Flat Rock and Huroc Dams Feasibility Study—Economic Contribution Analysis

PSC

PUBLIC SECTOR CONSULTANTS

Prepared by

Public Sector Consultants
www.publicsectorconsultants.com

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Executive Summary

As part of a broader feasibility study funded by a National Oceanic and Atmospheric Administration Great Lakes Restoration Initiative grant, project partners engaged GEI Consultants, Inc. (GEI) for conceptual engineering and design services and Public Sector Consultants (PSC) to assess the existing contributions of the Flat Rock and Huroc Dams to the local recreational economy and property values and then to estimate how the partial or full removal of both dams would shift those contributions. To conduct this analysis, PSC leveraged data provided by local recreational asset managers and organizations through interviews and other data requests. This work complements PSC's ongoing support for the project's community and stakeholder engagement efforts.

Regional Economic Contributions and Property Impacts

Parameters and Approach

PSC analyzed five scenarios for these analyses, outlined below.

- **Current impoundment:** Measured contributions from recreational activity associated with the impoundment (e.g., angling and other park visitation), as well as to values of study-area properties adjacent to and surrounding it.
- **Short-term partial removal:** Measured contributions from construction spending over one-year decommissioning phase for complete removal of Huroc Dam and replacement of Flat Rock Dam with a rock ramp.
- **Short-term full removal:** Measured contributions from construction spending over one-year decommissioning phase for complete removal of both dams and conducted a literature review of studies estimating impacts on property values following dam removal, some of which estimate short-term impacts.
- **Long-term partial removal:** Measured contributions based upon assumed long-term changes in recreational activity (e.g., nonmotorized boats, angling, and other visitation to the park) for ten years post decommissioning.
- **Long-term full removal:** Measured contributions based upon assumed long-term changes in recreational activity (e.g., angling, nonmotorized boats, and other visitation to the park) for ten years post decommissioning and conducted a literature review of studies estimating impacts to property values due to dam removal, and contributions to property value from rivers, greenways, and other natural open spaces and amenities.[1]

To estimate the economic contributions based on the current and potential future dam scenarios, PSC gathered and analyzed data to produce estimates of direct activity and modeled it in IMPLAN. To measure and estimate property value associated with the impoundment and potential net impacts resulting from dam modifications, we conducted a hedonic analysis[2] as well as an assessment of peer-reviewed studies

[1] Because the partial removal of the dam is expected to leave the existing impoundment intact with minimal water level declines (less than 0.5 feet) and is likely to result in insignificant levels of impacted residential property values and tax revenue, PSC confined its review of literature to studies of full dam removal scenarios and those estimating contributions from rivers and other natural green space amenities.

[2] Hedonic analysis is a statistical approach that accounts for and fractions all factors that can contribute to the value of a good. In this case we fractioned and modeled the value-components of residential homes in the study area to determine the compounded value from the impoundment.

that met suitability standards for inclusion and had similar study parameters. A comprehensive discussion of the methodologies behind each analysis is in the appendix on page 37.

Findings

- The current impoundment contributes direct, indirect, and induced benefits to the regional economy every year, totaling $74,000 in labor income and $110,000 in value-added; associated property value premiums within one-quarter mile of the impoundment total an estimated $3.1 million, generating $74,000 in property taxes.
    - Direct benefits from the impoundment include $44,000 in labor income, $63,000 in value-added, and over $9,000 in local and state taxes.
    - The premium associated with properties directly adjacent to the impoundment is $39,348, comprising over 15 percent of the average market value.
- Partial removal of the dams would support 32 jobs, $2.2 million in labor income, and $3.3 million in value-added during the one-year decommissioning phase and sustain long-term annual benefits that include $141,000 in labor income, $206,000 in value-added, and $47,000 in all taxes.
- Full removal of the dams would support 109 jobs, $7.4 million in labor income, and $11.0 million in value-added during the one-year decommissioning phase and sustain long-term annual benefits that include $310,000 in labor income, $453,000 in value-added, and $115,000 in all taxes.
- There is no definitive conclusion on the anticipated net change in property values in the study area following dam removal and replacement with a free-flowing river and surrounding green space. However, the literature suggests that impacts to the value of property surrounding an impoundment hinge on the quality and aesthetic recreational value of the natural amenity that replaces it, in both the short- and long-term.
    - The literature clearly establishes the significance of the relationship between proximity to water and property value, and demonstrates diminishing value as distance increases. The majority of any impacts resulting from dam removal, whether negative or positive, will likely be absorbed by the 56 lots currently adjacent to the impoundment. The remaining 385 properties in the study area will experience more modest impacts in the short- and long-term.
    - Impacts to properties surrounding the current impoundment will likely vary in the years following dam removal. While we would expect to see some degree of negative impact to property values (mostly among those adjacent to the current impoundment) in the short-term, some of the studies reviewed suggest that impacts will moderate and could even rebound in the long-term.
    - Negative impacts due to dam removal can be mitigated by the quality, aesthetic, and recreational value of the amenity that replaces the impoundment. This is a common theme throughout literature. The uncertainty of short- and long-term environmental conditions—including water quality, fish habitat, recreational opportunities on and off the water, quality of the greenway, upland habitat, and overall natural aesthetics—makes it especially difficult to anticipate long-term impacts on property values.

Detailed analytic results and expanded information on the approach are found in Economic Contribution Analysis section on page 12 and Property Value Analysis section on page 20.

Background

In partnership, the Huron-Clinton Metroparks (HCMA), the Michigan Department of Natural Resources (DNR), the Great Lakes Fishery Commission, Huron River Watershed Council, and the City of Flat Rock successfully submitted for a National Oceanic and Atmospheric Administration Fisheries Regional Partnership Grant that was funded through the Great Lakes Restoration Initiative. This grant is being used to conduct a feasibility study for alternative options for the Flat Rock and Huroc Dams that would benefit the local community and natural habitats (HCMA n.d.). These partners are focused on improved fish passage and reconnecting important tributary habitat to Great Lakes species while also minimizing the risk of sea lamprey infestation.

In collaboration with GEI and project partners, PSC conducted analyses to better understand the economic contributions of the dams, and the reservoirs they create, as well as how those contributions might shift over the short- and long-term following the decision to partially or fully remove the Flat Rock and Huroc Dams. These efforts focused on two key components.

First, PSC conducted interviews and collected economic data to estimate the direct economic effects of spending associated with *recreational activity* and modeled supply chain purchases, worker spending, and other indirect effects. All the effects were modeled in three categories:[3]

- **Employment:** The number of full- and part-time jobs associated with an industry.
- **Labor income:** The dollar total of employee compensation and proprietor income; the latter is associated with self-employed individuals.
- **Value-added:** The gross regional product, which includes labor income, other property income (e.g., rents and profits), and business taxes (e.g., excise and sales taxes) less subsidies received.

Second, PSC collected detailed property records from local assessors' offices to conduct a hedonic analysis and literature review of estimated impacts to property values in the event of its removal. The former was designed to assess how the current impoundment contributes to the property values of residential properties adjacent to the current water body. The latter was chosen in lieu of a quantitative analysis to provide relevant findings gathered from studies and analyses on the impacts to property values after a full dam removal, and contributions to property values by rivers and other natural green space amenities.[4]

[3] For more detailed information on IMPLAN methodology and terminology, see the appendix.

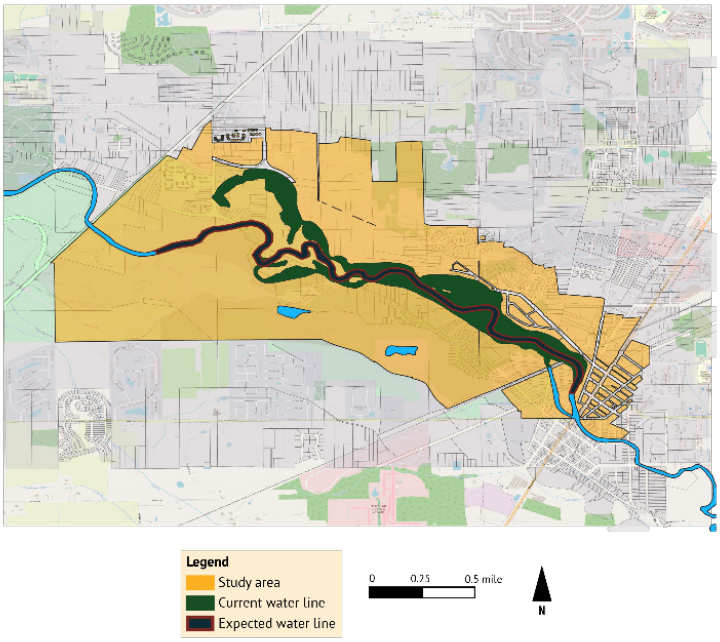
[4] The literature review focuses on the full dam removal scenario. Because the partial removal of the dam is expected to leave the existing impoundment intact with minimal water level declines (less than 0.5 feet), PSC assumes that residential property values, and, therefore, tax revenue levels, will not be significantly impacted.

Flat Rock and Huroc Dams

To provide valuable context for the economic impact analysis results, this section includes a high-level overview of the dams, as well as some general and site-specific information about the environmental context in the event of partial or full dam removal under the study's assumptions.

Background

The Flat Rock and Huroc Dams are located on the Huron River, just west of the City of Flat Rock, which is home to approximately 10,000 residents (U.S. Census Bureau 2022). Completed in 1924, the Flat Rock Dam was built by the Ford Motor Company to provide hydroelectricity for its new factory and continued to operate as such until 1950. The dam, now owned by HCMA, is 16 feet high and about 530 feet long. The dam creates an impoundment and backwater area to its northwest that is approximately 188 surface acres. While many areas of the impoundment are less than two feet deep and most of the water body is less than five feet deep, its maximum depth is about 12 feet (DNR 2017).



The Huroc Dam, which is owned by the City of Flat Rock, is a smaller dam just downstream from the larger Flat Rock Dam and creates an impoundment between the dams that sits between Huroc Park and the edge of the City of Flat Rock's downtown. The park is a popular location for residents and is the site for many community events. At the time of publication, any recreational activity in the impounded water body between the dams is prohibited by city ordinance. As a result, there is no designated and regularly accessible public access portage area for paddlers (e.g., canoers and kayakers) to continue downstream once they reach the Flat Rock Dam.

While a Denil-style fish ladder was installed at the upriver dam by the Huron River Fishing Association in 1996, and maintained intermittently, these dams are the first significant barriers to fish traveling upstream from Lake Erie. Despite the fish ladder, these dams still restrict fish passage and limit reproduction for a number of fish species, including lake sturgeon, walleye, and white bass (DNR 2017).

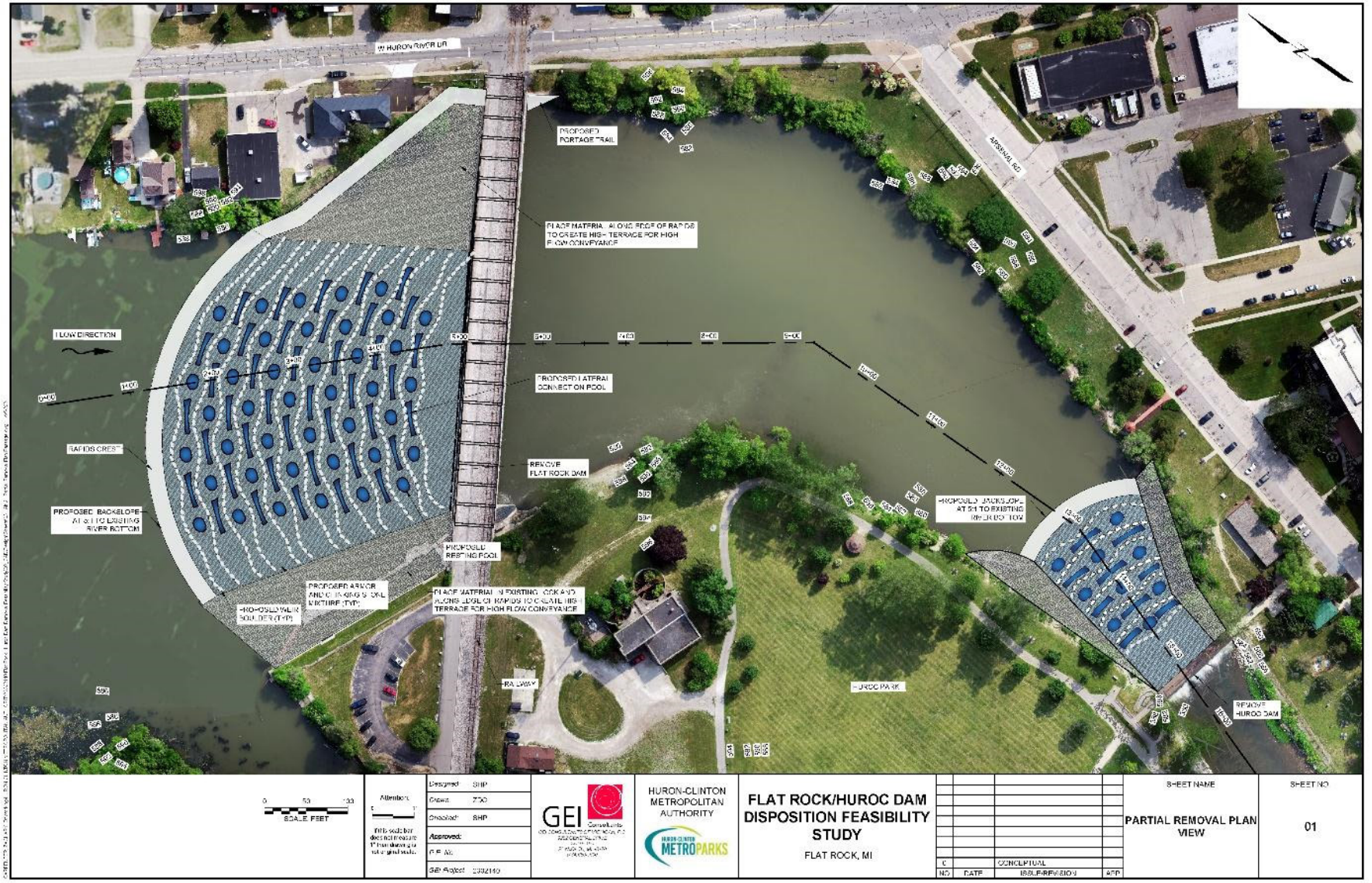
Dam Removal Scenarios

While no final decision has been made, PSC analyzed two options: partial and full dam removal. Under the full removal option, it is expected that there will be a length of time when the exposed bottomlands (previously impounded sediments) need to dry out. This process usually completes itself during the construction phase of a project as the impoundment is lowered. For the purposes of high-level environmental assessments, it is assumed that the impounded sediments have dried to the extent possible within the construction time frame, typically within the first six to nine months of the project.

Partial Dam Removal

As shown in Exhibit 1, the partial removal option would feature the replacement of the Flat Rock Dam with a rock ramp and the complete removal of the smaller Huroc Dam.

EXHIBIT 1. Partial Dam Removal Scenario



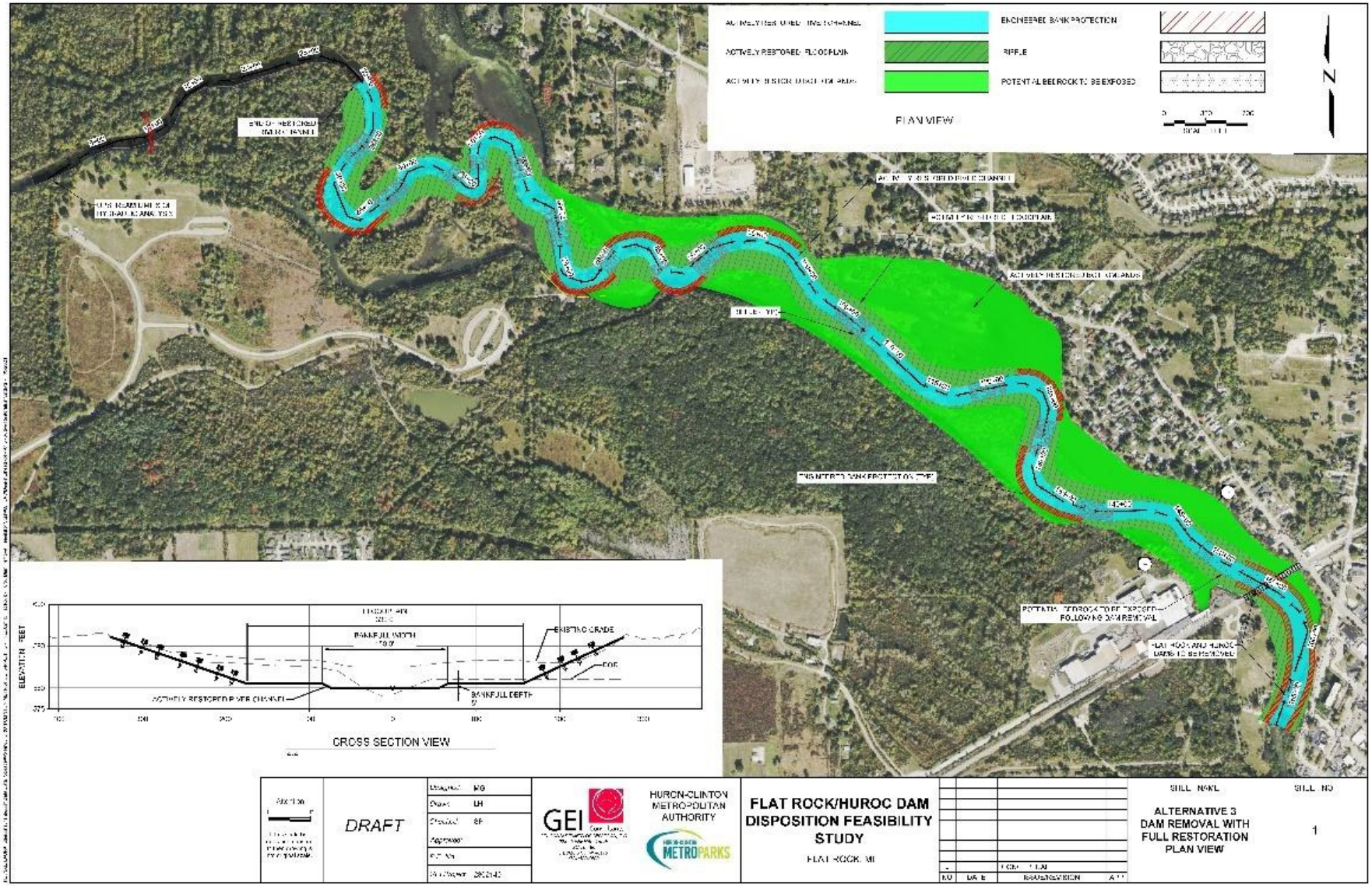
Source: GEI

The installation of a rock ramp in the location of the current Flat Rock Dam is expected to leave the impoundment largely as it exists today with possible 0.5 feet of drop in normal water surface elevation according to estimates from GEI. With the water surface largely maintained, there likely would be minimal impacts to wetlands, habitat, recreation, or adjacent property owners.

Full Dam Removal

The full removal of both dams is expected to result in the normal water surface elevation dropping approximately ten feet from existing conditions. This change will result in the exposure of land currently inundated by the dam. A river channel about 150 feet wide will form within the impoundment—similar to what the river looks like upstream and downstream of the Flat Rock Dam impoundment (Exhibit 2).

EXHIBIT 2. Full Dam Removal Scenario



Source: GEI

A floodplain will be created on either side of the river channel. Once the dam is removed and the sediment allowed time to dry out, native seed stored within the impounded sediment will germinate. Wetlands will likely form in the newly created floodplain adjacent to the river channel. Areas along the north bank of the impoundment are likely to form upland. Areas along the south bank may have more propensity to form wetland habitat due to the presence of existing adjacent wetlands.

Economic Contribution Analysis

Recreational Economy

To assess existing and potential shifts in recreation-related activity under partial and full removal scenarios, PSC 1) conducted an extensive review of the existing research literature, 2) spoke with local government officials, recreational asset managers, and other community stakeholders, and 3) identified existing reports and collected data on the number and types of visitors to the recreational facilities surrounding the impoundment. This research allowed PSC to analyze economic contributions for five different scenarios:

- Current impoundment
- Short-term partial removal (decommissioning phase)
- Short-term full removal (decommissioning phase)
- Long-term partial removal (ten years post decommissioning)
- Long-term full removal (ten years post decommissioning)

Current Impoundment Scenario

After talking with key stakeholders and reviewing survey results from a previous economic impact study that collected responses in the City of Flat Rock, PSC identified two key recreational activities associated with the current impoundment that could be impacted by the partial or full removal of the dams where usage was large enough to measure and visitor data was available:

- Angling at Huroc Park
- Park visitors at Oakwoods Metropark (non-boat rental)

Changes to the existing water body between the dams (Huroc Park) and the backwaters from the Flat Rock Dam near the Oakwoods Metropark Nature Center are likely to most greatly impact these related recreational activities. As a result, PSC focused on these activities' economic contributions.

While there are some paddlers accessing the impounded area and backwaters, these are expected to be mostly captured in the Oakwoods Metropark non-boat rental visitor counts because the major canoe and kayak rental facilities in the area either pull their customers out of the water before the impounded area at the Cedar Knoll Picnic Area (Motor City Canoe Rentals at Oakwoods Metropark) or drop them below the Huroc Dam (e.g, Atwater Paddles). Also, stakeholders noted in interviews that while there are usually a small handful of individuals using their own kayaks and canoes in the impounded area, the numbers are very small and they are unlikely to make a significant and measurable impact on the local economy. For these reasons, PSC did not include any paddlers from these sites in its analysis of the current economic contributions of the existing dams and impoundments.

Non-angling Huroc Park users were also not included in this analysis. While the presence of the impounded area likely adds to the recreational experience of non-angling activity at the park, a city ordinance prohibits any swimming, paddling, or other recreational activity in the water adjacent to Huroc Park. Therefore, attributing all visitor activity at Huroc Park to the presence of the impoundment would be likely to overestimate the economic contributions associated with the dams and impounded areas.

PSC leveraged interviews with recreational asset managers, local business owners, and other stakeholders to estimate annual visitor counts for each of these recreational activities (Exhibit 3).

EXHIBIT 3. Estimated Annual Visits by Type

Activity	Amount
Oakwoods Metropark Nature Center visitors (adjacent to backwaters)	2,017
Anglers (Huroc Park)	3,673

Source: DNR 2007; HCMA 2023; PSC analysis of stakeholder interviews

These counts were then applied to an inflation-adjusted recreation expenditure profile produced by an economic impact analysis of recreational activity along the Huron River, including the area near the City of Flat Rock. Spending categories associated with gasoline, meals, groceries, sporting goods, entertainment, and other retail spending were included in the analysis, but lodging expenses were not because while Isley et al.'s study (2017) of Huron River recreational spending did identify some lodging expenditures associated with river trips, it concluded that they averaged out to $0 per person because the vast majority of visitors do not stay overnight at hotels, motels, campsites, etc., when they visit. Average spending per trip for non-anglers and anglers was estimated at $15 and $42, respectively (Isley et al. 2017; U.S. Department of the Interior [US DOI] 2022).

Short-Term Economic Contributions (Partial and Full Removal)

For the short-term partial and full removal scenarios, which for the purposes of this study refer to the construction phase of the project, PSC assumed that backwater activities at Oakwoods Metropark and angling activity would be reduced to zero. The former assumption was made because stakeholder interviews indicated that any drop in water levels would make navigating these areas even more difficult. The latter assumption was made because the most recent survey of angling activity indicated that the vast majority of fishing activity in the area is happening at Huroc Park and at the site of the dams, which will be unavailable to anglers during construction.

That said, the expenditures associated with partial and full removal decommissioning, and therefore the amount of economic contribution stemming from spending on construction materials and labor, are different. To analyze these economic contributions, PSC used construction spending estimates provided by GEI (Exhibit 4).

EXHIBIT 4. Construction Costs—Partial and Full Dam Removal

Construction Costs*	Amount (2024)
Partial removal	$8,400,000
Full removal	$26,700,000

* Does not include contingency cost estimates
Source: GEI

Long-Term Economic Contributions (Full Removal)

While, in general, studies have shown that recreation activity on the river, particularly fishing and paddling, either grows or remains consistent following dam removal, some studies have found that the effects are not equally distributed (Robbins & Lewis 2008; Bi et al. 2019). For example, one study found that river restoration has a complex effect on recreation, increasing some types of activities (such as canoeing and kayaking), but potentially reducing other types, such as fishing (Bi et al. 2019). Unsurprisingly, this study also found that the impacts of dam removal and river restoration can differ depending on the extent to which local businesses serving the reservoir-based sites are able to adapt to changes in recreation preferences (Bi et al. 2019). For this reason, it is important to think critically about how the removal will impact various recreational activities differently over the long term, which for the purposes of this study would be ten years post dam removal.

Anglers

Predicting how fisheries, and, therefore, angling activity, will change following the removal of the dams over the short, medium, and long term is challenging. For the economic contribution analysis of the existing impoundment, PSC estimated the number of anglers at Huroc Park using a creel survey that specifically measured fishing in this area and applied an inflation-adjusted expenditure profile to derive estimates of the transactions that could be attributed to current angler activity. To assess the economic impacts of dam removal, it is necessary to go one step further to estimate how angler-related transactions will change following this major event, which is difficult given unpredictability of fish population changes and shifting angler preferences.

A review of the academic literature on this topic suggests that generalizing how fish populations will adapt following the removal of a dam is complex and often results in inexact projections because of the number of variables at play in any dam removal project (Hansen et al. 2023). For example, a recent study documented that even the most simplified models require detailed data on growth, feeding and prey preference, reproduction, and biomass data for each individual species in combination with a variety of system-wide parameters, like water temperature and flow (Bellmore et al. 2017). Also, it is important to consider other mitigating circumstances. For example, obviously not all anglers prefer river fishing, with some preferring the current ability to shoreline fish at Huroc Park and will look for that opportunity at other ponds and lakes in the area. Also, there are supply and demand dynamics at play, as changes that increase the costs of fishing activities may result in a decrease in visitor fishing trips (Hwang et al. 2020). These examples demonstrate how the change in the number of angler trips may have as much to do with the preferences of recreational anglers as it does with the changes in the new river ecosystem. For these reasons, PSC did not make assumptions about the change in the number of angler trips following dam removal.

However, removal of the dam is expected to shift those angler trips from primarily occurring onshore around an impounded pond-like area (e.g., Huroc Park and the area immediately downriver from the Huroc Dam) to more river-based fishing. Research does show that this shift from reservoir to river fishing can result in different visitation spending patterns (Hebdon et al. 2008). For example, one study found that the removal of the Edwards Dam on the Kennebec River in Maine resulted in greater overall angler satisfaction with fishing trips over the long term (Robbins and Lewis 2008). In this case, both the willingness to pay to fish and actual fishing-related expenditures increased after dam removal. Similarly, McKean et al. (2010) found that anglers' willingness to pay increases and their actual expenditures for fishing increase after dam removal. Although this study found that there could be a smaller number of visitor trips, mitigating the economic benefits of dam removal, the increased spending per trip still resulted in positive net results. To minimize those potential negative impacts of shifts from reservoir to river fishing, one study recommended that restoration plans should focus on expanding and enhancing onshore fishing opportunities along the restored river (Bi et al. 2019).

As previously stated, PSC did not make assumptions about changes in the number of angler trips, but did apply those angler trips to the previously described inflation-adjusted expenditure profile, which resulted in the per angler trip expenditure total increasing from $42 to $96 (Hebdon et al. 2008; McKean et al. 2010; US DOI 2022).

Park Visitation

For those using parks, such as the Oakwoods Metropark, there will likely be changes to recreational activity that are not associated with fishing and paddling. For the purposes of this analysis, it is assumed that they will be relatively small both because there are few public access points along the current upstream impoundment and the bridge providing access to Huroc Park is expected to remain in place. For these reasons, this activity was held constant in the long-term scenario projections.

Paddling

PSC's stakeholder interviews and reviews of the best available data suggest that there are approximately 5,000 people renting canoes or kayaks in the area each year, and as previously noted, the presence of the dams ensures that nearly all those trips either end before the impounded area or start below the Huroc Dam. In addition to limiting nonmotorized boating trips, the inability to bypass the dams limits visitor traffic at local businesses in the City of Flat Rock. Stakeholder interviews confirm demand for more river-based paddling options as well as the reduction in overall paddling activity due to the dams.

An analysis of those interviews, data from other liveries in similarly situated areas, and the academic literature suggest that the number of users would increase substantially were the dams to be fully removed. For example, one study found that nonmotorized boating activities significantly increased after dam drawdown periods that exposed previously submerged areas and more closely resembled a free-flowing river (Bi et al. 2019). That study also concluded that restoring the river flow would bring additional recreational demand from those who do not currently visit the region as frequently. In addition to determining that nonlocal visitors who engaged in river-based recreation activities had higher trip expenditures, the study also emphasized the importance of restoration efforts enhancing river-based recreational opportunities and increasing public awareness about these options.

Other factors may enhance the draw of the region post dam removal. Policymakers and funding have targeted improvements in the quality and access of the former DNR boat launch just downstream from

the impoundment over the next few years. That will also help improve access to existing and potentially new paddle rental companies hoping to become established in the Flat Rock and downriver areas.

After conducting this review, PSC made assumptions about the projected growth in the number of people renting canoes and kayaks over a ten-year period from an estimated 4,594 in 2023 to 25,006 ten years post dam removal (Bi et al. 2019 and Huron Watershed Council 2024).

Long-Term Economic Contributions (Partial Removal)

Given that the partial removal scenario, which involves the removal of both dams and the installation of a rock ramp at the Flat Rock Dam site, is only expected to result in a negligible drop in water levels, PSC has made relatively modest assumptions about shifts in recreational activity in the area. For example, given that the impoundment would remain mostly intact, PSC has not made assumptions in changes to annual angler trips. While even a small decline in water levels may affect backwater areas near Oakwoods Metropark, PSC assumed that recreational activity that is not related to canoe and kayak rental would remain constant following the partial dam removal effort.

One area in which PSC did make assumptions about recreational activity shifts was paddle rentals. While paddle rentals were not included in the current impoundment analysis, the partial dam removal scenario is expected to provide a much more accessible portage opportunity for those hoping to pass through the rock ramp area. Stakeholders indicated in interviews that this would result in more paddlers being able to pass through the currently impounded area, which increases the likelihood that the paddlers stop in Flat Rock for retail shopping and restaurant visits. Also, if the anticipated improvements are made to the former DNR boat launch south of Telegraph Road, more boat stops and rentals could occur over the long term. That said, stakeholders noted that while these shifts should be accounted for in the analysis of the long-term partial removal scenario, they also stated that they would not be as extensive as the full removal scenario. It is anticipated that paddling through will still be discouraged by a rock ramp feature in the partial removal scenario. For these reasons, PSC has used a more conservative estimate for growth in canoe and kayak rental activity for this scenario. PSC estimates that the number of people renting canoes and kayaks over a ten-year period will grow from 4,594 in 2023 to 10,106 ten years after partial dam removal (Bi et al. 2019; Huron Watershed Council 2024).

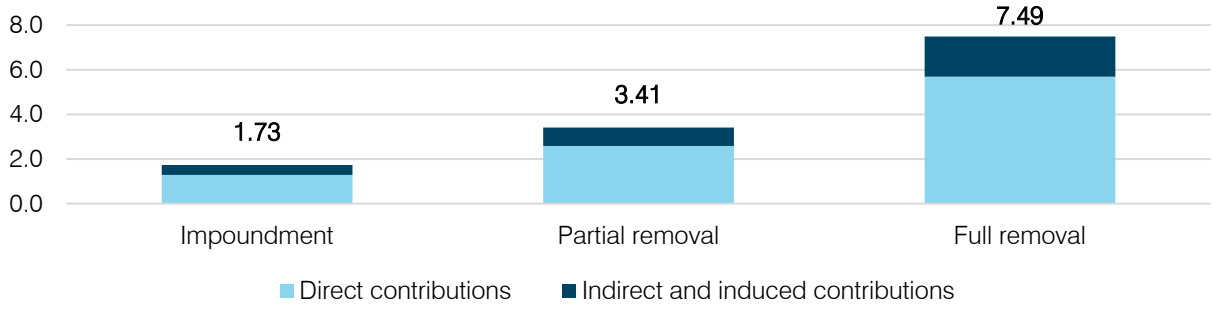
Results

After applying the approach outlined in the methodology section of this report, site visitation estimates were applied to the expenditure profiles for each scenario. For the short-term analyses, construction spending estimates were also included. Using these spending totals and IMPLAN, PSC modeled these various scenarios, with the results summarized in Exhibits 5, 6, and 7. The exhibits showcase the results of the following scenarios:

- Impoundment: The additional economic value attributed to recreational expenditures under the status quo
- Partial removal: The expected ongoing economic value captured by recreational activities under the partial dam removal scenario
- Full removal: The expected ongoing economic value captured by recreational activities under the full dam removal scenario

Given that the partial removal scenario would leave substantial impoundments upstream from the Flat Rock Dam and between the Flat Rock and Huroc Dams, the results show a smaller shift in long-term economic contributions, whereas the long-term full removal scenario has a different set of previously described assumptions that produce a larger change in contributions.

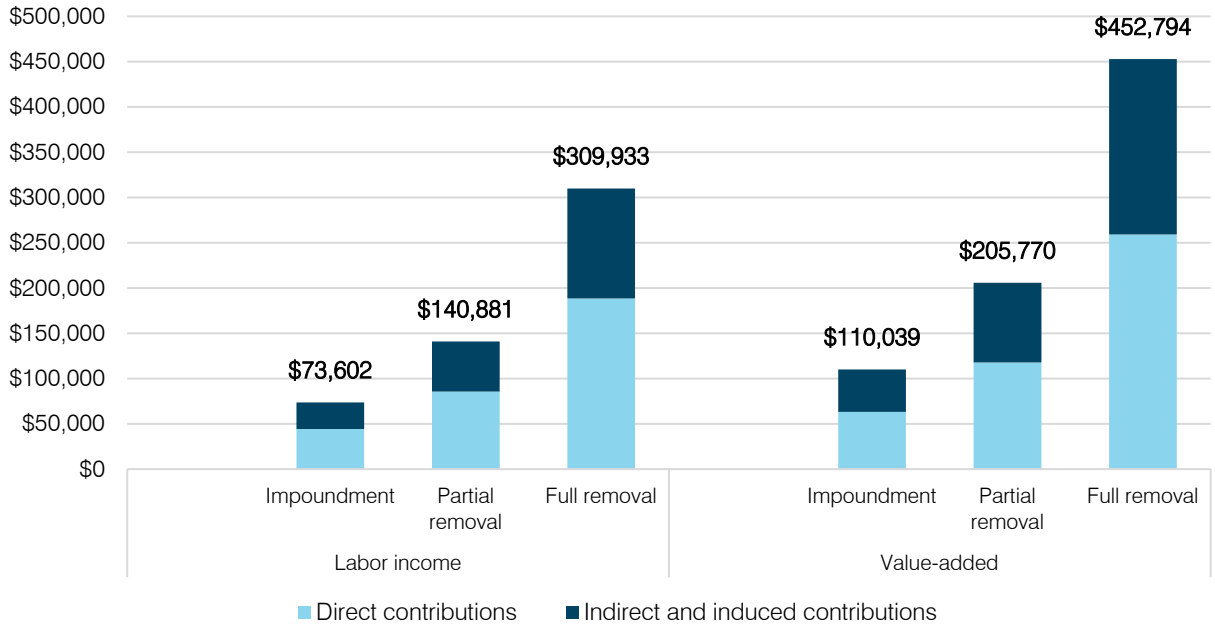
EXHIBIT 5. Employment Results: Jobs Supported and Sustained by Current Impoundment, Partial Removal Long-Term, and Full Removal Long-Term Scenarios



Source: PSC analysis

Exhibit 5 indicates that while the current impoundment contributes to about two jobs in the region each year, the partial and full removal scenarios are expected to contribute about 3.5 and 7.5 jobs, respectively. The increased recreational activity and spending under those scenarios drives these employment gains.

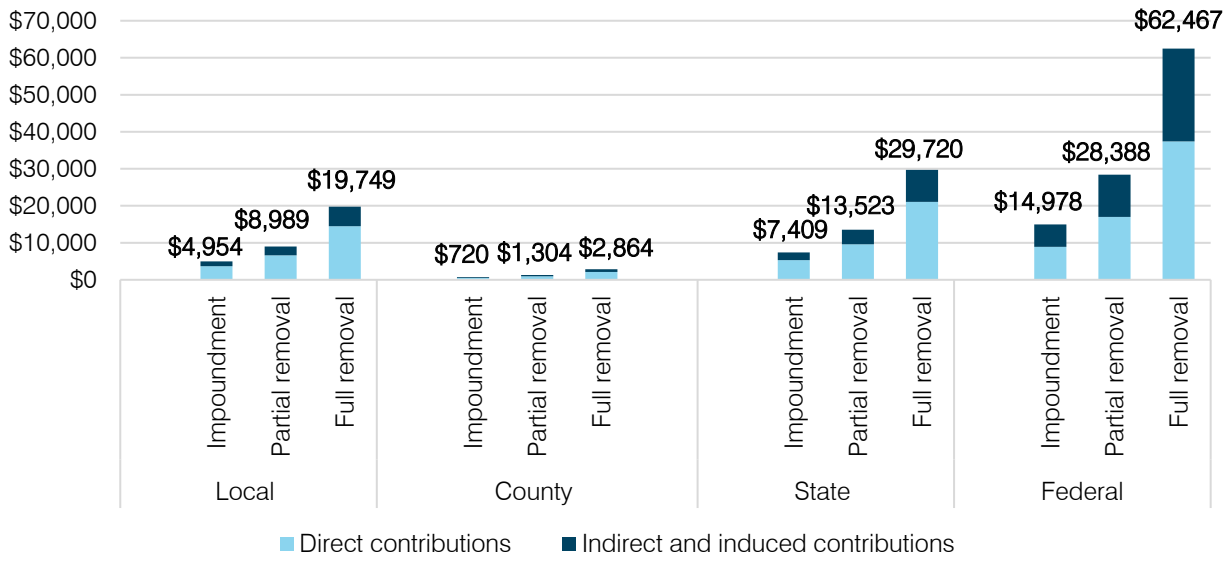
EXHIBIT 6. Labor Income and Value-added Contributions by Scenario: Current Impoundment, Partial Removal Long-Term, and Full Removal Long-Term



Source: PSC analysis

Similar to the employment outcomes, the increased recreational activity associated with the partial and full removal scenarios is expected to result in gains to the region's economy. Labor income is expected to increase in partial and full removal scenarios, which is a measure of income earned by workers and business owners. This increased spending for those scenarios is also expected to result in additional economic output in the form of gains to the gross regional product, referred to in this report as value-added, which includes labor income as well as other property income and indirect taxes paid by businesses.

EXHIBIT 7. Tax Contributions by Scenario: Current Impoundment, Partial Removal Long-Term, and Full Removal Long-Term



Source: PSC analysis

From a tax revenue perspective, the increased recreational spending post-partial or -full dam removal is expected to result in greater contributions to local, county, state, and federal governments.

PSC also assessed the short-term economic contributions associated with decommissioning phases of partial and full dam removal scenarios (Exhibits 8 and 9). This analysis uses the IMPLAN model to estimate how planned expenditures in dam decommissioning and restoration of the river channel disperses across the regional economy, as described in the appendix.[5] It is important to note that these jobs and additional economic contributions will only be present during the decommissioning phase, which is expected to last for about one year.

Removing the impoundment will take about 12 months of effort and require substantial expenditures for decommissioning the Huroc and Flat Rock Dams. These expenditures will diffuse across the region's economy to support jobs well beyond those employed in the decommissioning of the dams. Under a

[5] As the study area is an urban area with sufficient supply of excavation and construction companies, most such expenditures are expected to be captured by local providers. However, the purchases of rock and stone used in the restoration process largely come from outside the modeling region. Therefore, the model correctly assumes that expenditures for rock and aggregate are mostly made to suppliers outside of the local community and therefore have limited impact on the regional economy.

partial removal scenario, approximately $3.9 million of the total expected expenditures of $8.4 million ($11 million with contingency) in decommissioning and restoration expenditures are expected to be captured in the regional economy, generating support for about 32 annual jobs with wages of about $2.2 million, once accounting for multiplier effects. Similarly, of the expected $26.7 million ($35 million with contingency) in decommission expenditures under a full dam removal scenario, about $12.8 million is expected to be captured by the region's economy. PSC anticipates that these expenditures will support about 109 regional jobs with $7.4 million in total wages.

EXHIBIT 8. Economic Contributions During 12-Month Decommissioning Phase

Scenario and Effect Type	Jobs	Labor Income	Value-added
Partial Removal			
Direct	21	$1,452,360	$2,058,868
Indirect and induced	11	$761,172	$1,258,499
Partial Removal Total	32	$2,213,532	$3,317,367
Full Removal			
Direct	72	$4,901,702	$6,788,982
Indirect and induced	37	$2,544,591	$4,214,512
Full Removal Total	109	$7,446,292	$11,003,494

Source: PSC analysis
Note: Totals may not add up due to rounding.

This added economic activity is expected to support additional public revenues through local, county, state, and federal sales and income taxes, property taxes, and public fees. Exhibit 9 summarizes the expected tax effects during the 12 months of decommissioning and restoring the river.

EXHIBIT 9. Tax Impacts During 12-Month Decommissioning Phase

Scenario and Effect Type	Local	County	State	Federal	Total
Partial Removal					
Direct	$29,304	$3,696	$62,561	$295,685	$391,245
Indirect and induced	$40,680	$5,830	$66,766	$158,905	$272,181
Partial Removal Total	$69,984	$9,526	$129,327	$454,590	$663,427
Full Removal					
Direct	$94,016	$11,724	$203,315	$991,477	$1,300,532
Indirect and induced	$136,781	$19,610	$224,308	$531,531	$912,230
Full Removal Total	$230,796	$31,334	$427,623	$1,523,007	$2,212,761

Source: PSC analysis
Note: Totals may not add up due to rounding.

Property Value Analysis

PSC conducted a hedonic analysis to estimate the property value and tax effects associated with the residential properties along the current impoundment.

A hedonic analysis assessed the current impoundment's contribution to adjacent property values and tax revenue. Hedonic analysis is a statistical approach for accounting for and fractioning all factors that can contribute to a property's value, such as number of rooms and square footage. By holding constant as many factors as possible, the individual contributions of each factor to the final value of the property can be realized. The next section presents the findings of the hedonic analysis and reports how proximity to the Flat Rock and Huroc Dams' impoundments contributes to residential property values. Such estimates only convey contribution to property values but provide no basis for anticipating the change in residential property values should the Flat Rock and Huroc Dams be removed.

Baseline residential property values supported by proximity to the impoundment created by the dams are based on actual residential valuation differences between these properties and similar properties farther away. The approach to estimating these differences is called hedonic analysis and is commonly applied to assess how community features and blight impact residential property values (Muller 2009; Monson 2009).[6]

The hedonic analysis model in this report provides estimates of the impoundment's contribution to residential property values as determined by a residential property's distance from the shoreline and measured in value per meter–distance from the shoreline.[7] In the hedonic analysis, properties are assigned as either adjacent to the impoundment or within 400 meters (one-quarter mile) of the impoundment shoreline. If within 400 meters, the relationship between average property value and distance from the impoundment is calculated.

When interpreting the findings, one should note that the impoundment's estimated contribution to residential property values should not be interpreted as an impact on housing values or public tax revenues. While the estimates do provide an estimate of the net contribution that the impoundment makes to residential housing values, the estimates may not speak to one's preference of being near a free-flowing river in place of the impoundment. Depending on the value proposition residents place on proximity to the green space and river amenity, the overall impact that the Flat Rock Dam has on property values may be greater or lower than the estimated value contributions estimated here.[8]

Findings

The results of this analysis are likely to align with expectations in many cases. Overall, the average market value of residential properties in the study was estimated at around $140 to $160 per square foot when holding all other variables constant. These other variables, including impoundment adjacency, and

[6] The appendix of this report provides technical details on how the hedonic models were specified and estimated.

[7] The hedonic analysis uses assessed values to estimate the impoundment's contribution to property value in the surrounding community and taxable value. Taxable value, along with the 2022 township-level millage rate and properties' designation as homestead or nonhomestead, determines the impoundment's impact on the overall estimated tax revenue contribution of the impoundment.

[8] If the residents view the resulting free-flowing river as an eyesore, or otherwise a disamenity, then the expected economic impact will be greater than the estimated economic contribution assessment provided here. A more likely outcome, however, is that residents will view the river as an amenity, providing overall benefit, and, therefore, the trade-off between having an impoundment and a river will be more equivocal than suggested by the contribution estimates.

distance from the impoundment were analyzed to see what additional value they provided. For example, a finished basement provided about $40 per square foot of additional value and residential land was valued at about $14,000 per acre. The consistency of these baseline values to prior expectations provided confidence in the performance of the model in isolating the overall economic contribution of proximity to the impoundment.

Market value. Accordingly, estimates suggest that adjacency to the impoundment contributes about $39,348 to the average market value of residential properties. Each meter removed from the impoundment is associated with a marginal reduction in property values by about $6 to $8 per meter on average,[9] but this association is relatively weak statistically. This suggests that outside of a property being immediately adjacent to the impoundment, proximity has marginal effect on market values.

Assessed and taxable value. There were similar findings for assessed and taxable values, though the dollar value estimates reflected the standard market value adjustments for deriving such values. That is, adjacent properties have an average $17,314 boost in taxable value, and for every meter distance from the water's edge, that value decreases by about $6.[10] A total of 441 residential lots were included in the analysis, where 56 of those properties were adjacent to the impoundment. The average net added value provided by the impoundment on those adjacent properties make up the largest component of benefits to residential property owners—boosting overall value by $2.2 million. Nonadjacent property owners also benefit from proximity, but that benefit declines with distance from the impoundment (Exhibit 10).

[9] From a statistical perspective, the estimated marginal change in market value per meter distance from the embankment is not discernible from zero. That is to say, while the implication is that proximity to the embankment is associated with slightly higher values, should this experiment be repeated next year, the slope coefficient is equally likely to result in no association with distance from the embankment as it is to result in a marginal negative association as shown here.

[10] Taxable value estimates differ from assessed values in that taxable value cannot be less than the property's assessed value.

EXHIBIT 10. Current Impoundment Hedonic Analysis Results

Lot Type	Lots	Market Value Contributions	Taxable Value Contributions	Property Tax Contributions
Adjacent lots	56	$2,203,488	$969,601	$42,451
Nonadjacent lots	385	$912,234	$559,434	$31,188
Total	**441**	**$3,115,722**	**$1,529,035**	**$73,641**

Sources: Huron Charter Township Assessor's Office; City of Flat Rock Assessor's Office; PSC analysis

In a similar manner, contributions of adjacency and proximity to the impoundment on residential taxable values were estimated. Like that of the market values, adjacent property valuation results show that taxable value contributions over the 56 residential properties exceed that over the 385 nonadjacent but proximal lots. Accordingly, the combined net contribution to taxable value was estimated to be just under $1.53 million.

Tax contributions. The impoundment straddles taxing districts by township/city and school districts. Accordingly, 221 of the properties are in the Flat Rock Community School District, while 220 of the assessed properties are in the Huron School District. The assessors' report did not provide a breakout for the three taxing jurisdictions, which included Huron Township and the City of Flat Rock, but for the purposes of this assessment, the taxing jurisdictions are assumed to follow that of the school districts, which largely follow the same boundary around the impoundment. This indicates that homestead and nonhomestead (e.g., second homes) tax rates for the 221 properties in Huron Township/Huron School District have millage rates of 42.7023 and 60.7023, respectively. For the remaining 220 properties, the applied millage rates were 54.1300 and 72.1300 for homestead and nonhomestead properties, respectively. Additionally, of the 385 properties that were not adjacent to the impoundment, only 9 percent were nonhomestead properties, while of those that were adjacent to the impoundment, only 6 percent were nonhomestead properties.

The annual residential property tax contributions were estimated applying these millage rates to the 441 nearby residential property valuation estimates, based on location relative to the impoundment. Accordingly, the net boost from the presence of the impoundment in residential property taxes is estimated to be about $73,641 per year.

Literature Review of Property Value Impacts from Dam Removal

As discussed above, the impoundment has 56 adjacent residential properties and 385 nonadjacent residential properties within a quarter-mile of the impoundment and within Wayne County. Like that of the contribution assessment, this analysis estimates an effect on each of these 441 residential properties in relationship to the dam and the resulting impoundment. However, rather than recognizing the economic value that can be attributed to the presence of the impoundment, this study seeks to address the question, what might be the net effect of replacing one amenity with another? In this case, the amenity to be replaced is the impoundment, and it is to be replaced with a natural greenway and free-flowing river.

Based upon our literature, we believe that property values could experience a moderate negative impact in the short-term before partially or fully rebounding in the long-term, once the free-flowing river and

surrounding green space are implemented and matured. We are hesitant to conclude a net positive benefit upon removal of the dams in the absence of post-removal sales data, but will note that some studies, albeit under incomparable circumstances, have shown property values rebound and even added value in the long-term post dam removal. These positive findings were greatly impacted by the quality, maintenance and upkeep, and added utility of the natural spaces in the markets analyzed. A positive rebound in property values in the Flat Rock area in the long term will hinge on the quality, aesthetic, and recreational value of the new river channel.

Framing the Literature Review

PSC approached this question with a review of literature that sought to answer similar questions in similar scenarios, as opposed to estimating via quantitative analysis. A sound and defensible quantitative analysis of this nature requires data before and after the event in question. In the absence of property value data after an event, many unknown factors exist, requiring one to fill crucial data gaps with assumptions, sometimes using information from studies with similar bounds and parameters, or through a proxy analysis.[11,12] This is sometimes referred to as a benefits transfer analysis.[13]

PSC took a different approach, opting for a literature review rather than a benefits transfer analysis. The existing literature on this specific type of analysis is sparse.[14] Ideally, several parameters would be met for an appropriate comparison to our study site, including:

1. A setting in which a dam is removed and replaced with a free-flowing river and surrounding natural green space (or another open green space amenity)[15]
2. A rigorous analysis that involves several years' worth of data (prior to and after the event) on the transfer of sales among a sizeable number of properties that abut and are in close proximity to the amenity
3. Complete data on property amenities such as property size, bedrooms, bathrooms, and schools; and information on recently occurring events, including new developments in proximity to the properties, natural disasters, and other events or disruptions that impact property values

To further demonstrate the difficulty in pinpointing literature that could be used as a proxy to determine how property values would be affected by the Flat Rock project completion, studies must include projects

[11] Note that while nearly every quantitative analysis involves assumptions, sound judgment is required in determining the appropriateness of the number of and gravity of required assumptions.

[12] A proxy analysis would involve a quantitative analysis of the same type in an area where the event in question has already occurred, and assuming a similar outcome in the study area in question.

[13] There are benefits of this type of approach, including that the underlying model representing the value contributions are often much more robust than can be attained from a site-specific study. First, inclusive studies of property value impacts of natural amenities are expensive to undertake and require significant time investment to collect the relevant property data. Second, the study area data are not uniformly sufficient for undertaking comprehensive hedonic analyses. Candidate study sites are those with significant counts and varieties of both effected and baseline housing units by which property values can be compared. Such sites should also provide valuation measures before and after impoundment drawdown. As such before-and-after measures are not viable, a site-specific hedonic analysis is not viable. That is, the valuations from published study sites are derived from ideal conditions that often do not exist in sites of interest and can therefore provide generalizable estimates of the relationship between residential property values and proximity to water features. However, benefit transfer applications have a shortcoming in that its application may bias the predicted contribution if the study site characteristics are sufficiently unmatched by the policy site.

[14] Lewis et al. indicated in their 2008 study analyzing impacts to property values in Maine post-dam removal that: "To the best of our knowledge, this is one of the first studies to undertake an ex-post analysis of the economic impacts of a dam removal."

[15] The literature reviewing static analyses of property value associated with a dam, free-flowing river, park, or other such amenities exists, but fewer studies include a more rigorous benefits-transfer analysis which answers the question regarding change in associated value following dam replacement.

in comparable environmental settings and natural or nonnatural amenities. For example, a study on the west coast of the United States, even after meeting the criteria outlined above, will prove inadequate as a proxy to illustrate the potential impacts to property values in a small Midwest town. This is because changes to property values after an event, disruption, or construction project are not constant across differing geographic regions or environmental settings. Many additional factors come into play, such as the size and type of dam and any resulting water feature, size, utility, and desirability of the water body, population characteristics and income, as well as other factors such as the appeal of a region or neighborhood, which all impact perceived value and willingness-to-pay by varying degrees.

Per the aforementioned reasons, our literature review focuses on studies that generally satisfy several of the described criteria and seeks to demonstrate the range of changes to property values due to the replacement of one amenity for another, as well as static property values associated with amenities like free-flowing rivers, green space, and parks. This literature review will not pinpoint specific and reliable estimates of the direction or degree to which Flat Rock property values may be impacted by the dams' removal and subsequent replacement with an alternative amenity. Rather, it provides a range of findings that can be used contextually to understand the potential effects on these properties if the dam is removed.

The Value of Proximity

The extent to which residential property values are expected to be impacted by a full dam removal depends partially on a property's proximity to the resulting water's edge (in this case the resulting water's edge and elevation may be variable as a free-flowing river). In general, residents view proximity to water features as an amenity (Sander and Polasky 2009). Existing literature largely upholds the premise that an increase in distance to a water feature is negatively correlated with property value premiums associated with the water feature. Plainly stated, the farther away the property from a water feature, the less value that water feature contributes to the property. This is supported in a metastudy conducted by Nicholls and Crompton (2018) which found that "of the 44 distinct reviewed studies that included tests of statistical significance," only two produced findings of a negative impact of water frontage or view and/or positive impact of increasing distance to a water body.

Likewise, as property distance from the water feature increases, there is generally a negative impact on property values, though the rate of impact diminishes as distance continues to increase (e.g., adjacent properties with water frontage confer much higher premiums and risk greater premium losses from dam removal than other proximate properties without water frontage) (Nicholls and Crompton 2018). This is also consistent with the findings from our hedonic analysis on impoundment contributions to residential property values.

These findings suggest that Flat Rock properties currently adjacent to the impoundment could experience a decrease in property premiums immediately following dam removal and replacement of a more distantly located water feature or amenity. With that premise arises a host of new questions: To what extent might premiums decrease? Are there any scenarios in which a more distantly located water feature or natural green space may be more desirable than a waterfront location on an impoundment? How might initial impacts change in the long term? Literature provides us with examples from across the globe, most of which are not directly comparable to Flat Rock, but that can be used contextually when planning for dam removal and natural restoration initiatives. The body of literature showcases variability in the findings and the degree to which unique local attributes and amenities impact the interpretation of results.

One example in Michigan points to the value associated with proximity to a desirable water body. Isely et al. (2017) conducted an analysis of residential properties adjacent to the scenic Huron River (a prime recreational river in the state, accompanied by 13 parks and recreational areas) in Oakland and Wayne Counties and is the river on which our study site is located. The findings show that the premium conferred to properties due to river adjacency was 39 percent in Oakland County and 65 percent in Wayne County. While this study is not peer reviewed, it showcases the value that proximity to large bodies of water with desirable aesthetic and utility can bring to communities.[16,17] The findings, while impressive, are reported at the county levels. We are unable to isolate the impacts at smaller community levels and identify where data may be heavily skewed, either negatively or positively. This is important because premiums may vary wildly from community to community, depending on various unique community factors that are not controlled or accounted for in the regression model. Therefore, we cannot responsibly assume a similar premium in Flat Rock for potential future river frontage based upon findings from this study.

Residential Property Impoundment Proximity at Flat Rock and Huroc Dams

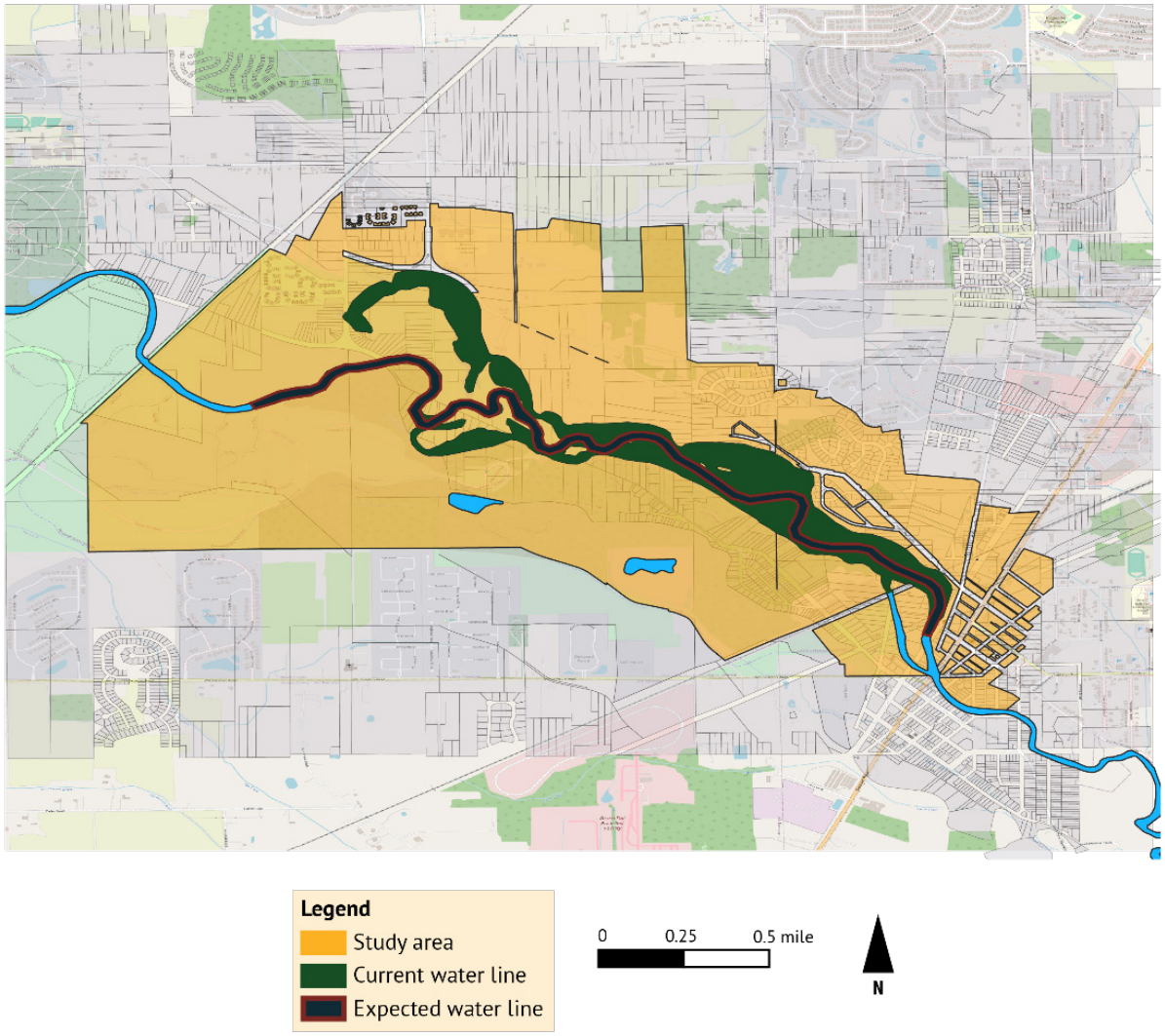
Exhibit 11 shows the current water's edge of the Flat Rock impoundment (green) and the expected river channel (brown) upon removal of the dam. The yellow-shaded area encircling the impoundment shows the properties within a quarter-mile radius of the original impoundment boundary and includes the 441 residential properties under the analysis. The blue water's edge is expected to have no material change between the current state and that of a full dam removal.

Under the full dam removal scenario, none of the now adjacent properties will be considered water adjacent to the new river channel. As shown in Exhibit 11, all property lines are expected to end well short of the anticipated river channel's edge.

[16] While Flat Rock was included in this study, results from the hedonic analysis on property values were not separated from Wayne County's overall results, so we cannot isolate or view findings from property sales in the study area.

[17] This study does not appear to use distance as a unit of measure in the hedonic analysis, and instead uses a binary indicator for adjacency. This limits the results of the analysis such that there is no premium fluctuation between properties closer to or farther away from the water's edge, which would allow for assessing changes in sales transactions at varying distances.

EXHIBIT 11. Full Removal Parcel Analysis Map



Sources: Huron Charter Township Assessor's Office; City of Flat Rock Assessor's Office; Charter County of Wayne Michigan; GEI; PSC analysis

Pre- and Post-Dam Removal Studies

Some dam removal study analyses show conflicting results. Some findings indicate an improvement in property values over time, while others show a negative effect on property values. With each study, additional takeaways are valuable. Results were influenced by factors outside of dam removal, including the dam condition and hazard classification as well as condition and maintenance of the environment after removal. These studies illustrate the importance of understanding the current benefits afforded by a dam (the utility and desirability of an impoundment created by a dam), if any; the type of natural amenity replacing the former dam area; and the improvements to environmental conditions and recreational opportunities over time that have been shown to positively impact property values.

Snyder et al. (2012) conducted a review of case studies on previously completed reports on the effects to real estate based on dam removal. Their overall conclusion was that dam removal has complex and varied effects (both environmentally and socioeconomically) that are partly dictated by local circumstances and ongoing background economic trends. They point out that some studies reported increases in value following dam removal (i.e., Bohlen and Lewis 2008; Born et al. 1998). Increases in value were generally related to improvements in water quality, removal of dam structures, and the enhancement of the natural riparian environment. Other studies described private property values decreasing briefly, one of which showed rebounded values by the end of two years (Kruse and Scholz 2006). The study cautions readers to interpret these findings with mindfulness, as the examples apply to small impoundments with little to no recreational value. The studies demonstrate the potential added value in restoration efforts that increase the recreational and aesthetic benefits of an alternative waterway.

Snyder et al. also reviewed a study of the potential impacts to property values in the event of the removal of four dams along the Klamath River (which, as of 2024, have been removed) in northern California and southern Oregon, implicating area reservoirs. A real estate evaluation concluded that property conversion from reservoir frontage to river view would negatively impact property values by 25 percent. This analysis did not appear to employ the same rigor or complexity as the other studies cited in this review, nor did it provide estimates for property values in a long-term restoration scenario. Since the dams' recent removals there does not appear to be an updated analysis of property value impacts.

Lewis et al. (2008) conducted what was believed to be one of the first studies undertaking an ex-post analysis of the impacts of dam removal. This study used hedonic property value methods to examine the effects of the presence and removal of hydropower dams on the Kennebec River in Maine on property values in adjacent communities. Three dams were examined: the Edwards Dam in Augusta (removed in 1999); the Ft. Halifax Dam, located in Winslow; and the Lockwood Dam, a dam on the mainstem of the Kennebec between Waterville and Winslow. Both the Ft. Halifax and Lockwood hydropower dams are upstream from the former Edwards Dam and were included in the analysis to account for river restoration efforts and spillover impacts to property values following the Edwards Dam removal.

Home sales data were obtained through assessment records between 1997 and 2005, before and after the 1999 dam removal. After accounting and controlling for property specific attributes, a hedonic analysis revealed some interesting results atypical of other valuation models of a similar nature.

- Before and after the Edwards Dam removal, results showed negative price premiums for homes in the surrounding communities. However, this negative impact significantly diminished after dam removal, as time passed and as river restoration and improvements were implemented. This is interesting to note, as there was no positive premium found even prior to the dam removal, contrary to PSC's analysis of property contributions afforded by the Flat Rock and Huroc Dams.
- Before the Edwards Dam was removed, a homeowner, on average, would be willing to pay an additional $2,000 to be a half-mile away from the dam. After removal, the willingness to pay, while still positive, shrank to $134.
- Upstream near the Ft. Halifax and Lockwood hydropower dams the marginal willingness to pay to be a half-mile away from the two dams was $6,000; this dropped to $1,500 after the Edwards Dam removal. While this finding showed vast improvement in sentiment, it showcases the lasting negative impact the dam had on those living nearby. The researchers were not entirely surprised by the improvement in willingness to pay because the improved fisheries and water quality had received much attention since the Edwards Dam removal. The recreational fishery upstream of the former dam

site recovered to a significant extent, and recreation on the stretch of river between Waterville and Augusta increased.

Guilfoos and Walsh (2023) conducted a study using a pre- and post-dam removal approach to gauge the overall impact of dam removal on residential property values across 75 sites in the New England region. Approximately 80 percent of the sale observations in this study included properties surrounding high hazard dams with impoundments. The overall estimates suggest that all properties within a 500-meter (0.3 miles) radius of the dam lose four to nine percent of their value post dam removal. The analysis did not bear statistically significant results, partially due to the number of sale observations. However, the study suggests that dam removal does not have detrimental impacts to the aggregate value of proximate homes. The reader should keep in mind that there were few properties included in the analysis within 100 meters of any dam, which skews the statistical findings in favor of dam removal.[18]

In 2008, Provencher et al. studied the property value impacts at 14 sites in south central Wisconsin, six which had dam removals, four with intact dams, and four with free-flowing rivers.[19] Residential properties within a quarter-mile from these sites were included in the analysis using sales data for the years 1993 through 2002. The authors concluded that "shoreline frontage along small impoundments confers no noticeable increase in residential property price compared to frontage along free-flowing rivers and that residential nonfrontage property located in the vicinity of a free-flowing river is more valuable than identical property located in the vicinity of an impoundment. Moreover, although the analysis is cross-sectional, the results are consistent with the conclusion that removing a dam does little harm to property values in the short run (two years in the study) and serves to increase property values in the long run, as the stream and associated riparian zone mature to a "natural" free-flowing state or is managed as a desirable open space." The authors also caution that the study is limited by the lack of property frontage observations at sites where a dam was removed, and further by the size of the impoundments included in the study (with surface areas eight to 194 acres and maximum depths of five to 15 feet). The Flat Rock study site has a surface area of approximately 188 acres and maximum depth of ten feet near the dam. The authors note that conclusions should not be extended to large impoundments where activities such as fishing, boating, and swimming are especially attractive.

Proximity to and Views of Lakes versus Other Water Bodies and Natural Amenities

Literature on studies of price premiums due to adjacency and proximity to, or views of water bodies and natural or nonnatural amenities vary in purpose, the research questions, econometric models employed, geographic areas, and sizes of the study area and the number of observations (properties) included in the analyses. For these reasons, each study's findings are unique to the respective study area and region and are not meant to provide apples-to-apples comparisons to the Flat Rock study area or to the other studies selected for review.

[18] The study notes the following: "One concern in our result, and in the other studies, is that there is a small number of individual homes that are very close to the removed dam. Small sample sizes reduce the power in any study and investigation of proximity effects closer than 200 meters may have large effects, but those effects cannot be differentiated from other idiosyncratic shocks to housing price changes without more observations."

[19] The primary value of sites with dams intact in this study is their aesthetic and scenic values and provide limited opportunities for nonmotorized boating and fishing.

The literature establishes that property values of lots adjacent to lakes tend to be higher than comparable properties adjacent to rivers (Mahan, Polasky, and Adams 2000). The same has been found for some forms of open space. In the Minneapolis-St. Paul region, researchers estimated that lake proximity premiums were larger than those for parks or golf courses (Anderson and West 2006). Nonetheless, views of water (in various forms) have been shown to contribute value to property. Further, some analyses have shown that the visual vista has a significant effect on the premium lakes confer to adjacent properties. Water view premiums observed in the following studies (where premium shares of mean property values were available) range from 3 percent to 44 percent.[20]

- Varying geography, one study (Muller 2009) controlled for the presence or absence of reservoir management with proximity and views of reservoirs in Indiana and Connecticut, determining that proximity to, or views of, water bodies is not sufficient to assure a positive effect of lake proximity to residential lot values. Once the valuation of water views has been incorporated into property value estimates, the effect of adjacency on property values moderates (Espey et al. 2007; Sander and Polasky 2009), suggesting that the visual vista is a key component of the value homebuyers place on lake adjacency.
- In a three-county area in South Carolina, an analysis found that lake frontage, access, and views all had positive impacts on property prices. Lake frontage premiums ranged from 52 percent to 61 percent, lake access from 34 percent to 39 percent, and lake views from 26 percent to 36 percent (Espey et al. 2007).
- In Ramsey County, Minnesota, a view of water was more highly valued than that of grass or a forest, and the same for proximity to a lake compared to a park, trail, or stream (Sander and Polasky 2009). The Ramsey County case study concluded that in the study area of analysis, properties with a lake view commanded a 44 percent premium, a value of nearly $46,000 (Doss and Taff 1996).
- The study also found that some wetland types were also found to hold implicit value in view and proximity. While forested wetlands carried a negative premium of $960 when increasing proximity by 200 meters, scrub-shrub wetlands conferred the highest implicit value of $2,900 when increasing proximity by the same distance. Moving an additional ten meters toward an emergent-vegetation wetland increased house value by $136 (but only up to 300 meters) and toward open-water wetlands by $99 (Doss and Taff 1996).
- A study of condominium values in eastern Massachusetts found that the premiums associated with a view of a pond ranged from 4 percent to 12 percent, compared to those without a view (Plattner and Campbell 1978).
- Kruse and Ahmann (2009) found a 28 percent premium strictly on water views among northern California properties.
- In Bellingham, Washington, lakefront premiums were estimated at 127 percent, and lakefront views at 18 percent (Benson et al. 1998).
- A few studies in this review (Conner 1973; Sander and Polasky 2009; Tapsuwan 2015) compared the valuation boost to residential properties between adjacency to lakes and rivers, noting that the estimated effect of river adjacency is slightly less than one-half that of a reservoir.

[20] Some of the observations in the reviewed literature are from regions and environments vastly different from our study area, but here we focus on the range of values found throughout the analyses conducted to provide context for the reader. Further, not every study provided premiums on view as a share of mean property values, and instead denoted premiums as a function of distance, or dollar amounts (i.e. total property value premiums or dollars per meter).

- Nicholls and Crompton (2017) summarized findings from 25 studies, concluding that premiums on views of and proximity to rivers and streams varied by the urban or rural setting. The authors conclude that the positive effect of a water view appeared to hold across the variety of water feature types considered (rivers, streams, and canals). In urban settings, the premium associated with river views was typically in the range of 10 to 30 percent, though in rural areas the effect of river view or access was less definitive; the authors note that this finding seems intuitive given the predominance of a variety of natural features (lakes, rivers, streams, forests, parks, open fields, etc.) in rural areas, that is, the broad supply of these features in rural settings.
    - Few of the studies produced counterintuitive results, though one such study was conducted in rural Michigan, where results showed that proximity to a stream had no influence on prices of surrounding land parcels.
    - Stream frontage in the Mohawk River watershed of western Oregon commanded a premium of 7 percent (Mooney and Eisgruber 2001). However, the existence and increasing width of a treed riparian buffer, a measure actively encouraged by the State of Oregon Plan for Salmon and Watersheds in an attempt to restore coastal salmon populations, reduced value by 3 percent to 11 percent for an average house with a 50-foot buffer.
        - This finding contrasts with an earlier analysis of California properties near streams which had been restored as a result of the Department of Water Resources' Urban Stream Restoration Program, which saw price increases of $4,500 to 19,000, or 3 percent to 13 percent of mean property price, depending on the specific restoration project under consideration (though none of these involved a treed buffer).
    - A significant takeaway from this meta study is that among some analyses reviewed, areas with high river recreation attractiveness benefited from the river premium, whereas the opposite was true if attractiveness was deemed to be low.

Literature Review Concluding Statements

The proposed scenarios for dam removal do not result in the complete removal of a water feature. Rather, they result in a shift in properties' proximity to and change in the type of water feature. Likewise, residential properties are likely to see a partial shift in the value premium associated with the impoundment, rather than an absolute change of that value. While this is known, there is still uncertainty surrounding what the resulting green space and free-flowing river will look like, the relative value it will provide to residents and visitors, and the ongoing maintenance and management of the resulting waterway and green space.

The hedonic assessment indicated that adjacency to the Flat Rock and Huroc Dams' impoundments contributes about $39,348 to the final value of a property. The 56 residential properties surrounding the impoundment have an average market value of $258,144, indicating a 15.25 percent market premium associated with impoundment adjacency. If the impoundment is removed, it will be replaced with another amenity. Among nonadjacent properties, there is a negligible effect of distance (to the water) on property values, as is reflected in hedonic analysis.

While PSC has not produced a quantitative impact estimate to properties in the study area in the event of dam removal, the vast majority of residential properties are nonadjacent (385 of the 441 in total) and will likely experience moderate or very little impact. This is indicated by our hedonic analysis results, which show a low impoundment premium for these properties relative to premiums found throughout the

literature. Most of the impacts, if any, are likely to be absorbed by the 56 properties adjacent to the impoundment.

The literature has shown results across the spectrum, but some consistencies have been identified.

- Studies have shown mixed effects after a dam removal. Some indicate that properties may initially experience a decrease in values, and that these values are likely to stabilize, and may even increase, over time. The stabilization and potential increase in long-term property values after dam removal is dependent on many factors, the driving factor of which is the relative improvement in the riparian environment.
- Similar themes are echoed in the literature regarding property value as it relates to dam removal and proximity to water features. One is the type, quality, safety, size, and usefulness of the dams and impoundments; another is the desirability, utility, and aesthetic of the natural amenity that will replace the impoundment.
- Stabilizing or even the increasing property values has been shown to be dependent on numerous factors, some of which are driven by regional attributes, area desirability, population characteristics, and other such factors outside the direct scope of a natural restoration initiative. Some of these factors are not quantifiable in an econometric model, but rather are understood through stakeholder engagement. The role that these subjective factors play in property value is real and is evident among research studies of this nature; nearly every study reviewed includes a concluding discussion section that introduces possible explanations for results inconsistent with findings from similar peer study, or otherwise confounding or counterintuitive results. In other words, each study area and project is unique and a proxy study is rarely a reliable predictor of specific and quantifiable future outcomes for another area.

Based upon the research, we have not found sufficient evidence to conclude a positive impact for residential properties in the study area immediately following the removal of the Flat Rock and Huroc Dams. Our review suggests property values may initially fluctuate to some degree at or below the identified 15 percent impoundment premium. The literature also suggests that any immediate premium losses resulting from dam removal will likely moderate and settle in the long term, following full restoration of a natural setting via an open greenway and free-flowing river. While some research indicates a long-term positive impact to property values following dam removal, the uncertainty of short- and long-term environmental conditions—including water quality, fish habitat, recreational opportunities on and off the water, quality of the greenway, upland habitat, and overall natural aesthetics—makes it especially difficult to anticipate impacts on property values, as the literature indicates they are a primary driver.

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Appendix: Methods and Model Parameters

IMPLAN Modeling

To analyze the amount of money visitors and residents spend on recreation related to the dam impoundments, Public Sector Consultants used IMpact for PLANning (IMPLAN), an input-output model to estimate economic impacts and contributions. It is a staple for regional economic analysts.

Economic Impact and Contribution Analyses

There are two major frameworks for input-output simulations. The first is an economic impact analysis, which examines the effect of something that affects the economy—like changes in wages or jobs—in a specific area. In this case, it is the dam impoundment and the recreational activities and expenditures associated with it. Because an economic impact analysis provides a model of what the economy is like with the economic feature being examined—in this case, the dam impoundment—a full accounting of what the economy would be like without the feature is required in modeling the outcomes.

The second framework is called an economic contribution analysis. This framework does not consider the possible absence of an economic feature. It only models the value of economic activity that can trace its source back to the existence of the economic feature being modeled. Economic contribution estimates tend to be larger than those of economic impact estimates.

IMPLAN Terminology and Methodology

Input-output models trace transactions among and between different economic sectors (like households, businesses, and governments) over the course of a year. Tracing these transactions offers a clearer picture of how a change in economic activity in one part of the economy creates changes in other parts of the economy. When a business sells from inventory, it takes a portion of those earnings to pay for other goods and services (e.g., to restock its inventory). Some of the wages companies pay to employees will go to local retailers and service providers, continuing the ripple effect throughout the economy. Because of all these additional transactions, the overall economic effect is greater than the value of all the different direct revenue streams (employer to employee, consumer to business, business to business, etc.), which is called the multiplier effect. The existence of multiplier effects in regional and national economies is well documented in economics literature (Coughlin and Mandelbaum 1991).

Direct Effects

The standard approach to modeling economic impacts with input-output models is to begin by establishing the value of transactions that represent direct expenditures related to the dam and impoundment. For the purposes of this study, these are expenditures by individuals utilizing impoundment and adjacent recreational facilities. The direct effects of this spending are organized into various commodity categories. Each commodity type, such as grocery retailing, gasoline, and restaurant meals, has unique economic profiles in the local economy. For example, purchases made at a local grocery store create a different set of secondary transactions than purchases made in other industries.

While recreational expenditures make up the direct effects, they are largely derived from the number of recreational users at facilities around the impoundment. As discussed above, the analysis assumes that these users will spend money in a particular pattern while visiting recreational assets in and around the

dam impoundment. The expenditure profile used for this analysis is an inflation-adjusted version of the one adopted by the United States Department of Agriculture and United States Forest Service (USDA/USFS) (White 2017). Expenditures by recreational users are measured on a per-party basis. To account for the different spending patterns of impoundment visitor types, party counts were broken out into distinct categories.

Indirect and Induced Effects

These direct effects are then used to estimate the secondary transactions that happen because of the direct effects. The first set of secondary transactions is the indirect effects, which are transactions between business sectors. Indirect effects are the intermediate purchases of goods from one business by another (such as restocking). A business's operational costs—like electricity, rent, and business services—are also indirect effects. Indirect effects ripple throughout the economy as businesses purchase goods and services from other businesses. These transactions cascade throughout the region, reduced only by the extent that inputs are purchased from suppliers outside the region. The second set of secondary transactions is called induced effects. Induced effects measure the value of new transactions by households, governments, and other institutions in response to higher labor income, taxes, and profits. These household and institutional expenditures from earnings generate new rounds of business-to-business transactions and associated payments to institutions. These expenditures continue throughout the regional economy, hampered only by the extent to which purchases are made for goods, services, and payments to institutions outside the local economy. The direct, indirect, and induced effects are summed together to calculate the total economic effects.

Contribution estimates start with the estimated total value of purchases by category. Standard input-output models examine the economy through the flow of transactions. However, figures for employment, labor income, and total regional income, which are also known as contributions to gross state product, are determined with fixed ratios to the value of sales transactions. For instance, if Industry X employs one employee for every $1 million in sales, then an increase in sales by $10 million translates into an increase in employment by ten workers. Similar fixed ratios for labor income and gross state product apply. The IMPLAN model provides 544 expenditure categories, and 11 household types by income group.

Hedonic Analysis

Overview

Hedonic analysis is used to generate estimates of how features like water bodies impact property values. If a dam impoundment is an amenity that adds value to surrounding properties, people will be willing to pay more for a property near the impoundment than they would for a property not near the impoundment. Alternatively, if a dam impoundment is detrimental, people will want to pay less for a property near the impoundment than they would for a property farther from the impoundment. The actual value that an amenity adds to a property can overlap with other property attributes. Accordingly, determining how

much the amenity contributes to a property's value requires a detailed case-by-case analysis of individual properties, which is what this analysis does.[21]

Once accounting for all relevant factors that explain market values, the remaining difference between the expected market value and the actual value is then statistically determined as the overall average realized property premiums of properties in proximity to the body of water relative to baseline properties distant from the water (Monson 2009).

Data and Analytic Parameters

This analysis utilized two sets of data that were cleaned, merged, and prepared for statistical modeling. These data are described below.

1. Residential property assessment data from with information on:
    a. Property addresses
    b. Market value, assessed value (including that of the land with and without built structures), and taxable value
    c. Lot and building characteristics, including square footage, number of floors, number of room/baths, heating, presence or absence of a garage, basement finish, and other lot-specific attributes
2. Parcel data, which provided lot size and property location, allowing for:
    a. The identification of associated taxing districts
    b. The addition of two factors of particular interest in this analysis: 1) whether the property shares a border with the impoundment and 2) the distance of the property boundary to the water line[22]

Model Parameters

The residential units included in this analysis are limited to a band that is one-quarter mile radius (400 meters) from the water's edge, as shown in the yellow-shaded region of Exhibit 11. Tests of bandwidths up to one-mile wide were undertaken before selecting the one-quarter mile band.[23] By limiting the analysis to a quarter-mile radius from the impoundment, the analysis largely entails a common neighborhood effect, differing only by the distance lots are from the impoundment.

Varying specifications of hedonic models were assessed, including variations based on the geographic radius of inclusion. Model fit statistics including model root mean squared error, adjusted R-squared, and

[21] For example, because there is limited lake-adjacent property, developers usually restrict the lot size of waterfront properties. Because smaller lots are generally considered less desirable than larger lots, holding all other factors constant, waterfront properties should cost less than larger lots away from the water. If an analysis compares the market value of waterfront lots to the value of lots away from the water without considering the smaller waterfront lot sizes, the analysis will underestimate the value the amenity brings to adjacent properties. Once the analysis acknowledges that smaller lot sizes along the water should suppress waterfront property values, the true relationship between prices and proximity to the water is revealed.

[22] The prior is a simple indicator variable taking a value of one if the property borders the impoundment. To be considered adjacent, the actual property line must touch the water. This excludes properties where a corner touches the water, but not a property border. It also excludes properties that are separated from the impoundment by a road or other public property like green space. Distance from the embankment is calculated as the shortest distance from a property line to the water's edge.

[23] Other bandwidths included residential enclaves that in themselves made comparisons difficult. For example, southeast of the impoundment is the downtown district of Flat Rock, positing a different lifestyle choice of residence where property values reflect the amenities afforded by downtown residence. Similarly, to the northeast of the impoundment is a region of new, high-density residential developments that may also reflect amenity propositions different enough from that of the immediate neighborhood to warrant caution.

Wald tests of coefficients against expected values (e.g., the average value per square foot of living space) were considered in selecting the final model specification. Hedonic models for taxable, assessed and parcel values were undertaken. Exhibit A1 shows the final hedonic model regression result for parcel value assessment.[24]

EXHIBIT A1. Hedonic Regression Results on Parcel Values Using 400-Meter Radius Study Region

	Coef.	Std Error	t-stat	prob>|t|
Number of bedrooms	-13615.55	9817.18	-1.39	0.166
Adjacency to impoundment	39347.65	11655.22	3.38	0.001
Distance (meters)	40.76	106.88	0.38	0.703
Distance (meters squared)	-0.10	0.25	-0.42	0.672
Number of baths	3435.02	5961.98	0.58	0.565
Huron School District	12945.67	7138.51	1.81	0.070
Homestead tax	403.59	98.49	4.10	0.000
Property acres	14128.32	2010.71	7.03	0.000
Square foot of bsmnt	39.54	5.00	7.91	0.000
Square foot of house	136.71	6.81	20.06	0.000
HVAC				
Forced air with ducts	-3634.15	51835.89	-0.07	0.944
Forced air without ducts	-116213.90	58756.96	-1.98	0.049
Forced heating and cooling	-11795.33	52150.01	-0.23	0.821
Forced hot water	14792.44	53663.06	0.28	0.783
No heating and cooling	33935.00	64659.15	0.52	0.600
Wall/floor furnace	-2963.37	56658.10	-0.05	0.958
Constant	65489.78	59673.38	1.10	0.273

The hedonic analysis provides some statistical assessment that can be useful in deriving expected bounds that may be realized. Exhibit A1 provides estimates of the coefficients, suggesting that holding other factors constant, impoundment-adjacent properties have an average increase of value of $39,347.65 over others. This is measured with a standard error of $11,655.22. Statistically, this suggests that there is a 95 percent chance that the boost in average adjacent property may be between $16,437.19 and $62,258.10.[25] An analogous range can be derived from the slope relationship between price and distance from the impoundment, but since the slope estimate is a compound estimate across two estimated coefficients, the statistical value ranges must be each distance from the impoundment (not shown here). Regardless, the marginal association of distance and average price, holding all else constant, does not provide conclusive

[24] The taxable and assessed value models applied the same explanatory variables and supported comparable results to that of the parcel value model.

[25] Determined as the mean value of $39,347.65 plus/minus 1.97 (standard deviations) times the standard error of $11,655.22.

evidence that closer proximity to the embankment commands a higher overall average price, but does suggest it.[26]

All the comparisons were made on expected values, controlling for other factors. To control for the possibility that any estimated price differences between properties and types of properties were not due to random chance, testing for model predictive power was undertaken. Once significance is established, the average differential can be applied across all corresponding residential properties to derive an overall estimate of the residential property values and property tax revenues that can be attributed to the impoundment.

Literature Review of Studies on Property Value Impacts

To choose the set of studies of focus for our literature review, PSC conducted a rigorous online search for works (most of which are peer reviewed) completed by respected and accomplished researchers in the subject area of hedonic analysis and environmental and economic impact analysis. Our team collaborated with GEI to ensure our studies included a wide range of analyses and findings to provide various outcomes from different regions. We also sought out studies that have some comparable characteristics to the study site.

Some of the selected materials are meta studies, or studies that analyze a collection of research on a topic. Additionally, each study relied upon a large body of research to inform the research, and in some cases a relevant study was discovered from a reference section. Most of the literature included in our review is cited in multiple similar studies. This indicates that the literature chosen is widely relied upon, respected, and used to inform multiple studies of the same type.

Most studies underlying this literature apply some form of hedonic regression analysis to estimate the value of proximity to the water feature. Other studies in the review used a benefit transfer method (Johnston and Rosenberger 2010). Relative to a site-specific study, which would use location-specific property data for developing a model that estimates the water feature's contribution to property values, a benefit transfer approach applies a model of the relationship from another study site and applies that model to the site in question, usually called the policy site.[27]

[26] The reader should note that these ranges are representative of the overall uncertainty of the modeled outcomes described in the Hedonic analysis.

[27] The benefits of this type of approach are that the underlying model representing the value contributions are often much more robust than can be attained from a site-specific study. Many reasons exist. First, inclusive studies of property value impacts of natural amenities are expensive to undertake and require significant time investment to collect the relevant property data. Second, the study area data are not uniformly sufficient for undertaking comprehensive hedonic analyses. Candidate study sites are those with significant counts and varieties of both effected and baseline housing units by which property values can be compared. Such sites should also provide valuation measures before and after impoundment drawdown. As such before-and-after measures are not viable, a site-specific hedonic analysis is not viable. That is, the valuations from published study sites are derived from ideal conditions that often do not exist in sites of interest and can therefore provide generalizable estimates of the relationship between residential property values and proximity to water features. However, benefit transfer applications have a shortcoming in that its application may bias the predicted contribution if the study site characteristics are sufficiently unmatched by the policy site.

230 N. Washington Square
Suite 300
Lansing, MI 48933