5.2 Site-Level Project Opportunities

The site-level projects developed for the Williams River watershed are provided for each portion of the watershed in Tables 5.3 through 5.9. The project strategy, technical feasibility, and priority for each project are listed by project number and reach/segment. A total of 89 projects were identified to promote the restoration or protection of channel stability and aquatic habitat. These tables summarize key information for each project, including the site stressors and constraints, project strategy, priorities for hazard mitigation and ecological benefit, relative costs (i.e., low, moderate, and high), and potential partners and funding sources.

Tables 5.3 to 5.8 include a ranking of project priority, using our best professional judgment (and input from VTDEC, WNCRD, and other local stakeholders), of hazard mitigation and ecological benefits. Many river corridor restoration projects help mitigate flood and erosion hazards **and** improve the ecological conditions of the reach and watershed as a whole (e.g., improved habitat, protection of water quality, etc.). However, some project types provide a greater benefit to one over the other. Table 5.9 describes transportation, residential, and infrastructure resiliency projects within the Williams River watershed. While it is difficult to place a specific value on each project, rankings of “low,” “medium,” and “high” are intended to provide a means to compare the types of benefits each project provides relative to the others. A summary of what is meant by these two priority types is provided below.

> *Hazard Mitigation Priority:* refers to the potential for the project to mitigate flood and erosion hazards for the river corridor in the reach and in downstream areas. For example, replacing an undersized culvert with an appropriately sized structure could reduce flood/erosion hazards around the structure and downstream.
>
> *Ecological Benefits Priority:* refers to the potential for the project to improve aquatic habitat conditions and water quality in the reach and watershed. For example, a riparian buffer planting will improve habitat by increasing shading along the river and reducing long-term bank erosion.

The project locations for the study area are included on the maps provided in Appendix C. The 89 projects are further broken down by category as follows: thirty-four (34) active geomorphic restoration projects, twenty-four (24) passive geomorphic restoration projects, including four (4) conservation projects, and thirty-one (31) infrastructure resiliency projects. Several of the projects are grouped into a single project number based on type and watershed zone (e.g., MBWR-1a-d: four different corridor protection projects along the Middle Branch). Select "high" priority projects within each watershed are described in greater detail in section 5.3. High priority projects for which a project packet was prepared are summarized in Appendix E.

5.2.1 Lower Williams River Site-level Project Opportunities

Table 5.3: Site-Level Project Identification for the Lower Williams River Watershed in the Towns of Rockingham and Chester, Vermont.

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
LWR-1 Rounds Road House Construction Site Segment M07.B 43.2067 N 72.5300 W	**Passive Restoration** Buffer Planting and Erosion Control	All of the woody vegetation was removed from the steep slope extending to the top of the valley wall where a house is being constructed. The slope appears unstable and will be a major source of sediment to the channel.	We recommend working with the private landowner to establish erosion control measures on the slope and to address any gully formation.	Low	Moderate	Reduce sediment loading to the channel	Low	Private Landowner; VTANR ERP
LWR-2a-d Multiple Locations Reach/Segment: M08.A, M08.B, M10, M11	**Passive Restoration** Corridor Protection	Small to large areas of accessible floodplain that provide valuable sediment, debris, and floodwater attenuation during larger events. Most sites have reduced woody buffer vegetation and tall eroding banks. High priority area on segment M08.B.	Protect corridor from future development and plant buffer with native woody vegetation where appropriate.	Varies by Project: Low to **High**	Varies by Project: Low to **High**	Protect floodplain area from future development and increase shading and woody debris inputs to channel. Provide minor to moderate flood water and sediment/debris storage.	Low to Moderate	VTANR ERP; Private landowners; VLT; WCNRCD and ONRCD Trees for Streams
LWR-3 Williams Road Bridge and Railroad Bridge Segment M08.B 43.2115 N 72.5360 W	**Active Restoration** Bridge Replacement	The Williams Road covered bridge is a major channel constriction (65% bankfull width). The railroad bridge immediately downstream is a slight floodprone constriction relative to the upstream and downstream channel widths. The covered bridge constriction likely increased upstream flooding during T.S. Irene.	Reconfigure abutments to increase bankfull width; in the long-term the bridge may need to be replaced to achieve lower flood risks. New structure/configuration would improve sediment transport and floodwater conveyance through the reach.	Moderate	Low	Remove a significant constriction that increased localized flooding during TS Irene.	High	Town of Rockingham; VTrans

Table 5.3: Site-Level Project Identification for the Lower Williams River Watershed in the Towns of Rockingham and Chester, Vermont.

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
LWR-4a-c Multiple Locations Reach/Segment: M08.B, M10, M11	**Passive Restoration** Conservation	Three large floodplain areas that provided critical floodwater and sediment storage during T.S. Irene. The river channel is highly active and is redeveloping a meandering planform. The M08.B and M10 floodplains are undeveloped, the M11 floodplain has houses and structures immediately adjacent.	Work with private land owners to prevent future development or agricultural conversion in river corridor.	**High**	Medium	Large area for sediment and floodwater attenuation, store and slow floodwaters before entering an extending stretch of river with minimal floodplain access.	Low to Moderate	VTANR; VLT; VRC, Private Landowners; Towns of Rockingham and Chester
LWR-6 Missing Link Road Reach M11 43.2398 N 72.5579 W	**Active Restoration** Bridge Retrofit	Missing Link Road bridge was destroyed during T.S. Irene and reconstructed following the storm. The new bridge has an opening that is very close to predicted bankfull width, however the stone armoring along the abutments constricts the channel to approximately 65% bankfull width.	Reconfigure the large stone armor under the bridge to increase bankfull width.	Moderate	Low	Reduce local flooding impacts without increasing scour risk to the bridge abutments.	Low to Moderate	Town of Chester

Table 5.3: Site-Level Project Identification for the Lower Williams River Watershed in the Towns of Rockingham and Chester, Vermont.

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
LWR-8 Railroad Bridge Reach M11 43.2528 N 72.5729 W	**Active Restoration** Bridge Retrofit/ Replacement	The railroad bridge is poorly aligned to the channel and has a wide center pier. The bridge is very wide (165% bankfull) however the alignment and the pier are causing significant sediment deposition under the bridge which is reducing capacity and increasing scour along the center pier footing. The bridge likely plugged with debris during T.S. Irene causing widespread flooding on both floodplains upstream and downstream of the crossing.	It is likely unfeasible to realign the railroad, therefore the bridge should be considered for replacement with a single span structure. Undermining of the center pier should be assessed. Dredging of excess sediment is a short term solution and this could potentially be reduced with the installation of deflector structures upstream to increase flow on both sides of the pier and reduce sediment accumulation.	**High**	Low	Improve floodwater, sediment, and debris transport through the bridge opening and reduce localized flooding of agricultural fields	Moderate to High	Green Mountain Railroad
LWR-10 Flamstead Rd. Bridge Reach M12 43.2715 N 72.5879 W	**Active Restoration** Replace Bridge	The Flamstead Road bridge is a major bankfull width constriction (55%) and is in poor-fair condition. The east abutment projects approximately 15 feet from the steep banks.	Replace with a larger structure that spans the straightened channel and does not further restrict flows.	Moderate	Low	Improve conveyance of floodwaters and sediment during large storms. Reduce the risk of debris catchment which could cause overbank flooding and damage to adjacent roads and houses.	High	Town of Chester, VTrans, VTANR

5.2.2 Upper Williams River Site-level Project Opportunities

Table 5.4: Site-Level Project Identification for the Upper Williams River Watershed in the Towns of Chester and Ludlow, Vermont.

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
UWR-1 Old Abutments for Farm Bridge Reach M13 43.2728 N 72.5983 W	**Active Restoration** Remove Old Abutments	Stacked stone abutments from a former farm bridge represent a major channel width and bankfull width constriction. The abutments are approximately 28ft wide and the straightened channel upstream/downstream is typically 35-38ft wide	Remove the old abutments on both banks and regrade left bank to reduce short-term erosion.	Low	Moderate	Improve conveyance of floodwaters and sediment during large storms	Low	Private Landowner
UWR-2a-e Multiple Locations Reach/Segment: M13, M14, M20.A	**Passive Restoration** Corridor Protection	Small to large areas of accessible floodplain that provide valuable sediment, debris, and floodwater attenuation during larger events. Most sites have reduced woody buffer vegetation and tall eroding banks. High priority areas on reaches M13 and M14.	Protect corridor from future development and plant buffer with native woody vegetation.	Varies by Project: Low to **High**	Varies by Project: Low to **High**	Protect floodplain area from future development and increase shading and woody debris inputs to channel. Provide minor to moderate flood water and sediment/debris storage.	Low to Moderate	VTANR ERP; Private landowners; VLT; ONRCD Trees for Streams
UWR-3 Colburn Road Bridge Abutment Reach M13 43.2902 N 72.6041 W	**Active Restoration** Remove Old Bridge Abutments	Stacked stone abutment from previous bridge is a moderate bankfull width constriction (67%). The new bridge and abutments are not a significant constriction.	Remove old bridge abutment on the right (west) bank to increase capacity for floodwater conveyance through the reach.	Moderate	Low	Improve conveyance of floodwaters and sediment during large storms. Reduce the risk of debris catchment which could cause overbank flooding and damage to adjacent roads and houses.	Low	Town of Chester, VTrans; VTANR

Table 5.4: Site-Level Project Identification for the Upper Williams River Watershed in the Towns of Chester and Ludlow, Vermont.

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
UWR-4 Willard Road Bridge Reach M13 43.2946 N 72.6036 W	**Active Restoration** Retrofit or Replace Bridge	The Willard Road bridge is a moderate bankfull constriction (67%) due to the right abutment projecting out from the steep banks along this channelized reach. The channel is narrower than curve width, however the constriction resulting from the abutment may increase local flood risk.	Assess whether the bridge abutment can be pushed back to better match the channel width upstream and downstream of the crossing. Otherwise, consider replacing with a larger structure over the long term.	Moderate	Low	Improve conveyance of floodwaters and sediment during large storms. Reduce the risk of debris catchment which could cause overbank flooding and damage to adjacent roads and houses.	High	Town of Chester; VTANR; VTrans
UWR-6 Thompson Road Bridge Reach M14 43.3036 N 72.6052 W	**Active Restoration** Retrofit Bridge	Both of the stacked stone abutments for the bridge project ~4-6ft from the steep banks and create a severe bankfull width constriction (58%).	Assess the stability of the bridge deck and girders if the abutments are pushed back.	Moderate	Low	Improve conveyance of floodwaters and sediment during large storms. Reduce the risk of debris catchment which could cause overbank flooding and damage to adjacent roads and houses.	High	Town of Chester, VTrans
UWR-8 Cota &Cota Gas Property Reach M16 43.3302 N 72.6154 W	**Active Restoration** Bank Restoration	The channel is highly constricted (20ft) by the railroad embankment to the west and a poured concrete bank on the east. The concrete appears to be undermined in several locations.	Remove the concrete bank and replace with a stacked stone wall keyed in to the channel bottom.	Low	Low	Increase bankfull width through this section to improve floodwater conveyance	Moderate	Private Landowner
UWR-10 Floodplain along Route 103 Reach M17 43.3374 N 72.6173 W	**Active Restoration** Berm Removal	A 2ft tall by 300ft long berm on the right bank is blocking access to a small floodplain area. Accessible floodplain areas are very limited in this portion the watershed.	Remove berm to restore access to floodplain. Assess road resiliency.	Moderate	Low	Restore access to a small floodplain in a portion of the watershed with very limited floodplain access.	Low to Moderate	VTANR; VTrans; Private Landowner

Table 5.4: Site-Level Project Identification for the Upper Williams River Watershed in the Towns of Chester and Ludlow, Vermont.

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
UWR-11 Smokeshire Road Multiple Locations Reach/Segment M18-M21	**Active Restoration** Roadway Sediment and Runoff Management	Five areas of excessive sediment generation were observed along Smokeshire Road. Due to the close proximity of the road to the channel through most of this section, large volumes of sediment are delivered to the river during storm events.	Improve ditch maintenance, check dam installation, road grading improvements ,etc.	Low	**High**	Reduce sediment inputs to the channel. Potentially increase transportation resiliency with improved surface runoff management	Moderate	Town of Chester, Town of Ludlow, VTANR, Better Backroads
UWR-12 Smokeshire Road Segment M20.A 43.3371 N 72.6603 W	**Active Restoration** Road Resiliency and Berm Removal	The channel appears to have avulsed during T.S. Irene and access to the former channel is blocked by a dredged gravel/cobble berm. The current channel appears stable but is very straight. Existing road embankment armoring may be insufficient if flow returns to the historic channel	Remove the spoils berm to restore access to the former channel as a flood chute. Road embankment armoring should be assessed and increased if necessary to protect the road.	Moderate	Low	Provide access to a floodplain and an overflow channel/flood chute .	Low to Moderate	Town of Chester, VTANR
UWR-14 Smokeshire Road at South Hill Road Reach M22 43.3353 N 72.6992 W	**Passive Restoration** Conservation	The channel extending upstream from Smokeshire Road is highly active and the floodplain shows evidence of major overbank flooding and channel braiding. Several historic berms were observed, including a very tall berm that appears to have been constructed to protect a logging road that is no longer in service.	Work with private land owners to prevent stream corridor from future development or agricultural conversion. Fully or partially remove berms to improve access to floodplain areas	**High**	Medium	Large area for sediment and floodwater attenuation, store and slow floodwaters before entering an extending stretch of river with minimal floodplain access	Low to Moderate	VTANR; VLT; VRC, Private Landowners; Towns of Ludlow

5.2.3 Middle Branch Williams River Site-level Project Opportunities

Table 5.5: Site-Level Project Identification for the Middle Branch Williams River Watershed in the Towns of Chester and Andover, Vermont.

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
MBWR-1a-d Multiple Locations Reach/Segment T5.01, T5.03, T5.05.A, T5.08	**Passive Restoration** Corridor Protection	Small to large areas of accessible floodplain that provide valuable sediment, debris, and floodwater attenuation during larger events. Most sites have reduced woody buffer vegetation and tall eroding banks. The T5.01 project site is high priority for bank stabilization and buffer planting, the T5.05.A site is very high priority for floodplain protection.	Protect corridor from future development and plant buffer with native woody vegetation.	Varies by Project: Low to **High**	Varies by Project: Low to **High**	Protect floodplain area from future development and increase shading and woody debris inputs to channel. Provide minor to moderate flood water and sediment/debris storage.	Low to Moderate	VTANR ERP; Private landowners; VLT; VRC; ONRCD Trees for Streams
MBWR-4 Floodplain near Route 11 and Reservoir Rd Reach T5.03 43.2688 N 72.6218 W	**Active and Passive Restoration** Berm Removal and Floodplain Protection	A 400ft long 4-5ft tall berm was constructed along the south bank following T.S. Irene. This berm blocks access to a large floodplain that provided critical floodwater and sediment attenuation during the 2011 and 2014 floods. This is the last large floodplain before the Middle Branch flows through the Village.	Remove berms and work with the landowner to protect floodplain from future development and plant buffer with native woody vegetation.	**High**	Moderate	Restore and protect access to a large and important floodplain area.	Moderate	VTANR, VRC, Private Landowner
MBWR-5 Kingsbury Road Segment T5.05.A 43.2604 N 72.6583 W	**Active Restoration** Bridge Replacement	The bridge and abutments are a major bankfull width constriction (56%) increasing upstream sediment deposition. Major overbank flooding during T.S. Irene and the 2014 flood seriously damaged the two houses adjacent to the bridge.	Replace bridge with a larger structure to allow for increased capacity of floodwaters and sediment. Special consideration for sediment transport given the very high upstream sediment load.	**High**	Low	Remove a major bankfull width constriction and improve conveyance of floodwaters and sediment during future storm events.	High	Town of Chester

Table 5.5: Site-Level Project Identification for the Middle Branch Williams River Watershed in the Towns of Chester and Andover, Vermont.

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
MBWR-6 Route 11 near Hill Top Rd Reach T5.07 43.2601 N 72.7018 W	**Active Restoration** Buyout and Floodplain Restoration	The property located on the bend immediately upstream of the Route 11 bridge was severely impacted by flooding during T.S. Irene. The channel is highly active and depositional through this section. Berms were constructed along the left bank to protect the house following the 2011 and 2014 floods. A flood chute formed along Rt11 during both floods.	The property is in the process of being purchased through a FEMA buyout, no further site work has been completed. Berms should be removed as part of the site work and the stability of the Rt11 embankment should be assessed.	**High**	Low	Remove house and berms to restore access to an important floodplain. Reduce flood risk to Rt 11.	Moderate to High	VTANR, FEMA, Town of Andover

5.2.4 South Branch Williams River Site-level Project Opportunities

Table 5.6: Site-Level Project Identification for the South Branch Williams River Watershed in the Town of Chester

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
SBWR-2 Grafton Road Bridge near Quarry Road Reach T5.S1.02 43.2551 N 72.6019 W	**Active Restoration** Bridge Retrofit	The abutments under the Grafton Road bridge create a moderate channel constriction (66%). The rock riprap left abutment projects well out into the channel.	Replace the riprap left abutment with stacked stone armor to increase bankfull width by approximately 10ft.	Low	Low	Increase floodwater and sediment conveyance through the structure	Low	VTrans
SBWR-3 Grafton Road Reach T5.S1.03 43.2473 N 72.6034 W	**Active Restoration** Remove Old Abutments	A stacked stone abutment on the east bank is a floodprone width constriction and is exacerbating local erosion.	Remove stacked stone abutment to increase channel and floodprone width.	Low	Low	Increase conveyance of floodwaters through the reach and reduce local erosion along the road embankment.	Low	VTrans, VTANR, Private Landowner

Table 5.6: Site-Level Project Identification for the South Branch Williams River Watershed in the Town of Chester

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
SBWR-5 Floodplain South of Popple Dungeon Road Reach T5.S1.06 43.2423 N 72.6349 W	**Active Restoration** Berm Removal	A 300ft long 5 ft tall berm that appears to be from the 1970's flooding is blocking access to a large undeveloped floodplain.	Remove berm and restore access to floodplain during large storm events.	Moderate	Low	Increase floodplain access to attenuate floodwater and sediment during large events.	Low to Moderate	VTANR, Private Landowner
SBWR-6 Floodplain along Popple Dungeon Road (PDR) Reach T5.S1.07 43.2384 N 72.6475 W	**Active Restoration** Berm Removal	Three berms totaling 550ft were observed along the edge of a lawn and along PDR. The two upstream berms do not appear to protect any infrastructure , the downstream berm along PDR is located on top of the bank armor. All of the berms are older than T.S. Irene but don't appear as old as 1970's.	Assess flood risks to the house if either of the upstream berms are removed. If possible, remove berms and reconnect the floodplain during high flows.	Moderate	Low	Restore access to a small floodplain to increase floodwater and sediment storage within the reach.	Low to Moderate	VTANR, Private Landowner
SBWR-7 Popple Dungeon Road near Zezza Rd Reach T5.S1.07 43.2390 N 72.6585 W	**Active Restoration** Culvert Replacement	Major overbank flooding occurred at this crossing during T.S. Irene when the culvert capacity was exceeded, possibly due to debris jamming, and floodwaters came over the road and flowed down the road for several hundred feet. The culvert bottom is rotting and may be an AOP barrier at some flows.	Replace culvert with a larger structure and extend the north wingwall to the valley wall to reduce overbank flooding risk. **Culvert bottom is scheduled for repair in 2017. The Town Highway Department is planning to replace with a bridge in the future.**	**High**	Moderate	Decrease flood risk at a major T.S. Irene damage site and improve AOP through the reach.	High	Town of Chester, VTrans

5.2.5 Lovers Lane Brook, Trebo Brook, and Whitmore Brook Site-level Project Opportunities

Table 5.7: Site-Level Project Identification for Lovers Lane Brook, Trebo Brook, and Whitmore Brook in the Town of Chester

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
LLB-1 Trail Crossing at Middle Branch Confluence Reach T5.S2.01.A 43.2582 N 72.5874 W	**Active Restoration** Culvert Replacement/ Removal	A steel culvert under an abandoned road/trail is partially filled with cobbles including a boulder pile at the inlet which may reduce AOP. Large deposits of coarse material and woody debris were observed immediately upstream. This constriction may have increased flooding along Route 103.	Explore removal of the culvert since the historic road/trail is abandoned. Structure removal would require additional excavation to clear the material along the trail and to establish stable slopes.	**High**	**High**	Remove a significant AOP barrier and improve floodwater and sediment conveyance at the mouth of the Brook.	Moderate	VTANR
LLB-2 Chester Elementary School Segment T5.S2.01.B 43.2658 N 72.5962 W	**Passive Restoration** Corridor Protection	A large forested floodplain is located along the north bank along the school property and extending upstream. The floodplain elevation is slightly below the south floodplain where the school is located.	Protect corridor from future development and plant buffer with native woody vegetation.	Moderate	Moderate	Protect floodplain area from future development	Low	VTANR ERP; Elementary School; Private landowners; VLT
LLB-3 Farm Road Crossing Segment T5.S2.01.C 43.2664 N 72.5987 W	**Active Restoration** Culvert Replacement	A concrete culvert under the farm access road is very small and is a major bankfull constriction (26%). The upstream channel is heavily channelized and aligns with the culvert, however the elevated road grade coupled with the culvert will increase local flooding.	Replace with a larger structure, this project should be considered in concert with LLB-4.	Low	Low	Improve conveyance of floodwaters and sediment through the reach, reduce local flooding.	Moderate	VTANR ERP; Private Landowner

Table 5.7: Site-Level Project Identification for Lovers Lane Brook, Trebo Brook, and Whitmore Brook in the Town of Chester

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
LLB-4 Farm Field Near Main St and Church St Segment T5.S2.01.C 43.2668 N 72.5990 W	**Active Restoration** Channel and Floodplain Restoration	Approximately 300ft of channel is deeply channelized and straightened with minimal access to the large floodplains on both banks. The banks are fractured and unstable and dense willow grow in the channel but woody bank and buffer vegetation is absent.	Construct a meandering channel based on predicted curve width and ensure floodplain access. Plant the buffer with native woody vegetation.	Moderate	Moderate	Increase floodplain access to store floodwaters and sediment. Improve habitat through the reach.	Moderate	VTANR ERP; ONRCD Trees for Streams; Private Landowner
TRE-1 Wetland Complex near White River Confluence Segment T7.01.A 43.2741 N 72.5934 W	**Passive Restoration** Corridor Protection	Recent dredging and ditching was observed along a farm road across an active beaver wetland.	Work with the landowner to reduce dredging activities and wetland disturbance. May be possible to conserve the entire hayfield to the south which would remove the need for an access road.	Low	Moderate	Remove source of disturbance to wetland complex, reduce sediment inputs to Williams River.	Low	VTANR ERP; Private Landowner; VLT
TRE-2 Hayfield Upstream of Cemetery Segment T7.01.B 43.2775 N 72.5956 W	**Passive Restoration** Buffer Planting and Corridor Protection	Woody vegetation is lacking along both banks for most of the segment.	Plant the banks and buffer with native woody vegetation and work with the landowner to protect the corridor from future development or agricultural conversion.	Low	Moderate	Reduce nutrient inputs to channel and increase shading.	Low	ONRCD Trees for Stream; Private Landowner; VTANR
WHB-1 Farm Road Crossing off of Wymans Falls Road Reach T8.01 43.2994 N 72.6076 W	**Active Restoration** Culvert Replacement and Channel Stabilization	A 2ft culvert under the farm road is a major constriction and leads to frequent overtopping and severe erosion at the edge of the field.	Recommend removing the culvert and constructing a stone lined tractor crossing with sufficient bankfull width.	Low	**High**	Reduce large inputs of sediment and nutrients during storm events	Low	VTANR ERP; Private Landowner

Table 5.7: Site-Level Project Identification for Lovers Lane Brook, Trebo Brook, and Whitmore Brook in the Town of Chester

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
WHB-2 Floodplain along Railroad near Wyman Falls Rd Reach T8.01 43.3000 N 72.6078 W	**Passive Restoration** Corridor Protection	The river corridor is highly active with multiple flood chutes and debris jams. Large volumes of sediment are stored within the reach. The pasture floodplain to the east is accessible but lacks woody vegetation.	Protect the stream corridor from future development and agricultural conversion; plant native woody vegetation within the floodplain buffer.	Moderate	Moderate	Protect an important section of channel and floodplain for floodwater and sediment attenuation.	Low	VTANR ERP; Private Landowner

5.2.6 Andover Branch, Potash Brook, and Trout Brook Site-level Project Opportunities

Table 5.8: Site-Level Project Identification for Andover Branch, Potash Brook, and Trout Brook in the Towns of Chester and Andover

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
AB-2a-b Multiple Locations Reach/ Segment: T5.S3.01, T5.S3.04.B	**Passive Restoration** Corridor Protection	Both of the large floodplain areas are undeveloped and were very important areas of sediment and floodwater attenuation during T.S. Irene and the 2014 flood. Large volumes of flood sediments working through the stream will continue to maintain access to these floodplains during small to moderate floods. The T5.S3.04.B floodplain has active beaver dams creating a braided channel through the densely vegetated floodplain forest.	Protect the stream corridor and floodplains from development	**High**	Moderate	Maintain two important floodplain areas along highly active sections of Andover Branch	Low	VTANR ERP; VLT; VRC; Private Landowners

Table 5.8: Site-Level Project Identification for Andover Branch, Potash Brook, and Trout Brook in the Towns of Chester and Andover

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
AB-3 Potash Brook Road Reach T5.S3.02 43.2714 N 72.6694 W	**Active Restoration** Culvert Replacement, Road Resiliency, Channel Stabilization	The channel upstream of Potash Brook Road is highly active and is splitting flow into a recently formed flood chute. The road was washed out during recent storms at the flood chute. The large culvert appears to have plugged with debris further increasing local flooding. Recently installed riprap in the center of the channel is increasing split flow, increasing risk to the road.	Replace the flood chute culvert with a much larger structure. Remove the channel armoring and install an over flow structure to direct low and moderate flows to the primary channel but allow larger storms to access the flood chute and associated floodplain area. An engineering study is currently in progress and a large secondary culvert will be installed in 2016/2017.	**High**	Moderate	Reduce the risk of the road washing out during the next large storm and provide access to the flood chute during large flows.	Moderate to High	Town of Chester; VTrans; FEMA
AB-5 Horseshoe Acres Campground Segment T5.S3.04.B 43.2832 N 72.7104 W	**Active Restoration** Berm Removal	A gravel spoils berm was constructed post-Irene to block access to a flood chute that formed along the eastern boundary of the campground property. The berm may have been rebuilt following 2014 flooding. The main stream channel is very narrow and may form a headcut or slowly continue to incise.	Remove the berm and restore flow to the flood chute during high flow periods. Bank stability should be assessed and likely improved along the flood chute to reduce erosion risk to the campground.	**High**	Low	Increase channel capacity for floodwater conveyance and reduce inundation risk for the lower portion of the campground.	Low to Moderate	Private Landowners; VTANR ERP
AB-6 Horseshoe Acres Campground Segment T5.S3.04.B 43.2838 N 72.7111 W	**Active Restoration** Berm Removal	A 350 ft long historic berm (likely 1970's vintage) is constructed on the left bank and completely blocks access to a 20-40ft wide floodplain between the channel and Weston Andover Road. Many large trees are growing on or very near the berm.	Remove portions of the berm to minimize tree disturbance and restore access to the floodplain area. Ensure that the road embankment is appropriately protected and install new armor as necessary.	**High**	Low	Restore access to an important floodplain area immediately downstream of a confluence of two high sediment load streams. Reduce flooding risk to the lower portion of the campground.	Moderate	Private Landowner; VTANR ERP; VTrans

Table 5.8: Site-Level Project Identification for Andover Branch, Potash Brook, and Trout Brook in the Towns of Chester and Andover

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
AB-8 Horseshoe Acres Campground Segment T5.S3.05.A 43.2884 N 72.7138 W	**Active Restoration** Berm Removal	Several small gravel berms were observed blocking flood chutes and side channels within a nice forested floodplain. No infrastructure is at risk within the floodplain.	Remove the berms and restore access to side channels and floodplain.	Moderate	Low	Increase floodplain access upstream of main campground area.	Low	Private Landowner; VTANR ERP
TRB-2 Horseshoe Acres Campground Reach T5.S3.b.01 43.2838 N 72.7155 W	**Active Restoration** Channel Restoration	A poured concrete stream ford is acting like an elevated grade control and has created a large AOP barrier. The structure is undermined and not safe for vehicles and is fenced off by the campground staff.	Remove the concrete structure and any associated culverts underneath. Install a boulder grade control step to reduce the risk of upstream incision.	Low	High	Restore AOP to Trout Brook	Low to Moderate	VTANR ERP; VTFWS; Private Landowners
PB-2 Potash Brook Road at Farrar Road Reach T5.S3.a.01 43.2844 N 72.6718 W	**Active Restoration** Culvert Replacement	The existing CMP culvert is badly deformed, rotted, and very undersized. Significant flooding damage to the road was observed during T.S. Irene and the 2014 floods. The culvert also has a significant outlet drop creating an AOP barrier.	Remove culvert and replace with a bridge designed to the curve width channel or greater given the high sediment and debris load. **Update: the culvert was replaced with a larger structure in 2016.**	**High**	**High**	Remove a major flood constriction and road flooding hazard, restore AOP	High	Town of Chester; VTrans; FEMA

5.2.7 Infrastructure and Utilities Resiliency Project Opportunities within the Williams River Watershed

Table 5.9: Site-Level Project Identification for Infrastructure and Utilities Resiliency in the Towns of Rockingham, Chester, Andover, and Ludlow.

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
LWR-5 Railroad Reach: M09 43.2285 N 72.5397 W	**Transportation Resiliency**	The channel takes a sharp bend to the east after cascading through a series of bedrock steps. A small floodplain with an active flood chute has formed along the right bank. Floodwaters entering this flood chute have undermined the very large riprap along the tall railroad embankment.	Replace railroad armor and key in the base of the embankment, likely excavating to bedrock. Preserve the small floodplain and flood chute area.	**High**	Low	Protect Green Mountain Railroad embankment from erosion and undermining during large storm events	Moderate	Green Mountain Railroad
LWR-7 Route 103 near Remington Rd Reach M11 43.2463 N 72.5712 W	**Infrastructure Resiliency**	The steep valley wall leading up to a house along Route 103 appears unstable. Large trees were recently cut and the slope may be at greater risk as the roots decompose. The slope is covered in dense growth of Japanese Knotweed.	Assess the slope stability during the fall or winter after vegetation has died back. Buffer plantings along the slope may be sufficient to reestablish deep rooting plants.	Moderate	Low	Stabilize slope that may threaten the house in the near future.	Low to High	Private Landowner
LWR-9 Chester Wastewater Treatment Plant Reach M11 43.2561 N 72.5764 W	**Relocate or Floodproof Structure**	The Chester WWTP is immediately adjacent to the Williams River and is in a confined valley between the railroad and Green Mountain Turnpike. T.S. Irene resulted in some inundation damage to the WWTP but overall damage was minor/moderate.	Assess options to relocate the WWTP. If this is not feasible then assess options to floodproof the existing plant by increasing floor elevations, installing waterproof barriers, elevating utilities, etc.	**High**	**High**	Reduce the risk of damage or service interruption during floods, reduce the risk of untreated sewage entering channel.	High to Very High	Town of Chester

Table 5.9: Site-Level Project Identification for Infrastructure and Utilities Resiliency in the Towns of Rockingham, Chester, Andover, and Ludlow.

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
UWR-5a-d Multiple Locations Route 103 and Smokeshire Road Reach: M14, M18, M21	**Road Resiliency**	Rip-rap is failing along the road embankment. A single line of trees at the lower M14 and the M21 sites are being undermined and if they fall the embankment will be highly vulnerable.	Assess stability of embankment and replace riprap where necessary. New armor should be keyed in to the channel bottom to prevent scour and undermining.	Moderate	Low	Protect roadways from erosion during moderate to large storm events.	Low to Moderate	VTrans, Town of Chester
UWR-7 Near Route 103 and Route 10 Intersection Reach M15 43.3249 N 72.6084 W	**Infrastructure Resiliency**	The channel is actively migrating and eroding the left bank immediately downstream of the railroad bridge. A large cobble bar formed as T.S. Irene sediments worked through the reach. The channel migration appears to be slowing but could rapidly advance in a large storm. Two houses and associated buildings may be at risk as erosion progresses.	Monitor the site bank stability and assess risk to the adjacent houses. Bank stabilization with riprap may be required to arrest channel migration and protect the houses.	Moderate	Low	Protect houses from damage as stream bank erodes.	Moderate	Town of Chester, VTrans, Private Landowners
UWR-9 Railroad Bridge near Newton Rd. Reach M17 43.3341 N 72.6146 W	**Railroad Resiliency**	Deep deposits of gravel have filled the channel through this section of the reach and have significantly reduced the capacity of the railroad bridge. The bridge is a high risk of total loss during a large event.	Assess options for sediment management or bridge retrofits to increase capacity for floodwater and sediment/debris conveyance. Channel dredging may provide short term relief, however the high upstream sediment load will quickly fill the channel back in. Reconfiguring the bridge is the best long term solution.	**High**	Low	Protect the railroad bridge from damage in large storm events.	Low to High	Green Mountain Railroad

Table 5.9: Site-Level Project Identification for Infrastructure and Utilities Resiliency in the Towns of Rockingham, Chester, Andover, and Ludlow.

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
UWR-13a-b Smokeshire Road Segments M20.B and M21	**Road Resiliency**	Two stretches of Smokeshire Road are very low relative to the bankfull elevation. The Chester road supervisor stated that these sections rarely flood but are frequently buried in large volumes of ice during spring melt.	Assess the road bed for stability and measures to erosion and sediment loading to channel. Raising road elevation would reduce flooding frequency but may increase ice jamming/damage risk downstream.	Low	Low	Protect road from flood/ice damage and reduce sediment inputs to channel.	Low to Moderate	Town of Chester
MBWR-2 Railroad Bridge Reach T5.01 43.2599 N 72.5811 W	**Railroad Resiliency and Bridge Replacement**	Major sediment accumulation under and near the railroad bridge has significantly reduced the capacity during floods. The railroad bed serves as a large levee across the floodplain which funnels water back to the bridge or directs flow to the south across the athletic fields. The area will continue to be highly depositional for a long time as flood sediments work through the river.	The only viable long term solution is to replace the bridge with a larger structure and increase channel width to provide greater capacity for floodwater and sediment during flood events. The rail bed should be evaluated for possible culverts or other flood overflow features that would increase floodplain connectivity.	**High**	Low	Reduce flooding risks at a known repeat problem area, improve sediment and debris transport through reach during storm events.	High	Green Mountain Railroad, Town of Chester
MBWR-3a-e Multiple Locations Reach: T5.02, T5.03, T5.04, T5.06	**Infrastructure Resiliency**	Failing rip-rap and unstable slopes were observed in many areas along the Middle Branch. The upstream site on T5.06 has an access road threatened by erosion, the other four sites are residential properties where houses are at risk damage due to bank erosion.	Assess options for stabilizing the eroding bank and protecting infrastructure. Sites with existing riprap may only require repairs, other sites may require installation of new bank stabilization features.	Moderate	Low	Protect infrastructure from erosion risk and potential complete loss during flood events. Reduce risk of sediment and debris entering the channel	Low to High	Private Landowners, Towns of Chester and Andover, FEMA

Table 5.9: Site-Level Project Identification for Infrastructure and Utilities Resiliency in the Towns of Rockingham, Chester, Andover, and Ludlow.

Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
SBWR-1 Route 103 Bridge Reach T5.S1.01 43.2570 N 72.5835 W	**Transportation Resiliency**	Moderate accumulation of sand and gravel under the Route 103 bridge has reduced the capacity and is increasing risk of damage to the structure and surrounding properties during flood events. Bridge clearance was measured as 6ft in August 2014.	This bridge should be monitored for sediment deposition and clearance, which may require semi-routine maintenance as there are still large volumes of flood related sediment working through the channel.	Moderate	Low	Reduce risk of flood damage to the bridge and to adjacent properties	Low	VTrans
SBWR-4a-e Multiple Locations Reach: T5.S1.03, T5.S1.04.B, T5.S1.08, T5.S1.09	**Transportation Resiliency**	Several areas with failing bank armor that is threatening Grafton Road and Popple Dungeon Road. High priority bank stabilization project on T5.S1.03 where the east embankment along Grafton Road (Route 35) is in very poor condition.	Stabilize eroding banks with stone armor keyed in to the channel bottom. Assess surface runoff issues that might exacerbate slope erosion from above. Route 35 repairs are scheduled for 2017.	**High**	Low	Protect transportation infrastructure from erosion damage.	Moderate	Town of Chester
AB-1a-c Multiple Locations Reach: T5.S3.01, T5.S3.03	**Infrastructure Resiliency**	Active bank erosion and failing bank armor are threatening a house and Route 11 along (T5.S3.01) and a quarry access road (T5.S3.01).	Remove the failing armor and install new placed rock armor sufficiently keyed in to channel bottom The T5.S3.01 site may require cutting the slope back to establish a stable grade.	Moderate	Low	Protect vulnerable infrastructure from erosion damage during flood events.	Moderate	Town of Chester; Private Landowners: VTrans
AB-4 Pettengill Rd Reach T5.S3.03 43.2787 N 72.6967 W	**Utilities Resiliency**	A utility pole located at the top of the valley wall is immediately threatened by an active mass failure. The mass failure advanced several feet during T.S. Irene and during the 2014 flood.	Move the utility pole to a stable location. It is not feasible to stabilize the mass failure, however buffer planting along the edge of the field may slow advancement.	Moderate	Low	Reduce risk of utility service interruption	Low to Moderate	Green Mountain Power

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Project ID, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
AB-7a - b & TRB-1 **Horseshoe Acres Campground** Segment T5.S3.05.A T5.S3.b.01	**Utilities Resiliency**	Three private bridges within the campground have exposed utility lines hanging below the bridge.	Secure the utility lines to the bottom of the bridge	Low	Low	Reduce risk of service interruption within campground.	Low	Private Landowner
PB-1 **Potash Brook Road** Reach T5.S3.a.01 43.2796 N 72.6708 W	**Infrastructure Resiliency**	The bank armor along the east bank downstream of the bridge has failed and the channel is pushing towards a house on the floodplain. The house is increasingly at risk of major flooding damage.	Remove failed armor and install a new stacked stone wall keyed in to the channel bottom and tied in to the upstream bridge opening.	Moderate	Moderate	Protect house from erosion damage, reduce sediment inputs to channel	Moderate	Town of Chester; Private Landowner; FEMA