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Richmond Engineering Services for HMGP – Alternatives Analysis

August 4, 2026

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Richmond Free Library & Virtually

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Outline/Agenda

1. Project Introduction/Refresher
    1. Goals and objectives
    2. Timeline and status
2. Hydraulic Study
    1. Model Development
    2. Model Validation
    3. Existing Conditions Results & Model Uses
3. Alternatives Analysis
    1. Methodology
    2. Results
    3. Recommendations
4. Next steps

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Project Overview

Overall goal:

- Complete a flood mitigation scoping study to assess current flood risks and evaluate mitigation options for reducing flood levels in Richmond in future events.

Objectives:

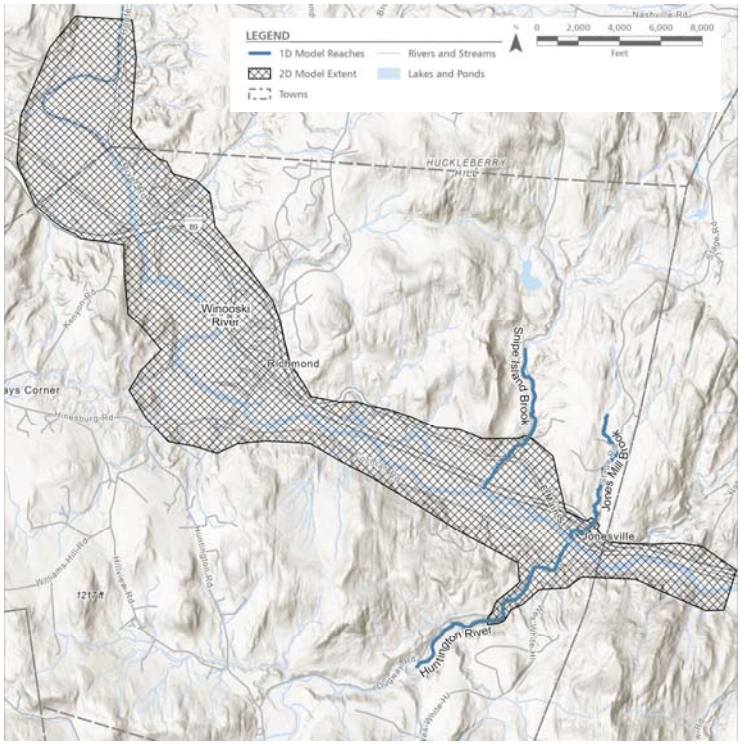
- Complete a hydraulic study of the Winooski River through the project area.
- Complete a hydraulic study of key tributaries to the Winooski River through the project area.
- Conduct an alternatives analysis to identify cost-effective flood mitigation projects eligible for FEMA Hazard Mitigation Grant Program (HMGP) funding.
- Develop conceptual level design plans, benefit cost analysis (BCA), and HMGP application materials for selected alternative.
- Present study findings in a final report.

Project Tasks and Status

Task	Status
Task 1 – Project Kickoff Meeting	Complete
Task 2 – Existing Data & Desktop Review	Complete
Task 3 – Hydraulic Study: Winooski River	Complete
Task 4 – Hydraulic Study: Tributaries	Complete
Task 5 – Alternatives Analysis	Complete/In Progress – Project Selection
Task 6 – Conceptual (30%) Designs	Up Next – Targeted completion end of October 2026
Task 7 – Benefit Cost Analysis (BCA)	Up Next – Targeted completion end of October 2026
Task 8 – Final Report & HMGP Application	Up Next – Targeted completion end of November 2026

Hydraulic Study – Model Development

Study Area



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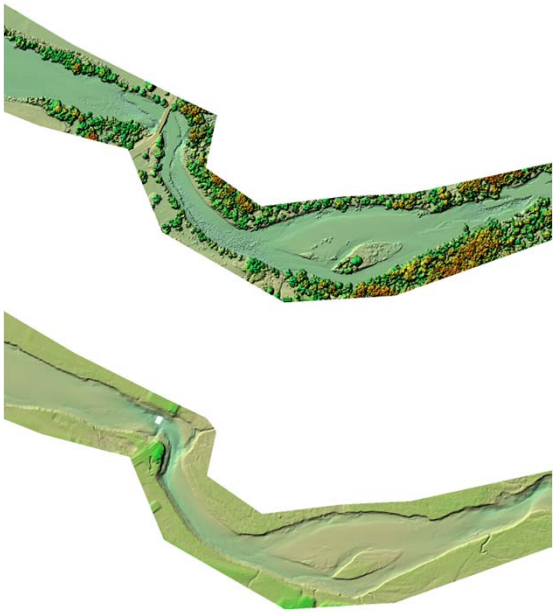
Hydraulic Study – Model Development

- Terrain
- Land Cover
- Infrastructure
  - Buildings
  - Bridges
- Hydrology Inputs



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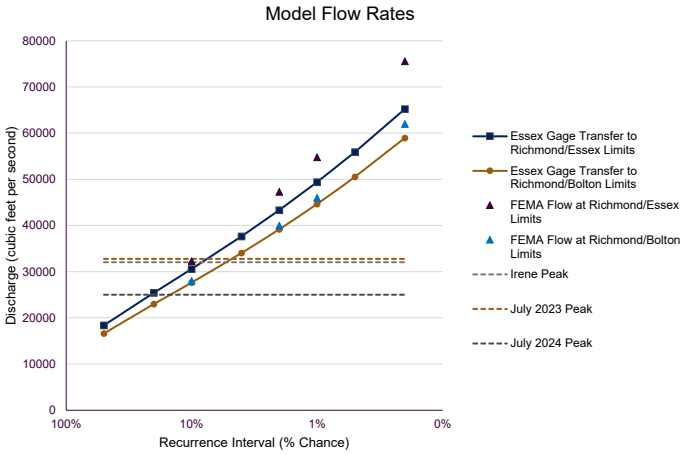
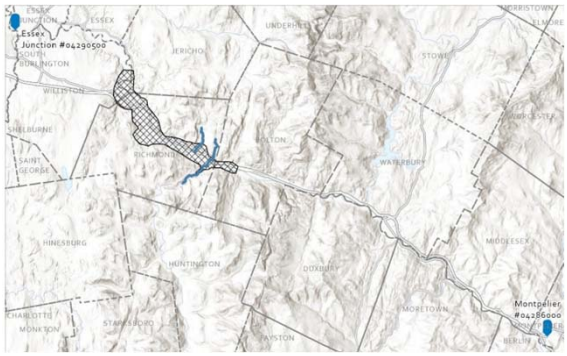
Hydraulic Study – Hydrology





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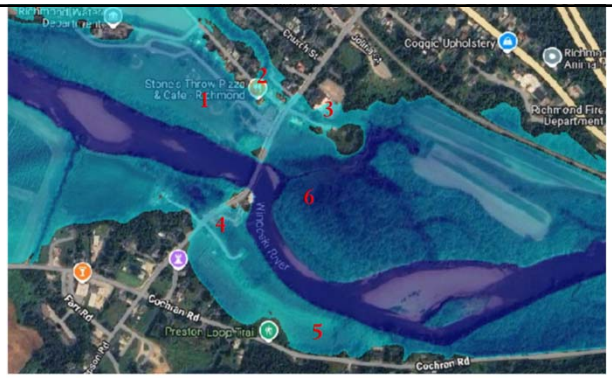
Hydraulic Study – Validation

- Validation Data
  - USGS High Water Marks
    - Model Mean Absolute Error:
      - -0.9 ft (T.S. Irene)
      - -0.2 ft (2023)
  - Aerial Imagery (2023, 2024)



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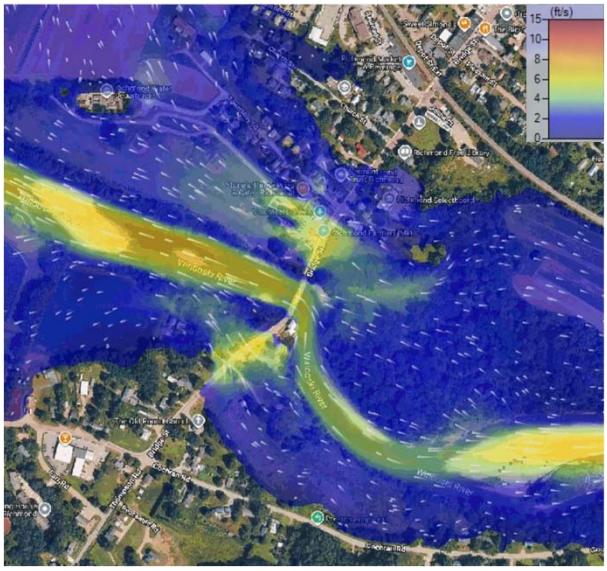
Hydraulic Study – Model Results

Areas vulnerable to inundation, erosion, and deposition

Flow patterns, elevations, depths and velocities

Simulated response to projects



What can the model be used for moving forward?

- Evaluate current conditions
- Evaluate flood mitigation alternatives
- Potential to refine as needed moving forward

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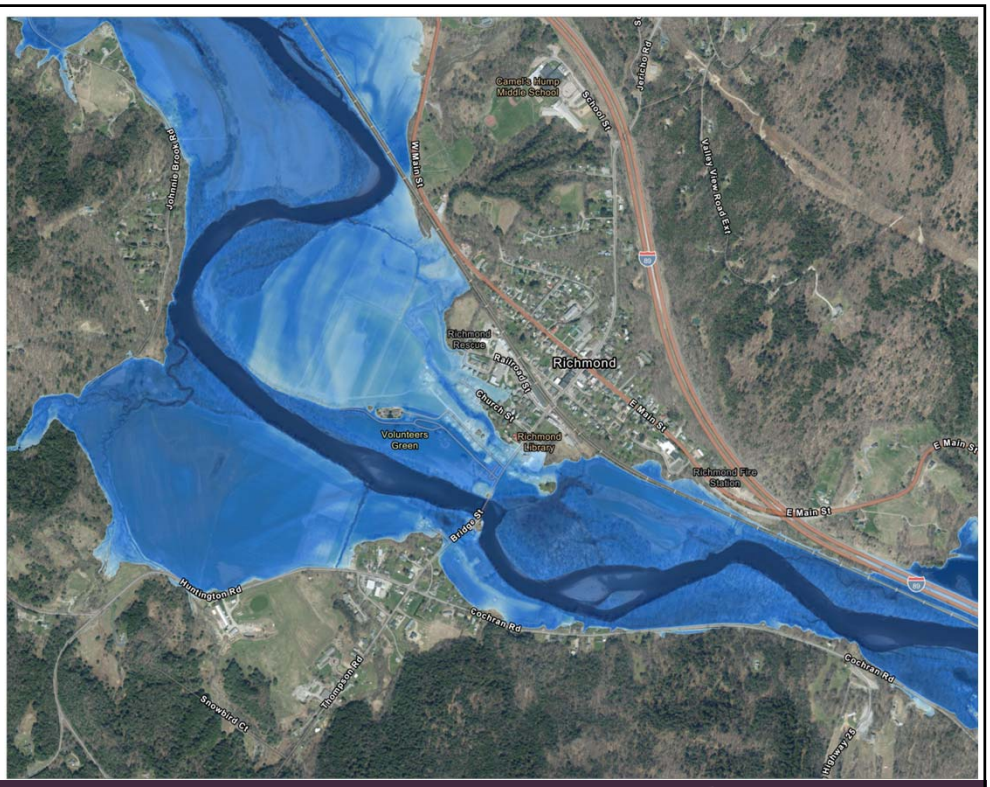
Hydraulic Study – Model Results

100-Year (1% AEP)



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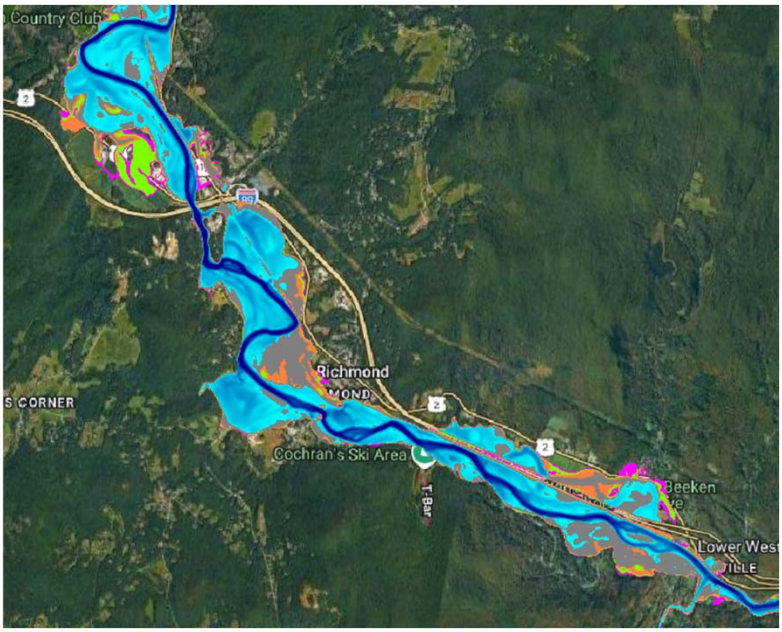
Hydraulic Study – Model Results

100-Year (1% AEP)

Hydraulic Study – Model Results

- Tested controls, bridges, constrictions, to define limitations, use this to transition to the alternatives.
- Defining the existing condition:
  - Landscape position
  - Already connected floodplains
  - Tributaries
  - Confluences



Alternatives Analysis - Methods

1. Identified potential flood mitigation solutions for vulnerable areas.
2. Ran hydraulic model scenarios.
3. Vetted projects using standard criteria in alternatives analysis matrix.
4. Provided next step recommendations for each identified and feasible solution.
5. Up Next:
   - Select project for conceptual design phase
   - Update criteria ratings (ex. “Community Alignment”) and refine alternatives analysis matrix based on feedback received today
   - Complete final flood scoping study report
     - Existing conditions
     - Hydraulic modeling
     - Alternatives analysis
     - Short and long-term approaches for improving flood resiliency in Richmond

Alternatives Analysis – Project Categories & Examples

Flood Resilience Strategy Category	Example Project Types
Design & Engineering	• Road relocation • Road stabilization • Bridge or culvert upsizing • Structural elevation • Structural floodproofing • Stormwater • Flood control
Nature-Based Solutions	• Floodplain reconnection • Dam removal • Stream and wetland restoration • Bioengineering • Green stormwater infrastructure
Land Use & Planning	• Property acquisition and demolition or relocation • Zoning and land-use regulations • Project scoping and development • Emergency services
Operations & Maintenance	• Road repairs and maintenance • Bridge and culvert repairs and maintenance • Warning and communication systems

Alternatives Analysis – Applying the Hydraulic Model

- Understand flood depths under existing conditions for low to high magnitude floods
- Run sensitivity analysis to understand order of magnitude floodplain lowering or construction removal needed to reduce flood level and/or flood velocity
- Run model scenarios at screening level for specific alternatives to help in applying alternatives analysis metrics.
- Model can be used in future studies in a similar way and updated as projects are implemented to capture new existing conditions.

Alternatives Analysis – Matrix Criteria and Scoring

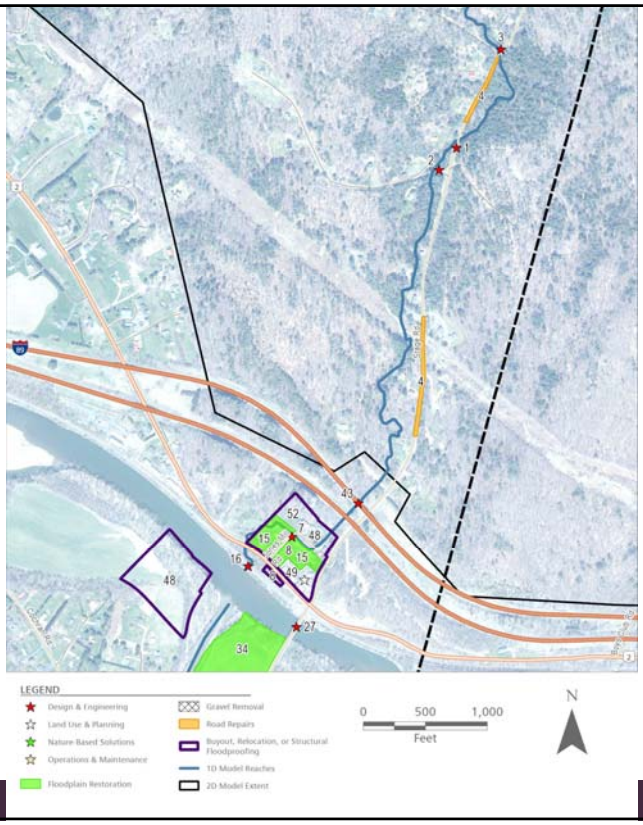
Criteria	Scoring		
	Low (0)	Moderate (1)	High (2)
Flood Mitigation Potential	No anticipated reduction to, or potential increase, of base flood elevation; potential increase in sediment erosion or deposition	Minimal to moderate reduction in flood level (< 1.0 ft) or mitigates fluvial erosion hazard. Minor to moderate impacts to sediment transport, erosion or deposition, anticipated.	Potential to reduce inundation by > 1ft or substantially mitigates fluvial erosion hazard. No to minimal negative impacts to sediment transport, erosion or deposition, anticipated.
Co-benefits	No anticipated co-benefits or potential negative impacts to co-benefits	Potential to recognize 1 or 2 co-benefits	Potential to recognize 3 or more co-benefits
Feasibility.	Major site constraints; complex engineering or construction required; complex landownership; potential permitting or regulatory challenges	Site constraints that can be addressed through standard engineering and analysis; moderate level of permitting; easements may be needed	No specialized engineering required; landowner support likely or publicly owned; standard permitting anticipated
Cost	High-cost project (>$1M)	Moderate cost project ($100k to $1M)	Low-cost project (<$100k)
Community Alignment	Does not directly align with existing plans or feedback received over the course of the project. Does not achieve flood inundation or erosion mitigation public benefit goals.	Public benefit exists but is minor. Private benefit for small cluster. Potential alignment with town plans and/or feedback received.	Clear public benefit. Clear alignment with feedback received during project and multiple town plans or projects.
HMGP Readiness/Eligibility	Project type not traditionally eligible for HMGP or may struggle to pass a FEMA Benefit-Cost Analysis given current conditions. Projects that score low in this category but high in others should be revisited by the Town for additional project development outside the current study.	Project type eligible but competitiveness and/or passing FEMA Benefit-Cost Analysis results are uncertain.	Project type clearly falls within the categories eligible for HMGP funding and a passing FEMA Benefit-Cost Analysis is anticipated. Developing application supporting documentation is feasible.

Alternatives Analysis – Results and Recommendations

Key Themes

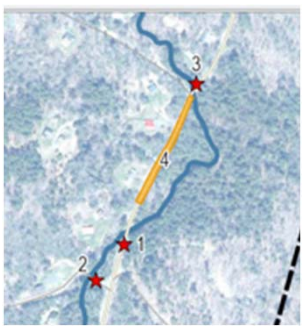
- Undersized culverts on tributaries to the Winooski can pose a flood hazard and erosion risk;
- Generally, the Winooski River accesses its floodplain through Richmond during high flows and there are limited floodplain reconnection opportunities on Town owned land. Pursuing floodplain reconnection and restoration opportunities for flood mitigation will require coordination with and support from private property owners.
- Infrastructure and property at the confluence of tributaries and the mainstem of the Winooski are impacted by both flooding along the tributary and the mainstem, making identification of feasible engineering solutions for mitigating impacts complex;
- Historic encroachments of important infrastructure (interstate, railroads) may limit opportunities for floodplain reconnection and constrict flood flows;
- Long-term planning, floodproofing, elevation, and relocation strategies become especially important in the absence of feasible engineered or nature-based solutions;

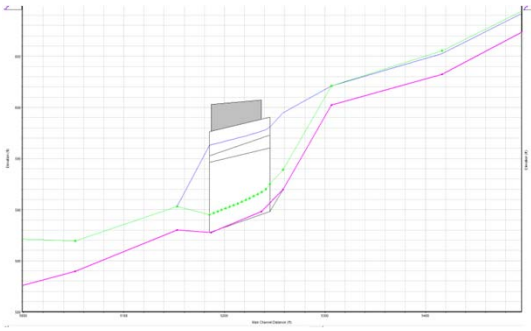
Jones Mill Brook& Stage Road Alternatives

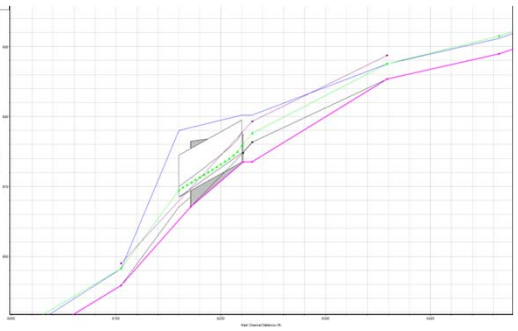


Alternative 1: Stage Road Culverts

Project Type	Description	Risks Mitigated / Concerns Addressed	Flood Mitigation Potential	Co-Benefits	Feasibility	Cost	Community Alignment	FEMA HMGP Readiness / Eligibility
Culvert or Bridge Upsizing	- Replacement of two undersized culverts on Stage Road (#1 and #3 in screenshot below). Channel restoration to remove deposited material at #3 inlet. - Both overtop and led to extensive roadway damage and lose of access on Stage Road. - Culvert projects have been combined to address the whole system.	Stream crossing washout; Roadway damage; driveway culvert washout; private property damage; loss of access	●	●	●	◐	●	●







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Alternatives: Jones Mill Road Neighborhood

Project Type	Description	Risks Mitigated / Concerns Addressed	Flood Mitigation Potential	Co-Benefits	Feasibility	Cost	Community Alignment	FEMA HMGP Readiness / Eligibility
Property acquisition and/or relocation	Alternative #48: Support and work with private property owners interested in property acquisition. Conceptual design not needed.	Public safety; Private property damage	●	◐	●	●	Varies	●
Floodplain Restoration	Alternative #15: Floodplain restoration on properties along Jones Mill Road, focus on acquired properties. Potential flood mitigation benefits limited by backwater conditions	Private property damage; Roadway damage	◐	●	●	◐	◐	◐
Road Relocation + Channel and Floodplain Restoration	Alternative #52: Consider alternatives for consolidating access to existing homes at one crossing. Restore the stream channel and floodplain through any abandoned crossings.	Roadway damage; loss of access	◐	●	◐	●	Uncertain	◐
Culvert Upsizing	Alternative #16: Upsizing of RR culvert identified in the Local Hazard Mitigation Plan as a structure with a geomorphic compatibility ranking of "Mostly Incompatible" or "Incompatible". Modeling results indicate no meaningful reduction in flood levels for the 100-yr event.	Flood Inundation; Undersized culvert	○	◐	○	○	●	◐

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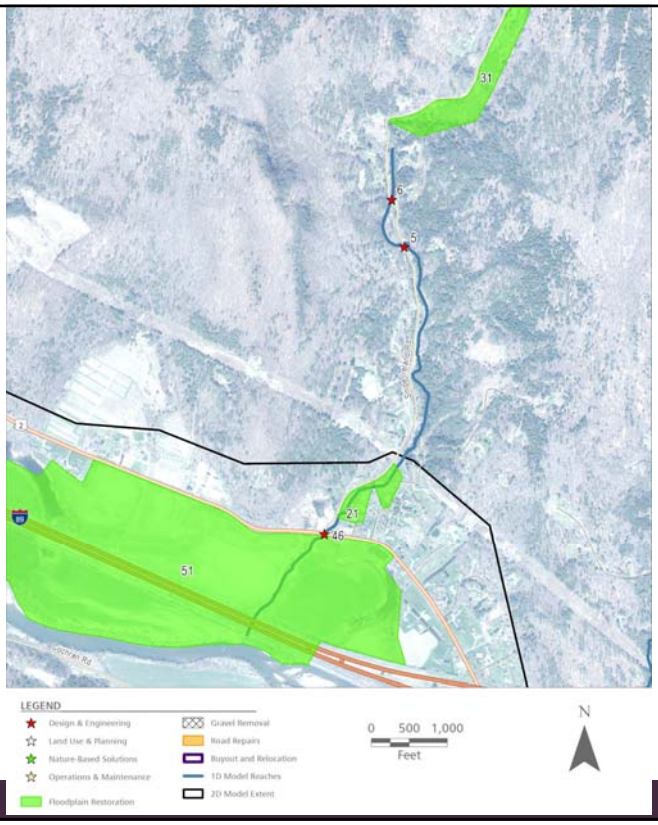
Snipe Island Brook Alternatives



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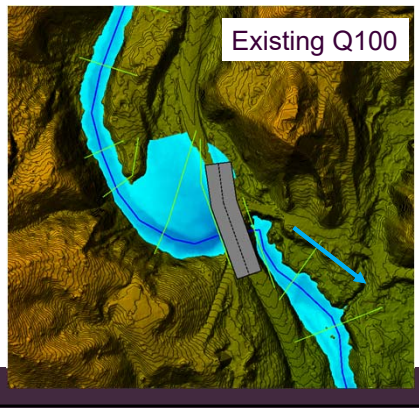
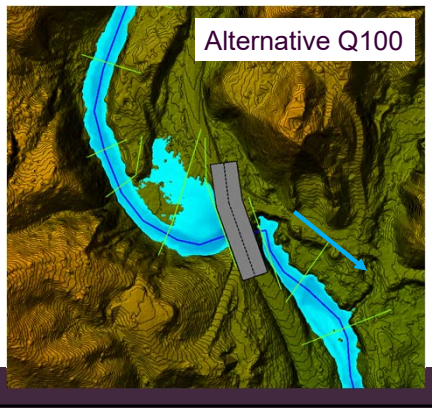
Alternative 5: Snipe Ireland Culvert Upsizing

Project Type	Description	Risks Mitigated / Concerns Addressed	Flood Mitigation Potential	Co-Benefits	Feasibility	Cost	Community Alignment	FEMA HMGP Readiness / Eligibility
Culvert or Bridge Upsizing	- Replacement, realignment, and upsizing of an undersized, poorly aligned, poor condition corrugated metal pipe arch in poor condition. - Model indicates existing culvert overtops in the 25-yr event, upsize could reduce > 2.5 ft at inlet during Q100 scenario - Culvert was identified as an issue in prior selectboard meetings and reviews of July 2024 flooding impacts	Stream crossing washout; Roadway damage; private property damage; loss of access	⬢	⬢	⬢	◐	⬢	◐





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Alternatives 21 & 46: Snipe Island Brook Floodplain Restoration and Route 2 Drainage Improvements

Project Type	Description	Risks Mitigated / Concerns Addressed	Flood Mitigation Potential	Co-Benefits	Feasibility	Cost	Community Alignment	FEMA HMGP Readiness / Eligibility
Floodplain restoration	- 75 to 100 ft wide and 2 to 4 ft deep floodplain cut along river left between Oneil Drive and Route 2. - Requires landowner support - 0.0 to 0.07 ft reduction in Q100 flood level, 0.02 to 0.7 ft/s reduction in Q100 velocity	Private property damage; Roadway damage; Flood inundation	⬡	◐	◐	◐	⬢	◐
Roadway drainage improvement	Lower approaches to Route 2 crossing on Snipe Island Brook. Lowering approaches would also require lowering deck, potentially reducing culvert capacity if not also associated with culvert removal. Not evaluated – floodplain culvert	Private property damage; Flood inundation	⬡	◐	◐	◐	◐	◐

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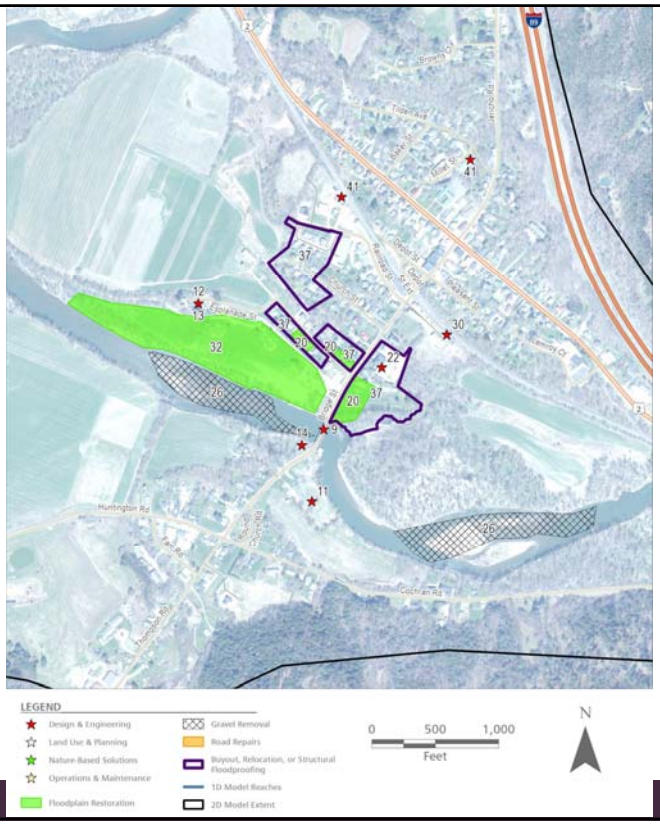
Winooski River / Village Alternatives



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Alternatives 26, 32, 53: Floodplain Restoration & Channel Sediment/Gravel Removal Alternatives

Project # and Type	Description	Risks Mitigated / Concerns Addressed	Flood Mitigation Potential	Co-Benefits	Feasibility	Cost	Community Alignment	FEMA HMGP Readiness / Eligibility
Alt 26 **Gravel removal/ Dredging**	- Alternative based on feedback received during public meeting to remove sediment upstream and downstream of bridge street. - Model results indicate < 0.1 ft reduction in Q100 flood levels in the village	Flood Inundation; Sediment Deposition	⬡	⬡	◐	⬡	◐	⬡
Alt 32 **Floodplain Restoration at Volunteers Green Only**	- Lower Volunteers Green by ~ 8ft and restore floodplain access. - Model results indicate 0.2 to 0.3 ft in the 100-yr WSE in the vicinity of Bridge Street and Esplanade Street and an increase of 0.1 ft on the south side of the wastewater treatment plant. Overall, this alternative has limited flood mitigation benefit.	Flood inundation; Erosion	⬡	⬢	◐	◐	⬡	◐
Alt 53 **Combined Floodplain Restoration and Gravel Removal**	- Lower Volunteers Green and along Bridge St by ~8 ft, create floodplain area on privately owned properties in vicinity of village pending landowner support, strategic gravel removal/dredging withing village. - Model results indicate 0.3 to 0.6 ft reduction in Q100 levels in the village and up to 1.5 ft immediately upstream of Bridge St.	Flood Inundation; Erosion	◐	⬢	◐	⬡	◐	◐

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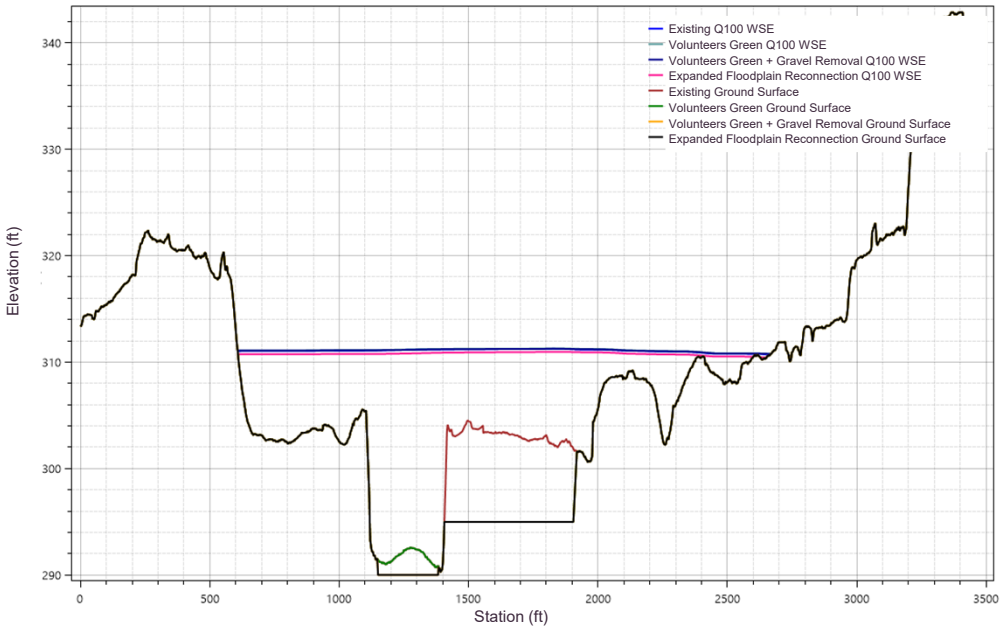
Alternatives 26, 32, 53: Model Cross Section



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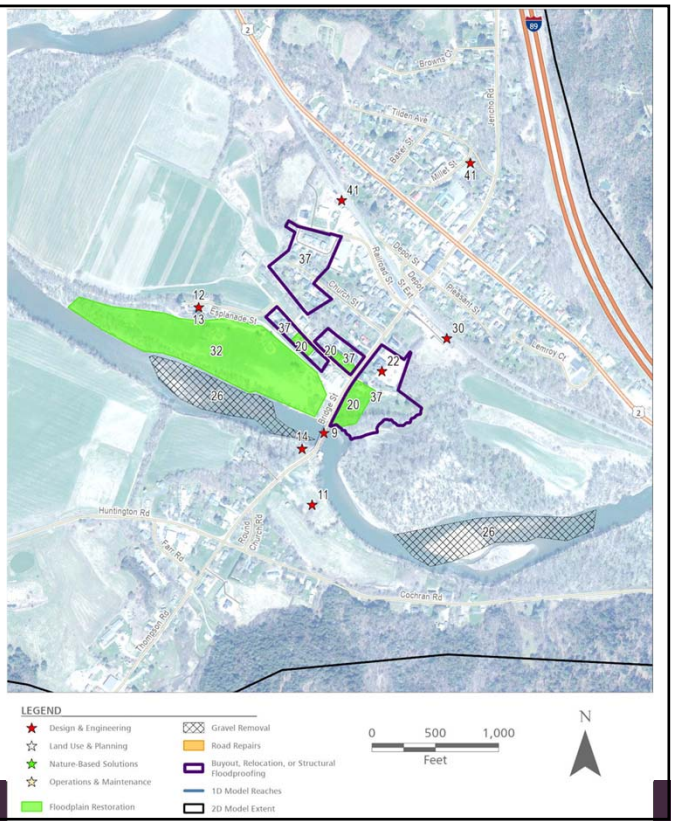
Richmond
Village Alternatives Continued:

- Alternative 41: Millet Street Gravel Wetland and Closed Drainage System Replacement

- Alternative 11: Town Water System Well Floodproofing

- Alternative 35: Relocating Volunteers Green Functions

- Alternative 37/Multiple: Floodproofing and elevating measures as appropriate based on property type



Alternatives Analysis – Recommendations for Concept Design Phase

Recommendation for Conceptual Design Phase

- Stage Road Culverts Replacement and Upsizing

Alternatives for Conceptual Design Phase

- Snipe Island Culvert Replacement and Upsizing
- Millet Street Gravel Wetland and Closed Drainage System Replacement
- BCA only for Town Water System Well Floodproofing (potential add-on as budget/timeline allows)
- Floodplain restoration alternative that requires additional landowner outreach and support

Next Steps for Other Alternatives

- Summaries analysis in the final project report
- Provide next step recommendations for feasible alternatives to support on-going flood resilience project implementation and planning

Up Next

- Select project for conceptual design phase (mid-August 2026)
- Update and refine alternatives analysis based on additional feedback received (mid-August 2026)
- Complete conceptual design, BCA, application documentation (late-August to October 2026)
- Complete flood study report with hydraulic studies, alternatives analysis, and conceptual design included as appendices. (November 2026)

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Thank you. Questions?

Contact / marpino@stone-env.com