CHAPTER 4 – IMPACTS AND MITIGATION

4.1 Introduction

This chapter evaluates the potential impacts on geology, soils and water resources from construction and operation of the Build Alternatives as well as the No Build Alternative. It also identifies the management and design practices that would be incorporated into the project to reduce the magnitude of the potential impacts. This chapter presents the potential impacts associated with each alternative; it does not compare the relative merits of the project alternatives.

Several issues related to soil and water impacts are addressed in separate technical reports. Potential impacts on agricultural soils are discussed in the Land Use Technical Report. Potential impacts on wetlands are discussed in the Biological Resources Technical Report. Potential impacts of hazardous waste on soil and water resources are discussed in the Hazardous Materials Technical Report. Finally, potential indirect and cumulative impacts on water quality as a result of growth are discussed in the Indirect Effects and Cumulative Impacts Technical Report.

4.1.1 Context and Key Issues

Geology

Potential impacts of roadway projects on geologic resources may occur as a result of changes to topographic landforms and the preclusion of future access to geologic resources. Unique landforms may be altered by blasting or earthwork that substantially alters the prevailing topography. Once paved and put into transportation use, geologic resources (for example, gravel, or coal) are no longer accessible for potential future extraction.

Soils

Absent proper controls during construction, water quality may be at risk of impact as a result of uncontrolled erosion and sediment transport. During construction, soil is exposed and disturbed by vegetation removal and earthwork. Highly erodible soils as designated by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) are sensitive to erosion because of their slope and texture. Additional soil erosion risks may occur when construction takes place on stream banks or within streams themselves.

Construction soil erosion can be controlled through the phasing of construction, the use of properly designed and implemented erosion prevention and sediment control practices, and maintenance of these practices until final stabilization is completed.

Groundwater

Absent appropriate stormwater treatment practices, groundwater quantity and quality may be impacted by roadway projects. Groundwater quantity may be reduced when the increased impervious surface area of the roadway reduces groundwater recharge. Without adequate stormwater treatment, contaminants from roadway runoff have the potential to migrate through the soil into groundwater. The susceptibility of groundwater to contamination depends on the permeability of the soil above it and the transmissivity of the aquifer. Impacts on groundwater resources may affect the suitability of groundwater as a drinking water supply source for public water supply systems or private wells. Typical roadway pollutants associated with the contamination of groundwater resources may include chloride, nutrients and metals. The contamination of groundwater may also impact the streams for which the groundwater provides the base flow. The Vermont Stormwater Management Manual contains stormwater treatment design standards intended, among other things, to protect groundwater quantity and quality.

Surface Water

Absent appropriate stormwater treatment practices, surface water resources may be impacted by the increased stormwater runoff that occurs as a result of increasing the area of impervious surfaces within a watershed. Roadway stormwater runoff may include sediments, nutrients, metals and deicing salt which can potentially reduce stream water quality and impact aquatic biota. Roadway stormwater runoff impacts on surface water can be reduced by stormwater treatment practices such as detention basins and grass lined swales. Stormwater treatment practices typically work by providing vegetative filtering, or by slowing runoff so that sediments, nutrients and metals have time to settle out before the water enters a receiving water. The Vermont Stormwater Management Manual contains stormwater treatment design standards intended to protect surface water quantity and quality.

Chloride from dissolved deicing salt cannot be removed by stormwater treatment practices.

Floodplains

Absent appropriate design of fill placement and the hydraulic capacity of structures (e.g., culverts and bridges), roadway construction in floodplains can potentially raise flood elevations.

4.1.2 Summary of Stormwater Best Management Practices

This section discusses the stormwater best management practices that are included in the design of the alternatives and the corresponding impact assessments. The best management practices include construction phase stormwater runoff and erosion control and post-construction or operational phase stormwater runoff treatment and control measures.

Construction Phase Stormwater Runoff and Erosion Control

Regardless of the build alternative selected, prior to any construction, an authorization under the National Pollutant Discharge Elimination System (NPDES) construction general permit (for work in unimpaired watersheds) or an individual NPDES permit (for work in impaired watersheds) must be obtained. VTrans would prepare an Erosion Prevention and Sediment Control Plan (EPSC), which would be approved by VANR DEC.

The EPSC plan would contain sufficient detail for the contractor to implement the appropriate erosion prevention strategies. The plan must include three parts; 1) a pre-construction plan of activities that should occur before construction begins (i.e. install silt fence), 2) a construction plan for erosion control during construction, such as phasing and temporary soil stabilization, and 3) a stabilization plan for permanent stabilization, such as the planting of vegetation (VANR DEC, 2006).

Specific erosion prevention practices will be selected and an EPSC plan created after the selection of the preferred alternative, but before construction occurs. It is anticipated that the proposed project would prevent erosion and control sedimentation by following the specifications contained in the *Vermont Standards and Specifications for Erosion Prevention and Sediment Control* (VANR DEC, 2006) among other measures to be specified in the EPSC irrespective of the alternative.

Post-Construction Phase Stormwater Runoff Control

The Vermont Stormwater Statute and stormwater rules establish the requirements for stormwater treatment. Under the rules for new development, the *2002 Vermont Stormwater Management Manual* establishes stormwater treatment and control standards for post-construction or operational phase stormwater management. The impact analysis anticipates that the new development areas within the Build Alternatives would be designed to be consistent with treatment and criteria standards contained in the 2002 *Vermont Stormwater Management Manual*, as shown in Table 4-1. For redevelopment areas, which consist of the modification of existing impervious surface, such as the modifications to VT 2A that would occur under the VT 2A and Hybrid Alternatives, a reduced set of standards and criteria apply. Specifically, the only applicable criterion from Table 4-1 is that twenty percent of the Water Quality volume must be provided. The specific stormwater treatment practices that would be provided under each Build Alternative are described and mapped in the *Preliminary Engineering Technical Report* (DEIS Appendix P).

Table 4-1
Vermont Stormwater Treatment Criteria and Standards

Criteria	Standard
Water Quality	Capture 90% of runoff from annual storm events, and remove 80% of the Total Suspended Solid loading and 40% of the Total Phosphorus Loading.
Channel Protection	12-24 hours of extended detention storage for the one-year, 24-hour rainfall event.
Groundwater Recharge	Maintain average annual predevelopment recharge rate.
Overbank Flood Protection	Post-development peak discharge rate shall not exceed the predevelopment peak discharge rate for the 10-year, 24-hour storm event.
Extreme Flood Protection	Post-development peak discharge rate shall not exceed the predevelopment peak discharge rate for the 100-year, 24-hour storm event.

Source: Vermont Stormwater Management Manual (VANR DEC, 2002).

4.1.3 VTrans Deicing Best Management Practices

The use of deicing salts for winter roadway maintenance is essential to providing safe roadways for the movement of goods and people throughout Vermont. The VTrans Smart Salting Program began in the winter of 1994-1995 to increase the efficiency of deicing salt application and reduce potential environmental impacts. As part of this program, infrared sensors attached to the vehicles of roadway maintenance supervisors were utilized to measure pavement temperature (USGS, 2005). The temperature of the pavement is a key variable in how much salt needs to be applied to melt ice—lower temperatures require more salt than higher temperatures. The Smart Salting Program also created a salt application chart to guide the use of deicing salts under various conditions of pavement temperature, snow and ice pack thickness (USGS, 2005).

In addition to the Smart Salting Program, VTrans is required to obtain a permit from VANR DEC on an annual basis to conduct deicing operations. VANR DEC typically requires adherence to VTrans's annual Operations Snow and Ice Control Plan. The VTrans Operations Snow and Ice Control Plan creates a priority system for the clearing of roadways after a storm. Roads are classified as blue (national highway system and Vermont truck routes), green (state roads that are not blue but have ADT over 3,000) and yellow (all other state roads). Blue and green routes should have bare pavement edge line to edge line as soon as practicable after a storm, while yellow routes should have 1/3 bare pavement in the center of the road as soon as practicable after a storm. Low salt and no salt zones are also delineated (USGS, 2005).

The VTrans Operations Snow and Ice Control Plan also requires that deicing salts only be used when temperatures are above twenty degrees; at less than twenty degrees, sand should be used. Finally, each district is required to report deicing salt usage on weekly basis to VTrans headquarters. VTrans is required to report deicing salt usage above 800 lbs per two lane miles to VANR DEC (VTrans, 2005).

VTrans is cooperating with ongoing USGS research to better understand the relationship between deicing salt usage and in-stream chloride concentrations.

4.2 No Build Alternative

Under the No Build Alternative, changes in soil and water resource conditions could occur as a result of increased impervious surface area from other development within or adjacent to the VT 2A and Circ A/B corridors. The future condition of soil and water resources depends on the effectiveness of current and future regulations, the amount of future growth and response of natural systems to change. Construction of improvements under the No Build Alternative would be accomplished in accordance with applicable regulations, (e.g. a construction general permit), as appropriate. Overall, it is anticipated that impacts to soil and water resources under the No Build Alternative would be minor.

Future development in the VT 2A corridor is expected to be concentrated in the Taft Corners area, including areas within the Muddy Brook and Allen Brook watersheds. Notable projects within the VT 2A corridor in Williston include the Pecor property on US 2 just off of VT 2A with the potential for 300 units; the adjacent Village Associates development with up to 110 units; and the Brandywine development with 49 units. Major projects in Essex Junction include Riverside in the Village on Park Street with up to 300 units; and Highland Village on Pearl Street with 77 condominium units.

Development to the east of the Circ A/B corridor is expected in the medium density residential zoning district south of Mountain View Road, and along US 2 as part of an expansion of the Village Zoning District west to the edge of the Circ A/B corridor (both within Allen Brook watershed). To the west of the Circ A/B corridor, north of Mountain View Road, the No Build Alternative includes the development of the Chittenden County Solid Waste District Regional Landfill (Winooski Direct watershed). Other specific known developments include the Coyote Run development to the east of the Circ A/B right-of-way and north of Metcalf Drive with 10 units, and the Goodrich/Barone property along US 2 with 14 units.

See the *Land Use Technical Report* (DEIS Appendix K) for more information on development expected in the VT 2A corridor under the No Build Alternative.

4.3 Geology

4.3.1 VT 2A Alternatives

<u>Alternative 2 – Four-Lane VT 2A with Signalized Intersection Improvements</u>

The impact of Alternative 2 on the existing topography of the VT 2A corridor would be minor because the Alternative 2 roadway vertical profile will be similar to the existing roadway profile.

Once land is paved and put into transportation use, the geologic resources it may contain are no longer accessible for future extraction. The Alternative 2 would encroach on areas identified as potential gravel sources within the VT 2A corridor. This impact is minor because the extraction of geologic resources would be incompatible with the existing residential character of land use within the VT 2A corridor, such as in the Village of Essex Junction.

Alternative 3 – Four-Lane VT 2A with Roundabouts

The impact of Alternative 3 on the existing topography of the VT 2A corridor would be minor because the Alternative 3 roadway vertical profile will be similar to the existing roadway profile.

Once land is paved and put into transportation use, the geologic resources it may contain are no longer accessible for future extraction. The Alternative 3 would encroach on areas identified as potential gravel sources within the VT 2A corridor. This impact is minor because the extraction of geologic resources would be incompatible with the existing residential character of land use within the VT 2A corridor, such as in the Village of Essex Junction.

Alternative 22 – Tapered Widening on VT 2A with Signalized and Roundabout Intersections

The impact of the VT 2A Alternatives on the existing topography of the VT 2A corridor would be minor because the Alternative 22 roadway vertical profile will be similar to the existing roadway profile.

Once land is paved and put into transportation use, the geologic resources it may contain are no longer accessible for future extraction. The Alternative 22 would encroach on areas identified as potential gravel sources within the VT 2A corridor. This impact is minor because the extraction of geologic resources would be incompatible with the existing residential character of land use within the VT 2A corridor in Williston. Alternative 22 would have no effect on geologic resources in Essex Junction.

4.3.2 Circ A/B Alternatives

Alternative 16a – Circ A/B Limited Access Highway (No Connection to US 2 and Trumpet Interchange at Redmond Road) with VT 2A Spot Improvements

Alternative 16a would require a large ledge cut (up to fifty feet deep) on the hill south of I-89 to construct a trumpet interchange.

Fill (up to forty feet deep) would be required between I-89 and US 2 in order to raise the Circ A/B roadway profile grade for the I-89 overpass. The Circ A/B roadway would meet the existing grade near US 2. Most of the roadway between US 2 and Mountain View Road would be just slightly above the existing grade in order to provide proper drainage. Fill would be required (up to thirty feet deep) to raise the Circ A/B roadway over Mountain View Road.

Once land is paved and put into transportation use, the geological resources it may contain are no longer accessible for future extraction. Alternative 16a would encroach on areas identified as potential gravel sources within the Circ A/B corridor, north of Mountain View Road and adjacent to the Winooski River. The impact is minor because the extraction of geologic resources would be incompatible with existing and planned land use and zoning in the Circ A/B corridor (e.g., Conservation and Open Space Overlay Zoning District along Redmond Creek and proposed Chittenden Solid Waste District regional landfill).

Alternative 16b – Circ A/B Limited Access Highway (Partial Cloverleaf Interchange at US 2 and Trumpet Interchange at Redmond Road) with VT 2A Spot Improvements

Alternative 16b would require a large ledge cut (up to fifty feet deep) on the hill south of I-89 to construct a trumpet interchange.

Fill (up to forty feet deep) would be required between I-89 and US 2 in order to raise the Circ A/B roadway profile grade for the I-89 overpass. The Circ A/B roadway would meet the existing grade near US 2. Most of the roadway between US 2 and Mountain View Road would be just slightly above the existing grade in order to provide proper drainage. Fill would be required (up to thirty feet deep) to raise the Circ A/B roadway over Mountain View Road.

Once land is paved and put into transportation use, the geological resources it may contain are no longer accessible for future extraction. Alternative 16b would encroach on areas identified as potential gravel sources within the Circ A/B corridor, north of Mountain View Road and adjacent to the Winooski River. The impact is minor because the extraction of geologic resources would be incompatible with existing and planned land use and zoning in the Circ A/B corridor (e.g., Conservation and Open Space Overlay Zoning District along Redmond Creek and proposed Chittenden Solid Waste District regional landfill).

Alternative 16c – Circ A/B Limited Access Highway (No Connection to US 2 and Diamond Interchange at Mountain View Road) with VT 2A Spot Improvements

Alternative 16c would require a large ledge cut (up to fifty feet deep) on the hill south of I-89 to construct a trumpet interchange.

Fill (up to forty feet deep) would be required between I-89 and US 2 in order to raise the Circ A/B roadway profile grade for the I-89 overpass. The Circ A/B roadway would meet the existing grade near US 2. Most of the roadway between US 2 and Mountain View Road would be just slightly above the existing grade in order to provide proper drainage. Fill would be required (up to thirty feet deep) to raise the Circ A/B roadway over Mountain View Road.

Once land is paved and put into transportation use, the geological resources it may contain are no longer accessible for future extraction. Alternative 16c would encroach on areas identified as potential gravel sources within the Circ A/B corridor, north of Mountain View Road and adjacent to the Winooski River. The impact is minor because the extraction of geologic resources would be incompatible with existing and planned land use and zoning in the Circ A/B corridor (e.g., Conservation and Open Space Overlay Zoning District along Redmond Creek and proposed Chittenden Solid Waste District regional landfill).

Alternative 17 – Circ A/B Boulevard with VT 2A Spot Improvements

Under Alternative 17, a ledge cut approximately 20 feet deep would be required on the hill south of I-89 to construct a diamond interchange with roundabouts.

Fill (up to forty feet deep) would be required between I-89 and US 2 in order to raise the Circ A/B roadway profile grade for the I-89 overpass. The Circ A/B roadway would meet the existing grade near US 2. Most of the roadway between US 2 and Mountain View Road would be just slightly above the existing grade in order to provide proper drainage.

Under Alternative 17, the Circ A/B roadway grade would be close to existing grade in the vicinity of Mountain View Road in order to meet the existing Mountain View Road profile and provide a signalized intersection.

Once land is paved and put into transportation use, the geological resources it may contain are no longer accessible for future extraction. Alternative 17 would encroach on areas identified as potential gravel sources within the Circ A/B corridor, north of Mountain View Road and adjacent to the Winooski River. The impact is minor because the extraction of geologic resources would be incompatible with existing and planned land use and zoning in the Circ A/B corridor (e.g., Conservation and Open Space Overlay Zoning District along Redmond Creek and proposed Chittenden Solid Waste District regional landfill).

4.3.3 Hybrid Alternatives

Alternative 18 – Four-Lane VT 2A with Signalized Intersection Improvements Plus Circ Street

The impact of Alternative 18 on the existing topography of the VT 2A corridor would be minor because the roadway vertical profile would be similar to the existing roadway profile.

In the Circ A/B corridor, a ledge cut approximately 20 feet deep would be required on the hill south of I-89 to construct a diamond interchange with roundabouts.

Fill (up to forty feet deep) would be required between I-89 and US 2 in order to raise the Circ Street profile grade for the I-89 overpass. The Circ Street would meet the existing grade near US 2. Most of the roadway between US 2 and Mountain View Road would be just slightly above the existing grade in order to provide proper drainage. The Circ Street would terminate at Mountain View Road.

Once land is paved and put into transportation use, the geologic resources it may contain are no longer accessible for future extraction. Alternative 18 would encroach on areas identified as potential gravel sources within the VT 2A corridor. This impact is minor because the extraction of geologic resources would be incompatible with the existing residential character of land use within the VT 2A corridor. No areas of potential gravel resources would be encroached upon by the construction of the Circ Street.

Alternative 19 – Four-Lane VT 2A with Roundabouts Plus Circ Street

The impact of Alternative 19 on the existing topography of the VT 2A corridor would be minor because the roadway vertical profile would be similar to the existing roadway profile.

In the Circ A/B corridor, a ledge cut approximately 20 feet deep would be required on the hill south of I-89 to construct a diamond interchange with roundabouts.

Fill (up to forty feet deep) would be required between I-89 and US 2 in order to raise the Circ Street profile grade for the I-89 overpass. The Circ Street would meet the existing grade near US 2. Most of the roadway between US 2 and Mountain View Road would be just slightly above the existing grade in order to provide proper drainage. The Circ Street would terminate at Mountain View Road.

Once land is paved and put into transportation use, the geologic resources it may contain are no longer accessible for future extraction. Alternative 19 would encroach on areas identified as potential gravel sources within the VT 2A corridor. This impact is minor because the extraction of geologic resources would be incompatible with the existing residential character of land use within the VT 2A corridor. No areas of potential gravel resources would be encroached upon by the construction of the Circ Street.

Alternative 23 – Tapered Widening on VT 2A with Signalized and Roundabout Intersections Plus Circ Street

The impact of Alternative 23 on the existing topography of the VT 2A corridor would be minor because the roadway vertical profile would be similar to the existing roadway profile.

In the Circ A/B corridor, a ledge cut approximately 20 feet deep would be required on the hill south of I-89 to construct a diamond interchange with roundabouts.

Fill (up to forty feet deep) would be required between I-89 and US 2 in order to raise the Circ Street profile grade for the I-89 overpass. The Circ Street would meet the existing grade near US 2. Most of the roadway between US 2 and Mountain View Road would be just slightly above the existing grade in order to provide proper drainage. The Circ Street would terminate at Mountain View Road.

Once land is paved and put into transportation use, the geologic resources it may contain are no longer accessible for future extraction. Alternative 23 would encroach on areas identified as potential gravel sources within the VT 2A corridor. This impact is minor because the extraction of geologic resources would be incompatible with the existing residential character of land use within the VT 2A corridor. No areas of potential gravel resources would be encroached upon by the construction of the Circ Street.

4.4 Soils

4.4.1 VT 2A Alternatives

Alternative 2 – Four-Lane VT 2A with Signalized Intersection Improvements

Alternative 2 permanent and temporary soil encroachment by Hydrologic Soil Group (HSG) is shown in Table 4-2. The HSGs are defined in Section 2.2.2. The largest single HSG affected is group D, soils with very slow infiltration rates and high runoff potential.

Table 4-2
Alternative 2 Hydrologic Soil Group Encroachment

HSG	Soil Infiltration Rate	Permanent (acres)	Temporary (acres)	Total
A	High	18.0	6.8	24.9
B	Moderate	13.3	4.7	18.0
C	Slow	3.1	1.6	4.7
D	Very Slow	23.8	7.9	31.7

As shown in Table 4-3, Alternative 2 would disturb a total of 79.1 acres of soil over the duration of construction. Of this amount, 5.3 acres are classified as highly erodible soils. Based on slope and soil K factors, 12.4 acres of soils that would be disturbed by the VT 2A Alternatives are in areas classified as “high risk” for potential soil erosion. High erosion risk areas along VT 2A are located at the crossing of the Unnamed Tributary of Muddy Brook, Allen Brook and the Winooski River. Additional measures to prevent disturbance and control erosion may be appropriate in these areas, such as double-rowed silt fencing. The relocation of Allen Brook on the east (upstream) side of VT 2A as part of the reconstruction of VT 2A creates a high potential for erosion. Erosion and sediment transport as a result of relocating Allen Brook can be minimized by the use of best management practices for in-stream construction such as flow diversion, cofferdams or turbidity curtains.

Table 4-3
Alternative 2 Construction Soil Disturbance*

<table>
<tr><th colspan="2"></th><th>Acres</th></tr>
<tr><td colspan="2">Total area of soil disturbance</td><td>79.1</td></tr>
<tr><td colspan="2">Highly erodible soils (NRCS)</td><td>5.3</td></tr>
<tr><td rowspan="3">Soil Erosion Risk (VANR DEC)†</td><td>Low</td><td>38.4</td></tr>
<tr><td>Medium</td><td>28.4</td></tr>
<tr><td>High</td><td>12.4</td></tr>
</table>

* Calculated using the construction slope line limits plus a 20 foot buffer. Due to construction phasing, the total areas shown would not be disturbed at one time.
† Calculated based on slope and surface soil K factors, using Table 3.2 in the Vermont Standards and Specifications for Erosion Prevention and Sediment Control.

Alternative 3 – Four-Lane VT 2A with Roundabouts

Alternative 3 permanent and temporary soil encroachment by Hydrologic Soil Group (HSG) is shown in Table 4-4. The HSGs are defined in Section 2.2.2. The largest single HSG affected is group D, soils with very slow infiltration rates and high runoff potential.

Table 4-4
Alternative 3 Hydrologic Soil Group Encroachment

HSG	Soil Infiltration Rate	Permanent (acres)	Temporary (acres)	Total
A	High	17.4	6.9	24.3
B	Moderate	11.4	4.6	16.1
C	Slow	2.6	1.3	3.9
D	Very Slow	23.1	7.5	30.7

As shown in Table 4-5, Alternative 3 would disturb a total of 74.9 acres of soil over the duration of construction. Of this amount, 4.8 acres are classified as highly erodible soils. Based on slope and soil K factors, 11.4 acres of soils that would be disturbed by Alternative 3 are in areas classified as “high risk” for potential soil erosion. High erosion risk areas along VT 2A are located at the crossing of the Unnamed Tributary of Muddy Brook, Allen Brook and the Winooski River. Additional measures to prevent disturbance and control erosion may be appropriate in these areas, such as double-rowed silt fencing. The relocation of Allen Brook on the east (upstream) side of VT 2A as part of the reconstruction of VT 2A creates a high potential for erosion. Erosion and sediment transport as a result of relocating Allen Brook can be minimized by the use of best management practices for in-stream construction such as flow diversion, cofferdams or turbidity curtains.

Table 4-5
Alternative 3 Construction Soil Disturbance*

		Acres
Total area of soil disturbance		74.9
Highly erodible soils (NRCS)		4.8
Soil Erosion Risk (VANR DEC)†	Low	37.6
	Medium	25.9
	High	11.4

* Calculated using the construction slope line limits plus a 20 foot buffer. Due to construction phasing, the total areas shown would not be disturbed at one time.
† Calculated based on slope and surface soil K factors, using Table 3.2 in the Vermont Standards and Specifications for Erosion Prevention and Sediment Control.

Alternative 22 – Tapered Widening on VT 2A with Signalized and Roundabout Intersections

Alternative 22 permanent and temporary soil encroachment by Hydrologic Soil Group (HSG) is shown in Table 4-6. The HSGs are defined in Section 2.2.2. The largest single HSG affected is group D, soils with very slow infiltration rates and high runoff potential.

Table 4-6
Alternative 22 Hydrologic Soil Group Encroachment

HSG	Soil Infiltration Rate	Permanent (acres)	Temporary (acres)	Total
A	High	14.8	7.2	22.0
B	Moderate	11.6	4.6	16.2
C	Slow	2.6	1.4	4.0
D	Very Slow	24.4	7.3	31.8

As shown in Table 4-7, Alternative 22 would disturb a total of 74.0 acres of soil over the duration of construction. Of this amount, 5.0 acres are classified as highly erodible soils. Based on slope and soil K factors, 11.9 acres of soils that would be disturbed by Alternative 22 are in areas classified as "high risk" for potential soil erosion. High erosion risk areas along VT 2A are located at the crossing of the Unnamed Tributary of Muddy Brook, Allen Brook and the Winooski River. Additional measures to prevent disturbance and control erosion may be appropriate in these areas, such as double-rowed silt fencing. The relocation of Allen Brook on the east (upstream) side of VT 2A as part of the reconstruction of VT 2A creates a high potential for erosion. Erosion and sediment transport as a result of relocating Allen Brook can be minimized by the use of best management practices for in-stream construction such as flow diversion, cofferdams or turbidity curtains.

Table 4-7
Alternative 22 Construction Soil Disturbance*

		Acres
Total area of soil disturbance		74.0
Highly erodible soils (NRCS)		5.0
Soil Erosion Risk (VANR DEC)†	Low	35.0
	Medium	27.1
	High	11.9

* Calculated using the construction slope line limits plus a 20 foot buffer. Due to construction phasing, the total areas shown would not be disturbed at one time.
† Calculated based on slope and surface soil K factors, using Table 3.2 in the Vermont Standards and Specifications for Erosion Prevention and Sediment Control.

4.4.2 Circ A/B Alternatives

Alternative 16a – Circ A/B Limited Access Highway (No Connection to US 2 and Trumpet Interchange at Redmond Road) with VT 2A Spot Improvements

Alternative 16a permanent and temporary soil encroachment by Hydrologic Soil Group (HSG) is shown in Table 4-8. The HSGs are defined in Section 2.2.2. The largest single HSG affected is group D, soils with very slow infiltration rates and high runoff potential.

Table 4-8
Alternative 16a Hydrologic Soil Group Encroachment

HSG	Soil Infiltration Rate	Permanent (acres)	Temporary (acres)	Total
A	High	21.7	3.0	24.8
B	Moderate	18.1	5.3	23.3
C	Slow	51.2	7.9	59.1
D	Very Slow	73.8	16.0	89.8

As shown in Table 4-9, Alternative 16a would disturb a total of 197.0 acres of soil over the duration of construction. Of this amount, 11.7 acres are classified as highly erodible soils would be disturbed. Based on slope and soil K factors, 36.3 acres of soils that would be disturbed are in areas classified as “high risk” for potential soil erosion. High erosion risk areas along the Circ A/B alignment are located on the hillside south of I-89, to the south and north of Allen Brook and at the Winooski River. Additional measures to prevent disturbance and control erosion may be appropriate in these areas, such as double-rowed silt fencing.

Table 4-9
Alternative 16a Construction Soil Disturbance*

		Acres
Total area of soil disturbance		197.0
Highly erodible soils (NRCS)		11.7
Soil Erosion Risk (VANR DEC)†	High	54.6
	Medium	106.2
	Low	36.3

* Calculated using the construction slope line limits plus a 20 foot buffer. Due to construction phasing, the total areas shown would not be disturbed at one time.
† Calculated based on slope and surface soil K factors, using Table 3.2 in the Vermont Standards and Specifications for Erosion Prevention and Sediment Control.

Alternative 16b – Circ A/B Limited Access Highway (Partial Cloverleaf Interchange at US 2 and Trumpet Interchange at Redmond Road) with VT 2A Spot Improvements

Alternative 16b permanent and temporary soil encroachment by Hydrologic Soil Group (HSG) is shown in Table 4-10. The HSGs are defined in Section 2.2.2. The largest single HSG affected is group D, soils with very slow infiltration rates and high runoff potential.

Table 4-10
Alternative 16b Hydrologic Soil Group Encroachment

HSG	Soil Infiltration Rate	Permanent (acres)	Temporary (acres)	Total
A	High	21.7	3.0	24.8
B	Moderate	18.1	5.3	23.3
C	Slow	51.2	7.9	59.1
D	Very Slow	94.3	15.6	109.9

As shown in Table 4-11, Alternative 16b would disturb a total of 217.1 acres of soil over the duration of construction. Of this amount, 14.0 acres are classified as highly erodible soils. Based on slope and soil K factors, 43.3 acres of soils that would be disturbed are in areas classified as "high risk" for potential soil erosion. High erosion risk areas along the Circ A/B alignment are located on the hillside south of I-89, to the south and north of Allen Brook and at the Winooski River. Additional measures to prevent disturbance and control erosion may be appropriate in these areas, such as double-rowed silt fencing.

Table 4-11
Alternative 16b Construction Soil Disturbance*

		Acres
Total area of soil disturbance		217.1
Highly erodible soils (NRCS)		14.0
Soil Erosion Risk (VANR DEC)†	Low	61.0
	Medium	112.9
	High	43.3

* Calculated using the construction slope line limits plus a 20 foot buffer. Due to construction phasing, the total areas shown would not be disturbed at one time.
† Calculated based on slope and surface soil K factors, using Table 3.2 in the Vermont Standards and Specifications for Erosion Prevention and Sediment Control.

Alternative 16c – Circ A/B Limited Access Highway (No Connection to US 2 and Diamond Interchange at Mountain View Road) with VT 2A Spot Improvements

Alternative 16c permanent and temporary soil encroachment by Hydrologic Soil Group (HSG) is shown in Table 4-12. The HSGs are defined in Section 2.2.2. The largest single HSG affected is group D, soils with very slow infiltration rates and high runoff potential.

Table 4-12
Alternative 16c Hydrologic Soil Group Encroachment

HSG	Soil Infiltration Rate	Permanent (acres)	Temporary (acres)	Total
A	High	22.3	3.4	25.7
B	Moderate	17.3	5.3	22.5
C	Slow	35.3	7.9	43.2
D	Very Slow	73.1	15.6	88.7

As shown in Table 4-13, Alternative 16c would disturb a total of 180.1 acres of soil over the duration of construction. Of this amount, 11.7 acres are classified as highly erodible soils. Based on slope and soil K factors, 36.1 acres of soils that would be disturbed are in areas classified as “high risk” for potential soil erosion. High erosion risk areas along the Circ A/B alignment are located on the hillside south of I-89, to the south and north of Allen Brook and at the Winooski River. Additional measures to prevent disturbance and control erosion may be appropriate in these areas, such as double-rowed silt fencing.

Table 4-13
Alternative 16c Construction Soil Disturbance*

		Acres
Total area of soil disturbance		180.1
Highly erodible soils (NRCS)		11.7
Soil Erosion Risk (VANR DEC)†	Low	54.4
	Medium	89.7
	High	36.1

* Calculated using the construction slope line limits plus a 20 foot buffer. Due to construction phasing, the total areas shown would not be disturbed at one time.
† Calculated based on slope and surface soil K factors, using Table 3.2 in the Vermont Standards and Specifications for Erosion Prevention and Sediment Control.

Alternative 17 – Circ A/B Boulevard with VT 2A Spot Improvements

Alternative 17 permanent and temporary soil encroachment by Hydrologic Soil Group (HSG) is shown in Table 4-14. The HSGs are defined in Section 2.2.2. The largest single HSG affected is group D, soils with very slow infiltration rates and high runoff potential.

Table 4-14
Alternative 17 Hydrologic Soil Group Encroachment

HSG	Soil Infiltration Rate	Permanent (acres)	Temporary (acres)	Total
A	High	17.4	3.4	20.8
B	Moderate	16.1	4.8	20.9
C	Slow	30.5	7.6	38.1
D	Very Slow	61.7	15.2	76.9

As shown in Table 4-15, Alternative 17 would disturb a total of 156.7 acres of soil over the duration of construction. Of this amount, 11.5 acres are classified as highly erodible soils. Based on slope and soil K factors, 31.6 acres of soils that would be disturbed are in areas classified as "high risk" for potential soil erosion. High erosion risk areas along the Circ A/B alignment are located on the hillside south of I-89, to the south and north of Allen Brook and at the Winooski River. Additional measures to prevent disturbance and control erosion may be appropriate in these areas, such as double-rowed silt fencing.

Table 4-15
Alternative 17 Construction Soil Disturbance*

		Acres
Total area of soil disturbance		156.7
Highly erodible soils (NRCS)		11.5
Soil Erosion Risk (VANR DEC)†	Low	45.8
	Medium	79.3
	High	31.6

* Calculated using the construction slope line limits plus a 20 foot buffer. Due to construction phasing, the total areas shown would not be disturbed at one time.
† Calculated based on slope and surface soil K factors, using Table 3.2 in the Vermont Standards and Specifications for Erosion Prevention and Sediment Control.

4.4.3 Hybrid Alternatives

Alternative 18 – Four-Lane VT 2A with Signalized Intersection Improvements Plus Circ Street

Alternative 18 permanent and temporary soil encroachment by Hydrologic Soil Group (HSG) is shown in Table 4-16. The HSGs are defined in Section 2.2.2. The largest single HSG affected is group D, soils with very slow infiltration rates and high runoff potential.

Table 4-16
Alternative 18 Hydrologic Soil Group Encroachment

HSG	Soil Infiltration Rate	Permanent (acres)	Temporary (acres)	Total
A	High	19.4	7.4	26.8
B	Moderate	14.7	5.2	19.8
C	Slow	18.6	5.8	24.4
D	Very Slow	78.1	22.1	100.3

As shown in Table 4-17, Alternative 18 would disturb a total of 171.3 acres of soil over the duration of construction. Of this amount, 6.9 acres are classified as highly erodible soils. Based on slope and soil K factors, 35.7 acres of soils that would be are in areas classified as "high risk" for potential soil erosion. High erosion risk areas along the Circ Street alignment are located on the hillside south of I-89, and to the south and north of Allen Brook. Additional measures to prevent disturbance and control erosion may be appropriate in these areas, such as double-rowed silt fencing. The relocation of Allen Brook on the east (upstream) side of VT 2A as part of the reconstruction of VT 2A creates a high potential for erosion. Erosion and sediment transport as a result of relocating Allen Brook can be minimized by the use of best management practices for in-stream construction such as flow diversion, cofferdams or turbidity curtains.

Table 4-17
Alternative 18 Construction Soil Disturbance*

		Acres
Total area of soil disturbance		171.3
Highly erodible soils (NRCS)		6.9
Soil Erosion Risk (VANR DEC)†	Low	63.8
	Medium	71.8
	High	35.7

* Calculated using the construction slope line limits plus a 20 foot buffer. Due to construction phasing, the total areas shown would not be disturbed at one time.
† Calculated based on slope and surface soil K factors, using Table 3.2 in the Vermont Standards and Specifications for Erosion Prevention and Sediment Control.

Alternative 19 – Four-Lane VT 2A with Roundabouts Plus Circ Street

Alternative 19 permanent and temporary soil encroachment by Hydrologic Soil Group (HSG) is shown in Table 4-18. The HSGs are defined in Section 2.2.2. The largest single HSG affected is group D, soils with very slow infiltration rates and high runoff potential.

Table 4-18
Alternative 19 Hydrologic Soil Group Encroachment

HSG	Soil Infiltration Rate	Permanent (acres)	Temporary (acres)	Total
A	High	18.8	7.5	26.3
B	Moderate	12.8	5.1	17.9
C	Slow	18.1	5.5	23.6
D	Very Slow	77.5	21.8	99.3

As shown in Table 4-19, Alternative 19 would disturb a total of 167.0 acres of soil over the duration of construction. Of this amount, 6.4 acres are classified as highly erodible soils. Based on slope and soil K factors, 34.7 acres of soils that would be are in areas classified as “high risk” for potential soil erosion. High erosion risk areas along the Circ Street alignment are located on the hillside south of I-89, and to the south and north of Allen Brook. Additional measures to prevent disturbance and control erosion may be appropriate in these areas, such as double-rowed silt fencing. The relocation of Allen Brook on the east (upstream) side of VT 2A as part of the reconstruction of VT 2A creates a high potential for erosion. Erosion and sediment transport as a result of relocating Allen Brook can be minimized by the use of best management practices for in-stream construction such as flow diversion, cofferdams or turbidity curtains.

Table 4-19
Alternative 19 Construction Soil Disturbance*

		Acres
Total area of soil disturbance		167.0
Highly erodible soils (NRCS)		6.4
Soil Erosion Risk (VANR DEC)†	Low	63.0
	Medium	69.3
	High	34.7

* Calculated using the construction slope line limits plus a 20 foot buffer. Due to construction phasing, the total areas shown would not be disturbed at one time.
† Calculated based on slope and surface soil K factors, using Table 3.2 in the Vermont Standards and Specifications for Erosion Prevention and Sediment Control.

Alternative 23 – Tapered Widening on VT 2A with Signalized and Roundabout Intersections Plus Circ Street

Alternative 23 permanent and temporary soil encroachment by Hydrologic Soil Group (HSG) is shown in Table 4-20. The HSGs are defined in Section 2.2.2. The largest single HSG affected is group D, soils with very slow infiltration rates and high runoff potential.

Table 4-20
Alternative 23 Hydrologic Soil Group Encroachment

HSG	Soil Infiltration Rate	Permanent (acres)	Temporary (acres)	Total
A	High	16.2	7.8	24.0
B	Moderate	13.0	5.1	18.1
C	Slow	18.1	5.6	23.7
D	Very Slow	78.8	21.6	100.4

As shown in Table 4-21, Alternative 23 would disturb a total of 166.1 acres of soil over the duration of construction. Of this amount, 6.5 acres are classified as highly erodible soils. Based on slope and soil K factors, 35.2 acres of soils that would be disturbed are in areas classified as “high risk” for potential soil erosion. High erosion risk areas along the Circ Street alignment are located on the hillside south of I-89, and to the south and north of Allen Brook. Additional measures to prevent disturbance and control erosion may be appropriate in these areas, such as double-rowed silt fencing. The relocation of Allen Brook on the east (upstream) side of VT 2A as part of the reconstruction of VT 2A creates a high potential for erosion. Erosion and sediment transport as a result of relocating Allen Brook can be minimized by the use of best management practices for in-stream construction such as flow diversion, cofferdams or turbidity curtains.

Table 4-21
Alternative 23 Construction Soil Disturbance*

		Acres
Total area of soil disturbance		166.1
Highly erodible soils (NRCS)		6.5
Soil Erosion Risk (VANR DEC)†	Low	60.4
	Medium	70.5
	High	35.2

* Calculated using the construction slope line limits plus a 20 foot buffer. Due to construction phasing, the total areas shown would not be disturbed at one time.
† Calculated based on slope and surface soil K factors, using Table 3.2 in the Vermont Standards and Specifications for Erosion Prevention and Sediment Control.

4.5 Groundwater

4.5.1 VT 2A Alternatives

Alternative 2 – Four-Lane VT 2A with Signalized Intersection Improvements

Nutrient and metal pollutants are removed by stormwater treatment practices and are attenuated by soil. However, chloride from deicing salt cannot be removed by stormwater treatment practices or soil attenuation because it tends to remain dissolved in water (Thunqvist, 2004). If all the deicing salt applied under Alternative 2 reached groundwater, then the additional average annual deicing salt loading to groundwater would be 79.6 tons.

The majority of homes and businesses in the area of VT 2A are supplied by the Champlain Water District, thereby precluding impacts to public drinking water supplies, even if contamination of groundwater occurred. Approximately 11 private wells are within 500 feet of the section of VT 2A that would be altered by Alternative 2. The existing chloride concentration in these private wells is unknown. The national secondary drinking-water standard for chloride is 250 mg/l. Based on the low (10-30 mg/) measured chloride concentrations in groundwater in wells at the Williston Fire Department and the I-89 southbound rest stop, the relatively small additional chloride loading from Alternative 2 would not be expected to endanger the quality of the groundwater utilized by private wells or the overall quality of groundwater as an environmental resource. The predominance of Hydrologic Soil Group D (very slow infiltration rate) soils in the VT 2A and Circ A/B corridors further reduces the likelihood of groundwater resources being affected.

Alternative 3 – Four-Lane VT 2A with Roundabouts

Nutrient and metal pollutants are removed by stormwater treatment practices and are attenuated by soil. However, chloride from deicing salt cannot be removed by stormwater treatment practices or soil attenuation because it tends to remain dissolved in water (Thunqvist, 2004). If all the deicing salt applied under Alternative 3 reached groundwater, then the additional average annual deicing salt loading to groundwater would be 58.1 tons.

The majority of homes and businesses in the area of VT 2A are supplied by the Champlain Water District, thereby precluding impacts to public drinking water supplies, even if contamination of groundwater occurred. Approximately 11 private wells are within 500 feet of the section of VT 2A that would be altered by Alternative 3. The existing chloride concentration in these private wells is unknown. The national secondary drinking-water standard for chloride is 250 mg/l. Based on the low (10-30 mg/) measured chloride concentrations in groundwater in wells at the Williston Fire Department and the I-89 southbound rest stop, the relatively small additional chloride loading from Alternative 3 would not be expected to endanger the quality of the groundwater utilized by private wells or the overall quality of groundwater as an environmental resource. The predominance of Hydrologic Soil Group D (very slow infiltration rate) soils in the VT 2A and Circ A/B corridors further reduces the likelihood of groundwater resources being affected.

Alternative 22 – Tapered Widening on VT 2A with Signalized and Roundabout Intersections

Nutrient and metal pollutants are removed by stormwater treatment practices and are attenuated by soil. However, chloride from deicing salt cannot be removed by stormwater treatment practices or soil attenuation because it tends to remain dissolved in water (Thunqvist, 2004). If all the deicing salt applied under Alternative 22 reached groundwater, then the additional average annual deicing salt loading to groundwater would be 37.0 tons.

The majority of homes and businesses in the area of VT 2A are supplied by the Champlain Water District, thereby precluding impacts to public drinking water supplies, even if contamination of groundwater occurred. Approximately 11 private wells are within 500 feet of the section of VT 2A that would be altered by Alternative 22. The existing chloride concentration in these private wells is unknown. The national secondary drinking-water standard for chloride is 250 mg/l. Based on the low (10-30 mg/) measured chloride concentrations in groundwater in wells at the Williston Fire Department and the I-89 southbound rest stop, the relatively small additional chloride loading from Alternative 22 would not be expected to endanger the quality of the groundwater utilized by private wells or the overall quality of groundwater as an environmental resource. The predominance of Hydrologic Soil Group D (very slow infiltration rate) soils in the VT 2A and Circ A/B corridors further reduces the likelihood of groundwater resources being affected.

4.5.2 Circ A/B Alternatives

Alternative 16a – Circ A/B Limited Access Highway (No Connection to US 2 and Trumpet Interchange at Redmond Road) with VT 2A Spot Improvements

Nutrient and metal pollutants are removed by stormwater treatment practices and are attenuated by soil. However, chloride from deicing salt cannot be removed by stormwater treatment practices or soil attenuation because it tends to remain dissolved in water (Thunqvist, 2004). If all the deicing salt applied under Alternative 16a reached groundwater, then the additional average annual deicing salt loading to groundwater would be 278.9 tons.

The majority of homes and businesses in the area of Circ A/B corridor are supplied by the Champlain Water District, thereby precluding impacts to public drinking water supplies, even if contamination of groundwater occurred. Approximately 9 private wells are within 500 feet of the roadway that would be constructed under Alternative 16a. The existing chloride concentration in these private wells is unknown. The national secondary drinking-water standard for chloride is 250 mg/l. However, based on the low (10-30 mg/) measured chloride concentrations in groundwater in wells at the Williston Fire Department and the I-89 southbound rest stop, the relatively small additional chloride loading from Alternative 16a would not be expected to endanger the quality of the groundwater utilized by private wells or the overall quality of groundwater as an environmental resource. The predominance of Hydrologic Soil Group D (very slow infiltration rate) soils in the VT 2A and Circ A/B corridors further reduces the likelihood of groundwater resources being affected.

Alternative 16b – Circ A/B Limited Access Highway (Partial Cloverleaf Interchange at US 2 and Trumpet Interchange at Redmond Road) with VT 2A Spot Improvements

Nutrient and metal pollutants are removed by stormwater treatment practices and are attenuated by soil. However, chloride from deicing salt cannot be removed by stormwater treatment practices or soil attenuation because it tends to remain dissolved in water (Thunqvist, 2004). If all the deicing salt applied under Alternative 16b reached groundwater, then the additional average annual deicing salt loading to groundwater would be 304.9 tons.

The majority of homes and businesses in the area of Circ A/B corridor are supplied by the Champlain Water District, thereby precluding impacts to public drinking water supplies, even if contamination of groundwater occurred. Approximately 9 private wells are within 500 feet of the roadway that would be constructed under Alternative 16b. The existing chloride concentration in these private wells is unknown. The national secondary drinking-water standard for chloride is 250 mg/l. However, based on the low (10-30 mg/) measured chloride concentrations in groundwater in wells at the Williston Fire Department and the I-89 southbound rest stop, the relatively small additional chloride loading from Alternative 16b would not be expected to endanger the quality of the groundwater utilized by private wells or the overall quality of groundwater as an environmental resource. The predominance of Hydrologic Soil Group D (very slow infiltration rate) soils in the VT 2A and Circ A/B corridors further reduces the likelihood of groundwater resources being affected.

Alternative 16c – Circ A/B Limited Access Highway (No Connection to US 2 and Diamond Interchange at Mountain View Road) with VT 2A Spot Improvements

Nutrient and metal pollutants are removed by stormwater treatment practices and are attenuated by soil. However, chloride from deicing salt cannot be removed by stormwater treatment practices or soil attenuation because it tends to remain dissolved in water (Thunqvist, 2004). If all the deicing salt applied under Alternative 16c reached groundwater, then the additional average annual deicing salt loading to groundwater would be 265.8 tons.

The majority of homes and businesses in the area of Circ A/B corridor are supplied by the Champlain Water District, thereby precluding impacts to public drinking water supplies, even if contamination of groundwater occurred. Approximately 9 private wells are within 500 feet of the roadway that would be constructed under Alternative 16c. The existing chloride concentration in these private wells is unknown. The national secondary drinking-water standard for chloride is 250 mg/l. However, based on the low (10-30 mg/) measured chloride concentrations in groundwater in wells at the Williston Fire Department and the I-89 southbound rest stop, the relatively small additional chloride loading from Alternative 16c would not be expected to endanger the quality of the groundwater utilized by private wells or the overall quality of groundwater as an environmental resource. The predominance of Hydrologic Soil Group D (very slow infiltration rate) soils in the VT 2A and Circ A/B corridors further reduces the likelihood of groundwater resources being affected.

Alternative 17 – Circ A/B Boulevard with VT 2A Spot Improvements

Nutrient and metal pollutants are removed by stormwater treatment practices and are attenuated by soil. However, chloride from deicing salt cannot be removed by stormwater treatment practices or soil attenuation because it tends to remain dissolved in water (Thunqvist, 2004). If all the deicing salt applied under Alternative 17 reached groundwater, then the additional average annual deicing salt loading to groundwater would be 234.7 tons.

The majority of homes and businesses in the area of Circ A/B corridor are supplied by the Champlain Water District, thereby precluding impacts to public drinking water supplies, even if contamination of groundwater occurred. Approximately 7 private wells are within 500 feet of the roadway that would be constructed under Alternative 17. The existing chloride concentration in these private wells is unknown. The national secondary drinking-water standard for chloride is 250 mg/l. However, based on the low (10-30 mg/) measured chloride concentrations in groundwater in wells at the Williston Fire Department and the I-89 southbound rest stop, the relatively small additional chloride loading from Alternative 17 would not be expected to endanger the quality of the groundwater utilized by private wells or the overall quality of groundwater as an environmental resource. The predominance of Hydrologic Soil Group D (very slow infiltration rate) soils in the VT 2A and Circ A/B corridors further reduces the likelihood of groundwater resources being affected.

4.5.3 Hybrid Alternatives

Alternative 18 – Four-Lane VT 2A with Signalized Intersection Improvements Plus Circ Street

Nutrient and metal pollutants are removed by stormwater treatment practices and are attenuated by soil. However, chloride from deicing salt cannot be removed by stormwater treatment practices or soil attenuation because it tends to remain dissolved in water (Thunqvist, 2004). If all the deicing salt applied under Alternative 18 reached groundwater, then the additional average annual deicing salt loading to groundwater would be 175.0 tons.

The majority of homes and businesses in the area of the VT 2A and Circ A/B corridor are supplied by the Champlain Water District, thereby precluding impacts to public drinking water supplies, even if contamination of groundwater occurred. Approximately 13 private wells are within 500 feet of the roadways that would be constructed under Alternative 18. The existing chloride concentration in these private wells is unknown. The national secondary drinking-water standard for chloride is 250 mg/l. Based on the low (10-30 mg/) measured chloride concentrations in groundwater in wells at the Williston Fire Department and the I-89 southbound rest stop, the relatively small additional chloride loading from Alternative 18 would not be expected to endanger the quality of the groundwater utilized by private wells or the overall quality of groundwater as an environmental resource. The predominance of Hydrologic Soil Group D (very slow infiltration rate) soils in the VT 2A and Circ A/B corridors further reduces the likelihood of groundwater resources being affected.

Alternative 19 – Four-Lane VT 2A with Roundabouts Plus Circ Street

Nutrient and metal pollutants are removed by stormwater treatment practices and are attenuated by soil. However, chloride from deicing salt cannot be removed by stormwater treatment practices or soil attenuation because it tends to remain dissolved in water (Thunqvist, 2004). If all the deicing salt applied under Alternative 19 reached groundwater, then the additional average annual deicing salt loading to groundwater would be 153.5 tons.

The majority of homes and businesses in the area of the VT 2A and Circ A/B corridor are supplied by the Champlain Water District, thereby precluding impacts to public drinking water supplies, even if contamination of groundwater occurred. Approximately 13 private wells are within 500 feet of the roadways that would be constructed under Alternative 19. The existing chloride concentration in these private wells is unknown. The national secondary drinking-water standard for chloride is 250 mg/l. Based on the low (10-30 mg/) measured chloride concentrations in groundwater in wells at the Williston Fire Department and the I-89 southbound rest stop, the relatively small additional chloride loading from Alternative 19 would not be expected to endanger the quality of the groundwater utilized by private wells or the overall quality of groundwater as an environmental resource. The predominance of Hydrologic Soil

Group D (very slow infiltration rate) soils in the VT 2A and Circ A/B corridors further reduces the likelihood of groundwater resources being affected.

Alternative 23 – Tapered Widening on VT 2A with Signalized and Roundabout Intersections Plus Circ Street

Nutrient and metal pollutants are removed by stormwater treatment practices and are attenuated by soil. However, chloride from deicing salt cannot be removed by stormwater treatment practices or soil attenuation because it tends to remain dissolved in water (Thunqvist, 2004). If all the deicing salt applied under Alternative 23 reached groundwater, then the additional average annual deicing salt loading to groundwater would be 132.4 tons.

The majority of homes and businesses in the area of the VT 2A and Circ A/B corridor are supplied by the Champlain Water District, thereby precluding impacts to public drinking water supplies, even if contamination of groundwater occurred. Approximately 13 private wells are within 500 feet of the roadways that would be constructed under Alternative 23. The existing chloride concentration in these private wells is unknown. The national secondary drinking-water standard for chloride is 250 mg/l. Based on the low (10-30 mg/) measured chloride concentrations in groundwater in wells at the Williston Fire Department and the I-89 southbound rest stop, the relatively small additional chloride loading from Alternative 23 would not be expected to endanger the quality of the groundwater utilized by private wells or the overall quality of groundwater as an environmental resource. The predominance of Hydrologic Soil Group D (very slow infiltration rate) soils in the VT 2A and Circ A/B corridors further reduces the likelihood of groundwater resources being affected.

4.6 Surface Water

4.6.1 VT 2A Alternatives

Alternative 2 – Four-Lane VT 2A with Signalized Intersection Improvements

Development of Alternative 2 would involve capture and treatment of stormwater runoff from approximately 34 acres of site area. The area receiving treatment would be approximately 90 percent impervious. This includes approximately eight acres of impervious area expansion.

Table 4-22 summarizes the results of the Simple Method Results. The Simple Method pollutant model results indicate negligible change (order of magnitude in the hundredths of one percent) in sediment loadings to Allen Brook. There would be similarly negligible change in the loading of nutrients and metals to Allen Brook.

There would be negligible change in sediment, nutrient and metal loadings to Muddy Brook and the Winooski River.

Table 4-22
Alternative 2 Simple Method Results†

	Sediment (TSS)		Total Phosphorus (TP)		Nitrate (NO_3)		Copper (Cu)		Zinc (Zn)	
	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)
Muddy Brook	80.0	0.01	1.8	0.03	4.9	0.02	0.1	0.04	0.8	0.04
Allen Brook	148	0.02	1.3	0.05	4.0	0.03	0.1	0.05	0.6	0.05
Winooski Direct	1,370	*	6.9	*	14.3	*	0.8	*	4.6	*

†Pollutant loadings include the effect of stormwater treatment practices
*Non-measurable change from existing conditions

The Toler deicing salt analysis conservatively anticipates that all the deicing salt applied to VT 2A would reach surface waters. Table 4-23 summarizes the results of the Toler Analysis. Alternative 2 would result in a 1.6 mg/l increase the average annual chloride concentration in the Unnamed Tributary of Muddy Brook at RM 0.2 (South Brownell Road). At RM 0.2 the existing mean chloride concentration is 369.1 mg/l, in excess of the 230 mg/l EPA recommended criterion for chloride aquatic life toxicity.

Under Alternative 2, average annual chloride concentrations would increase by 1 mg/l or less in Muddy Brook, Allen Brook and the Winooski River. Based on measured background concentrations and the small magnitude of the predicted increases, Muddy Brook, Allen Brook and the Winooski River are not expected to exceed the EPA recommended criterion for chloride aquatic life toxicity. Therefore, the predicted chloride concentration increases are unlikely to have an adverse affect on aquatic biota.

Table 4-23
Alternative 2 Toler Analysis Results

	Unnamed Tributary of Muddy Brook (RM 0.2)	Muddy Brook (RM 1.2)	Allen Brook (RM 2.4)	Winooski River (at Muddy Brook)
Background Average Annual Chloride Concentration (mg/l)	369.1[1]	135.8 [1]	96.9 [1]	17.6 [1]
Increase in Average Annual Chloride Concentration	1.6	0.9	0.8	0.0
Total Average Annual Chloride Concentration (mg/l) *	370.7	136.7	97.7	17.6

[1] Background chloride concentration based on measured chloride concentrations.
[2] Background chloride concentration modeled based on the number of roadway lane-miles in the watershed upstream of the analysis location. Does not include potential non-roadway chloride loadings.
* Criteria: 230 mg/l chronic aquatic life toxicity, 250 mg/l national secondary drinking-water standard, 860 mg/l acute aquatic life toxicity.
† Includes loadings to the Unnamed Tributary of Muddy Brook.
‡ Includes loadings to Muddy Brook, Allen Brook and direct loadings to the Winooski River.

<u>Alternative 3 – Four-Lane VT 2A with Roundabouts</u>

Development of Alternative 3 would involve capture and treatment of stormwater runoff from approximately 35 acres of site area. The site area would be approximately 90 percent impervious. This includes an impervious area expansion of approximately six acres from existing conditions.

Table 4-24 summarizes the results of the Simple Method Results. The Simple Method pollutant model results indicate negligible change (order of magnitude in the hundredths of one percent) in sediment loadings to Allen Brook. There would be similarly negligible change in the loading of nutrients and metals to Allen Brook.

There would be negligible change in sediment, nutrient and metal loadings to Muddy Brook and the Winooski River.

Table 4-24
Alternative 3 Simple Method Results†

	Sediment (TSS)		Total Phosphorus (TP)		Nitrate (NO_3)		Copper (Cu)		Zinc (Zn)	
	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)
Muddy Brook	451	0.03	1.4	0.03	6.0	0.02	0.3	0.08	1.7	0.08
Allen Brook	283	0.04	0.8	0.03	4.1	0.03	0.2	0.08	0.9	0.09
Winooski Direct	501	*	1.5	*	7.1	*	0.3	*	1.9	*

†Pollutant loadings include the effect of stormwater treatment practices
*Non-measurable change from existing conditions

The Toler deicing salt analysis conservatively anticipates that all the deicing salt applied to VT 2A would reach surface waters. Table 4-25 summarizes the results of the Toler Analysis. Alternative 3 would result in a 0.2 mg/l increase the average annual chloride concentration in the Unnamed Tributary of Muddy Brook at RM 0.2 (South Brownell Road). At RM 0.2 the existing mean chloride concentration is 369.1 mg/l, in excess of the 230 mg/l EPA recommended criterion for chloride aquatic life toxicity.

Under Alternative 3, average annual chloride concentrations would increase by less than 1 mg/l in Muddy Brook, Allen Brook and the Winooski River. Based on measured background concentrations and the small magnitude of the predicted increases, Muddy Brook, Allen Brook and the Winooski River are not expected to exceed the EPA recommended criterion for chloride aquatic life toxicity. Therefore, the predicted chloride concentration increases are unlikely to have an adverse affect on aquatic biota.

Table 4-25
Alternative 3 Toler Analysis Results

	Unnamed Tributary of Muddy Brook (RM 0.2)	Muddy Brook (RM 1.2)	Allen Brook (RM 2.4)	Winooski River (at Muddy Brook)
Background Average Annual Chloride Concentration (mg/l)	369.1[1]	135.8 [1]	96.9 [1]	17.6 [1]
Increase in Average Annual Chloride Concentration	0.2	0.6	0.6	0.0
Total Average Annual Chloride Concentration (mg/l) *	369.3	136.4	97.5	17.6

[1] Background chloride concentration based on measured chloride concentrations.
[2] Background chloride concentration modeled based on the number of roadway lane-miles in the watershed upstream of the analysis location. Does not include potential non-roadway chloride loadings.
* Criteria: 230 mg/l chronic aquatic life toxicity, 250 mg/l national secondary drinking-water standard, 860 mg/l acute aquatic life toxicity.
† Includes loadings to the Unnamed Tributary of Muddy Brook.
‡ Includes loadings to Muddy Brook, Allen Brook and direct loadings to the Winooski River.

Alternative 22 – Tapered Widening on VT 2A with Signalized and Roundabout Intersections

Development of Alternative 22 would involve capture and treatment of stormwater runoff from approximately 33 acres of site area. The site area would be approximately 82 percent impervious. This includes an impervious area expansion of approximately four acres from existing conditions.

Table 4-26 summarizes the results of the Simple Method Results. The Simple Method pollutant model results indicate negligible change (order of magnitude in the hundredths of one percent) in sediment loadings to Allen Brook. There would be similarly negligible change in the loading of nutrients and metals to Allen Brook.

There would be negligible change in pollutant loadings to Muddy Brook and the Winooski River, except for copper and zinc in Muddy Brook, where loadings of these pollutants would increase by 0.17 to 0.18 percent under Alternative 22.

Table 4-26
Alternative 22 Simple Method Results†

	Sediment (TSS)		Total Phosphorus (TP)		Nitrate (NO_3)		Copper (Cu)		Zinc (Zn)	
	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)
Muddy Brook	1,110	0.08	3.3	0.06	12.3	0.04	0.6	0.17	3.6	0.18
Allen Brook	207	0.03	0.6	0.02	3.3	0.02	0.1	0.06	0.6	0.06
Winooski Direct	53.6	*	0.8	*	4.4	*	0.0	*	-0.1	*

†Pollutant loadings include the effect of stormwater treatment practices
*Non-measurable change from existing conditions

The Toler deicing salt analysis conservatively anticipates that all the deicing salt applied to VT 2A would reach surface waters. Table 4-27 summarizes the results of the Toler Analysis.

Alternative 22 would result in a 0.6 mg/l increase the average annual chloride concentration in the Unnamed Tributary of Muddy Brook at RM 0.2 (South Brownell Road). At RM 0.2 the existing mean chloride concentration is 369.1 mg/l, in excess of the 230 mg/l EPA recommended criterion for chloride aquatic life toxicity.

Under Alternative 22, average annual chloride concentrations would increase by less than 1 mg/l in Muddy Brook, Allen Brook and the Winooski River. Based on measured background concentrations and the small magnitude of the predicted increases, Muddy Brook, Allen Brook and the Winooski River are not expected to exceed the EPA recommended criterion for chloride aquatic life toxicity. Therefore, the predicted chloride concentration increases are unlikely to have an adverse affect on aquatic biota.

Table 4-27
Alternative 22 Toler Analysis Results

	Unnamed Tributary of Muddy Brook (RM 0.2)	Muddy Brook (RM 1.2)	Allen Brook (RM 2.4)	Winooski River (at Muddy Brook)
Background Average Annual Chloride Concentration (mg/l)	369.1[1]	135.8 [1]	96.9 [1]	17.6 [1]
Increase in Average Annual Chloride Concentration	0.6	0.6	0.3	0.0
Total Average Annual Chloride Concentration (mg/l) *	369.7	136.4	97.2	17.6

[1] Background chloride concentration based on measured chloride concentrations.
[2] Background chloride concentration modeled based on the number of roadway lane-miles in the watershed upstream of the analysis location. Does not include potential non-roadway chloride loadings.
* Criteria: 230 mg/l chronic aquatic life toxicity, 250 mg/l national secondary drinking-water standard, 860 mg/l acute aquatic life toxicity.
† Includes loadings to the Unnamed Tributary of Muddy Brook.
‡ Includes loadings to Muddy Brook, Allen Brook and direct loadings to the Winooski River.

4.6.2 Circ A/B Alternatives

Alternative 16a – Circ A/B Limited Access Highway (No Connection to US 2 and Trumpet Interchange at Redmond Road) with VT 2A Spot Improvements

Development of Alternative 16a would involve collection and treatment of stormwater runoff from approximately 186 acres of site area. The site area would be approximately 25 percent impervious. This includes an impervious area expansion of approximately 38 acres from existing conditions within the Circ A/B corridor.

Table 4-28 summarizes the results of the Simple Method Results. The Simple Method pollutant model results indicate negligible change (order of magnitude in the hundredths of one percent) in sediment loadings to Allen Brook. Nutrient and metal loadings to Allen Brook would increase, up to 0.78 percent, depending on the pollutant. Although the Allen Brook watershed is not impaired by phosphorus and the increase in phosphorus loads is not required to be offset by the VANR DEC Stormwater Rules or Water Resources Board precedent, loadings of constituents other the sediment may be eliminated through an offset project to reduce the existing loading from other areas in the watershed.

In Redmond Creek, pollutant loadings would increase by 2.38 to 13.31 percent, depending on the pollutant. In Winooski Tributary 1, pollutant loadings vary, from a decrease of 3.1 percent, to an increase of 2.67 percent, depending on the pollutant.

Table 4-28
Alternative 16a Simple Method Results†

	Sediment (TSS)		Total Phosphorus (TP)		Nitrate (NO_3)		Copper (Cu)		Zinc (Zn)	
	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)
Allen Brook	-5	~ 0.00	22.2	0.78	17.8	0.12	1.0	0.55	6.1	0.57
Redmond Creek	816	4.85	6.3	8.64	8.9	2.38	0.5	10.24	2.8	13.31
Winooski Trib 1	-372	-0.69	3.8	1.50	-3.1	-0.22	0.2	1.93	1.5	2.67
Winooski Direct	120	*	21.2	*	24.6	*	1.5	*	9.2	*

†Pollutant loadings include the effect of stormwater treatment practices
*Non-measurable change from existing conditions

The Toler deicing salt analysis conservatively anticipates that all the deicing salt applied to Circ A/B would reach surface waters. Table 4-29 summarizes the results of the Toler Analysis. Alternative 16a is not expected to contribute to any waterbodies exceeding the EPA recommended criterion for chloride aquatic life toxicity (230 mg/l). The largest increase in chloride concentrations would occur in the Unnamed Tributary of the Winooski (1) at its confluence with the Winooski River (42.3 mg/l); however the total estimated chloride concentration in this waterbody would be less than half of the 230 mg/l criterion. Therefore, the predicted chloride concentration increases are unlikely to have an adverse affect on aquatic biota.

Table 4-29
Alternative 16a Toler Analysis Results

	Allen Brook (RM 2.4)	Winooski Tributary (1) (at the Winooski River)	Redmond Creek (at the Winooski River)	Winooski River (at Muddy Brook) ‡
Background Average Annual Chloride Concentration (mg/l)	96.9 [1]	64.4 [2]	17.4 [2]	17.6 [1]
Increase in Average Annual Chloride Concentration	4.1	42.3	18.5	0.2
Total Average Annual Chloride Concentration (mg/l) *	101.0	106.7	35.9	17.8

[1] Background chloride concentration based on measured chloride concentrations.
[2] Background chloride concentration modeled based on the number of roadway lane-miles in the watershed upstream of the analysis location. Does not include potential non-roadway chloride loadings.
* Criteria: 230 mg/l chronic aquatic life toxicity, 250 mg/l national secondary drinking-water standard, 860 mg/l acute aquatic life toxicity.
† Includes loadings to the Unnamed Tributary of Muddy Brook.
‡ Includes loadings to Muddy Brook, Allen Brook and direct loadings to the Winooski River.

Alternative 16b – Circ A/B Limited Access Highway (Partial Cloverleaf Interchange at US 2 and Trumpet Interchange at Redmond Road) with VT 2A Spot Improvements

Table 4-30 summarizes the results of the Simple Method Results. The Simple Method pollutant model results indicate a small decrease (0.13 percent) in sediment loadings to Allen Brook. Nutrient and metal loadings to Allen Brook would increase, up to 0.93 percent, depending on the pollutant. Although the Allen Brook watershed is not impaired by phosphorus and the increase in phosphorus loads is not required to be offset by the VANR DEC Stormwater Rules or Water Resources Board precedent, loadings of constituents other the sediment may be eliminated through an offset project to reduce the existing loading from other areas in the watershed.

In Redmond Creek, pollutant loadings would increase by 1.82 to 10.68 percent, depending on the pollutant. In Winooski Tributary 1, pollutant loadings vary, from a decrease of 3.1 percent, to an increase of 2.67 percent, depending on the pollutant.

Table 4-30
Alternative 16b Simple Method Results†

	Sediment (TSS)		Total Phosphorus (TP)		Nitrate (NO_3)		Copper (Cu)		Zinc (Zn)	
	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)
Allen Brook	-913	-0.13	26.6	0.93	17.7	0.12	0.9	0.52	5.7	0.54
Redmond Creek	632	3.75	5.0	6.86	6.8	1.82	0.4	8.24	2.2	10.68
Winooski Trib 1	-404	-0.75	3.6	1.41	-3.4	-0.25	0.2	1.85	1.4	2.49
Winooski Direct	-317	*	19.1	*	17.2	*	1.3	*	8.0	*

†Pollutant loadings include the effect of stormwater treatment practices
*Non-measurable change from existing conditions

The Toler deicing salt analysis conservatively anticipates that all the deicing salt applied to Circ A/B would reach surface waters. Table 4-31 summarizes the results of the Toler Analysis. Alternative 16b is not expected to contribute to any waterbodies exceeding the EPA recommended criterion for chloride aquatic life toxicity (230 mg/l). The largest increase in chloride concentrations would occur in the Unnamed Tributary of the Winooski (1) at its confluence with the Winooski River (42.3 mg/l); however the total estimated chloride concentration in this waterbody would be less than half of the 230 mg/l criterion. Therefore, the predicted chloride concentration increases are unlikely to have an adverse affect on aquatic biota.

Table 4-31
Alternative 16b Toler Analysis Results

	Allen Brook (RM 2.4)	Winooski Tributary (1) (at the Winooski River)	Redmond Creek (at the Winooski River)	Winooski River (at Muddy Brook) ‡
Background Average Annual Chloride Concentration (mg/l)	96.9 [1]	64.4 [2]	17.4 [2]	17.6 [1]
Increase in Average Annual Chloride Concentration	5.2	42.3	18.5	0.2
Total Average Annual Chloride Concentration (mg/l) *	102.1	106.7	35.9	17.8

[1] Background chloride concentration based on measured chloride concentrations.
[2] Background chloride concentration modeled based on the number of roadway lane-miles in the watershed upstream of the analysis location. Does not include potential non-roadway chloride loadings.
* Criteria: 230 mg/l chronic aquatic life toxicity, 250 mg/l national secondary drinking-water standard, 860 mg/l acute aquatic life toxicity.
† Includes loadings to the Unnamed Tributary of Muddy Brook.
‡ Includes loadings to Muddy Brook, Allen Brook and direct loadings to the Winooski River.

Alternative 16c – Circ A/B Limited Access Highway (No Connection to US 2 and Diamond Interchange at Mountain View Road) with VT 2A Spot Improvements

Table 4-32 summarizes the results of the Simple Method Results. The Simple Method pollutant model results indicate a small decrease (0.42 percent) in sediment loadings to Allen Brook. Nutrient loadings to Allen Brook would increase, up to 0.53 percent, depending on the pollutant. Although the Allen Brook watershed is not impaired by phosphorus and the increase in phosphorus loads is not required to be offset by the VANR DEC Stormwater Rules or Water Resources Board precedent, loadings of constituents other the sediment may be eliminated through an offset project to reduce the existing loading from other areas in the watershed.

In Redmond Creek, pollutant loadings would increase by 1.82 to 10.68 percent, depending on the pollutant. In Winooski Tributary 1, pollutant loadings vary, from a decrease of 2.7 percent, to an increase of 2.18 percent, depending on the pollutant.

Table 4-32
Alternative 16c Simple Method Results†

	Sediment (TSS)		Total Phosphorus (TP)		Nitrate (NO_3)		Copper (Cu)		Zinc (Zn)	
	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)
Allen Brook	-3,012	-0.42	15.0	0.53	2.2	0.02%	-0.1	-0.04	-0.4	-0.04
Redmond Creek	632	3.75	5.0	6.86	6.8	1.82%	0.4	8.24	2.2	10.68
Winooski Trib 1	-1,036	-1.91	5.5	2.18	-2.7	-0.19%	0.1	0.95	0.7	1.29
Winooski Direct	78	*	21.2	*	22.8	*	1.4	*	8.8	*

†Pollutant loadings include the effect of stormwater treatment practices
*Non-measurable change from existing conditions

The Toler deicing salt analysis conservatively anticipates that all the deicing salt applied to Circ A/B would reach surface waters. Table 4-33 summarizes the results of the Toler Analysis. Alternative 16c is not expected to contribute to any waterbodies exceeding the EPA recommended criterion for chloride aquatic life toxicity (230 mg/l). The largest increase in chloride concentrations would occur in the Unnamed Tributary of the Winooski (1) at its confluence with the Winooski River (41.8 mg/l); however the total estimated chloride concentration in this waterbody would be less than half of the 230 mg/l criterion. Therefore, the predicted chloride concentration increases are unlikely to have an adverse affect on aquatic biota.

Table 4-33
Alternative 16c Toler Analysis Results

	Allen Brook (RM 2.4)	Winooski Tributary (1) (at the Winooski River)	Redmond Creek (at the Winooski River)	Winooski River (at Muddy Brook) ‡
Background Average Annual Chloride Concentration (mg/l)	96.9 [1]	64.4 [2]	17.4 [2]	17.6 [1]
Increase in Average Annual Chloride Concentration	4.4	41.8	18.5	0.1
Total Average Annual Chloride Concentration (mg/l) *	101.3	106.2	35.9	17.7

[1] Background chloride concentration based on measured chloride concentrations.
[2] Background chloride concentration modeled based on the number of roadway lane-miles in the watershed upstream of the analysis location. Does not include potential non-roadway chloride loadings.
* Criteria: 230 mg/l chronic aquatic life toxicity, 250 mg/l national secondary drinking-water standard, 860 mg/l acute aquatic life toxicity.
† Includes loadings to the Unnamed Tributary of Muddy Brook.
‡ Includes loadings to Muddy Brook, Allen Brook and direct loadings to the Winooski River.

Alternative 17 – Circ A/B Boulevard with VT 2A Spot Improvements

Development of Alternative 17 would involve collection and treatment of stormwater runoff from approximately 186 acres of site area. The site area would be approximately 22 percent impervious. This includes an impervious area expansion of approximately 32 acres from existing conditions.

Table 4-34 summarizes the results of the Simple Method Results. The Simple Method pollutant model results indicate negligible change (order of magnitude in the hundredths of one percent) in sediment loadings to Allen Brook. Nutrient and metal loadings to Allen Brook would increase, up to 0.73 percent, depending on the pollutant. Although the Allen Brook watershed is not impaired by phosphorus and the increase in phosphorus loads is not required to be offset by the VANR DEC Stormwater Rules or Water Resources Board precedent, loadings of constituents other the sediment may be eliminated through an offset project to reduce the existing loading from other areas in the watershed.

In Redmond Creek, pollutant loadings would increase by 2.1 to 12.0 percent, depending on the pollutant. In Winooski Tributary 1, pollutant loadings vary, from a decrease of 3.3 percent, to an increase of 2.54 percent, depending on the pollutant.

Table 4-34
Alternative 17 Simple Method Results†

	Sediment (TSS)		Total Phosphorus (TP)		Nitrate (NO_3)		Copper (Cu)		Zinc (Zn)	
	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)
Allen Brook	-211	-0.03	20.7	0.73	15.5	0.11	0.9	0.50	5.4	0.51
Redmond Creek	727	4.32	5.7	7.77	7.8	2.10	0.4	9.13	2.5	12.0
Winooski Trib 1	-395	-0.74	3.6	1.44	-3.3	-0.24	0.2	1.85	1.4	2.54
Winooski Direct	-1,600	*	8.4	*	2.0	*	0.6	*	3.5	*

†Pollutant loadings include the effect of stormwater treatment practices
*Non-measurable change from existing conditions

The Toler deicing salt analysis conservatively anticipates that all the deicing salt applied to Circ A/B would reach surface waters. Table 4-35 summarizes the results of the Toler Analysis. Alternative 17 is not expected to contribute to any waterbodies exceeding the EPA recommended criterion for chloride aquatic life toxicity (230 mg/l). The largest increase in chloride concentrations would occur in the Unnamed Tributary of the Winooski (1) at its confluence with the Winooski River (28.3 mg/l); however the total estimated chloride concentration in this waterbody would be less than half of the 230 mg/l criterion. Therefore, the predicted chloride concentration increases are unlikely to have an adverse affect on aquatic biota.

Table 4-35
Alternative 17 Toler Analysis Results

	Allen Brook (RM 2.4)	Winooski Tributary (1) (at the Winooski River)	Redmond Creek (at the Winooski River)	Winooski River (at Muddy Brook) ‡
Background Average Annual Chloride Concentration (mg/l)	96.9 [1]	64.4 [2]	17.4 [2]	17.6 [1]
Increase in Average Annual Chloride Concentration	4.5	28.3	17.8	0.1
Total Average Annual Chloride Concentration (mg/l) *	101.4	92.7	35.2	17.7

[1] Background chloride concentration based on measured chloride concentrations.
[2] Background chloride concentration modeled based on the number of roadway lane-miles in the watershed upstream of the analysis location. Does not include potential non-roadway chloride loadings.
* Criteria: 230 mg/l chronic aquatic life toxicity, 250 mg/l national secondary drinking-water standard, 860 mg/l acute aquatic life toxicity.
† Includes loadings to the Unnamed Tributary of Muddy Brook.
‡ Includes loadings to Muddy Brook, Allen Brook and direct loadings to the Winooski River.

4.6.3 Hybrid Alternatives

Alternative 18 – Four-Lane VT 2A with Signalized Intersection Improvements Plus Circ Street

Development of Alternative 18 would involve collection and treatment of stormwater runoff from approximately 34 acres of site area within the VT 2A corridor and 82 acres of site area within the Circ A/B corridor. The site area receiving treatment would be approximately 90 percent impervious within VT 2A and 20 percent impervious within the Circ A/B corridor. This includes an impervious area expansion of approximately eight acres within the VT 2A corridor and twelve acres within the Circ A/B Corridor.

Table 4-36 summarizes the results of the Simple Method Results. The Simple Method pollutant model results indicate a 0.15 percent decrease sediment loading to Allen Brook. Nutrient and metal loadings to Allen Brook would increase, up to 0.51 percent, depending on the pollutant. Although the Allen Brook watershed is not impaired by phosphorus and the increase in phosphorus loads is not required to be offset by the VANR DEC Stormwater Rules or Water Resources Board precedent, loadings of constituents other the sediment may be eliminated through an offset project to reduce the existing loading from other areas in the watershed.

There would be negligible change (order of magnitude in the hundredths of one percent) in the pollutant loadings to Muddy Brook and the Winooski River. In Winooski Tributary 1, pollutant loadings vary, from a decrease of 1.42 percent, to an increase of 0.54 percent, depending on the pollutant.

Table 4-36
Alternative 18 Simple Method Results†

	Sediment (TSS)		Total Phosphorus (TP)		Nitrate (NO_3)		Copper (Cu)		Zinc (Zn)	
	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)
Muddy Brook	80.0	0.01	1.8	0.03	4.9	0.02	0.1	0.04	0.8	0.04
Allen Brook	-1,110	-0.15	14.6	0.51	7.5	0.05	0.5	0.26	2.8	0.27
Winooski Trib 1	-761	-1.42	1.0	0.41	-7.5	-0.55	0.1	0.40	0.3	0.54
Winooski Direct	1,370	*	6.9	*	14.3	*	0.8	*	4.6	*

†Pollutant loadings include the effect of stormwater treatment practices
*Non-measurable change from existing conditions

The Toler deicing salt analysis conservatively anticipates that all the deicing salt applied to VT and the Circ Street would reach surface waters. Table 4-37 summarizes the results of the Toler Analysis. Alternative 18 would result in a 1.6 mg/l increase the average annual chloride concentration in the Unnamed Tributary of Muddy Brook at RM 0.2 (South Brownell Road). At RM 0.2 the existing mean chloride concentration is 369.1 mg/l, in excess of the 230 mg/l EPA recommended criterion for chloride aquatic life toxicity.

Under Alternative 18, Muddy Brook, Allen Brook, Winooski Tributary (1) and the Winooski River are not expected to exceed the EPA recommended criterion for chloride aquatic life toxicity (230 mg/l). The largest increase in chloride concentrations would occur in the Unnamed Tributary of the Winooski (1) at its confluence with the Winooski River (8.8 mg/l); however the total estimated chloride concentration in this waterbody would be less than one third of the 230 mg/l criterion. Therefore, the predicted chloride concentration increases are unlikely to have an adverse affect on aquatic biota.

Table 4-37
Alternative 18 Toler Analysis Results

	Unnamed Tributary of Muddy Brook (RM 0.2)	Muddy Brook (RM 1.2) †	Allen Brook (RM 2.4)	Winooski Tributary (1) (at the Winooski River)	Winooski River (at Muddy Brook) ‡
Background Average Annual Chloride Concentration (mg/l)	369.1 [1]	135.8 [1]	96.9 [1]	64.4 [2]	17.6 [1]
Increase in Average Annual Chloride Concentration	1.6	0.9	4.3	8.8	0.1
Total Average Annual Chloride Concentration (mg/l)*	370.7	136.7	101.2	73.2	17.7

[1] Background chloride concentration based on measured chloride concentrations.
[2] Background chloride concentration modeled based on the number of roadway lane-miles in the watershed upstream of the analysis location. Does not include potential non-roadway chloride loadings.
* Criteria: 230 mg/l chronic aquatic life toxicity, 250 mg/l national secondary drinking-water standard, 860 mg/l acute aquatic life toxicity.
† Includes loadings to the Unnamed Tributary of Muddy Brook.
‡ Includes loadings to Muddy Brook, Allen Brook and direct loadings to the Winooski River

Alternative 19 – Four-Lane VT 2A with Roundabouts Plus Circ Street

Development of Alternative 19 would involve capture and treatment of stormwater runoff from approximately 35 acres of site area within the VT 2A corridor and 82 acres of site area within the Circ A/B corridor. The site area receiving treatment would be approximately 85 percent impervious within VT 2A and 20 percent impervious within the Circ A/B corridor. This includes an impervious area expansion of approximately six acres within the VT 2A corridor and 12 acres within the Circ A/B Corridor.

Table 4-38 summarizes the results of the Simple Method Results. The Simple Method pollutant model results indicate a 0.14 percent decrease sediment loading to Allen Brook. Nutrient and metal loadings to Allen Brook would increase, up to 0.49 percent, depending on the pollutant. Although the Allen Brook watershed is not impaired by phosphorus and the increase in phosphorus loads is not required to be offset by the VANR DEC Stormwater Rules or Water Resources Board precedent, loadings of constituents other the sediment may be eliminated through an offset project to reduce the existing loading from other areas in the watershed.

There would be negligible change (order of magnitude in the hundredths of one percent) in the pollutant loadings to Muddy Brook and the Winooski River. In Winooski Tributary 1, pollutant loadings vary, from a decrease of 1.42 percent, to an increase of 0.54 percent, depending on the pollutant.

Table 4-38
Alternative 19 Simple Method Results†

	Sediment (TSS)		Total Phosphorus (TP)		Nitrate (NO_3)		Copper (Cu)		Zinc (Zn)	
	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)
Muddy Brook	451	0.03	1.4	0.03	6.0	0.02	0.3	0.08	1.7	0.08
Allen Brook	-978	-0.14	14.1	0.49	7.6	0.05	0.5	0.29	3.2	0.30
Winooski Trib 1	-761	-1.42	1.0	0.41	-7.5	-0.55	0.1	0.40	0.3	0.54
Winooski Direct	501	*	1.5	*	7.1	*	0.3	*	1.9	*

†Pollutant loadings include the effect of stormwater treatment practices
*Non-measurable change from existing conditions

The Toler deicing salt analysis conservatively anticipates that all the deicing salt applied to VT and the Circ Street would reach surface waters. Table 4-39 summarizes the results of the Toler Analysis. Alternative 19 would result in a 0.2 mg/l increase the average annual chloride concentration in the Unnamed Tributary of Muddy Brook at RM 0.2 (South Brownell Road). At RM 0.2 the existing mean chloride concentration is 369.1 mg/l, in excess of the 230 mg/l EPA recommended criterion for chloride aquatic life toxicity.

Under Alternative 19, Muddy Brook, Allen Brook, Winooski Tributary (1) and the Winooski River are not expected to exceed the EPA recommended criterion for chloride aquatic life toxicity (230 mg/l). The largest increase in chloride concentrations would occur in the Unnamed Tributary of the Winooski (1) at its confluence with the Winooski River (8.8 mg/l); however the total estimated chloride concentration in this waterbody would be less than one third of the 230 mg/l criterion. Therefore, the predicted chloride concentration increases are unlikely to have an adverse affect on aquatic biota.

Table 4-39
Alternative 19 Toler Analysis Results

	Unnamed Tributary of Muddy Brook (RM 0.2)	Muddy Brook (RM 1.2) †	Allen Brook (RM 2.4)	Winooski Tributary (1) (at the Winooski River)	Winooski River (at Muddy Brook) ‡
Background Average Annual Chloride Concentration (mg/l)	369.1 [1]	135.8 [1]	96.9 [1]	64.4 [2]	17.6 [1]
Increase in Average Annual Chloride Concentration	0.2	0.6	4.2	8.8	0.1
Total Average Annual Chloride Concentration (mg/l)*	369.3	136.4	101.1	73.2	17.7

[1] Background chloride concentration based on measured chloride concentrations.
[2] Background chloride concentration modeled based on the number of roadway lane-miles in the watershed upstream of the analysis location. Does not include potential non-roadway chloride loadings.
* Criteria: 230 mg/l chronic aquatic life toxicity, 250 mg/l national secondary drinking-water standard, 860 mg/l acute aquatic life toxicity.
† Includes loadings to the Unnamed Tributary of Muddy Brook.
‡ Includes loadings to Muddy Brook, Allen Brook and direct loadings to the Winooski River

Alternative 23 – Tapered Widening on VT 2A with Signalized and Roundabout Intersections Plus Circ Street

Development of Alternative 23 would involve collection and treatment of stormwater runoff from approximately 33 acres of site area within the VT 2A corridor and 82 acres of site area within the Circ A/B corridor via the stormwater treatment and control practices described in Section 5.3. The site area receiving treatment would be approximately 82 percent impervious within VT 2A and 20 percent impervious within the Circ A/B corridor. This includes an impervious area expansion of approximately four acres within the VT 2A corridor and 12 acres within the Circ A/B Corridor. The entire impervious area within the VT 2A corridor would receive full water quality treatment.

Table 4-40 summarizes the results of the Simple Method Results. The Simple Method pollutant model results indicate a 0.14 percent decrease sediment loading to Allen Brook. Nutrient and metal loadings to Allen Brook would increase, up to 0.51 percent, depending on the pollutant. Although the Allen Brook watershed is not impaired by phosphorus and the increase in phosphorus loads is not required to be offset by the VANR DEC Stormwater Rules or Water Resources Board precedent, loadings of constituents other the sediment may be eliminated through an offset project to reduce the existing loading from other areas in the watershed.

There would be negligible change (order of magnitude in the hundredths of one percent) in the pollutant loadings to Muddy Brook and the Winooski River. In Winooski Tributary 1, pollutant loadings vary, from a decrease of 1.42 percent, to an increase of 0.54 percent, depending on the pollutant.

Table 4-40
Alternative 23 Simple Method Results†

	Sediment (TSS)		Total Phosphorus (TP)		Nitrate (NO_3)		Copper (Cu)		Zinc (Zn)	
	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change	Net Change (lbs/yr)	Percent Change (%)	Net Change (lbs/yr)	Percent Change (%)
Muddy Brook	522	0.04	1.6	0.03	7.2	0.03	0.3	0.10	2.0	0.10
Allen Brook	-1,030	-0.14	14.0	0.49	6.4	0.04	0.5	0.27	3.0	0.28
Winooski Trib 1	-761	-1.42	1.0	0.41	-7.5	-0.55	0.1	0.40	0.3	0.54
Winooski Direct	268	*	0.8	*	3.4	*	0.2	*	0.9	*

†Pollutant loadings include the effect of stormwater treatment practices
*Non-measurable change from existing conditions

The Toler deicing salt analysis conservatively anticipates that all the deicing salt applied to VT and the Circ Street would reach surface waters. Table 4-41 summarizes the results of the Toler Analysis. Alternative 23 would result in a 0.6 mg/l increase the average annual chloride concentration in the Unnamed Tributary of Muddy Brook at RM 0.2 (South Brownell Road). At RM 0.2 the existing mean chloride concentration is 369.1 mg/l, in excess of the 230 mg/l EPA recommended criterion for chloride aquatic life toxicity.

Under Alternative 23, Muddy Brook, Allen Brook, Winooski Tributary (1) and the Winooski River are not expected to exceed the EPA recommended criterion for chloride aquatic life toxicity (230 mg/l). The largest increase in chloride concentrations would occur in the Unnamed Tributary of the Winooski (1) at its confluence with the Winooski River (8.8 mg/l). However, the total estimated chloride concentration in this waterbody would be less than one third of the 230 mg/l criterion. Therefore, the predicted chloride concentration increases are unlikely to have an adverse affect on aquatic biota.

Table 4-41
Alternative 23 Toler Analysis Results

	Unnamed Tributary of Muddy Brook (RM 0.2)	Muddy Brook (RM 1.2) †	Allen Brook (RM 2.4)	Winooski Tributary (1) (at the Winooski River)	Winooski River (at Muddy Brook) ‡
Background Average Annual Chloride Concentration (mg/l)	369.1 [1]	135.8 [1]	96.9 [1]	64.4 [2]	17.6 [1]
Increase in Average Annual Chloride Concentration	0.6	0.6	3.8	8.8	0.1
Total Average Annual Chloride Concentration (mg/l)*	369.7	136.4	100.7	73.2	17.7

[1] Background chloride concentration based on measured chloride concentrations.
[2] Background chloride concentration modeled based on the number of roadway lane-miles in the watershed upstream of the analysis location. Does not include potential non-roadway chloride loadings.
* Criteria: 230 mg/l chronic aquatic life toxicity, 250 mg/l national secondary drinking-water standard, 860 mg/l acute aquatic life toxicity.
† Includes loadings to the Unnamed Tributary of Muddy Brook.
‡ Includes loadings to Muddy Brook, Allen Brook and direct loadings to the Winooski River

4.7 Floodplains

4.7.1 VT 2A Alternatives

<u>Alternative 2 – Four-Lane VT 2A with Signalized Intersection Improvements</u>
Based on roadway slope line limits, permanent encroachment on the FEMA 100-year floodplain and VANR Allen Brook floodway would total 0.5 and 1.1 acres respectively. Alternative 2 would impact riparian habitat during the construction of the replacement Allen Brook bridge and the pedestrian crossing structure over the Winooski River. The Biological Resources Technical Report discusses wildlife habitat impacts, including riparian wildlife habitat impacts and mitigation in more detail.

In general, adverse impacts to flood storage and stream geomorphology would be avoided through the stormwater treatment practices that would be implemented as part of any of the Build Alternatives. For example, the Vermont Stormwater Management Manual provides standards for channel protection control (one-year storm), overbank flood control (ten-year storm), and extreme flood control (100-year storm) that would be met as part of the proposed project.

<u>Alternative 3 – Four-Lane VT 2A with Roundabouts</u>
Based on roadway slope line limits, permanent encroachment on the FEMA 100-year floodplain and VANR Allen Brook floodway would total 0.5 and 1.1 acres respectively. Alternative 3 would impact riparian habitat during the construction of the replacement Allen Brook bridge and the pedestrian crossing structure over the Winooski River. The Biological Resources Technical

Report discusses wildlife habitat impacts, including riparian wildlife habitat impacts and mitigation in more detail.

In general, adverse impacts to flood storage and stream geomorphology would be avoided through the stormwater treatment practices that would be implemented as part of any of the Build Alternatives. For example, the Vermont Stormwater Management Manual provides standards for channel protection control (one-year storm), overbank flood control (ten-year storm), and extreme flood control (100-year storm) that would be met as part of the proposed project.

Alternative 22 – Tapered Widening on VT 2A with Signalized and Roundabout Intersections

Based on roadway slope line limits, permanent encroachment on the FEMA 100-year floodplain and VANR Allen Brook floodway would total 0.5 and 1.0 acres respectively. Alternative 3 would impact riparian habitat during the construction of the replacement Allen Brook bridge. The Biological Resources Technical Report discusses wildlife habitat impacts, including riparian wildlife habitat impacts and mitigation in more detail.

In general, adverse impacts to flood storage and stream geomorphology would be avoided through the stormwater treatment practices that would be implemented as part of any of the Build Alternatives. For example, the Vermont Stormwater Management Manual provides standards for channel protection control (one-year storm), overbank flood control (ten-year storm), and extreme flood control (100-year storm) that would be met as part of the proposed project.

4.7.2 Circ A/B Alternatives

Alternative 16a – Circ A/B Limited Access Highway (No Connection to US 2 and Trumpet Interchange at Redmond Road) with VT 2A Spot Improvements

Based on roadway slope line limits, permanent encroachment on the FEMA 100-year floodplain and VANR Allen Brook floodway would total 2.0 and 1.8 acres respectively. Alternative 16a would impact riparian habitat at the Allen Brook and Redmond Creek crossings. Riparian habitat at the Winooski River would not be affected because the proposed bridge would span over the habitat. The Biological Resources Technical Report discusses wildlife habitat impacts, including riparian wildlife habitat impacts and mitigation in more detail.

In general, adverse impacts to flood storage and stream geomorphology would be avoided through the stormwater treatment practices that would be implemented as part of any of the Build Alternatives. For example, the Vermont Stormwater Management Manual provides standards for channel protection control (one-year storm), overbank flood control (ten-year storm), and extreme flood control (100-year storm) that would be met as part of the proposed project.

Alternative 16b – Circ A/B Limited Access Highway (Partial Cloverleaf Interchange at US 2 and Trumpet Interchange at Redmond Road) with VT 2A Spot Improvements

Based on roadway slope line limits, permanent encroachment on the FEMA 100-year floodplain and VANR Allen Brook floodway would total 8.1 and 10.1 acres respectively. Alternative 16b would impact a relatively substantial area of riparian habitat at Allen Brook to construct of partial cloverleaf interchange with US 2 (total of four crossings of Allen Brook, including roadway and ramps). Riparian habitat would also be affected during the construction of the Redmond Creek crossing. Riparian habitat at the Winooski River would not be affected because the proposed bridge would span over the habitat. The Biological Resources Technical Report discusses wildlife habitat impacts, including riparian wildlife habitat impacts and mitigation in more detail.

In general, adverse impacts to flood storage and stream geomorphology would be avoided through the stormwater treatment practices that would be implemented as part of any of the Build Alternatives. For example, the Vermont Stormwater Management Manual provides standards for channel protection control (one-year storm), overbank flood control (ten-year storm), and extreme flood control (100-year storm) that would be met as part of the proposed project.

Alternative 16c – Circ A/B Limited Access Highway (No Connection to US 2 and Diamond Interchange at Mountain View Road) with VT 2A Spot Improvements

Based on roadway slope line limits, permanent encroachment on the FEMA 100-year floodplain and VANR Allen Brook floodway would total 2.0 and 1.8 acres respectively. Alternative 16c would impact riparian habitat at the Allen Brook and Redmond Creek crossings. Riparian habitat at the Winooski River would not be affected because the proposed bridge would span over the habitat. The Biological Resources Technical Report discusses wildlife habitat impacts, including riparian wildlife habitat impacts and mitigation in more detail.

In general, adverse impacts to flood storage and stream geomorphology would be avoided through the stormwater treatment practices that would be implemented as part of any of the Build Alternatives. For example, the Vermont Stormwater Management Manual provides standards for channel protection control (one-year storm), overbank flood control (ten-year storm), and extreme flood control (100-year storm) that would be met as part of the proposed project.

Alternative 17 – Circ A/B Boulevard with VT 2A Spot Improvements

Based on roadway slope line limits, permanent encroachment on the FEMA 100-year floodplain and VANR Allen Brook floodway would total 2.0 and 1.7 acres respectively. Alternative 17 would impact riparian habitat at the Allen Brook and Redmond Creek crossings. Riparian habitat at the Winooski River would not be affected because the proposed bridge would span over the habitat. The Biological Resources Technical Report discusses wildlife habitat impacts, including riparian wildlife habitat impacts and mitigation in more detail.

In general, adverse impacts to flood storage and stream geomorphology would be avoided through the stormwater treatment practices that would be implemented as part of any of the Build Alternatives. For example, the Vermont Stormwater Management Manual provides standards for channel protection control (one-year storm), overbank flood control (ten-year storm), and extreme flood control (100-year storm) that would be met as part of the proposed project.

4.7.3 Hybrid Alternatives

Alternative 18 – Four-Lane VT 2A with Signalized Intersection Improvements Plus Circ Street

Based on roadway slope line limits, permanent encroachment on the FEMA 100-year floodplain and VANR Allen Brook floodway would total 1.8 and 3.1 acres respectively. Alternative 18 would impact riparian habitat at the Allen Brook crossings (VT 2A and Circ Street crossings) and the VT 2A Winooski River crossing. The Biological Resources Technical Report discusses wildlife habitat impacts, including riparian wildlife habitat impacts and mitigation in more detail.

In general, adverse impacts to flood storage and stream geomorphology would be avoided through the stormwater treatment practices that would be implemented as part of any of the Build Alternatives. For example, the Vermont Stormwater Management Manual provides standards for channel protection control (one-year storm), overbank flood control (ten-year storm), and extreme flood control (100-year storm) that would be met as part of the proposed project.

Alternative 19 – Four-Lane VT 2A with Roundabouts Plus Circ Street

Based on roadway slope line limits, permanent encroachment on the FEMA 100-year floodplain and VANR Allen Brook floodway would total 1.8 and 3.1 acres respectively. Alternative 19 would impact riparian habitat at the Allen Brook crossings (VT 2A and Circ Street crossings) and the VT 2A Winooski River crossing. The Biological Resources Technical Report discusses wildlife habitat impacts, including riparian wildlife habitat impacts and mitigation in more detail.

In general, adverse impacts to flood storage and stream geomorphology would be avoided through the stormwater treatment practices that would be implemented as part of any of the Build Alternatives. For example, the Vermont Stormwater Management Manual provides standards for channel protection control (one-year storm), overbank flood control (ten-year storm), and extreme flood control (100-year storm) that would be met as part of the proposed project.

Alternative 23 – Tapered Widening on VT 2A with Signalized and Roundabout Intersections Plus Circ Street

Based on roadway slope line limits, permanent encroachment on the FEMA 100-year floodplain and VANR Allen Brook floodway would total 1.7 and 3.0 acres respectively. Alternative 23 would impact riparian habitat at the Allen Brook crossings (VT 2A and Circ Street crossings) and the VT 2A Winooski River crossing. The Biological Resources Technical Report discusses wildlife habitat impacts, including riparian wildlife habitat impacts and mitigation in more detail.

In general, adverse impacts to flood storage and stream geomorphology would be avoided through the stormwater treatment practices that would be implemented as part of any of the Build Alternatives. For example, the Vermont Stormwater Management Manual provides standards for channel protection control (one-year storm), overbank flood control (ten-year storm), and extreme flood control (100-year storm) that would be met as part of the proposed project.

4.8 Summary of Impacts and Mitigation

4.8.1 VT 2A Alternatives

Alternative 2 – Four-Lane VT 2A with Signalized Intersection Improvements

Alternative 2 would involve construction on 5.3 acres of highly erodible soils, and negligible change in sediment loadings to Allen Brook. Deicing salt loadings to streams would increase proportionally to the increase in roadway surface. Impacts will be minimized through the use of measures described in an Erosion Prevention and Sediment Control Plan for construction impacts and stormwater treatment practices for post-construction stormwater impacts. Deicing salt is typically not removed by stormwater treatment practices, but deicing salt impacts can be controlled by adherence to the annual VTrans Operations Snow and Ice Control Plan.

Alternative 3 – Four-Lane VT 2A with Roundabouts

Alternative 3 would involve construction on 4.8 acres of highly erodible soils, and negligible change in sediment loadings to Allen Brook. Deicing salt loadings to streams would increase proportionally to the increase in roadway surface. Impacts will be minimized through the use of measures described in an Erosion Prevention and Sediment Control Plan for construction impacts and stormwater treatment practices for post-construction stormwater impacts. Deicing salt is typically not removed by stormwater treatment practices, but deicing salt impacts can be controlled by adherence to the annual VTrans Operations Snow and Ice Control Plan.

Alternative 22 – Tapered Widening on VT 2A with Signalized and Roundabout Intersections

Alternative 22 would involve construction on 5.0 acres of highly erodible soils, and negligible change in sediment loadings to Allen Brook. Deicing salt loadings to streams would increase proportionally to the increase in roadway surface. Impacts will be minimized through the use of measures described in an Erosion Prevention and Sediment Control Plan for construction impacts and stormwater treatment practices for post-construction stormwater impacts. Deicing salt is typically not removed by stormwater treatment practices, but deicing salt impacts can be controlled by adherence to the annual VTrans Operations Snow and Ice Control Plan.

4.8.2 Circ A/B Alternatives

Alternative 16a – Circ A/B Limited Access Highway (No Connection to US 2 and Trumpet Interchange at Redmond Road) with VT 2A Spot Improvements

Alternative 16a would involve construction on 11.7 acres of highly erodible soils, and negligible change in sediment loadings to Allen Brook. Deicing salt loadings to streams would increase proportionally to the increase in roadway surface. Impacts will be minimized through the use of measures described in an Erosion Prevention and Sediment Control Plan for construction impacts and stormwater treatment practices for post-construction stormwater impacts. Deicing salt is typically not removed by stormwater treatment practices, but deicing salt impacts can be controlled by adherence to the annual VTrans Operations Snow and Ice Control Plan.

Alternative 16b – Circ A/B Limited Access Highway (Partial Cloverleaf Interchange at US 2 and Trumpet Interchange at Redmond Road) with VT 2A Spot Improvements

Alternative 16b would involve construction on 14.0 acres of highly erodible soils, and a less than one-percent change in sediment loadings to Allen Brook. Deicing salt loadings to streams would increase proportionally to the increase in roadway surface. Impacts will be minimized through the use of measures described in an Erosion Prevention and Sediment Control Plan for construction impacts and stormwater treatment practices for post-construction stormwater impacts. Deicing salt is typically not removed by stormwater treatment practices, but deicing salt impacts can be controlled by adherence to the annual VTrans Operations Snow and Ice Control Plan.

Alternative 16c – Circ A/B Limited Access Highway (No Connection to US 2 and Diamond Interchange at Mountain View Road) with VT 2A Spot Improvements

Alternative 16c would involve construction on 11.7 acres of highly erodible soils, and a less than one-percent change in sediment loadings to Allen Brook. Deicing salt loadings to streams would increase proportionally to the increase in roadway surface. Impacts will be minimized through the use of measures described in an Erosion Prevention and Sediment Control Plan for construction impacts and stormwater treatment practices for post-construction stormwater impacts. Deicing salt is typically not removed by stormwater treatment practices, but deicing salt impacts can be controlled by adherence to the annual VTrans Operations Snow and Ice Control Plan.

Alternative 17 – Circ A/B Boulevard with VT 2A Spot Improvements

Alternative 17 would involve construction on 11.5 acres of highly erodible soils, and negligible change in sediment loadings to Allen Brook. Deicing salt loadings to streams would increase proportionally to the increase in roadway surface. Impacts will be minimized through the use of measures described in an Erosion Prevention and Sediment Control Plan for construction impacts and stormwater treatment practices for post-construction stormwater impacts. Deicing salt is typically not removed by stormwater treatment practices, but deicing salt impacts can be controlled by adherence to the annual VTrans Operations Snow and Ice Control Plan.

4.8.3 Hybrid Alternatives

Alternative 18 – Four-Lane VT 2A with Signalized Intersection Improvements Plus Circ Street

Alternative 18 would involve construction on 6.9 acres of highly erodible soils, and a less than one-percent change in sediment loadings to Allen Brook. Deicing salt loadings to streams would increase proportionally to the increase in roadway surface. Impacts will be minimized through the use of measures described in an Erosion Prevention and Sediment Control Plan for construction impacts and stormwater treatment practices for post-construction stormwater impacts. Deicing salt is typically not removed by stormwater treatment practices, but deicing salt impacts can be controlled by adherence to the annual VTrans Operations Snow and Ice Control Plan.

Alternative 19 – Four-Lane VT 2A with Roundabouts Plus Circ Street

Alternative 19 would involve construction on 6.4 acres of highly erodible soils, and a less than one-percent change in sediment loadings to Allen Brook. Deicing salt loadings to streams would increase proportionally to the increase in roadway surface. Impacts will be minimized through the use of measures described in an Erosion Prevention and Sediment Control Plan for construction impacts and stormwater treatment practices for post-construction stormwater impacts. Deicing salt is typically not removed by stormwater treatment practices, but deicing salt impacts can be controlled by adherence to the annual VTrans Operations Snow and Ice Control Plan.

Alternative 23 – Tapered Widening on VT 2A with Signalized and Roundabout Intersections Plus Circ Street

Alternative 23 would involve construction on 6.5 acres of highly erodible soils, and a less than one-percent change in sediment loadings to Allen Brook. Deicing salt loadings to streams would increase proportionally to the increase in roadway surface. Impacts will be minimized through the use of measures described in an Erosion Prevention and Sediment Control Plan for construction impacts and stormwater treatment practices for post-construction stormwater impacts. Deicing salt is typically not removed by stormwater treatment practices, but deicing salt impacts can be controlled by adherence to the annual VTrans Operations Snow and Ice Control Plan.