and permits are started in earnest and often lasts the entire project duration with public meetings, regulatory review, and post removal celebrations and ultimately continuous river use.

5.1.2. Permitting & Design (2 years) – Regulatory approvals, environmental assessments, and engineering analysis and design.

Regulatory Coordination

During the design process, a pre-application meeting with the applicable agencies would be beneficial and ensure that all parties are able to provide input on the most efficient permitting process for the project to move forward. Next steps include the following:

- Pre-application meeting with USACE, USFWS, NCWRC, etc.
- FERC deregulation
- Draft permit applications & agency coordination:
    - CWA Section 404 NWP
    - CWA Section 401 WQC
    - Stormwater Erosion and Sediment Control Certificate of Coverage
    - NPDES Construction Stormwater Permit
    - Dam Safety Review
    - BE/BA and USFWS ESA Section 7 Consultation
    - NHPA Section 106 Consultation
    - FEMA CLOMR
    - SHPO/THPO

The two most time-consuming regulatory processes will be in elements related to FERC and FEMA.

Based on correspondence with Buncombe County and State jurisdiction of FEMA Floodways it is anticipated that both a conditional letter of map revision (CLOMR) and final letter of map revision (LOMR) will need to be obtained for the dam removal work. The time to develop these documents is included in the duration noted above.

FERC has three methods to end federal oversight of hydroelectric projects. These are either driven by the licensee or by FERC and are described below. Should MSD decide to pursue removal of Craggy Dam, it will need to follow the procedures outlined for voluntary surrender of the FERC exemption.

An exemptee may decide it no longer wishes to hold a FERC issued exemption for any reason, e.g., economics, or impacts from a natural catastrophe. MSD, as the license exemptee for a fully constructed project, needs to apply to FERC to surrender its hydroelectric project license exemption. The primary steps include the Agency consultation, Petition surrender, and FERC actions.

Relevant agencies are site specific and include the National Marine Fisheries Service, the USFWS, the National Park Service, the United States Environmental Protection Agency, the appropriate State fish and wildlife agencies, the appropriate State water resource management agencies, and the certifying agency under section 401(a)(1) of the Federal Water Pollution Control Act (33 U.S.C. § 1341(c)(1)). Many of which are needed coordination with a non-FERC dam removal. Which is why it would be beneficial if the US Army Corps of Engineers (USACE) took the lead on permitting. FERC actions include public notice and review which could take an extended period of time given the review requirements. The regulatory coordination will advocate the dam removal process is conducted under the USACE and state agencies purview to avoid redundant processes and expedite the project. The timeline noted for Planning and Permitting assumes this will be the case.

There are several unknown circumstances associated with the removal of Craggy Dam that may affect the permitting timeline.

- If it is determined that historic structures will be affected by the dam removal project an additional **6 months** will be added to the timeline.
- If the Appalachian elktoe mussel is found to be impacted by the project, it could extend the permit coordination a **full year**. This allows for the survey and ultimate relocation during the appropriate season prior to receiving permits.
- An additional **6 to 12 months** may be required to complete the full FERC decommissioning process if the licenses surrender does not allow the shift to USACE as the lead federal permitting agency

Design Development

To take the conceptual design plan provided in **Appendix D**, and bring it to a construction ready plan, more data and analysis will be needed. These are likely to include:

- Resurvey of the accumulated sediment upstream of the dam to account for changes caused by Hurricane Helene
- Sediment sampling of the impounded sediments to determine if passive release will be acceptable
- Survey and sediment assessment on Beaverdam Creek to determine how much stabilization action for the creek and associated sewer line crossing will be necessary.

- River flow analysis to determine optimal dam removal time window
- Surveys for species of concern: Appalachian elktoe mussel (*Alasmidonta raveneliana*), gray bat (*Myotis grisescens*), Northern long-eared bat (*Myotis septentrionalis*), and tricolored bat (*Perimyotis subflavus*).

Depending on the presence of species of concern as determined by the field surveys, project design may need to be altered to mitigate impacts to species of concern.

Fully developed design plans will be required to apply for final permits. Once construction permits are received there may be a period of bidding and contracting with a construction entity depending on the predetermined implementation process, which is not included in the estimated duration.

If bid documents, including specifications, and bid support are required additional time will be required to develop these documents. It is expected approximately **6 months** will be added to the design time for the development and coordination of specifications and other bid documents.

5.1.3. Sediment Management & Mobilization (6–24 months) – Controlled release to minimize downstream impact

Sediment Remobilization Analysis

A sediment-transport model was not developed to assess the movement of accumulated sediments upstream of the dam. However, based on previous dam removal sediment transport studies, if the sediment were allowed to be released passively, there are two distinct phases of sediment evacuation (Collins et al., 2024). The first phase (Phase 1 Sediment Remobilization) is process-based following a rapid channel evolution of incision through the impounded sediments. Due to the increased energy gradient approximately half of that sediment would migrate downstream within the first six months after the dam was removed, and that the remaining sediment would slowly migrate downstream over the following few years (Collins, et. al. 2024). The second phase (Phase 2 Sediment Remobilization) is event-based where substantial change is associated with flood events and takes multiple years to complete.

No annual suspended sediment analyses were identified for the French Broad River; however, baseline estimates of sediment concentration and yield were developed for 84 distinct ecoregions across the United States with data from more than 2900 sites (Simon, et al. 2004). The Blue Ridge ecoregion (No. 66 in the analysis) represents the project location and contributing watershed. The estimated sediment yield is provided in quartile values as well as minimum and maximum values. The yield can be multiplied by the drainage area to estimate typical suspended sediment loads at the project site. Results are shown in **Table 3**. The movement of the suspended-sediment load is associated with the $Q_{1.5}$ which was estimated as the effective discharge in the Simon et al. (2003) study. Using equations developed for the ecoregions, the $Q_{1.5}$ for the project location is 480 m^3/s.

Table 3: Suspended sediment yield and loads

Category/Quartile	Sediment Yield (T/day/km^2)	Sediment Load (T/day)
Minimum	2.22	5,548
25th	5.18	12,945
50th	13.1	32,737
75th	19.2	47,981
Maximum	223	557,277

Note - Drainage area = 965 mi^2, 2499 km^2.

Based on the initial sediment probing, much of the accumulated sediment upstream of the dam is silt and sand and would be largely mobilized as suspended sediment. Assuming the sediment release would be daily during the first phase of sediment evacuation described above, we can compare the first phase sediment load to that of the estimated baseline sediment loads for the project site. The range of expected sediment loading during Phase 1 is shown in **Table 4.** Sediment quantity was converted to sediment mass by converting to cubic meters, multiplying by the density of wet sand (1922 kg/m^3) and dividing by 1000 to convert to metric ton. Using the estimated 60% of the load mobilized in 6 months from Collins et al. (2024) a sediment load for Phase 1 Sediment Remobilization can be estimated.

Table 4: Phase 1 Sediment Remobilization

Accumulated sediment wedge extent	Accumulated sediment quantity (yd^3)	Accumulated sediment quantity (m^3)	Accumulated sediment mass (T)	60% Accumulated sediment mass (T)	Accumulated sediment load (T/day)
Minimum	120,000	91,747	176,337	105,802	580
Maximum	216,000	165,144	317,406	190,444	1,044

The Phase 1 Sediment Remobilization load for the maximum accumulated sediment is only a fraction of the minimum estimated sediment load for the project site based on its location within the Blue Ridge ecoregion.

Additional analysis of the river's ability to transport sediment and biological impacts based on results from Hurricane Helene sediment mobilization should also be considered once data are available. Further, the effects of Hurricane Helen on the accumulated sediment could have increased the volume long term or may have filled and scoured as flows descended, going back to a similar condition surveyed and observed during field assessments. It is recommended a new bathymetry be completed if dam removal design is advanced.

Sediment Remobilization Approach

Based on the information regarding sediment load, existing water quality and impacts by Hurricane Helene, the downstream system is expected to be able to assimilate the Phase 1 Sediment Remobilization and subsequent pulses of sediment during the Phase 2 Sediment Remobilization. Phase 1 is expected to take approximately 6 months to complete, while Phase 2 could take multiple years depending on the frequency of the events at the 5-yr and greater return interval. However, Phase 1 could be managed and extended into a longer time period if the dam was only partially removed and left to headcut the sediment wedge only as the dam was lowered at a rate directed through regulatory coordination. Given this would not change the downstream reach's ability to recover from temporary

sediment deposition during dam removal and channel evolution processes and would increase the costs it is not recommended. Therefore, sediment remobilization will be concurrent with structure removal and river restoration implementation in the next step.

5.1.4. Structure Removal & River Restoration (1 year) – Dismantling the dam and other structures and restoring natural riverbanks

The design presented in this report proposes to remove the dam, flume wall, headgates and powerhouse structures in their entirety and to restore the bed and banks of the French Broad River. Primary means of riverbed restoration will be to allow passive sediment release (i.e. stored sediment remobilization) through the progressive dam removal steps noted in the sequence of construction, found in the conceptual design plans provided in **Appendix D**. The dam is primarily composed of stacked stone with the cap and left bank abutment made of concrete. It is recommended that all natural stone materials be reused as bank protection, bed or outfall protection, or dispersed within the river margins. All other materials are assumed to be disposed of off-site as MSD has indicated they cannot provide an on-site disposal area. The headgates will not be removed as part of the dam removal. Instead, it will be closed and remain in place to create a dry work area for removal of the powerhouse and flume wall.

It is anticipated that Beaverdam Creek bed elevation will lower as part of Phase 1 and Phase 2 sediment remobilization of the French Broad River. This lowering may require bed protection downstream of the Riverside Road box culvert to prevent undercutting and maintenance of aquatic organism passage. This bed protection should be installed after removal of the dam but prior to removal of the powerhouse, flume, and headgates structures. The lowering may also necessitate various actions to protect MSD's 66-inch sewer interceptor which crosses Beaverdam Creek.

After the dam is fully removed any outfalls or river access points along the French Broad River requiring modification as determine appropriate during the final design process will be completed. This work should not be completed upstream of the dam prior to Phase 1 sediment remobilization. All modifications will be developed and installed for the anticipated riverbed conditions after Phase 2 sediment remobilization has completed.

The powerhouse should be decommissioned and removed after the dam removal is completed. All material is assumed to be disposed of offsite. The flume wall should be removed beginning downstream and working up stream with final structural removal of the headgates. Portions of the flume wall are made of stacked stone. It is recommended to reuse all salvageable stone material as bank protection or disposed of within the channel margines given its natural stone composition.

Final site cleanup will include minor planting along the banks and restoration of the disturbed areas from construction access.

5.1.5. Post-Removal Monitoring (5+ years) – Assessing ecological recovery and community benefits

Coordination with agencies along with the results of further survey and design work will determine if/what monitoring will be required during and after construction. These could include turbidity monitoring at select locations, cross section monitoring up- and downstream of the dam to track sediment movement, vegetation monitoring to ensure exposed banks are re-vegetating along an appropriate timeline, and/or monitoring for threatened and endangered species.

5.2. Cost Considerations

A preliminary summary of expected costs to bring the concept to construction ready plans, to obtain the necessary permits and regulatory buy-in, and to construct the project is presented in **Table 5** below.

Table 5: Cost Summary

Task	Low Estimate	High Estimate
Assessments & Studies	$ 137,000	$ 178,100
Design	$ 451,000	$ 586,300
Regulatory	$ 115,000	$ 149,500
Construction Support Activities	$ 2,010,000	$ 2,223,000
Dam Removal	$ 340,000	$ 423,000
Flume Wall Removal	$ 1,890,000	$ 2,251,000
Headgates Removal	$ 333,000	$ 666,000
Powerhouse Removal	$ 1,000,000	$ 2,000,000
Post Construction Monitoring	$ 50,000	$ 200,000
Total	**$ 6,326,000**	**$ 8,676,900**

Assessment and Studies, Design and Regulatory categories include all the anticipated studies and work to obtain permits and develop construction drawings, specifications for bid documents. Specific assessments assumed necessary include the following:

- Tier 1 sediment sampling and analysis
- Mussel survey
- Bat survey
- Baseline habitat survey
- Historic structures survey
- Geomorphic survey
- Topographic survey
- WOTUS delineation
- Biological assessment
- Biological resources technical report

It was assumed there are no historic structures impacted by the project. If there are it would increase costs by about $8,000-$10,000, which could easily be within the cost estimate range provided in **Table 5**. The design and regulatory steps include the work required to surrender the FERC exemption and work with the NC Dam Safety program for removal coordination. These steps also assume the costs to complete the necessary work for FEMA coordination to include both a CLOMR and LOMR and work with the NC floodplain mapping program.

The construction cost estimate was developed with the following assumptions, inclusions and exclusions:

- The construction is initiated in 2027. Construction at an earlier or later date may result in a change in price due to year-over-year escalation.
- Excludes handling of hazardous materials in the sediment, soil, powerhouse or dam infrastructure
- Includes removal of dam infrastructure (Craggy Dam, headgates structure, flume wall, and powerhouse) with haul-off of all demolition materials to off-site locations

    - Some minor features (abutments, stone walls) may be left in place if the integrity of remaining infrastructure (roads/railroads) is compromised by their removal
- Craggy Dam will be removed first in the construction sequence so that all subsequent work on the powerhouse, flume wall, and flume intake structure can occur in a dry work zone. No major pump around is anticipated, only intermittent dewatering to maintain optimal construction and erosion & sediment control conditions in the flume.
- After dam removal the powerhouse will be deconstructed and then work will proceed on flume wall demolition from downstream to upstream.
- The intake structure and stabilization of the access/staging areas will finalize the removal phase of the project.
- All sediments impounded by Craggy Dam will be passively flushed during the drawdown/infrastructure removal process; no sediment in the reservoir will be hydraulically or mechanically excavated or dredged.
- The entirety of limits of disturbance associated with the dam removal permits will be stabilized per the agency's requirements. No additional revegetation efforts have been considered in the reservoir footprint upstream of the presumed project area.

The most significant costs associated with dam removal construction are from the demolition of the flume wall, off-site material wasting, and demolition and removal of the powerhouse.

5.2.1. Acknowledgement of Cost Exclusions

Cost items not included in this assessment include; any structure determined beneficial to Taylor's Wave, any value compensation for the dam that maybe required to satisfy MSD's legal requirements in the bond order, and any necessary infrastructure improvements required as a result of dam removal. Taylors's Wave backwater structure is excluded since its functionality was evaluated under a dam removal scenario and the conditions acceptable to proceed with the design without additional structure. The party responsible for any feature adjustment would be discussed if the dam were removed but is not considered a definitive part of the potential dam removal project. The value of the dam and bond order requirement are not certain currently. This would be negotiated as part of the liability waiver as the design and stakeholder collaboration advances. Infrastructure improvements required as a result of dam removal could include actions necessary to fortify the 66-inch sewer interceptor across Beaverdam Creek, changes to stormwater and wastewater discharges, and extensions of affected boat ramps. The full scope of impacts and associated costs would be included in future phases of dam removal design.

5.2.2. Cost Saving Opportunities

Reduce Construction Extent

While this report evaluated full removal of the dam, flume, and powerhouse, a partial-removal scenario – where the dam is fully removed, but the powerhouse and/or flume are left partially or fully intact – could be considered. Such an approach would likely significantly reduce the cost of the project (estimated **savings of $3.9 to $4.4 million**), while still restoring the flow of the river. The riverbank along the current flume would vegetate and slowly fill in if blocked off, but the width of the river would remain more consistent to the typical condition.

On-site Material Wasting

Another partial removal alternative includes the demolition of the flume wall and powerhouse but on-site wasting of the material within the existing flume footprint. This would save some costs associated with hauling material off-site for disposal (estimated **savings of approximately $1.1 million**). The

wasted material would eventually be covered from river deposits and slowly revegetate. A more proactive approach could also be taken with significant waste material crushing and infilling of the gaps and covered with compost and seeded. These steps would accelerate the revegetation of the flume area and create the more typical average channel width of the French Broad River at this location.

PART C – ENERGY ALTERNATIVES ANALYSIS

6. ENERGY ALTERNATIVES ANALYSIS

6.1. Background and Purpose

This section evaluates various alternative energy possibilities through the lens of financial feasibility, land area requirements, greenhouse gas emissions, and permitting feasibility. This section does not imply MSD preferences or technical ability to operate different energy sources. A preliminary task to this analysis was determining which renewable technologies to consider for evaluation. Discussions with MSD staff and preliminary research informed the three scenarios chosen. A brief narrative of this process follows.

First, continued reliance on electrical output from Craggy Dam and associated hydropower facility (henceforth, Craggy Hydro) was chosen as the baseline scenario as this option is envisioned in MSD's current planning. The specific future operations of Craggy Hydro in this analysis are modeled after the Craggy Life Extension and Reliability option as described in the Capital Improvement Plan report authored by Hatch in May 2025 (Hatch Report).

Second, MSD's electric utility bills include relatively low electricity rates, so a grid only option was added for evaluation as a potential low-cost solution.

Third, on-site or near-site photovoltaic (PV) solar was identified as a low-cost renewable energy among a variety of renewable energy options considered. Other generation and storage technologies like wind, methane-powered fuel cells, and battery energy storage systems were believed to offer materially lower returns on investment compared to PV solar in this particular context. For wind, the relatively low electricity requirements at MSD preclude meaningful economies of scale that are enjoyed by utility scale wind farms, with just two modern turbines required to offset foregone hydropower generation. For methane, MSD has previous experience with methane-fired generation in recent years and expressed a desire to avoid this fuel due to sub-optimal prior experiences. Finally, battery energy storage systems provided negligible opportunities to reduce electricity costs as a result of the low spread paid by MSD between on- and off-peak grid supplied electricity, as revealed through an investigation of their recent electric utility bills.

6.2. Overview and Assumptions

Three energy alternative futures for the MSD facility were evaluated in this analysis, detailed below.

***Scenario 1 - Dam Remains*:** The operation of Craggy Hydro continues and is upgraded according to the recommendations described in the Hatch Report. This scenario enables Craggy Hydro to provide a proportion of electrical needs of the MSD facility, while the existing electrical grid connection is required to meet the remaining electricity needs.

***Scenario 2 – Grid Power*:** Operations of Craggy Hydro are discontinued, and the dam is removed. All electrical energy is provided by the existing electrical grid connection.

***Scenario 3 – Solar Power*:** Operations of Craggy Hydro are discontinued, and the dam is removed. A PV solar facility is created on or near MSD property that provides a similar quantity of electrical

energy as Craggy Hydro on an annual basis during its first year of operation[3]. The remaining electrical needs are provided by the existing electrical grid connection[4].

Like any financial analysis, findings are dependent on a variety of assumptions and the specifics of the financial framework in which the analysis is undertaken. Therefore, we provide a workbook of calculations (*craggy_alternative_calcs_June_20_2025.xlsx*) with clearly stated inputs that can be user-modified and is intended as an evergreen tool. The first tab in the workbook ("User Guide") orients the user to the workbook and provides guidance on modifying inputs in the analysis. Methodology that is generally universal to all three scenarios is described below. Detailed discussion of scenario-specific methodology is provided in **Appendix E**.

6.2.1. Temporal Scope

The period of analysis is a total of 27 years beginning in January of 2025. The first two years in the model represent planning and construction years for *Scenario 2* and *Scenario 3*, followed by 25 years of project operational life, ending in December 2051. The 25-year operational life is determined by the generally accepted life of a modern solar facility of 25 years, consistent with the 25-year warranty on premium grade solar panels[5]. For *Scenario 2* and *Scenario 3,* Stantec assumes that Craggy Hydro will continue regular power generating operations until the final day of December 2026, providing no electricity from hydrogeneration beyond this date.

6.2.2. Analytical Scope and Limitations

This analysis includes reasonably foreseeable market costs to the best of our ability. However, no financial guarantees are given or implied and any decisions by MSD should be supplemented by an independent analytical process. In addition, this energy analysis relies in large part on findings from the Hatch Report and the various assumptions within that report. Furthermore, we have not independently verified any aspect of the Hatch (2025, 2024) Report.

Though the values presented in this section are unrounded numbers, they should be understood as approximate values. They remain unrounded in this report to facilitate easier identification of corresponding numbers in the provided Excel spreadsheet without ambiguity. Estimates reflect our best understanding of financial implications around the electricity, solar facility and tax incentive structures that exist at the time of preparing this report in early 2025. Tax incentives are particularly challenging to interpret with unique tax situations, evolving federal regulations and nested policies that

[3]Due to well documented power degradation of PV solar systems, annual generation from PV solar is decreased in the model by a fixed percentage in each subsequent year. The degradation factor chosen and its rationale are discussed in **Appendix E.**

[4] Unlike the continued operation of Craggy Hydro, MSD has no existing specialized knowledge or experience operating a solar power facility. Also, MSD's core expertise in water chemistry, water transport, and associated processes and equipment is not generally transferable to the solar facility context. Therefore, MSD does not wish to operate the envisioned solar facility and instead prefers it to be owned and/or operated by third party.

[5] For Example:
<https://www.lg.com/us/business/solar-panel/warranty-b2b>
<https://solar.na.panasonic.com/support/solar-support/solar-warranty>
<https://us.qcells.com/complete-energy-solutions/solar-panel/>
<https://www.trinasolar.com/us/resources/blog/trina-solar-announces-trina-protect-25-year-product-and-power-warranty-residential-pv>
https://www.jinkosolar.com/uploads/JinkoSolar-Global%20Limited%20Warranty%20(Rev112318)-EN.pdf

may be relevant in this context. We strongly recommend engaging a tax professional to verify the availability of tax incentives and any other tax implications of the various energy alternatives.

6.2.3. Dollar Denomination

In this report, Stantec presents findings in constant dollar denomination. This constant, or 'real' dollar denomination removes the impacts of inflation so that the purchasing power of all dollars in this report are constant and fixed to the purchasing power that prevails in a specified year. Because the most recent full year with known inflation data is 2024, Stantec denominates all values in 2024 US dollars, unless otherwise noted. Presenting the projected costs in 2024 US Dollars (stylized as 2024$) allows for easy comparison between projected annual costs and benefits across years by avoiding the need to make assumptions about future rates of inflation.

6.2.4. Discount Rate

A discount rate is required in a financial analysis that extends over multiple years as a result of generally accepted concept of the time value of money. In this case the discount rate is a real societal discount rate, which approximates the rate at which society is willing to forgo something of value today to obtain something of greater value in the future, while holding the value of a dollar constant over time. Broadly consistent with new policy recommendations for a real social discount rate by leading academic economists (Blomquist 2024), the discount rate used in this analysis is 2.5% for evaluation of real dollars. This discount rate is used to calculate present values from the schedule of expenditures for each category of cost. Present values for all items in this report are discounted back to the year 2025.

Notably, the chosen real discount rate of 2.5% in this analysis appears to be materially lower than the 6.0% discount rate employed in the Hatch report. However, unlike the 2.5% rate used here, the 6.0% rate used by Hatch is a nominal discount rate, meaning that the value of a dollar is not held constant over time. Converting the 2.5% real discount rate used here into a nominal rate requires adding the rate of future expected inflation. Assuming 2.5% future inflation, the implied nominal rate used in the present analysis is therefore 5.0%, and generally similar to the nominal discount rate of 6.0% used by Hatch. In addition to these chosen rates, higher rates may also be justified depending on the context and the use case. The Excel-based tool provided alongside this analysis allows the user to modify a variety of key inputs, including the real discount rate and future inflation expectations, based on custom user-defined values.

6.2.5. Electricity Requirements and Generation

The total energy requirements by MSD are informed by approximately 20 years (2002 - 2022) of historical data. The average annual electrical energy used by MSD over this period was 18.4 million kWh. While there is annual variation exhibited in the time-series data, we see no obvious near-term trend and assume the historical average to be generally indicative of future electricity needs for the duration of the projection period.

The total energy generated by Craggy Hydro used in future years is informed by estimates provided in the Hatch Report, specifically the quantity of electrical energy implied in each year as found in Table 4-1.

Notably, the facility experienced an unexpected and complete outage beginning in 2024, prior to Hurricane Helene. As of this writing in May 2025, electricity generation has yet to be restored from this outage. The electricity generation data that the subsequent analysis relies upon does not include the impact of this lengthy and ongoing outage nor the possibility that a similar event may occur in a future year and therefore may overrepresent aggregate generation future years.

6.2.6 *Permitting*

Permitting considerations are discussed in **Appendix E** for all scenarios, with a particular emphasis on *Scenario 3*. *Scenario 1* is unlikely to pose major permitting hurdles in the foreseeable future as it is currently operating and represents existing conditions. Dam removal, considered in both *Scenario 2* and *Scenario 3* require a variety of permits and agency involvement throughout the process. Permitting considerations for dam removal are discussed in **Section 6**.

6.3. Energy Alternatives

A summary description of the scenarios evaluated in this analysis are included in this section. For a detailed explanation of the two O&M estimates used in *Scenario 1* and specific methodology for the financial analysis of each scenario more generally, refer to **Appendix E**.

Scenario 1 – Dam Remains

Scenario 1 serves as a baseline comparison for the alternative scenarios. In *Scenario 1*, there is no removal of Craggy Hydro. Additionally, MSD will continue to generate a portion of its energy from the Craggy Hydro and purchase the remaining electrical energy from the grid, as described in the sections above. Costs incurred for this scenario include purchase of grid electricity operations expenditures (OpEx), and capital expenditures (CapEx). OpEx and CapEx are informed from the Life Extension and Reliability scenario in the Hatch Report. This scenario is estimated by Hatch to increase annual electricity generation from Craggy Hydro by approximately 50% compared to recent historical baseline. Table 6 summarizes the key quantitative inputs in this scenario derived from the Hatch Report.

Table 6: Inputs Derived from Hatch Report Regarding Craggy Hydro

Input Description	Input Value	Source in Hatch Report (2025)	Notes
Future CapEx	$3,875,000	Calculated from values in Hatch Table 4-1	Present value shown from 27 years of varying cost schedule
Future O&M	$3,342,000	Calculated from values in Table 4-1 in Hatch	Present value shown from 27 years of varying cost schedule
Annual Electricity Generation Before Hatch's Life Extension and Reliability Capex (MWh/Yr)	7,978,000	Inferred from values in Table 4-1 in Hatch	Hatch describes this as being calculated from average quantity between FY2015 to FY2022
Annual Electricity Generation After Hatch's Reliability and Life Extension Capex (MWh/Yr)	11,967,000	Inferred from values in Table 4-1 in Hatch	Hatch estimates this level of generation to begin in 2031
Implied Percent Increase in Generation from Craggy Dam from Reliability and Life Extension Capex	50%		Inferred from two previous rows
Assumed Grid Electricity Cost	$0.06/kWh	Footnote 2 on Hatch Table 3-1	
Electricity Cost Escalation Factor (Nominal)	2.5%	Footnote 2 on Hatch Table 3-1	
Operational Cost Escalation Factor (Nominal)	3.0%	First paragraph of Section 4.1 in Hatch	Footnote 2 to Hatch's Table 3-1 describes a lower 2.0% rate for this input. However, the 2.0% does not appear to be used after attempts at recreating the Hatch analysis.

Scenario 2 – Grid Power

Scenario 2 envisions MSD removing Craggy Hydro and purchasing all electricity through its existing connection to the regional electricity grid. Costs incurred for this scenario include the purchase of grid electricity and two years of OpEx at Craggy Hydro.

Scenario 3 – Solar Power

Scenario 3 envisions MSD removing Craggy Hydro and developing a solar facility to replace foregone electricity resulting from removal of Craggy Hydro. As in Scenario 1, MSD will purchase the remainder of its electricity needs from the grid.

The solar facility will be sized to generate similar annual electricity to that estimated in the Hatch Report for future operation of Craggy Hydro. Similar to hydropower, the ability to produce solar power is dependent on certain environmental conditions including available solar energy. Stantec expects land requirements for the envisioned solar facility to not exceed 32.3 acres. This area would accommodate a facility of the necessary size including space needed for solar panels and racks, spacing to allow mowing and maintenance, electrical control equipment sheds, collector cables, and perimeter setbacks and fencing.

Costs associated with *Scenario 3* include:

- Initial costs include permitting, land preparation, design and construction of the solar facility, purchase of materials, and upgrades to electrical distribution.
- Solar annual O&M costs include typical routine maintenance items like cleaning and inspection, as well as ongoing costs like insurance, asset management, land leasing and property taxes, as well as occasional out-of-warranty repair and replacement of necessary components.
- Solar decommissioning costs, assuming that the project will be decommissioned at the end of the 25-year project life.
- Potential federal tax credit opportunities.

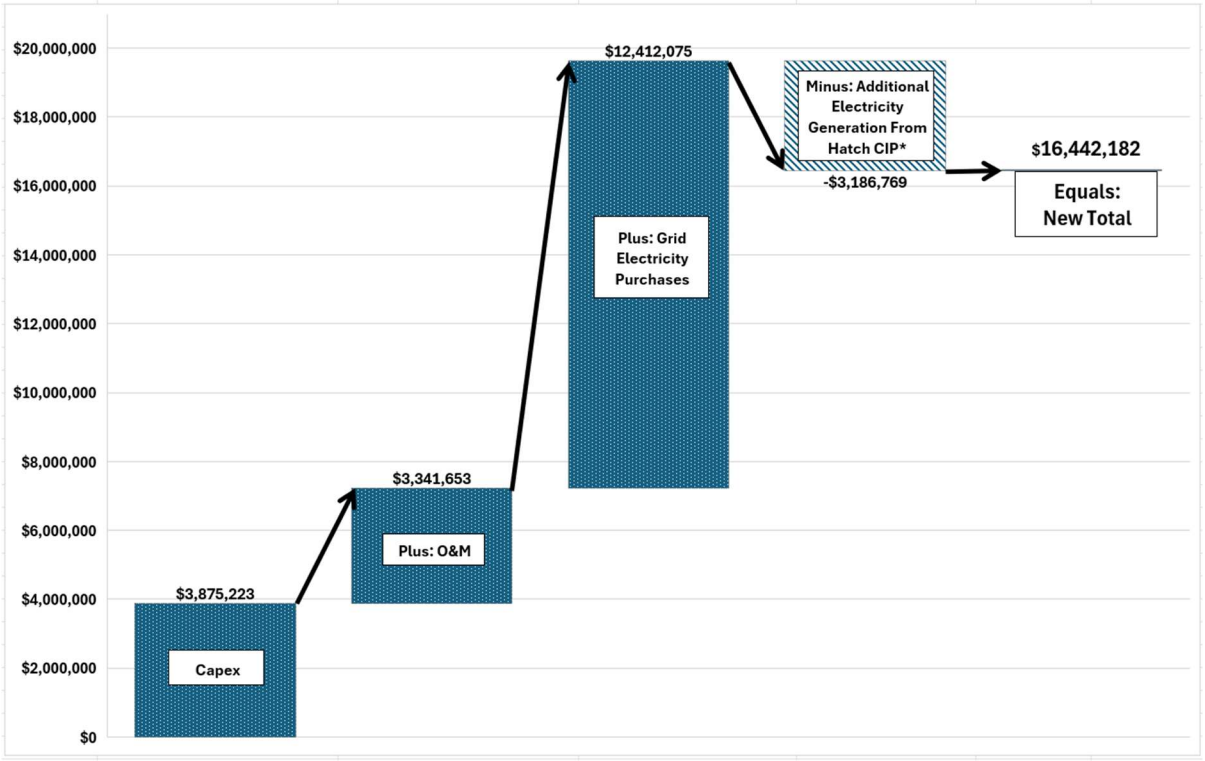
6.4. Financial Results of Energy Alternatives

The three energy future alternatives were identified and evaluated for present cost over a 27-year period, consisting of 2 years of planning and 25 years of operation.

- ***Scenario 1 – Dam Remains*:** Present value costs total $16.4 million.
- ***Scenario 2 – Grid Power (Dam Removed)*:** Present value costs total $21.0 million
- ***Scenario 3 – Solar Power (Dam Removed)*:** Present value costs total $26.9 million to $32.3 million depending on whether the facility qualifies for federal tax credits.

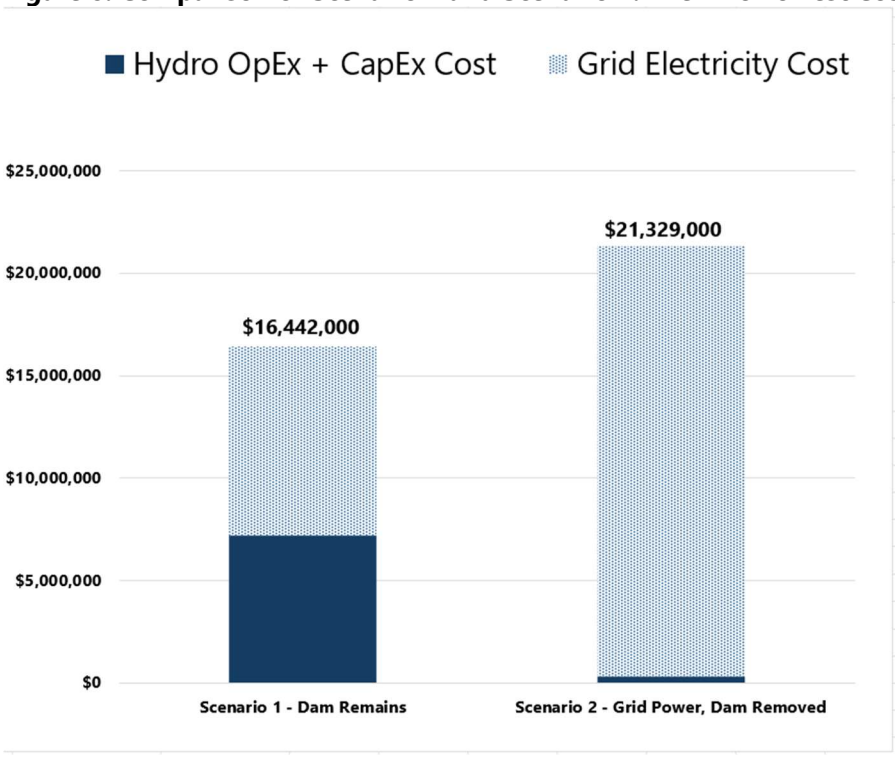
Graphical results of the financial analysis for Scenario 1, Scenarios 1 and 2, and all Scenarios are provided in **Figures 7-9,** respectively.

Figure 7: Detailed Energy Costs for Craggy Dam Scenario 1



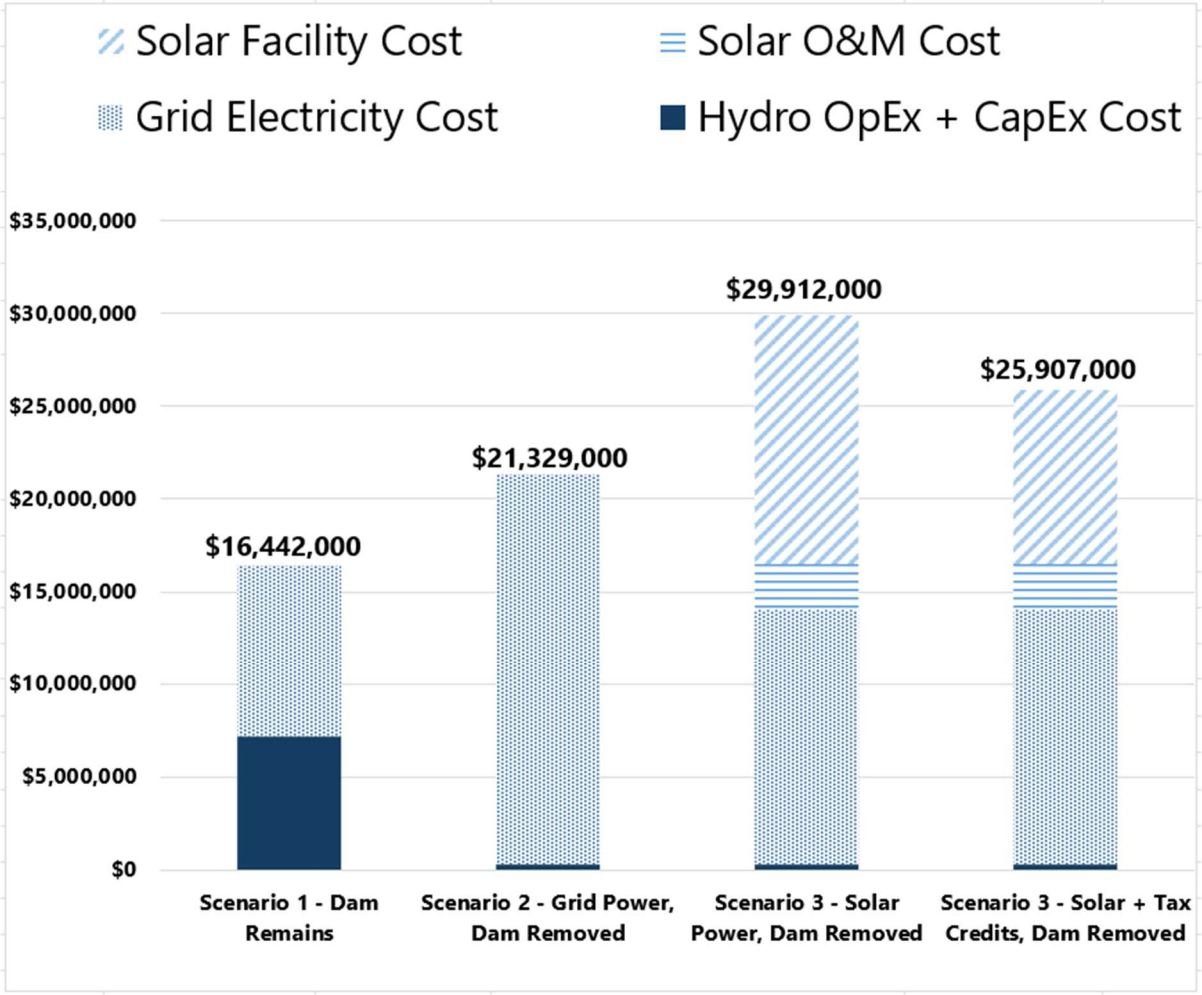
*CIP: Capital Improvement Plan. This follows Hatch's recommendations for the Reliability and Life Extension scenario

Figure 8: Comparison of Scenario 1 and Scenario 2: The Two Lowest Cost Energy Scenarios*



*Notes:
-Totals reflect costs incurred over 27-year project lifespan for electricity needed to fulfill MSD operational needs and presented in 2024 dollars.
-Readers are advised to study the entirety of the report to understand the data sources, assumptions, uncertainties and caveats associated with the monetary estimates provided in this figure

Figure 9: Energy Costs for all Craggy Dam Scenarios



*Notes:
-Totals reflect costs incurred over 27-year project lifespan for electricity needed to fulfill MSD operational needs and presented in 2024 dollars.
-Readers are advised to study the entirety of the report to understand the data sources, assumptions, uncertainties and caveats associated with the monetary estimates provided in this figure

As a reminder, costs displayed in **Figures 7-9** represent total present value costs over the entire system and over a 27-year period. In a recent MSD publication[6], MSD estimated approximately 135,000 individuals lived in households that were served by MSD in FY 2023. Therefore, each $1.0 million dollar difference in present cost across scenarios equates to approximately $7.40 in present costs per person over the 27-year period. This is a one-time $7.40 per person, not an annually recurring $7.40 per person. Specific costs per person for each scenario are provided in **Appendix E**.

In summary, *Scenario 1* is the lowest cost scenario, while *Scenario 2* and *Scenario 3* are estimated to increase costs over Scenario 1. However, these findings are subject to several uncertainties recalled below. *Scenario 2* and *Scenario 3* may also be viable options, contingent upon MSD's ability and desire to increase their cost of service to pursue additional non-financial goals like those described in this report.

With respect to cost uncertainty of *Scenario 1*, The Hatch report describes that its cost development for Craggy Hydro as based on assessments conducted prior to Hurricane Helene and, "[t]herefore, some or all of the assumptions and conclusions from the Condition Assessment Report may no longer be accurate." Furthermore, Hatch costs are developed within the context of AACE Class 4 and Class 5 estimates, denoting assumed cost accuracies of –30% to +50% and –50% to +100%, respectively. Because this analysis relies heavily upon the Hatch report for *Scenario 1*, the findings in the present analysis are subject to these same uncertainties.

6.5. Greenhouse Gas Results of Energy Alternatives

This section explores the implications of various energy scenarios on overall greenhouse gas (GHG) emissions. A qualitative and quantitative discussion is provided below.

The largest source of GHG emissions associated with MSD electrical needs is the proportion of electricity needs sourced from the regional electricity grid. If Craggy Hydro is removed and no solar facility is built to replace the foregone electricity generation additional quantities of electricity will be required from the regional electricity grid and GHG emissions associated with grid electricity will increase. If Craggy Hydro is removed and the foregone electrical energy is replaced by a newly constructed solar facility, GHG emissions from the electricity grid will remain relatively similar to *Scenario 1*.

Though grid electricity is the single largest source of GHG emissions for each scenario, other sources of emissions also exist and are presented below. Each of the three scenarios produces a unique set of sources of GHG emissions associated with implementation and/or operations as summarized qualitatively in **Table 7**.

[6] < https://www.msdbc.org/documents/annualreports/FY2023.pdf> See page 96.

Table 7: Qualitative evaluation of GHG emission sources and their relative magnitude

	Biogenic emissions in reservoir	Grid electricity emissions	Craggy Hydro operational emissions	Craggy removal emissions	Solar facility construction emissions
Scenario 1: Dam Remains	*	**	*	-	-
Scenario 2: Grid	-	***	-	*	-
Scenario 3: Solar	-	**	-	*	*

-: Not applicable or de minimis
*: Estimated small source of emissions
**: Estimated moderate source of GHG emissions
***: Estimated large source of GHG emissions

- **Biogenic Emissions in Reservoir, *Scenario 1*:** Biogenic processes relating to the accelerated decomposition of organic matter in sediments behind the dam result in the generation of modest annual GHGs emissions of carbon dioxide and methane. If the dam was not in place, organic matter would be less likely to be released as carbon dioxide and methane to the atmosphere as a result of a natural process termed enhanced burial[7]. According to The GHG Reservoir (G-res) Tool[8], "When a reservoir is created, there will be a change in GHG emissions which are dependent on local environmental conditions".
- **Grid Electricity Emissions, *Scenarios 1, 2*, and *3*:** Combustion of fossil fuels powering the electrical grid from which MSD draws electrical energy results in a large quantity of annual GHG emissions. For reference, the regional electricity grid ('SRVC') is composed of approximately 49.5% fossil fuel generation in 2023 (EPA 2025). Because the annual electricity needed from the grid is larger under *Scenario 2* than under either *Scenario 1* or *Scenario 3*, grid related emission will be proportionally higher in magnitude in *Scenario 2*.
- **Craggy Hydro Operational Emissions, *Scenario 1*:** Operations of Craggy Hydro result in modest annual GHGs through routine operations from the hydro facility as well as the manufacture of consumable materials and required replacement hardware.
- **Craggy Removal Emissions, *Scenario 2* and *3*:** Decommissioning and/or removal of the dam and hydro facility will result in indirect emissions associated with fossil fuels powering the heavy machinery used to disassemble and move large quantities of material that currently constitute the hydro facility.
- **Solar Facility Construction Emissions, *Scenario 3*:** Construction of the solar facility would result in relatively modest emissions resulting from indirect emissions during manufacturing and installation of the necessary solar facility and supporting electrical equipment and structures.

[7] For more discussion on GHG emissions from reservoirs and hydro dams, see:
<https://www.epa.gov/air-research/research-emissions-us-reservoirs>
<https://www.sciencedirect.com/science/article/abs/pii/S1364032118302235>
<https://www.nature.com/articles/s41561-022-01004-2>
<https://www.hydropower.org/factsheets/greenhouse-gas-emissions>

[8] G-res is a leading tool to estimate GHG emissions from reservoirs associated with dam facilities. The tool was developed in collaboration with notable international organizations and can be found at: <https://www.grestool.org/>

Quantifying Grid Emissions

Because grid emissions are the single largest source of GHG emissions across each scenario, we conducted a GHG analysis to estimate the impacts of the three scenarios on overall emissions from the regional electricity grid.

The analysis relies on the most recently available average emission factor for the local grid region ('SRVC') of 0.596 pounds of CO2e per kWh generated, equivalent to 0.2703 metric tons (MT) per MWh (USEPA 2025). The SRVC grid region covers most of South Carolina and North Carolina, as well as parts of Virginia. Multiplying the total amount of net electricity required from the grid (after self-generation from hydro or solar) by the average emission factor yields the total increase in GHG emissions from each scenario.

Results from the analysis are provided below in **Table 8**. *Scenario 1* is associated with the lowest level of GHG emissions, followed by *Scenario 3*, and finally *Scenario 2*.

Table 8: Net GHG emissions associated with grid drawn electricity

	Scenario 1	Scenario 2	Scenario 3
Net kWh drawn from grid over 27-year analysis	202,177,572	473,651,148	233,781,930
Electric grid emissions attributable to MSD (MT CO2e)	54,687	128,117	63,235
Average annual electric grid emissions attributable to MSD (MT CO2e)	2,025	4,745	2,342
Number of cars emitting an equivalent annual quantity of CO2e*	446	1,045	516

Notes: CO2e is a common metric of GHGs, whereby the radiative forcing of various species of GHGs are converted into CO2 equivalent units. The typical car used here assumes 25 MPG & 12,000miles/yr

In summary, each scenario offers a unique set of GHG emission pathways. *Scenario 1* is associated with the lowest emissions on the grid, while *Scenario 2* is associated with the highest emissions. While we anticipate that GHG emissions from the electricity grid to be the single largest source of emissions under each scenario, other sources, both one-time and annually recurring, also feature as sources of potentially meaningful emissions.

STUDY RESULTS AND RESOURCES

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. Study Conclusions

There are multiple benefits to the community, economy and environment associated with the removal of Craggy Dam.

The community benefits include improved safety and hazard risk avoidance, reduced flooding, and increased recreational activities. Economic benefits include job development opportunities particularly associated with outdoor recreation, but also the service industry that builds in around to support, feed, and house participants and providers of outdoor recreation associated activities. Environmental benefits include improvements to water quality, in-stream habitat for native and endangered species and river connectivity that restores the natural processes necessary for high quality riverine systems.

The Study determined there are no physical, financial, or environmental reasons that prohibit the removal of Craggy Dam. Additionally, there will be little to no negative impact on the upstream Taylor's Wave and would in fact support a larger engagement of river users and it would induce a positive impact on adjacent properties by reducing the flooding. Tradeoffs associated with the removal of Craggy Dam include the greenhouse gas implications of replacing hydropower with other energy sources and potential, temporary changes to river aesthetics.

It is estimated that the cost to fully remove Craggy Dam and all the associated hydropower facilities is $6.3 million to $8.7 million. Significant cost savings of $3.9 to $4.4 million can be found if portions of the hydropower system are left in place and the dam alone is fully removed. The time to fully engage with stakeholders, design, permit and construct the project is anticipated to take four to six years based on required species investigations, FEMA coordination, and extent of facility removal.

The primary cost to dam removal as borne by MSD is the loss of hydropower production. The Life Extension and Reliability plan established in the Hatch Report assumes significant capital investment over a period of 30 years and project future electricity generation estimates which assume the units remain fully operational year-round with a 0.95 capacity factor (Hatch 2024) aside from planned maintenance. Based on the Hatch scenario, Craggy Hydro is found to offer an economical option for supplementing MSD electricity needs. Relying entirely on grid power represents a modestly more expensive option if dam removal costs are borne by a third party as anticipated. Solar power is more expensive still and appears to be the least economical option in this context.

Communities across the County are supporting dam removal projects for their beneficial outcomes on their lives, economy, and river health. Initial community support in Buncombe County is present as was identified in preliminary outreach.

7.2. Recommendations for MSD and American Rivers

There are multiple benefits and impacts to the community, economy and environment associated with the removal of Craggy Dam. There do not appear to be any significant issues with existing infrastructure, sediment, or regulatory processes that would prevent dam removal. However, there are impacts for MSD that should be considered if the dam is removed including how to best stabilize the 66-inch interceptor crossing of Beaverdam Creek. Total MSD electricity costs are found to be minimized by

keeping the hydropower facility and following the Life Extension and Reliability scenario as recommended in the Hatch Report. Relying on grid power only, and relying on grid power plus solar power, both increase total electricity costs. While electricity costs go up under a dam/hydro power removal scenario the maintenance and capital improvement costs are reduced by avoiding costs associated with repair and replacement in the Hatch (2024) Report.

Given the initial community and regulatory support and benefits and impacts for dam removal we recommend the following action:

- Review the Hatch Report to validate the assumptions on MSD's operation of Craggy Hydro.
- Evaluate the existing on-going grid power use and amount of usable hydropower production with duration of off-line facilities due to maintenance issues not fully captured in the Hatch Report.
- Develop and conduct a community outreach and engagement plan to gauge community and stakeholder perspective and long-term interests in investments, including solar power and recreation, around the French Broad River.
- Utilize the investigations in the Stantec and Hatch Reports as well as community input to inform future decision making by Buncombe County MSD board leadership regarding the future of Craggy Dam.

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