

Dam 4



Dam 6

Brandywine River Restoration Trust

Brandywine Dam 4 & 6: Dam Removal Section 106 Consultation

January 19,
2023



Agenda

1. Introduction
2. Project Goals
3. Review of Dam 4 & 6 Sites and Historic Resources
4. Review of Alternatives for Fish Passage at Dam 4 & 6
5. Consulting Party questions on Alternatives Analysis
6. General Discussion



Introduction (USACE)

1. Attendee Introductions
2. Reason for Meeting
3. Background on Section 106 Process

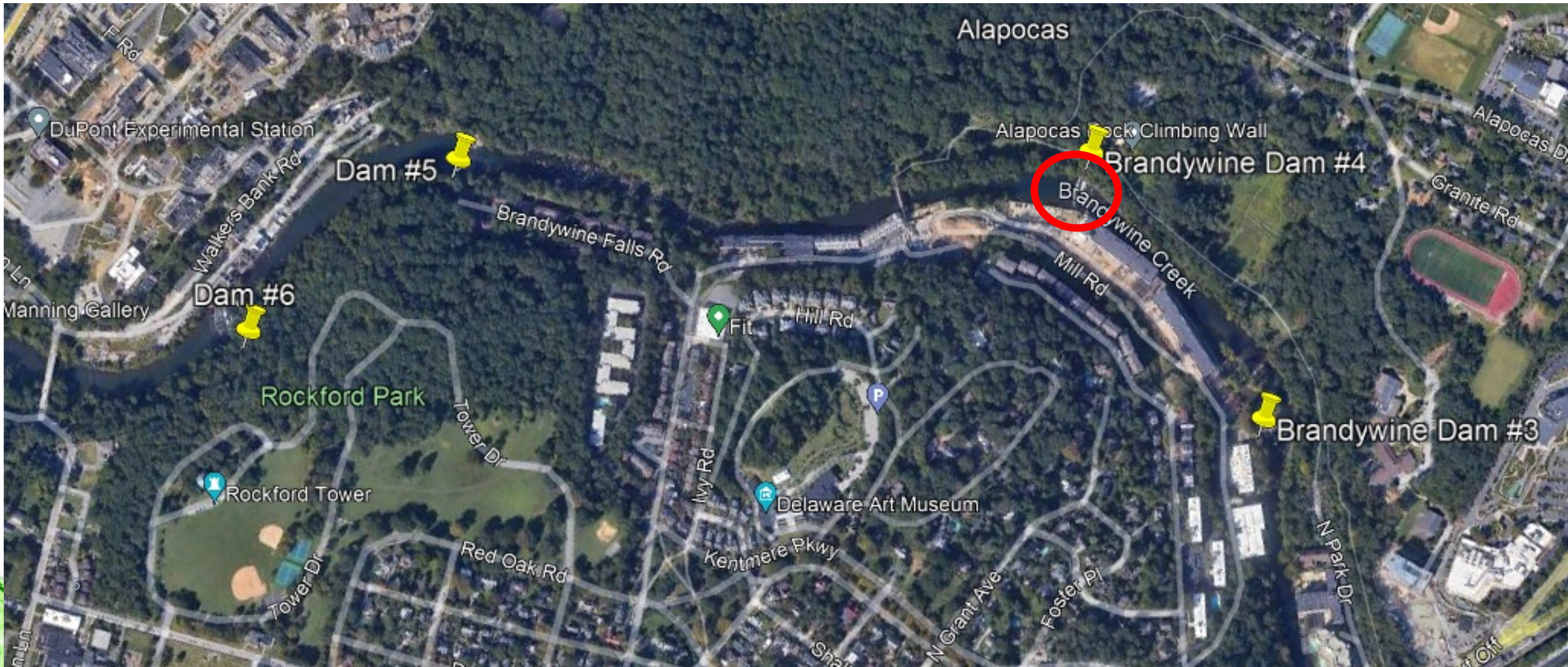


BRRT Goals for Brandywine River

1. Restore historic American shad runs utilized by Native Americans by providing passage of American Shad and River Herring the 10 remaining dams in the Delaware portion of the Brandywine
2. Provide reductions in flood water elevations where feasible as part of fish passage
3. Improve water quality
4. Increase recreational use
5. Provide equitable access
6. Economic development
7. Minimize impacts to archaeological and historic resources to the extent that fish passage is not substantially compromised



Review of Dam 4 Site and Historic Resources



Review of Dam 4 Site and Historic Resources

Dam 4
(Earlier Dam)

Dam 4
(Current Dam)

Utility

Alapocas Run
culvert walls

Non-functional
Technical Fishway

Former Bancroft
Mill Buildings:
new buildings
constructed/
under
construction



Review of Dam 4 Site and Historic Resources

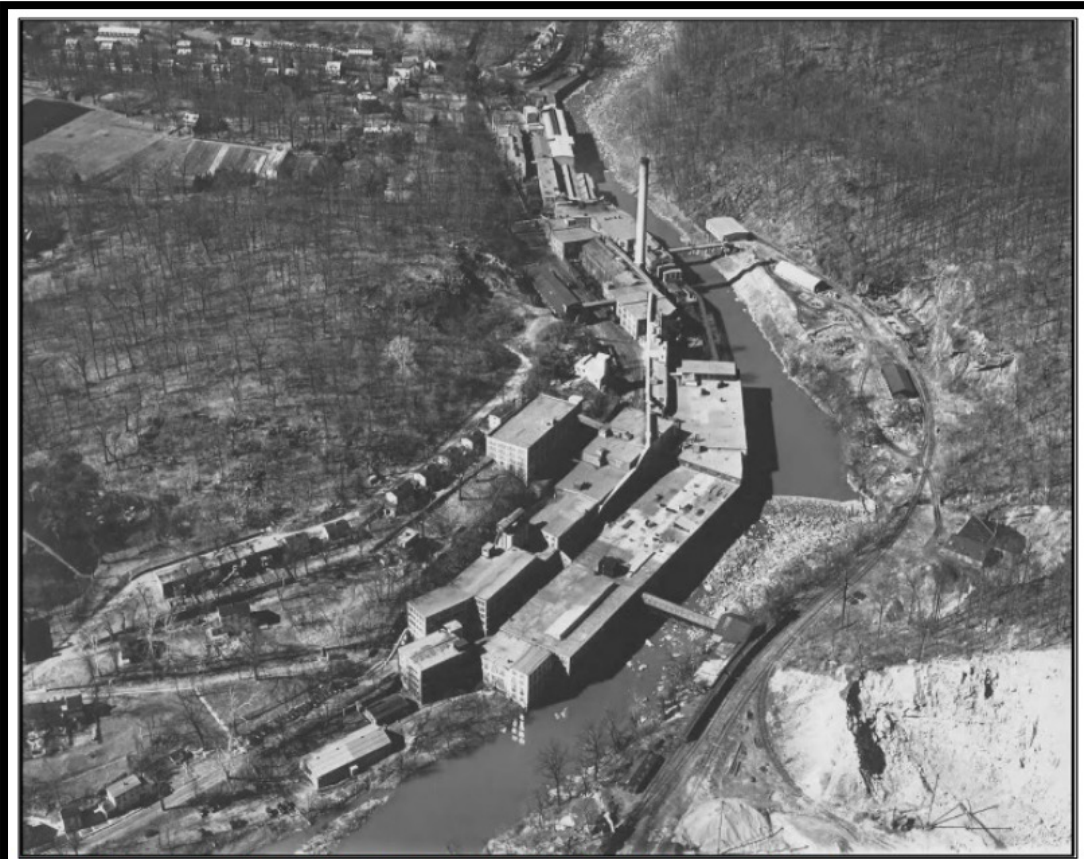


Figure 68. Aerial image Bancroft Mill, 1930. (Dallin Aerial Image Collection, Hagley Museum and Library)



WILLIAM BRETZGER/THE NEWS JOURNAL

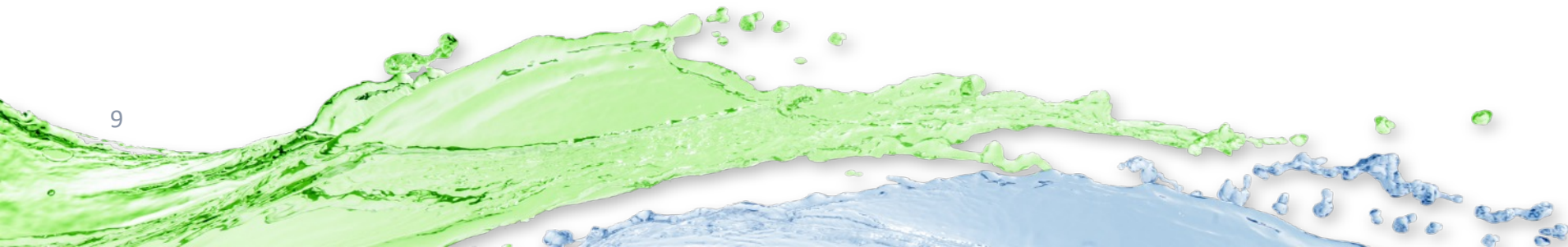
A large portion of the abandoned Bancroft Mills complex burns out of control along the Brandywine in Wilmington after a fire there was reported shortly after 2 a.m. Nov. 9.

Figure 70. View of the remaining large buildings associated with Bancroft Mills, severely damaged by fire in late 2016. They were subsequently razed. (The News Journal)

Review of Dam 4 Site and Historic Resources



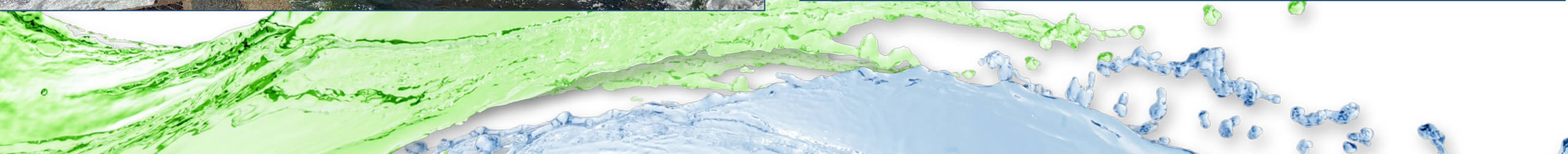
Review of Dam 4 Site Archaeological Resources



Dam 4



Creek Embankment



Dam 4 Access



Review of Dam 4 Site Archaeological Resources



RICHARD GRUBB & ASSOCIATES

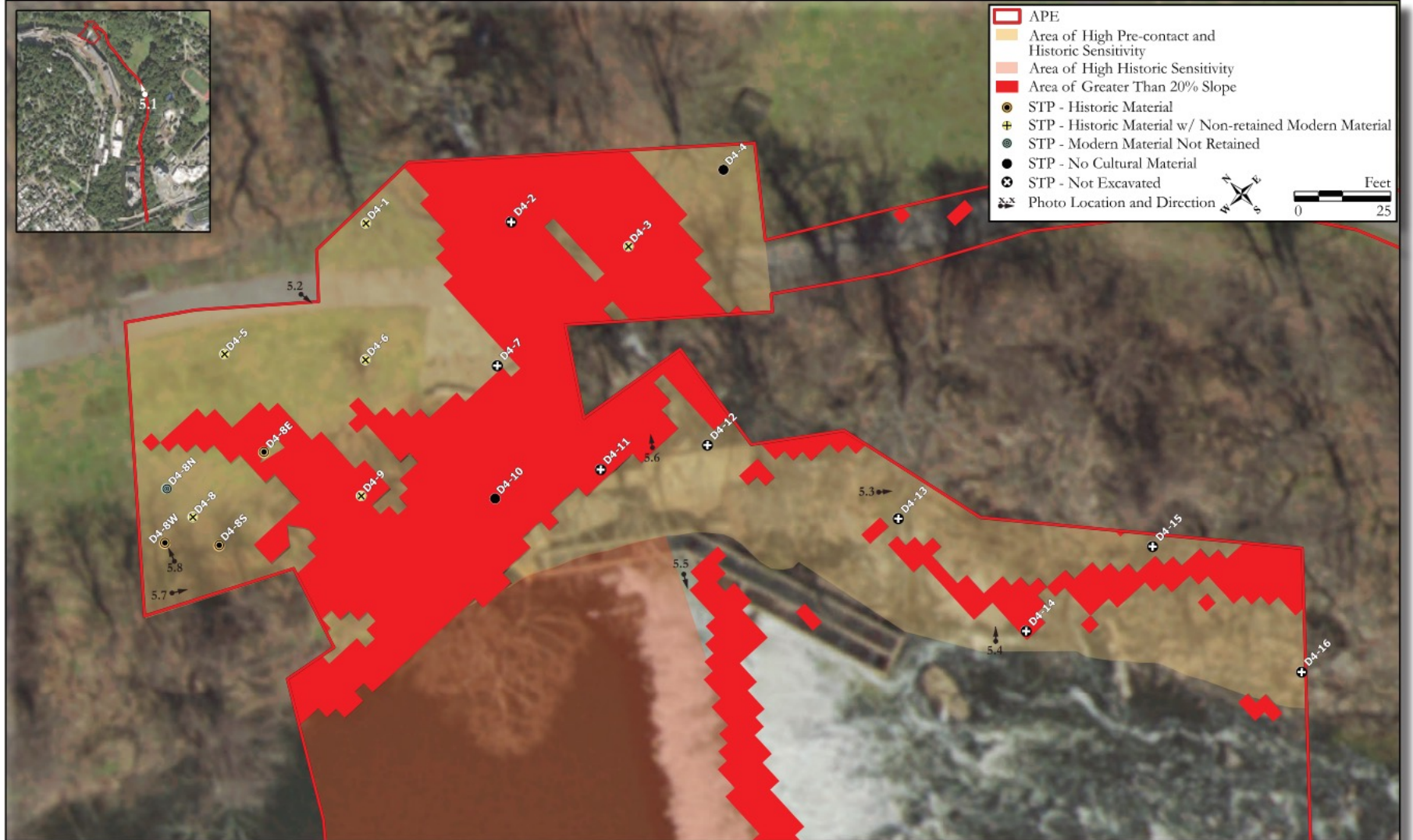


Figure 5.12: Aerial photograph of the Dam 4 APE showing photograph locations, areas of archaeological sensitivity, and STP locations and results.

Dam 4 Shovel Test Pit Profile

- 12 Shovel Test Pits Dug
- 64 Historic Artifacts Found. All from Imported Fill Layers
- Artifacts Include Wire Nails, Slag, Coal, Beer Bottle Glass, Rubber Hose, Ceramics
- Soil Layers Identified were Mostly of Imported Fill from the Late 19th and 20th Century
- No archaeological sites identified in the upland portion of the APE
- Archaeological Monitoring of Dam Removal Recommended



Review of Dam 4 Historic Resources

Boundaries of Dam 4

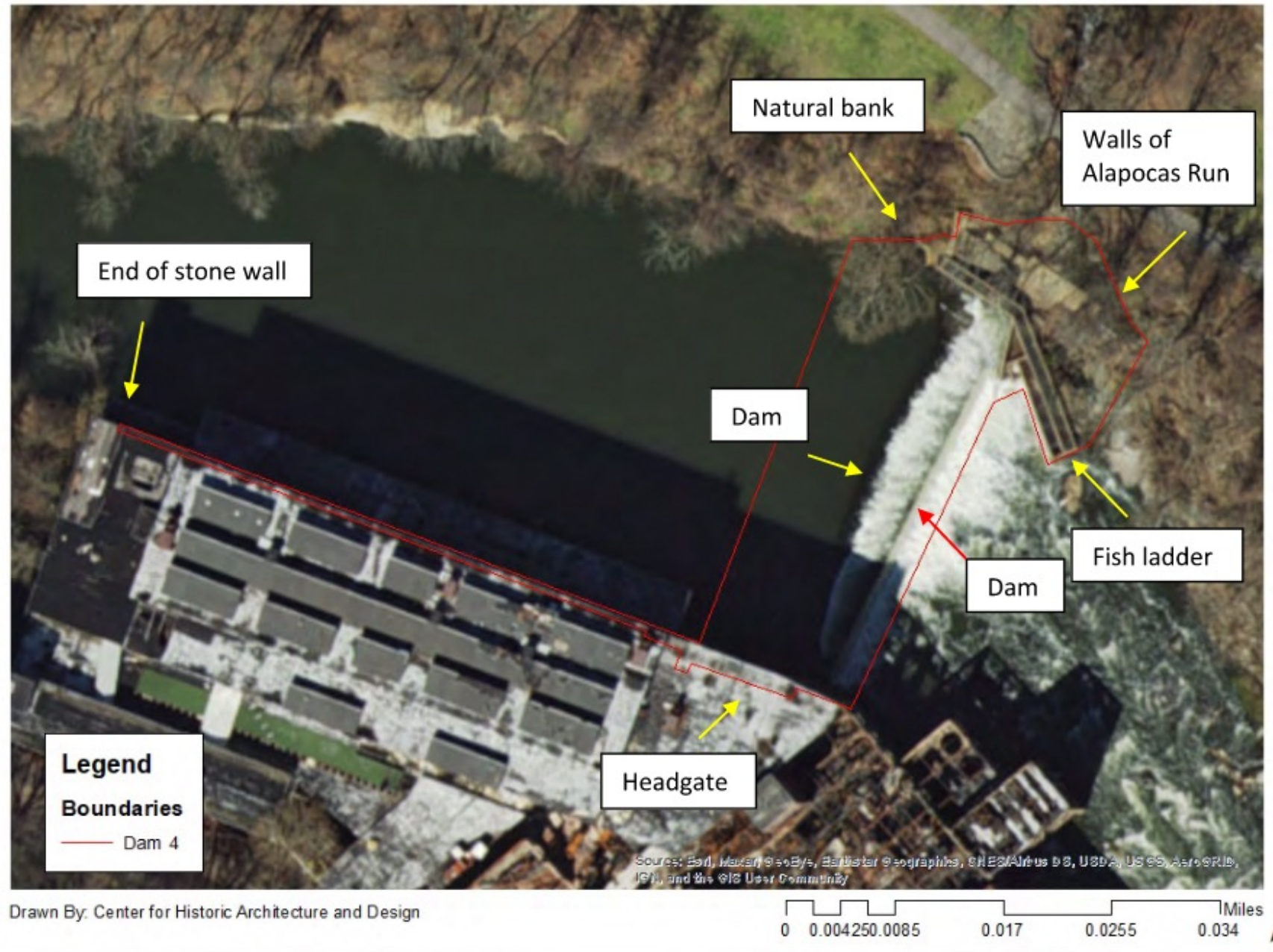


Figure 71. Boundary map of the Dam 4 complex.

Review of Dam 4 Historic Resources

2 resources evaluated in
APE

- Kentmere Dam complex
- Alapocas Run bridge and stone walls



Kentmere Dam Complex

Determined Eligible

- Under Criterion A and C

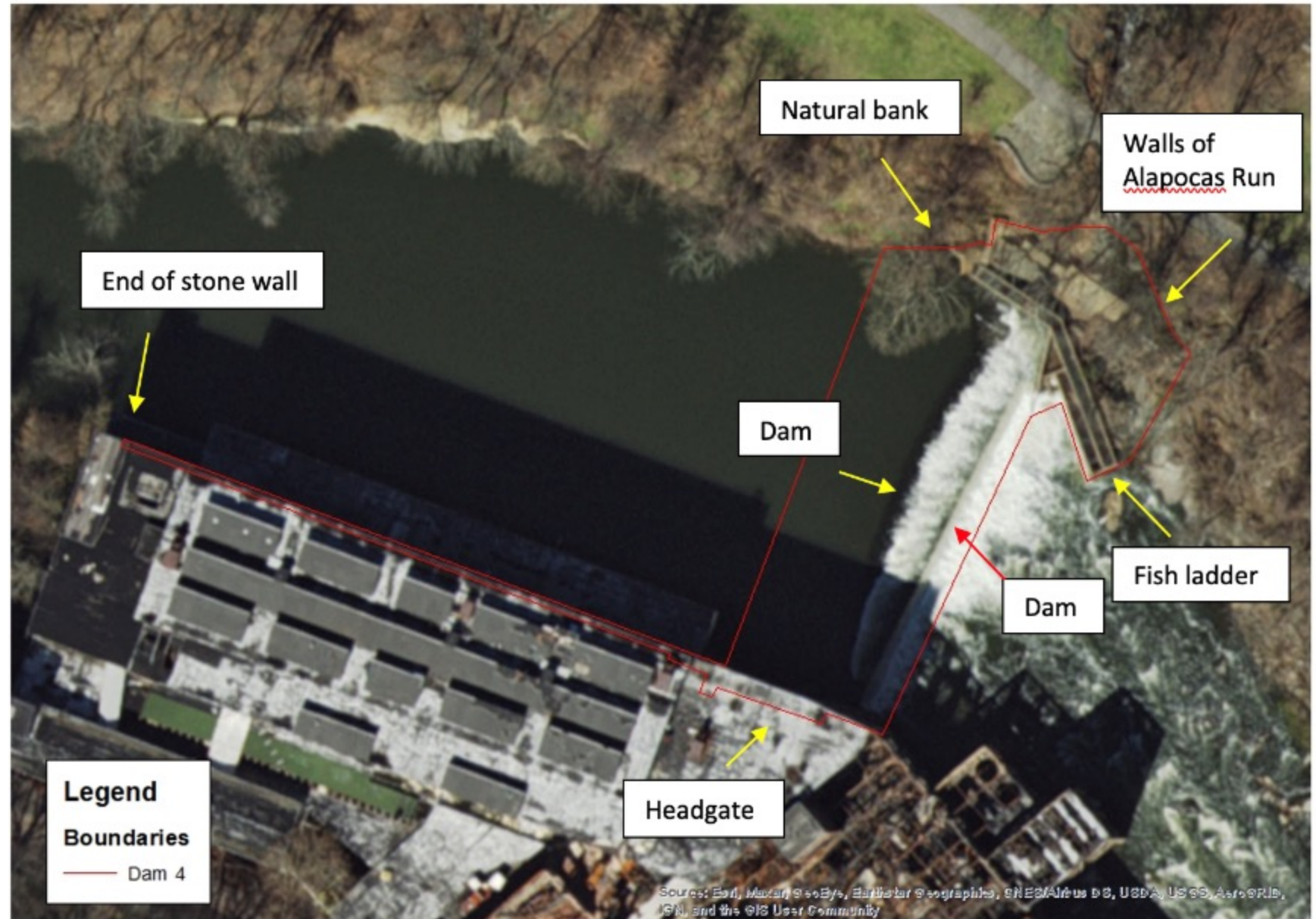
Components:

- Upper dam, 1896
- Current dam, c. 1940
- Fish ladder, c. 1970

Associated with:

- Joseph Bancroft and Sons, Co. Kentmere Plant

Boundaries of Dam 4



Drawn By: Center for Historic Architecture and Design

0 0.004250 0.0085 0.017 0.0255 0.034 Miles

Alapocas Run bridge

Determined Ineligible

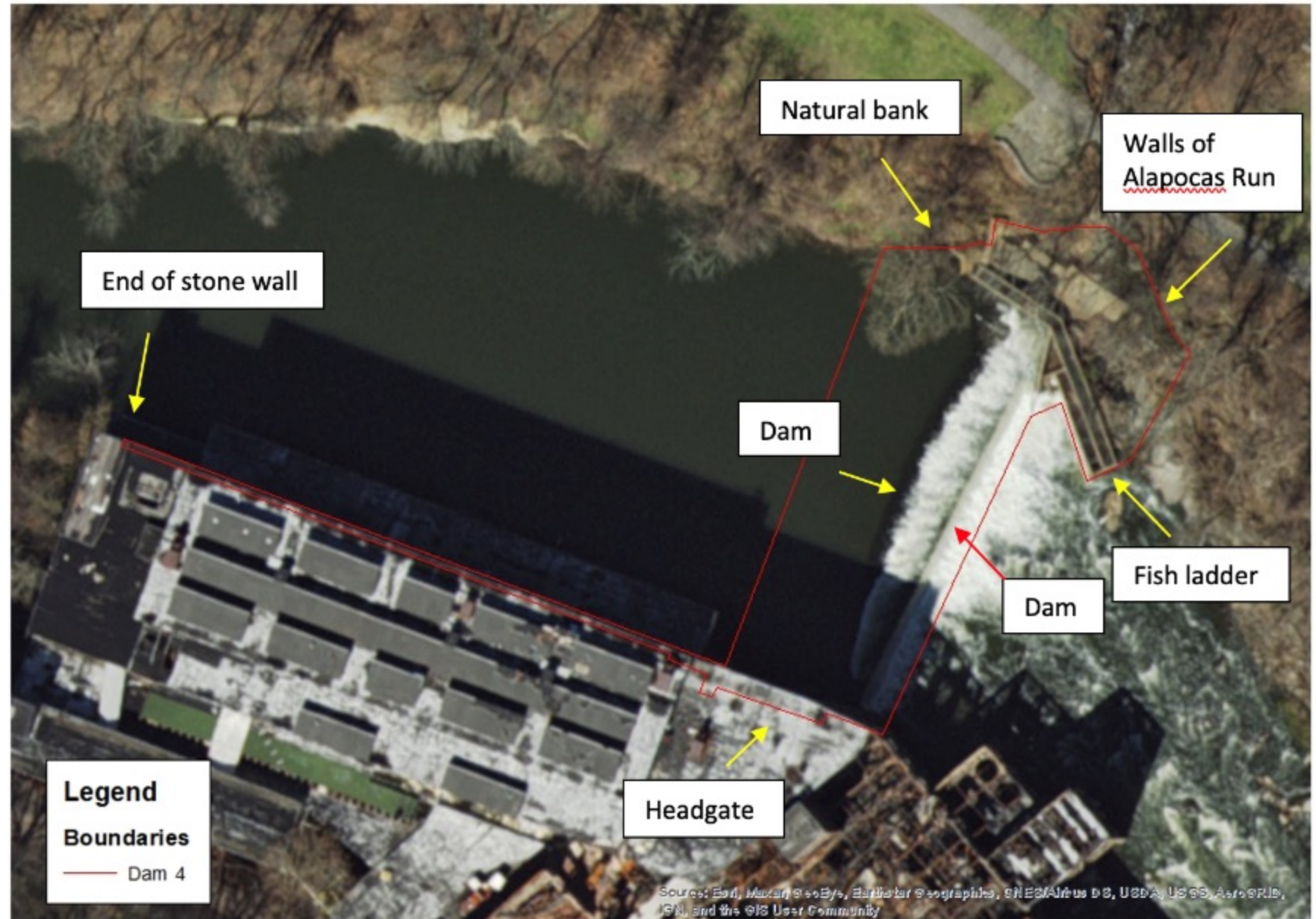
Components:

- Bridge, c. 2000
- Walls / substructure, c. 1897

Associated with:

- Joseph Bancroft and Sons, Co. Kentmere Plant

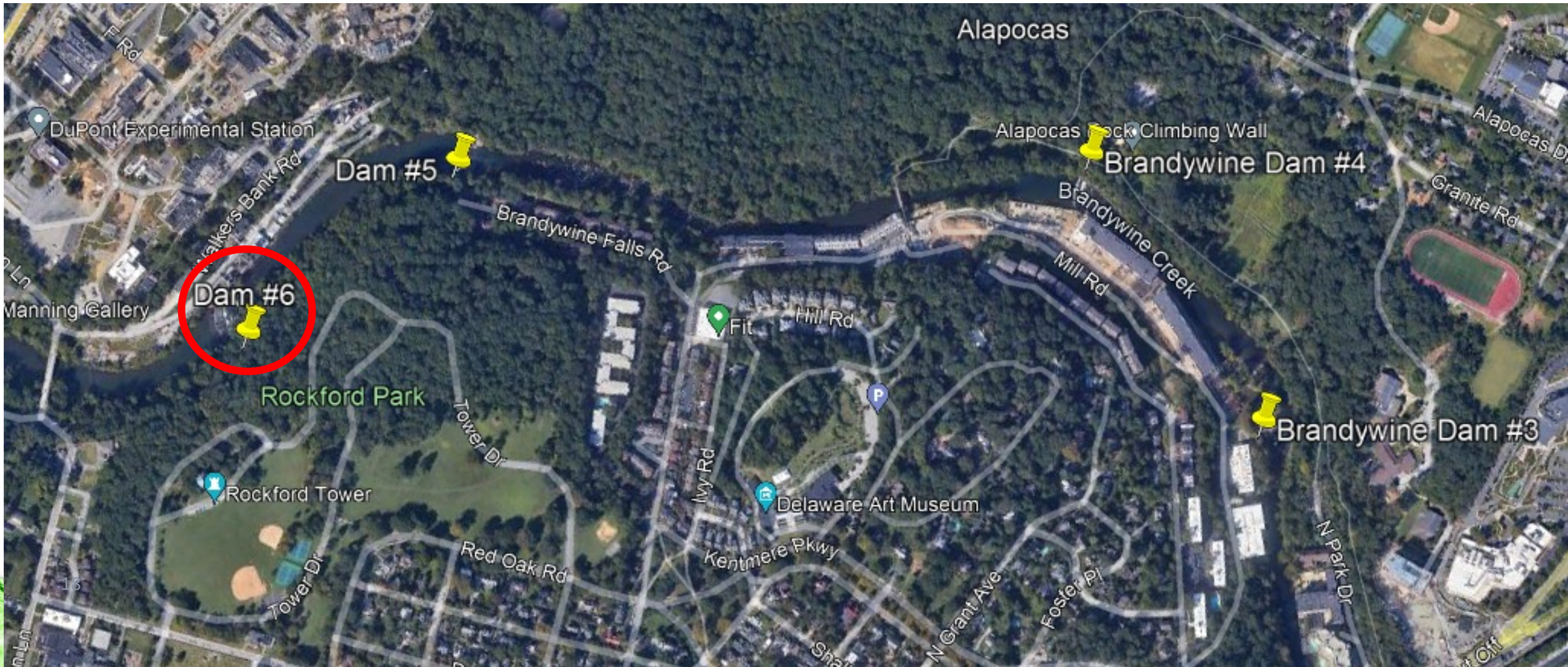
Boundaries of Dam 4



Drawn By: Center for Historic Architecture and Design

0 0.004250 0.0085 0.017 0.0255 0.034 Miles

Review of Dam 6 Site and Historic Resources

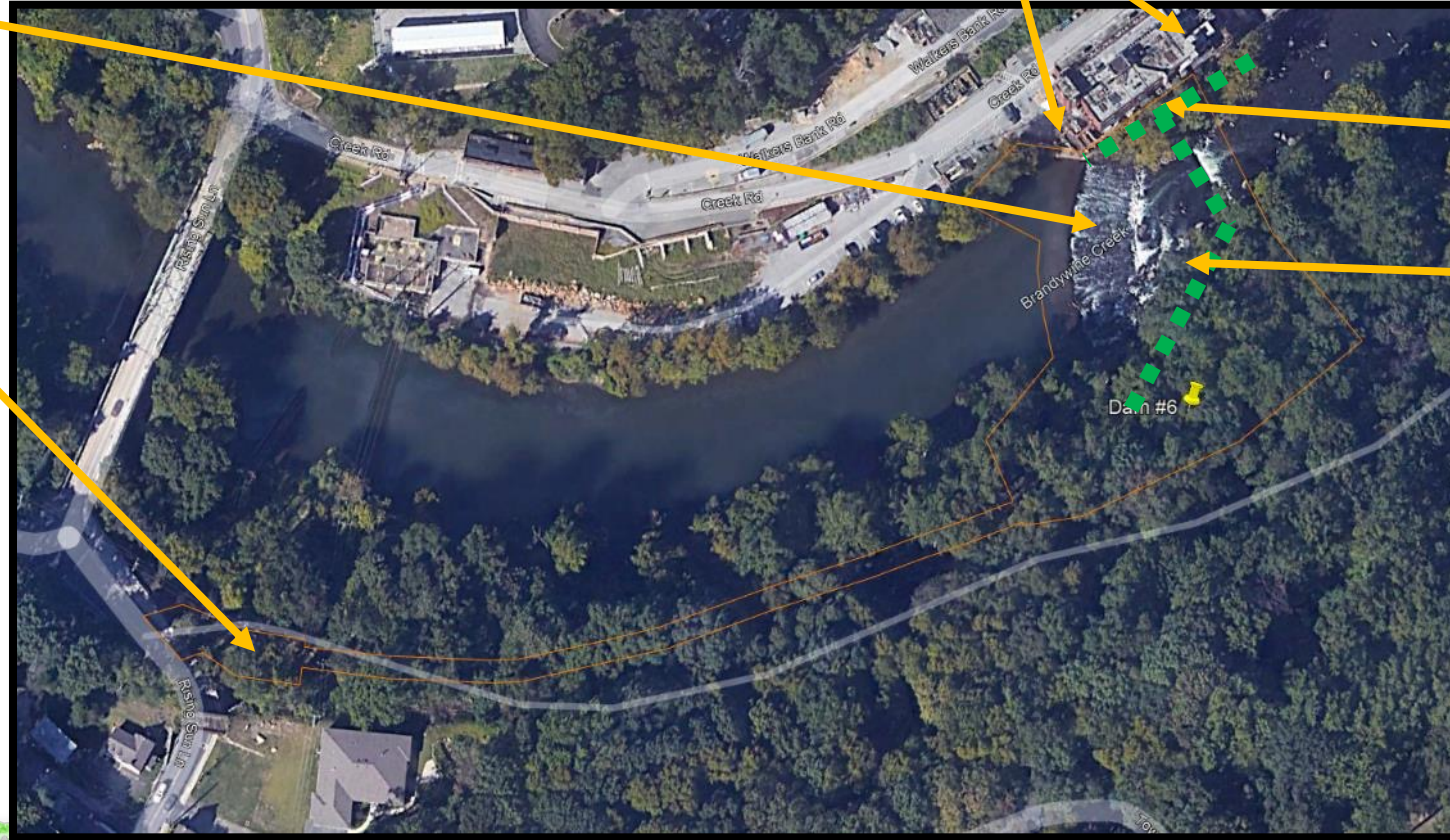


Review of Dam 6 Site and Historic Resources

Dupont Experimental
Station Buildings

Dam 6

Culvert
& Bridge



Utilities

USGS Water
Monitoring
Station

Review of Dam 6 Site and Historic Resources



Figure 132. View of the USGS Water Monitoring Station Gage House, looking east, 2021. (Center for Historic Architecture and Design)

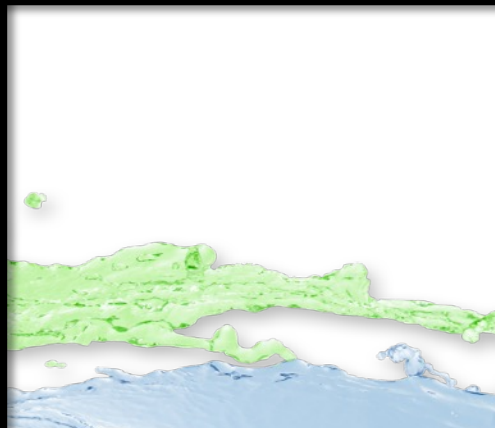
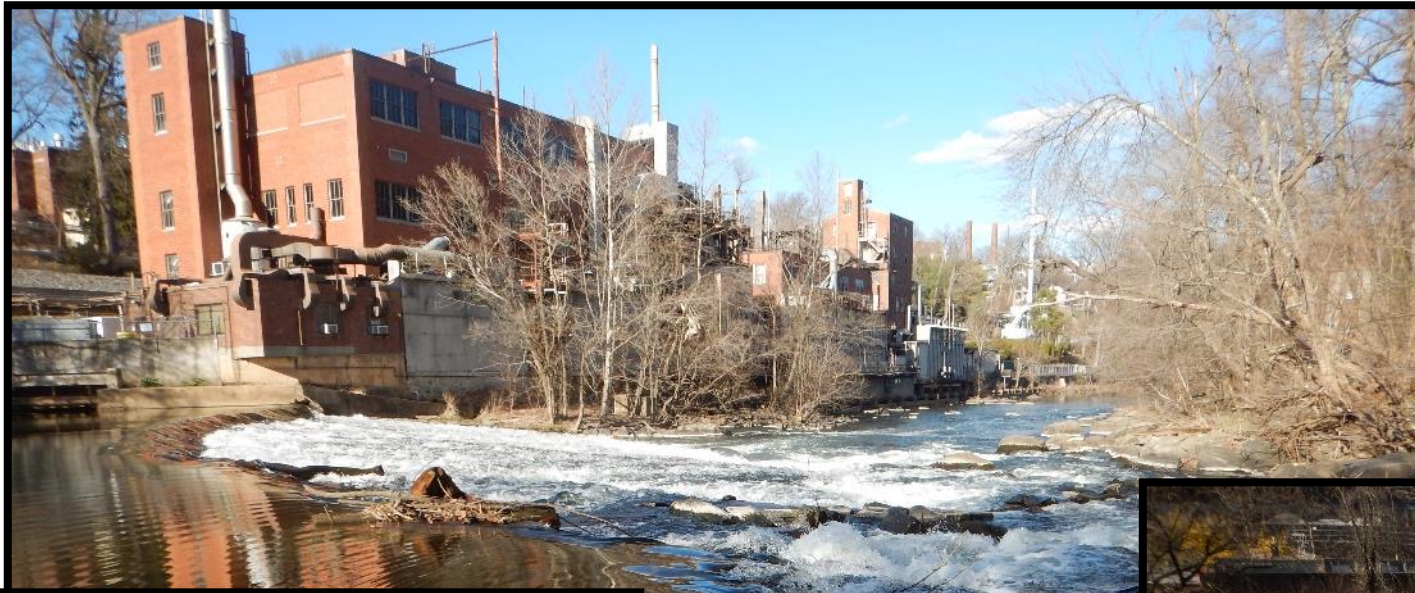


Figure 109. A group of women and girls standing in front of Dam 6, showing the head gate and Glaze Mill in the background, c. 1896. (Hagley Museum and Library)



Figure 121. Aerial view of the DuPont Experimental Station, with Dam 6 in the lower right-hand corner, 1956. (Hagley Museum and Library)

Review of Dam 6 Site and Historic Resources



Review of Dam 6 Site Archaeological Resources

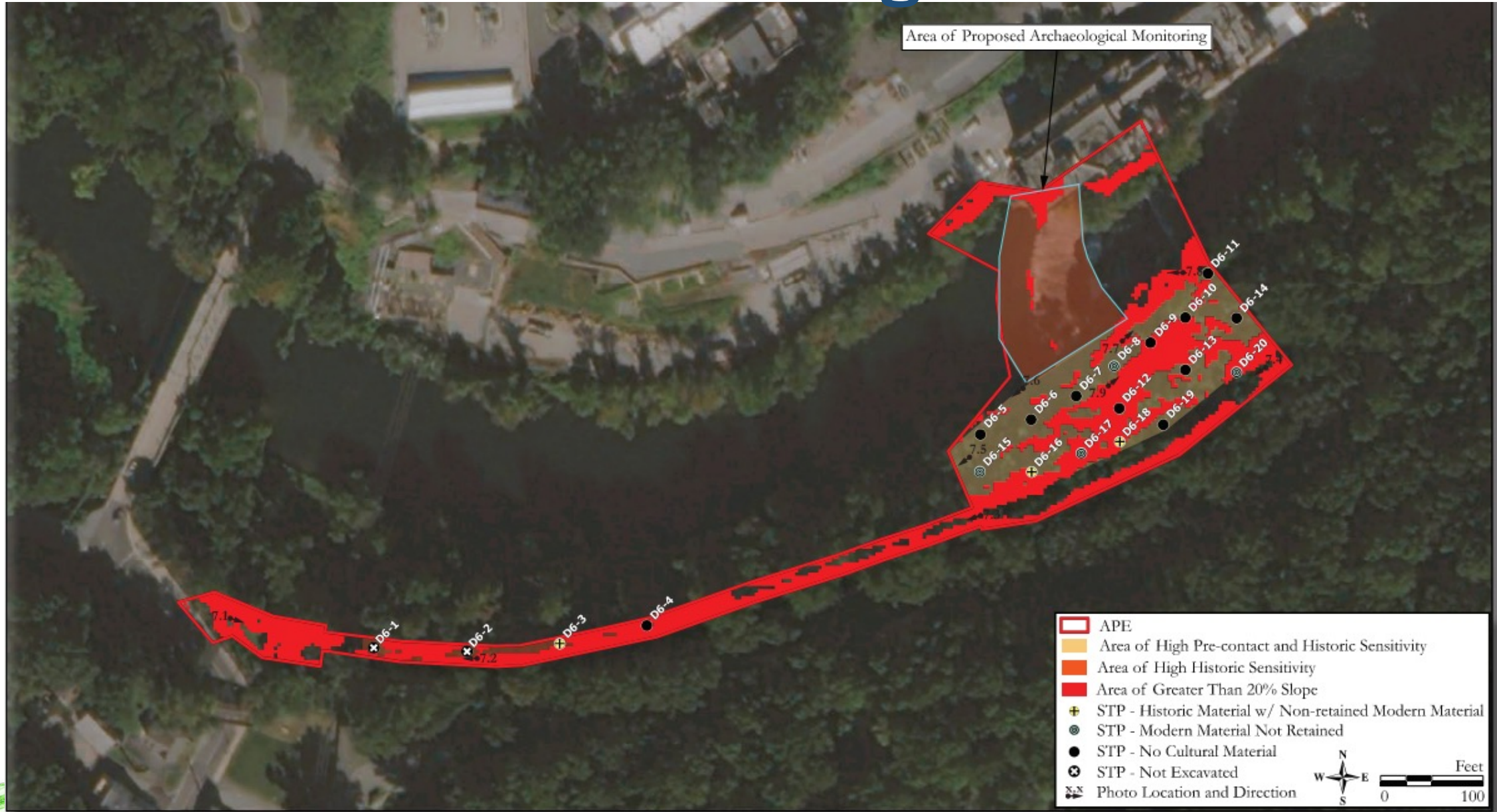
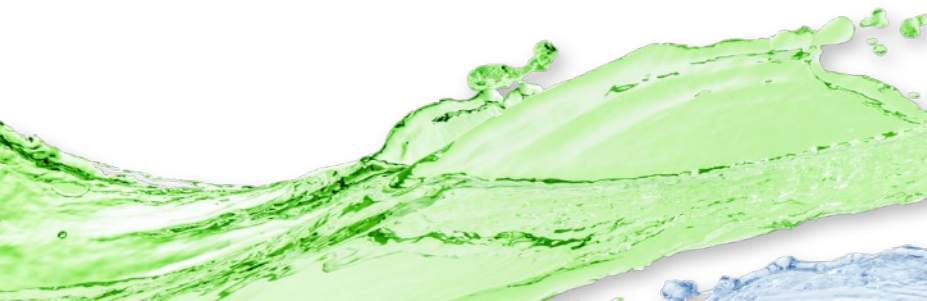


Figure 7.11: Aerial photograph of the Dam 6 APE showing photograph locations, areas of archaeological sensitivity, and STP locations and results.

Dam 6 Access Path



View of Dam 6

- 18 Shovel Test Pits Dug
- Primarily Fill over Truncated Subsoil
- 6 Artifacts Recovered (Early 20th Century Material, Spike, Bolt, Window Glass, Beer Bottle)
- No archaeological sites identified in the upland portion of the APE
- Archaeological Monitoring of the Dam's Removal Recommended



Review of Dam 6 Historic Resources

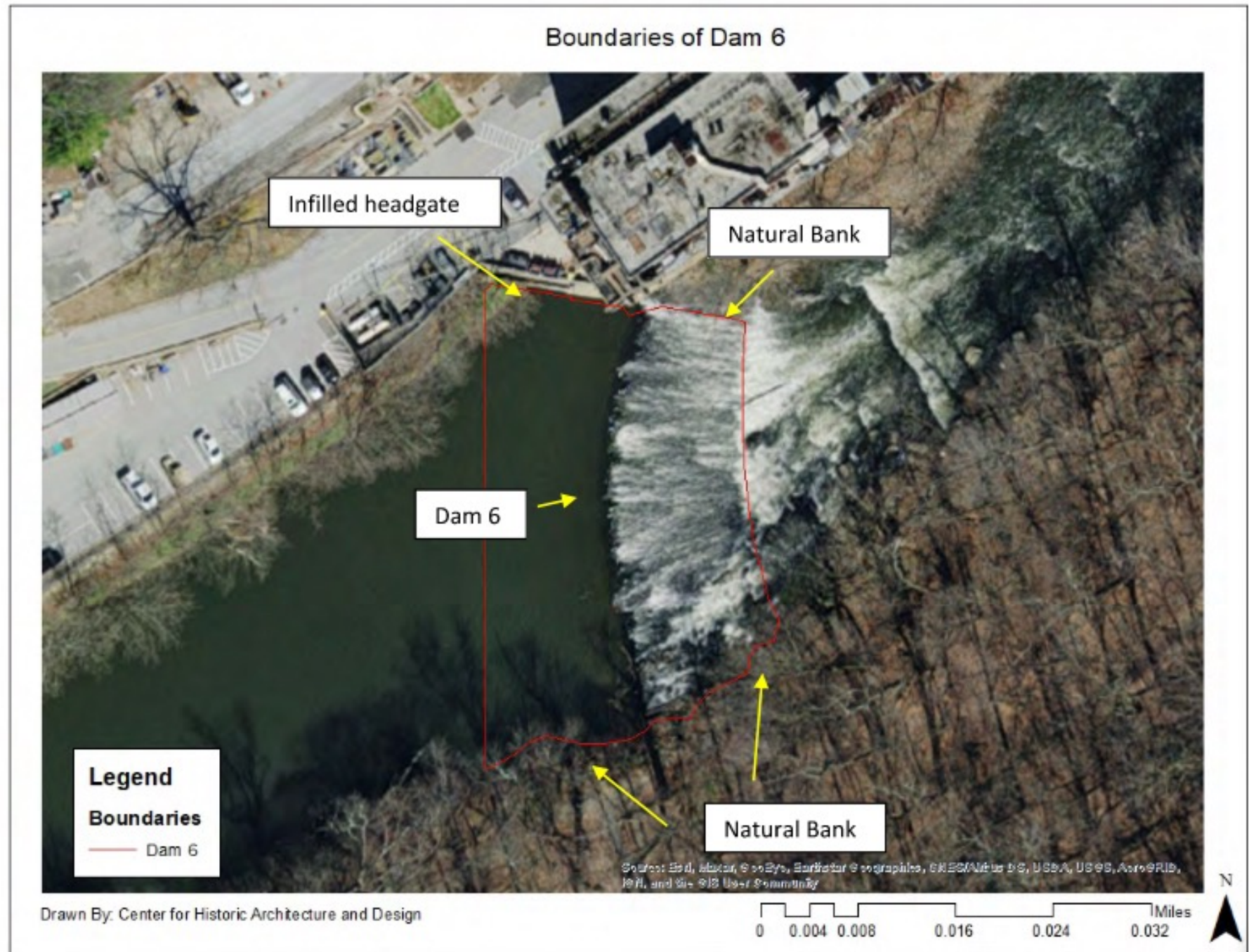


Figure 113. Boundaries for the Dam 6 complex.

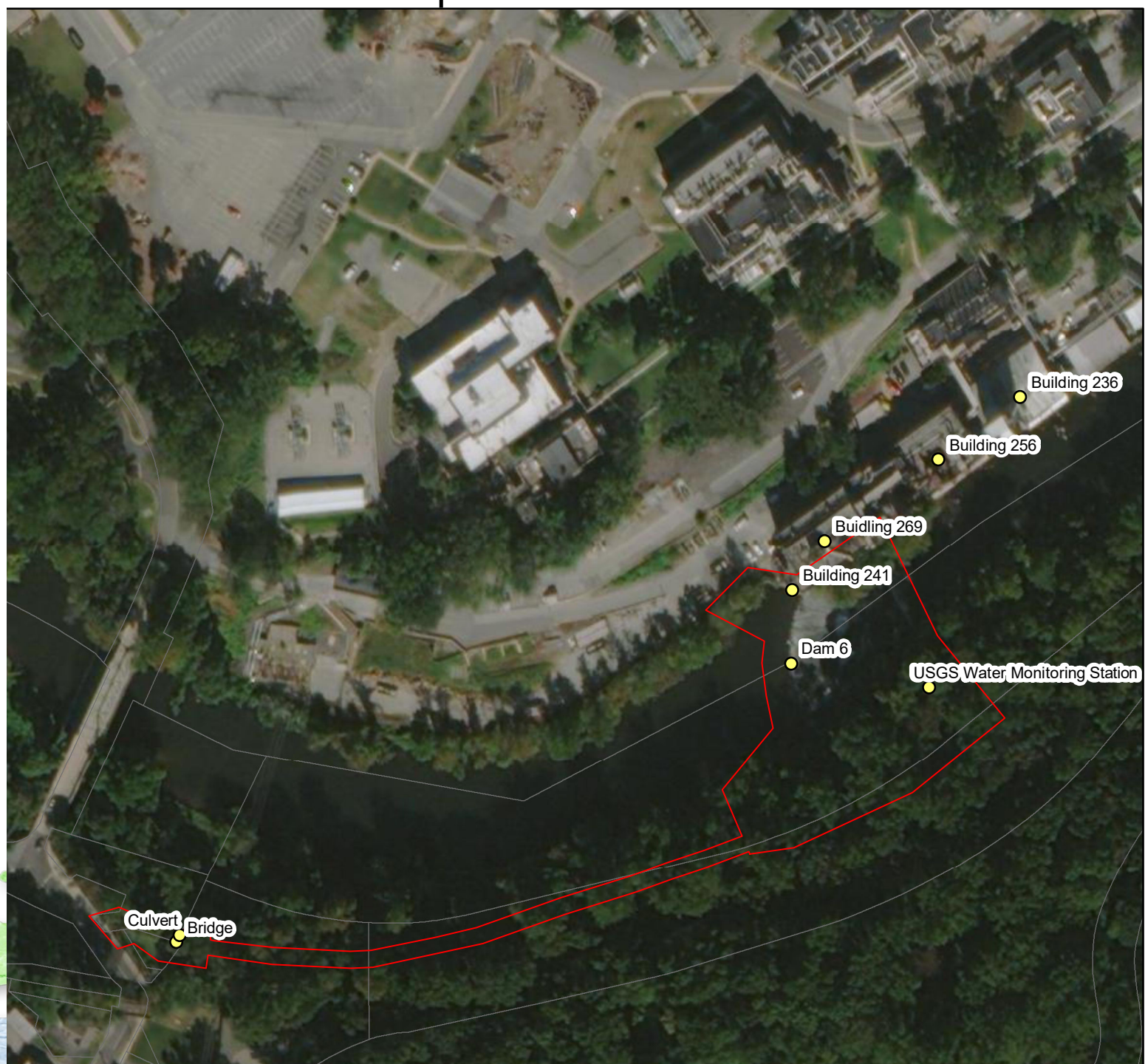
Review of Dam 6 Historic Resources

4 resources evaluated in APE

- Lower Hagley Yard Dam complex
- Stone culvert
- Platform bridge
- USGS Water Monitoring Station

4 resources surveyed but not evaluated

- DuPont Experimental Station



Lower Hagley Yard Dam Complex

Determined Eligible

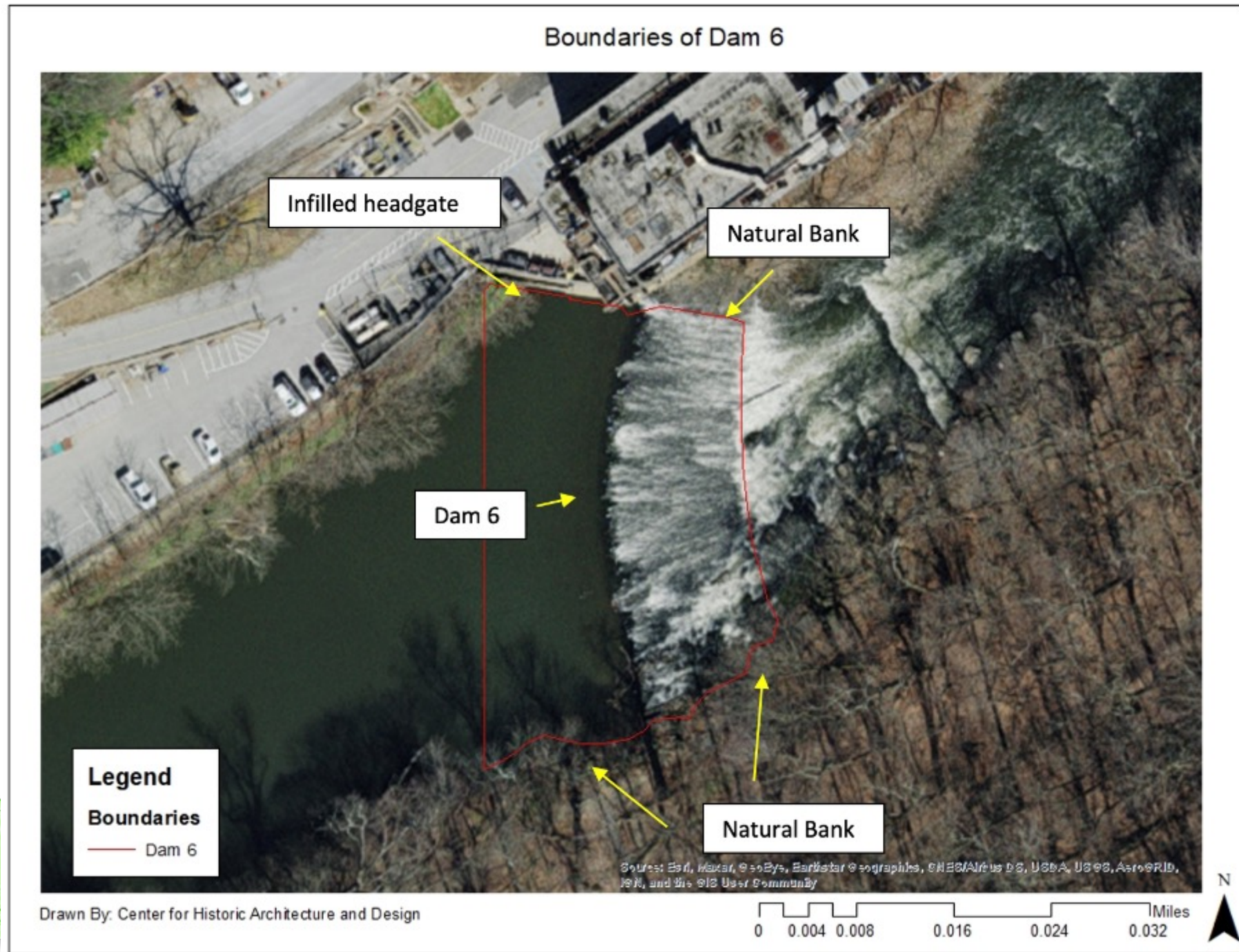
- Under Criterion A and C

Components:

- Dam, c. 1839

Associated with:

- DuPont powder mills



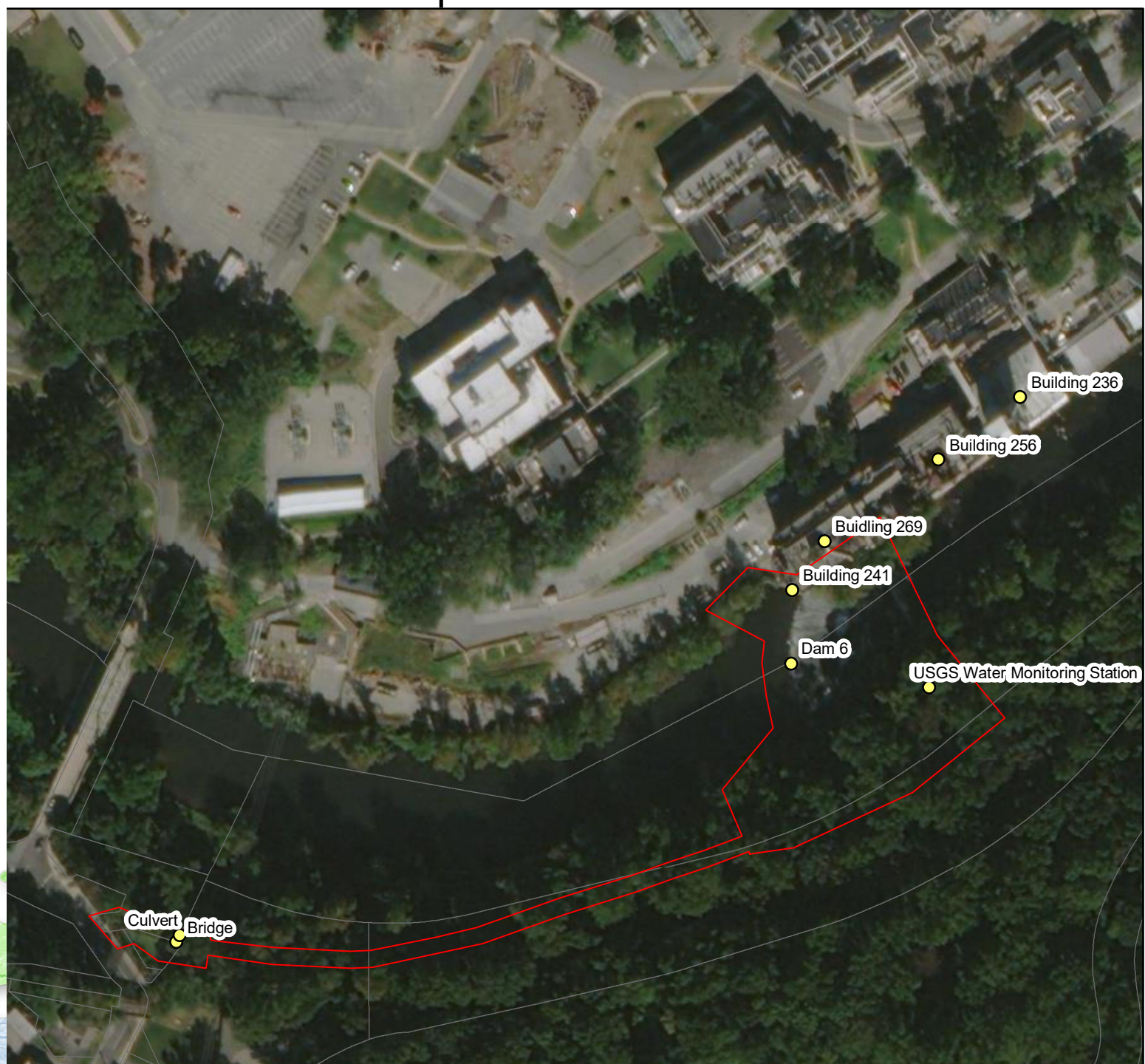
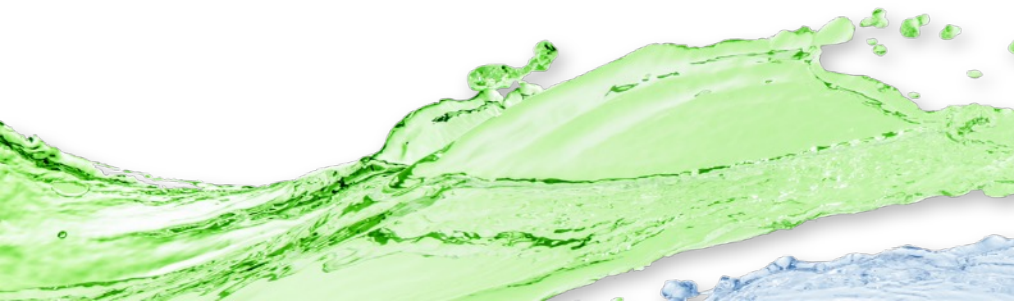
Other Resources in APE

All determined ineligible

Stone culvert, late 19th cen.

Platform bridge, c. 1946

USGS Water Monitoring Station, 1946



DuPont Experimental Station

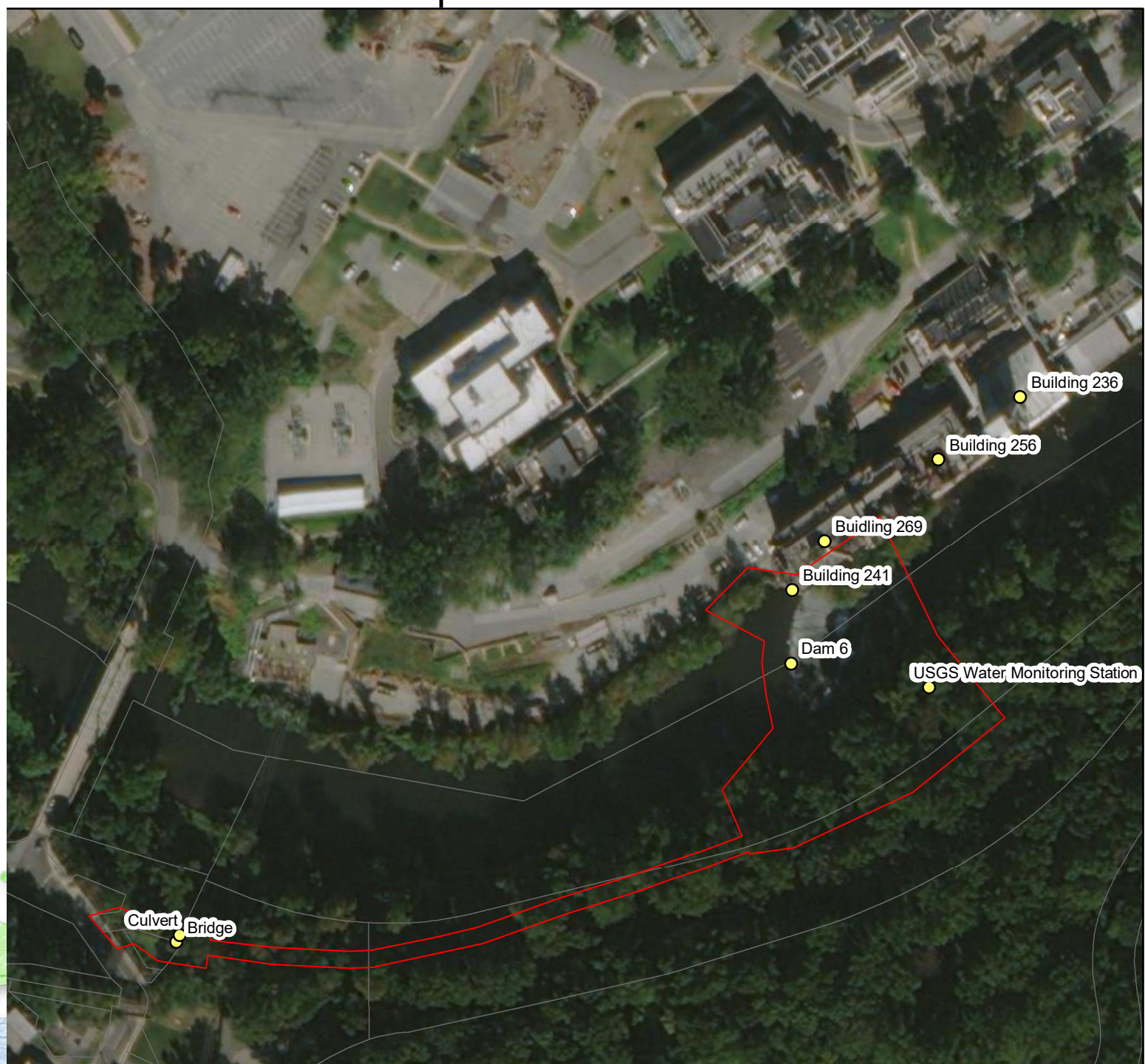
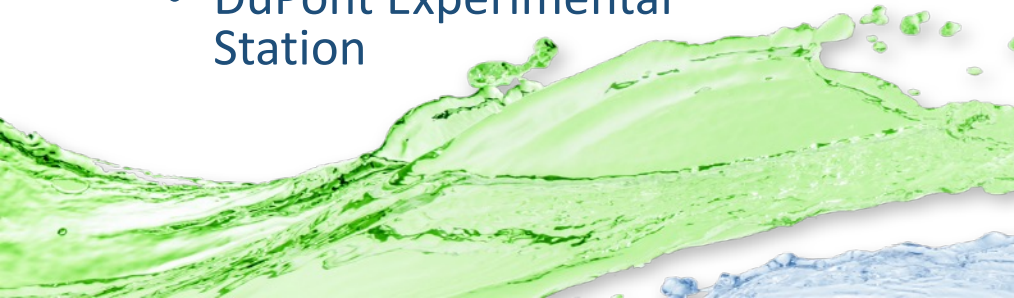
Surveyed, not
evaluated

Components:

- Building 241, c. 1930
- Building 269, 1940
- Building 256, 1937
- Building 236, 1930

Associated with:

- DuPont Experimental
Station



Review of Historical & Cultural Resource Findings

Findings:

- i. Dam 4 (Kentmere Dam):
 - i. No findings of significant archaeological significance in upland portion of APE
 - ii. Archaeological monitoring during dam removal recommended
- ii. Dam 6 (Lower Hagley Yard Dam):
 - i. No findings of significant archaeological significance in upland portion of APE
 - ii. Archaeological monitoring during dam removal recommended to record dam construction techniques

Questions Historical & Cultural Resource Findings

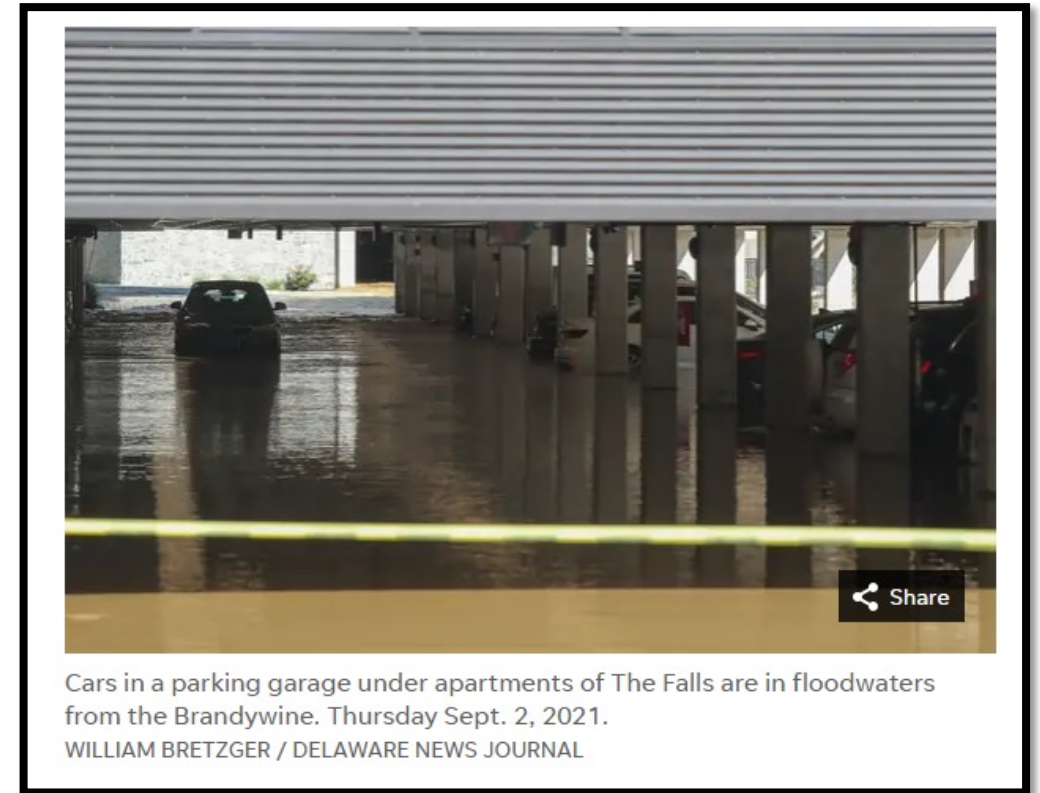
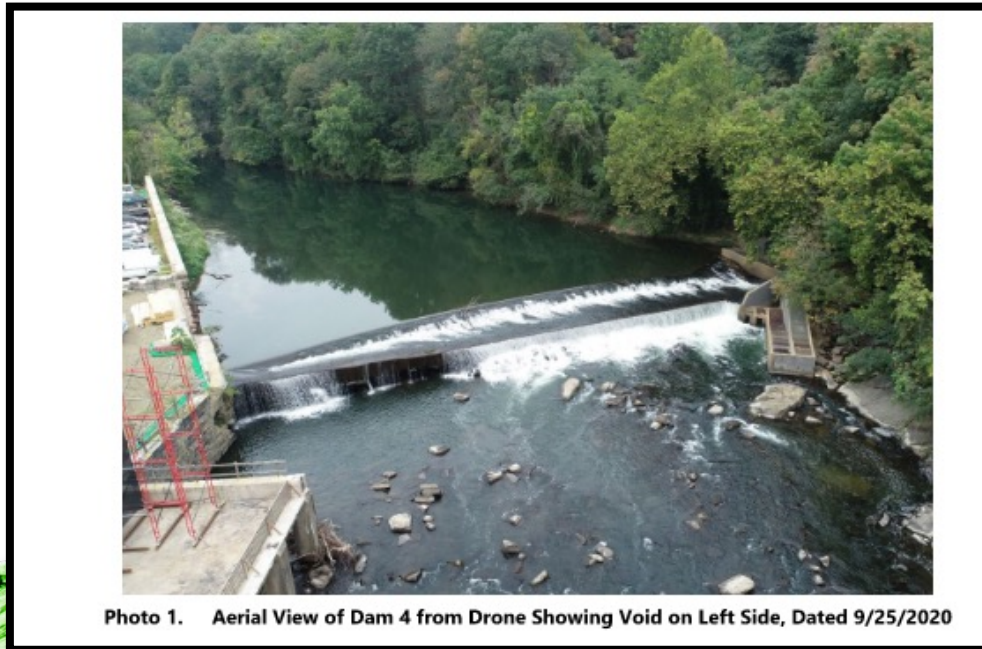


Alternatives

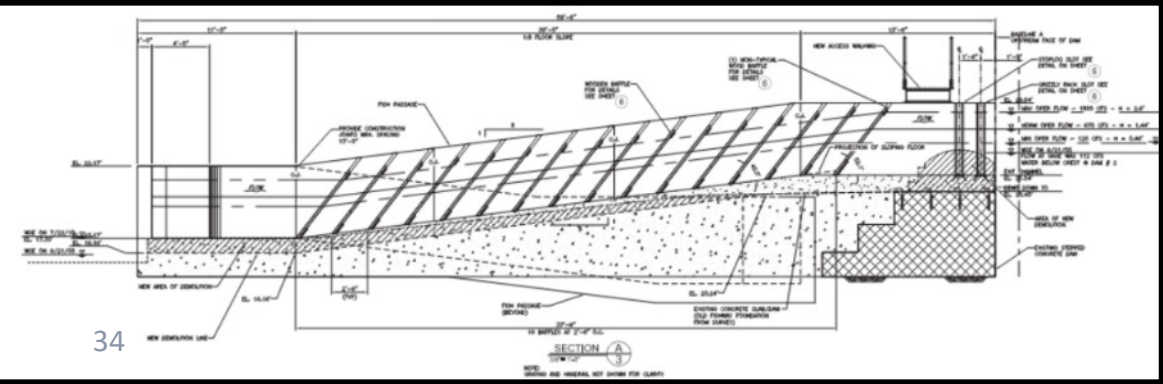
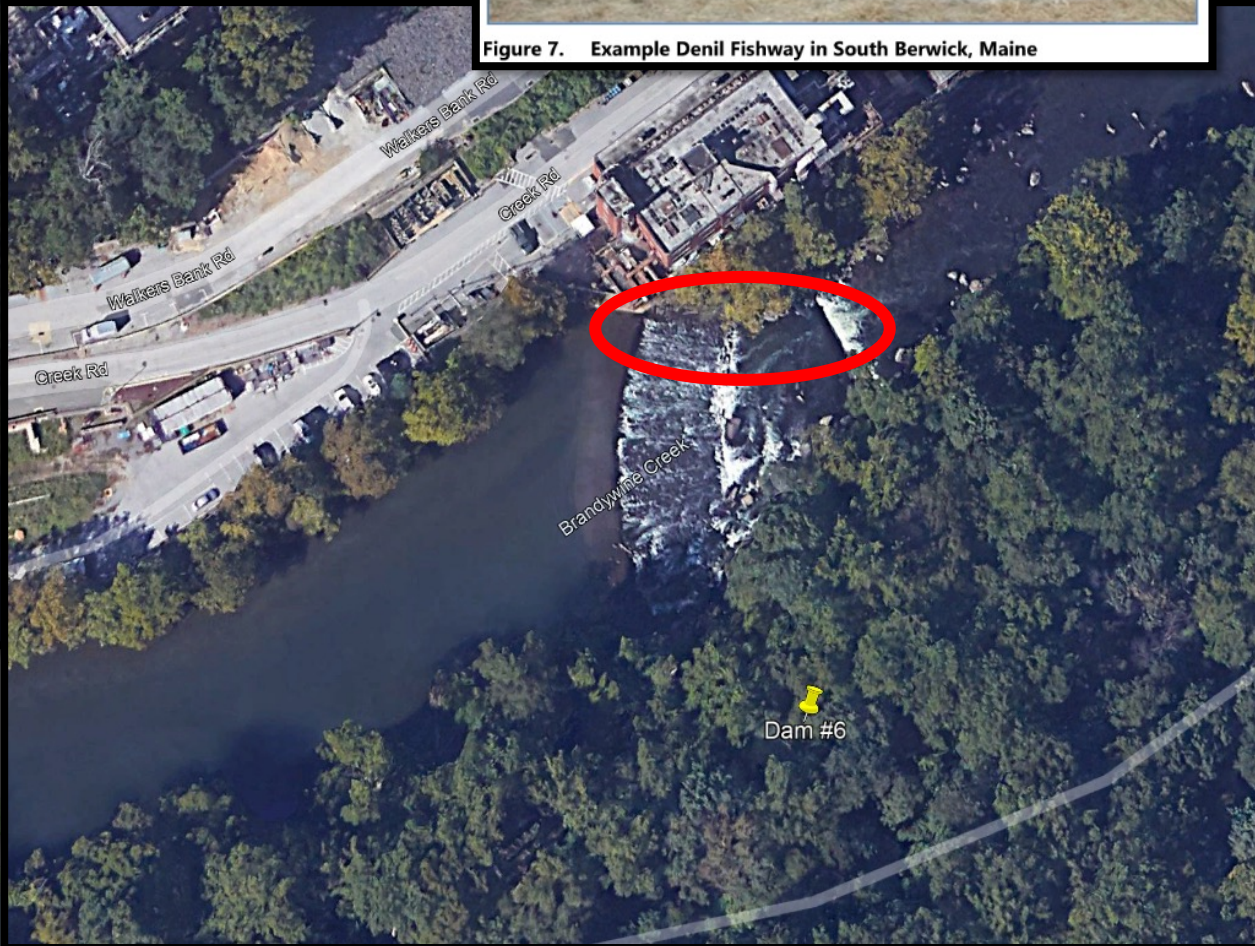
1. No Action
2. Technical Fishway
3. Nature-like Fishway: Bypass Channel or Rock Ramp
4. Dam Removal

Alternatives: No Action

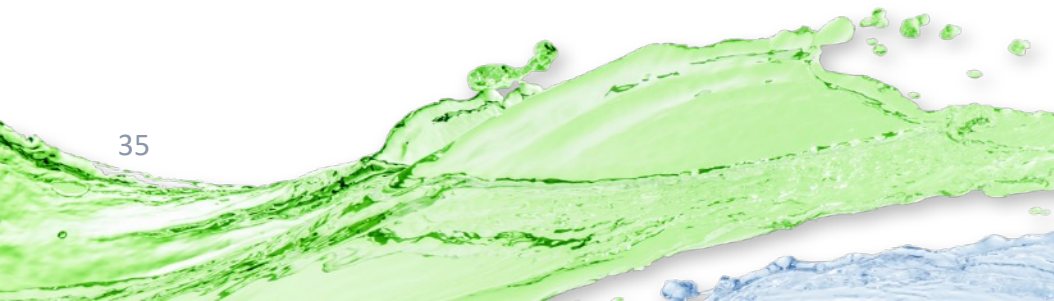
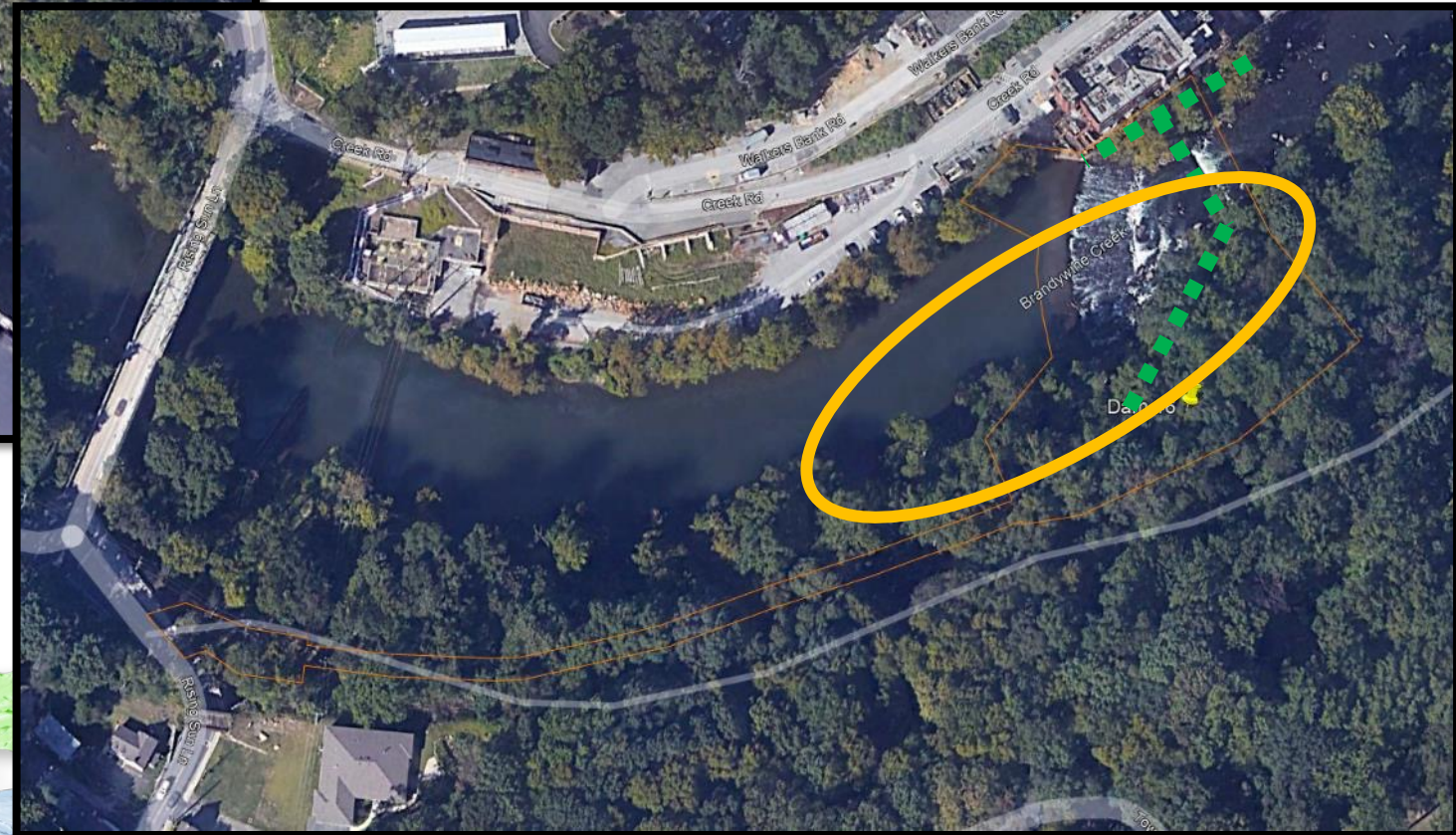
- Continued barrier to upstream American Shad passage
- Flooding remains an issue at and above the dams



Alternatives: Denil Fishway



Alternatives: Bypass Channel



Alternatives: Rock Ramp

Example NLF

Before



Upstream view of dam during low flow

After



Upstream view of completed ramp

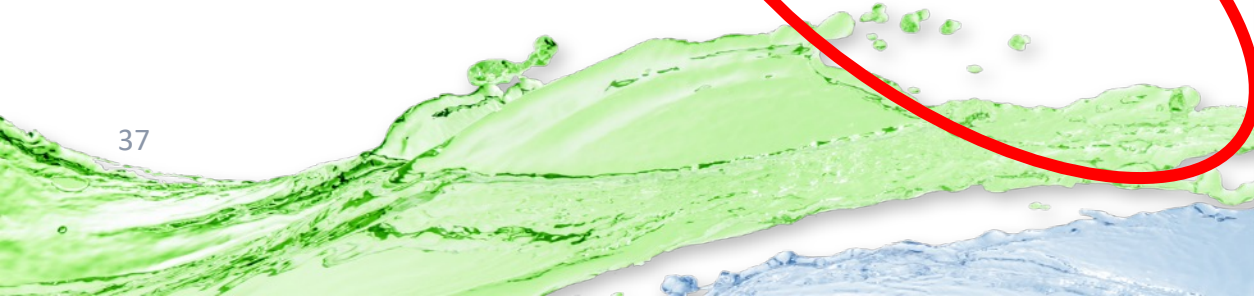


Closer view of rapids showing boulder weirs

Aadland, Luther. 2010. Reconnecting Rivers: Natural Channel Design in Dam Removals and Fish Passage. Published by the Minnesota Department of Natural Resources. January 2010.



Alternatives: Rock Ramp



Alternatives: Full Dam Removal



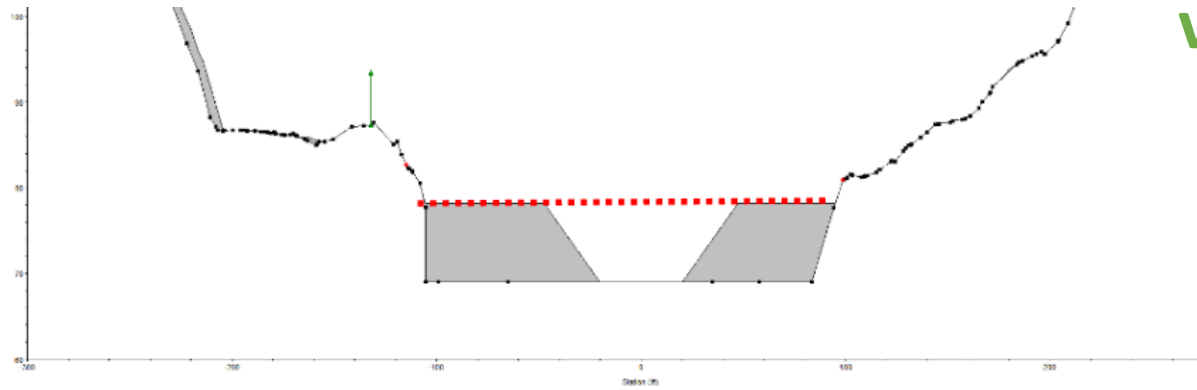
Alternatives: Partial Dam Removal



Figure 4. Example Partial Dam Removal by Kleinschmidt - Lombard Dam; Vassalboro, Maine

Alternatives: Dam Removal

Partial Dam Removal



vs.

Full-width Dam Removal

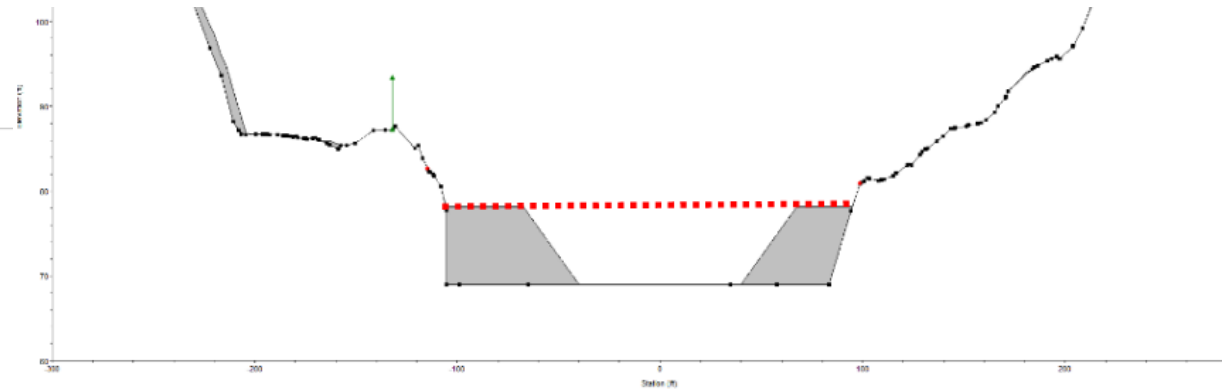
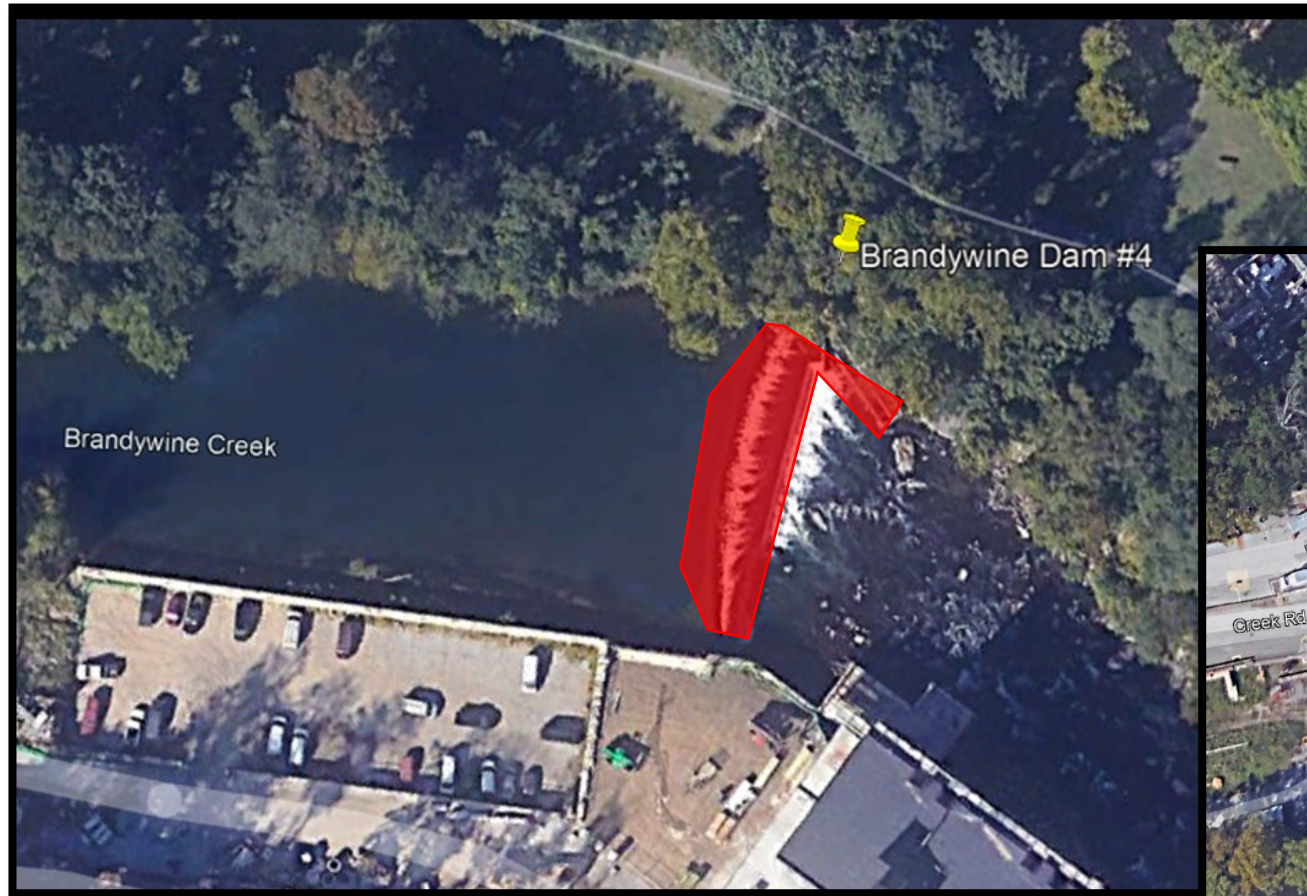


Figure 12. Partial-width Removal Geometry Visualization for Dam 6 in HEC-RAS Modeling Software (red line is dam crest, grey is dam/banks to remain)

Figure 11. Full Removal Geometry Visualization for Dam 6 in HEC-RAS Modeling Software (red line is existing dam crest, grey is dam/banks to remain)



Alternatives: Dam Removal



Full Removal v.s. Partial Removal
in the context of these sites



Alternatives Summary: Dam 4

Table 4. Dam 4: Summary of Alternative Benefits and Challenges

Alternative Option	Benefits	Challenges
No Action	<ul style="list-style-type: none"> - No cost - Continued deterioration could result in passage of migratory fish after the dam has completely failed - No immediate impacts to the historic resource of Dam 4 	<ul style="list-style-type: none"> - Dam not passable for migratory fish - Risk of dam failure remains, including risk to public safety - Risk of loss of historic resource due to deterioration - No reduction in flood water levels anticipated
Technical Fishway	<ul style="list-style-type: none"> - Potentially lower cost than bypass, but depends on design and fishway location - Smaller footprint than rock ramp or bypass - Existing technical fishway could be evaluated for modification/re-use 	<ul style="list-style-type: none"> - Requires two notches in the historic dam for the fishway exit and supplemental attraction water/downstream fish passage - Less effective upstream passage as compared to full width rock ramp or dam removal - High maintenance burden for debris removal and staffing during upstream migration period to open/close fishway and keep clean of sediment/debris - limited conveyance of attraction water could limit effective fish passage at higher flows - No year-round passage of resident species unless operated year-round. - Limited to no reduction in flood water levels anticipated
Dam Removal	<ul style="list-style-type: none"> - Provides ecological connectivity - Provides the best fish passage effectiveness. - Potential for shorter construction period than natural bypass channel - Anticipated reduction in flood levels local to dam and impoundment - Opens the Brandywine to recreation use by boaters 	<ul style="list-style-type: none"> - Causes a release of sediment from the impoundment - Impacts to historic resource that is Dam 4 - Need to consult with right abutter regarding structural design on buildings and infrastructure that was recently constructed

Alternative Option	Benefits	Challenges
Natural Bypass Channel	<ul style="list-style-type: none"> - Provides the acceptable fish passage effectiveness. - Results in minimal fill within the waterway - Construction may be able to be done partially in the dry (out of water) - Preservation of most of the historic resource in place, (but still have risk of further deterioration of the dam) 	<ul style="list-style-type: none"> - Not a viable solution due to infrastructure constraints - Does not address necessary dam maintenance - Likely requires a concrete diversion wall along the length of the fishway to separate it from the river - Significant excavation required and disposal of spoils would be required - Anticipated to be the highest cost alternative - Increased maintenance as compared to dam removal or no action alternative - Still requires impacts to historic resource to provide downstream passage

Alternatives Summary: Dam 6

Table 7. Dam 6: Summary of Alternative Benefits and Challenges

Alternative Option	Benefits	Challenges
No Action	<ul style="list-style-type: none"> - Low cost - No immediate archaeological or architectural impacts 	<ul style="list-style-type: none"> - No reduction in flood water levels anticipated (continued flooding of Dupont property) Dam 6 remains a barrier for anadromous and resident fish passage - Potential for continued loss of stone at toe of dam
Technical Fishway	<ul style="list-style-type: none"> - Potentially lower cost than bypass, but more expensive than dam removal - Smaller footprint than rock ramp or bypass 	<ul style="list-style-type: none"> - Requires two notches in the historic dam for the fishway exit and supplemental attraction water/downstream fish passage - Less effective upstream passage as compared to full width rock ramp or dam removal - High maintenance burden for debris removal and staffing during upstream migration period to open/close fishway and keep clean of sediment/debris - limited conveyance of attraction water could limit effective fish passage at higher flows - No year-round passage of resident species unless operated year-round. - Anticipate potential increase in flood water levels
Bypass Channel on River Right (Nature-like fishway)	<ul style="list-style-type: none"> - Provides the acceptable fish passage effectiveness. - Preservation of most of the historic resource in place, - Results in minimal fill within the waterway - Lower maintenance - Construction can be completed mostly in the dry - May have less flood water level impacts 	<ul style="list-style-type: none"> - Not a viable solution due to infrastructure constraints - Significant excavation required and disposal of spoils would be required - Likely requires a concrete diversion wall along the fishway to separate it from the river - Requires the construction of a flow control structure at the fishway exit and notching of the dam for supplemental attraction flow - conflicts with existing utilities and requires relocation of ~400 feet of sewer line - Anticipated to be the highest cost alternative - Increased maintenance as compared to dam removal or no action alternative - Still requires impacts to historic resource to provide downstream passage

Alternative Option	Benefits	Challenges
Full-Width Rock Ramp (Nature-like Fishway)	<ul style="list-style-type: none"> - Provides variable velocity across all flows to increase fish passage - More natural looking - Minimal shading to deter shad passage - Lower maintenance than technical fishway or bypass fishway - Sediment and debris generally pass through, minimizing clogging - Anticipated to be the most effective fish passage other than dam removal 	<ul style="list-style-type: none"> - Complicated hydraulics require modeling - Potentially higher construction cost - Impacts to existing aquatic resources by more fill in river - Long construction period with potential for short-term impacts to downstream water quality - Likely increase in flood water elevations near the fishway - Requires at least two notches in historic dam for passage - Archaeological & Architectural Resource Impacts
Dam Removal	<ul style="list-style-type: none"> - Offers greatest improvement in fish passage - Restores full connectivity from below impoundment to above Dam 6 - Provides additional protection of sewer line below Dam 6 - Potential for shorter construction period than natural bypass channel - Anticipated reduction in flood levels local to dam and impoundment - Opens the Brandywine to recreation use by boaters 	<ul style="list-style-type: none"> - Small release of sediment from impoundment - Impacts to historic resource that is Dam 4 - Preservation of existing sewer lines during construction and site stabilization - Need to consult with Delaware DOT regarding changes in hydraulics at upstream bridge

Review of Historical & Cultural Resource Findings

Anticipated Adverse Effects:

- i. Dam 4 (Kentmere Dam):
 - i. Permanent impact to dam (eligible resource)
- ii. Dam 6 (Lower Hagley Yard Dam):
 - i. Permanent impact to dam (eligible resource)

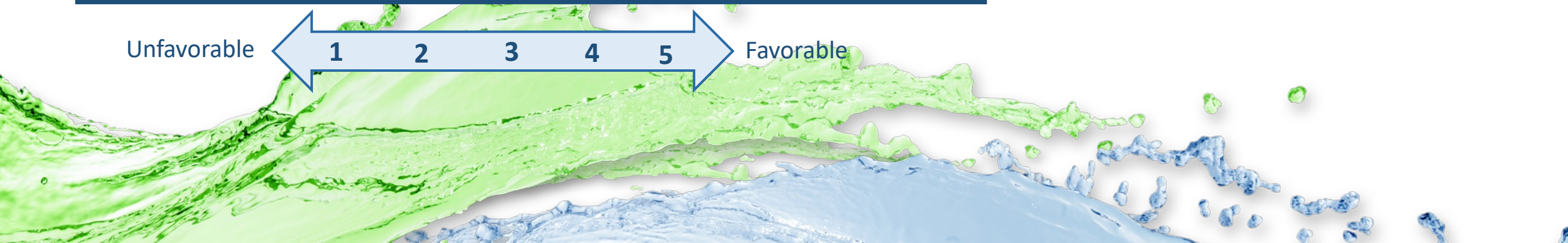
Dupont buildings:

Not evaluated for eligibility, but no buildings will be impacted as part of this project

Considering all factors, removal of a substantial portion of both Dam 4 and Dam 6 is the preferred solution to provide fish passage

FACTORS	Technical Options			Removal Options		
	Technical Fishway	Natural Bypass	Rock Ramp	Partial ~20%	Substantial ~80%	Full ~100%
Passage Efficiency	1	2	4	2	4	5
Flood Reduction	1	1	0	3	4	5
River Ecology	1	2	3	3	5	5
Technical Difficulty	2	1	2	3	4	4
Cost / Resources	2	1	1	5	4	3
Adverse Impact Historical & Archaeological	4	5	5	3	2	1
TOTAL SCORE	11	12	15	19	23	23

- ✓ *Enables significant passage*
- ✓ *Mitigates flood levels*
- ✓ *Enhances river ecology*
- ✓ *Preserves dam for public*



Questions?



Photo 1. Aerial View of Dam 4 from Drone Showing Void on Left Side, Dated 9/2



Next Steps

1. Comments to USACE by January 26, 2023
2. BRRT propose mitigation stipulations for adverse effects
3. Consulting Parties provide feedback on proposed stipulations
4. Finalize Memorandum of Agreement with final stipulations included

