

Fitzgerald Environmental Associates, LLC.

Applied Watershed Science & Ecology

**Town of Richmond Phase I
Stream Geomorphic Assessment Report
DRAFT**

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Prepared for:

Chittenden County Regional Planning Commission
South Burlington, Vermont

1.0 Executive Summary

This report summarizes data collected by Fitzgerald Environmental Associates, LLC. for three small tributary watersheds draining directly to the Winooski River in the Town of Richmond, Vermont. The watersheds have been named according to their proximity to Richmond Town roads, as follows: Governor Peck Road Tributary; Jericho Road Tributary; Stage Road Tributary. The watersheds have drainage areas of 2.6, 1.9 and 1.4 square miles, respectively. The three tributaries were identified for assessment by the Town of Richmond and the Chittenden County Regional Planning Commission, and the Phase 1 approach of the VTANR Stream Geomorphic Assessment (SGA) Protocol (VTDEC, 2006) was utilized for data collection and analysis.

The Governor Peck Road Tributary watershed contains a mix of agricultural, forested, and low to medium-density residential land use with a low degree of urbanization (3.7% impervious cover). The mainstem channel network is largely characterized by high-gradient reaches with gravel and cobble substrate found in unconfined valley settings. The primary stressors to geomorphic stability and habitat conditions in the watershed include: 1) historic impacts to the channel boundary conditions (e.g., straightening) in the lower watershed; 2) current impacts from encroachment of residential and commercial land uses on the stream corridor along Governor Peck Road; 3) undersized culverts associated with upper Governor Peck Road crossings. Based on the results of the Phase 1 analysis, a total of 7 reaches have been identified for future assessment using the SGA Phase 2 approach.

The Jericho Road Tributary watershed also contains a mix of agricultural, forested, and low to medium-density residential land use with a low degree of urbanization (2.8% impervious cover). The mainstem channel network is largely characterized by high-gradient reaches with cobble substrate and steep valley side slopes. The primary stressors to geomorphic stability and habitat conditions in this tributary watershed include: 1) historic impacts to the channel boundary conditions (e.g., straightening) in the lower watershed; 2) aggradation of fine sediment in the middle reaches caused by road (and ATV trail) runoff, floodplain reduction along the Old Jericho Road Trail, and large-scale mass wasting. Based on the results of the Phase 1 analysis, a total of 6 reaches have been identified for future assessment using the SGA Phase 2 approach.

The Stage Road Tributary watershed contains a mix of forested and low-density residential land use with a very low degree of urbanization (1.7% impervious cover). The mainstem channel network is characterized by high-gradient reaches with cobble substrate and steep valley side slopes, with the exception of two depositional reaches in

the lower watershed. The primary stressors to geomorphic stability and habitat conditions in this tributary watershed are channelization, straightening and river corridor development in the lower watershed. Based on the results of the Phase 1 analysis, a total of 3 reaches have been identified for future assessment using the SGA Phase 2 approach.

Additional recommendations for data analysis beyond the SGA Phase 2 approach include the development of rainfall-runoff models for those reaches where culverts have been identified as problematic and potentially undersized. Little additional effort would be required to develop the data needed to run the rainfall-runoff models (much of the data has been generated through the Phase 1 analysis), and the resulting discharge data would provide a sound basis for prioritizing structures for replacement for the Town of Richmond. This approach is described in further detail in the conclusions in Section 7.0.

2.0 Introduction:

The Town of Richmond and the Chittenden County Regional Planning Commission (CCRPC) identified three tributaries watersheds within Richmond for assessment of fluvial geomorphic condition and erosion hazards. Fitzgerald Environmental Associates, LLC. (FEA) was retained by CCRPC to carry out a Phase 1 assessment following the Stream Geomorphic Assessment (SGA) Protocols developed by VTANR. The Phase 1 SGA approach results in watershed-scale data about the landscape (e.g., soils and land cover) and the stream channel (e.g., slope and form), providing a basis for understanding the natural and human-impacted conditions within the watershed. The SGA data also aids in the identification of specific stressors affecting the physical conditions of the stream channels and structures (e.g., bridges and culverts) within watersheds.

Each of the three tributary watersheds has a drainage area less than 3 square miles and outlets directly to the Winooski River in Richmond. The tributary watersheds were previously unnamed, and were named during this analysis according to their proximity to Richmond Town roads. The SGA convention for reach numbering is consistent with that used in the analysis of the Winooski mainstem, where the “R” refers to the Winooski River reach where each small tributary (S) enters. Separate summaries of the watershed data are provided below for the three tributaries. These summaries include descriptions of the watershed zones and specific reaches where land cover and soils characteristics indicate potential areas for channel adjustments and fluvial erosion hazards. Following these descriptions are recommendations for future monitoring and data collection that would aid in the identification of projects that that could protect, sustain, or restore fluvial geomorphic equilibrium conditions, through the implementation of either passive or active stream corridor management strategies.

Tables summarizing the data compiled through the Phase 1 analysis are found in Appendix B. These tables include summaries of the watershed land use and land cover (Table 1), the physical conditions and reference stream types in the watershed (Table 2), impact ratings and priorities for future assessment (Table 3), and predicted stream channel adjustment processes (Tables 4). The relative reach impact score within each watershed was evaluated to determine the priority for future Phase 2 assessment. Generally, reaches with higher impact scores received a higher priority ranking. However some reaches with low impact scores were considered high priorities for future assessment if they contain problematic stream crossings (e.g., culverts), or had channel adjustment processes observed during the windshield surveys that warrant further investigation. Data specific to each reach are summarized in the reach summary sheets in Appendix C. These data form the basis for the impact ratings and prioritization as described above.

3.0 Governor Peck Road Tributary Watershed (R8.S1)

The Governor Peck Road Tributary watershed is found in the northwestern part of Richmond and extends into the town of Jericho in the vicinity of Browns Trace Road (see map in Appendix A). The watershed encompasses an area of 2.6 square miles, with 4.5 miles of stream channel along the mainstem from the headwaters to the outlet. The overall slope of the mainstem channel is 2.9%, reflecting the moderate to high-gradient nature of a majority of the reaches in the watershed. One additional subtributary draining a residential area along Sunset Ridge Road was included in the analysis (R8.S1.04-S1).

The land use within this tributary watershed is dominated by forested and agricultural areas, with a mix of low and medium-density residential and commercial land along Governor Peck Road. Currently the impervious cover of the watershed is 3.7%, below levels (5-10%) associated with decline of channel stability and biotic integrity in small watersheds in Chittenden County (Fitzgerald, 2007).

The surficial geology of the watershed is dominated by lacustrine clays deposited during the early Holocene when Lake Vermont occupied much of the Champlain Valley and persisted at an elevation of 620 feet above sea level for approximately 4,000 years (Wright, 2003). Some areas of glacial till and alluvial substrates are also found in the headwaters zone and near the tributary outlet to the Winooski River, respectively. In the lower part of the watershed, the highly erosive properties of the soils have led to the development of steep valley side walls in two low-gradient reaches. These reaches are characterized by narrow, meandering gravel-bottomed channels found within unconfined

valleys with recurring beaver ponding. In the middle and upper reaches of the watershed where glacial till is present and the channel slopes are greater, coarse-bottomed (e.g., gravel and cobble) channels are found in mostly confined valley settings.

Below are narrative descriptions of three zones of the Governor Peck Road Tributary watershed summarized during the Phase 1 analysis:

Upper Watershed Zone (R8.S1.06 through R8.S1.08)

The upper watershed zone of this tributary area above Browns Trace Road and south of Milo White Road is occupied by forested terrain that has been only minimally impacted by low-density residential development. Due to the steep topography of this watershed zone, B and C-type channels (Rosgen, 1994) are found where the valley setting is more confined and substrates are coarser. Due to the limited human impacts in this watershed zone, no reaches have been identified from the Phase 1 analysis as having a high priority for further assessment, but recommendations have been made for the Phase 2 assessment of two reaches with medium priority (see Section 6.0).

Middle Watershed Zone (R8.S1.03-R8.S1.05; R8.S1.04-S1)

The middle zone of the watershed is found along Governor Peck Road up to the crossing with Browns Trace Road. Throughout the middle zone of the watershed most of the mainstem reaches are characterized by coarse-bottomed channels with B and C-type geometry found in unconfined and semi-confined valley settings. The subtributary stemming from the fourth mainstem reach (R8.S1.04-S1) is found in very steep terrain (channel slopes greater than 5%) in a confined valley setting. Impacts from road encroachment, two undersized culverts, and stormwater runoff concentrated by roadside ditches were observed along the Governor Peck Road during the windshield survey. Few impacts from the residential area associated with Sunset Ridge Road were noted. From the Phase 1 analysis, two reaches from this watershed zone have been identified as having high impact ratings and high priorities for further assessment.

- **R8.S1.03:** This mainstem reach is found to the east of Governor Peck Road upstream of an area of historic beaver activity. The reach is characterized by a moderate-gradient, gravel-bottomed channel with C-type geometry. This reach has received a high impact rating due to the observed changes in planform (28% of the reach has been straightened),

and the road encroachment which has led to a reduced floodplain and corridor. Some depositional features were observed during the field visit (Figure 1), indicating the potential for future lateral adjustments.



Figure 1. Depositional feature in reach R8.S1.03

- **R8.S1.05:** This mainstem reach is found along Governor Peck Road from the confluence with the subtributary upstream to where the channel bends to the east away from the road. The reach is characterized by a moderate-gradient, gravel-bottomed channel with C-type geometry. This reach has received a high impact rating due to the encroachments, stormwater discharges, and undersized culverts associated with Governor Peck Road. Two culvert crossings appear to be inadequately sized, resulting in aggradation of sediment above the structure and scour below. One roadside drainage along Governor Peck Road enters main channel in upper reach and delivers significant amounts sediment to the downstream section. Numerous depositional features were observed during the field visit (Figure 2), indicating the potential for future lateral adjustments. Despite these impacts, numerous brook trout were observed in the reach in plunge pools (at the culvert outfalls) during August, indicating that reach provides important cold water refugia for trout in late summer.



Figure 2. Depositional features in reach R8.S1.05

Lower Watershed Zone (R8.S1.01 & R8.S1.02)

The lower watershed zone is found from the outlet to the Winooski River up to the reach break with R8.S1.03. In this watershed zone the channel slope lessens, maintaining a highly sinuous planform (in the absence of straightening) with E-type channel geometry. Although no beaver activity was observed during the windshield surveys in this watershed zone, a review of aerial photography from 1999 and 2003 suggests that beaver ponding occurs frequently in reach R8.S1.02. Impacts to channel stability were noted due to encroachment on the stream corridor by the road and adjacent commercial land uses, as well as historic straightening associated with the Verberg farm near the outlet. Numerous meander migrations in reach R8.S1.02 suggest that the channel is active in its lateral migration, perhaps in partial response to beaver influences. From the Phase 1 analysis, both reaches have been identified as having high impact ratings and high priorities for further assessment.

- **R8.S1.01:** This mainstem reach is found from the outlet to the Winooski River up to the reach break approximately 250 feet upstream of the I-89 culvert inlet. This reach has had severe historic impacts to the planform (44% of the channel has been straightened). In addition, a section of the reach in the vicinity of the I-89 crossing lacks a vegetative buffer greater than 25 feet, which likely elevates surface water temperatures during the summer months due to lack of canopy cover.



Figure 3. Stormwater outfall and lack of woody vegetative buffer in R8.S1.01

- **R8.S1.02:** This reach is found from the reach break with R8.S1.01 up to an area of historic beaver activity along Governor Peck Road. Although this reach has had limited direct impacts to the channel boundary conditions (channel straightening in 15% of reach), its changes in planform and abundant depositional features indicate that it is undergoing significant lateral migration. Additionally, the adjacent commercial and industrial land use in the lower reach is causing significant fine sediment delivery to the channel (Figure 4).

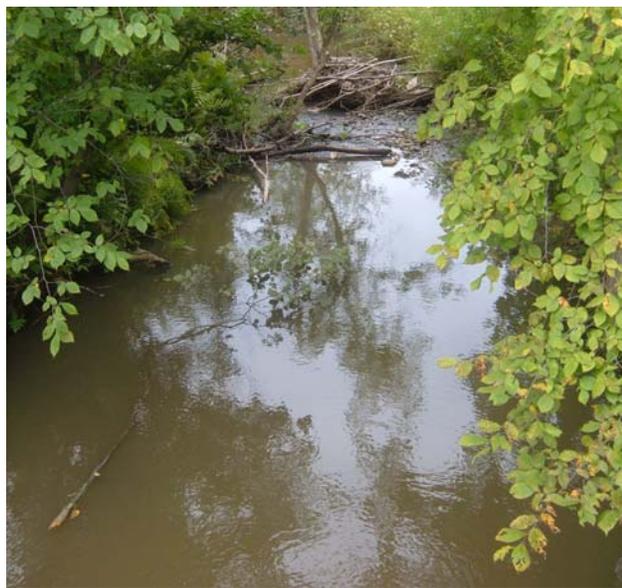


Figure 4. Suspended sediments in lower R8.S1.02 during baseflow conditions.

4.0 Jericho Road Tributary Watershed (R8.S2)

The Jericho Road Tributary watershed is also found in the northwestern part of Richmond (see map in Appendix A). The watershed encompasses an area of 1.9 square miles, with 2.7 miles of stream channel along the mainstem from the headwaters to the outlet. The overall slope of the mainstem channel is 5.4%, reflecting the high-gradient nature of a majority of the reaches in the watershed. Three additional small subtributaries stemming from the mainstem were included in the analysis.

The land use within this tributary watershed is dominated by forested and agricultural areas, with a mix of low and medium-density residential land along Jericho Road. Currently the impervious cover of the watershed is 2.8%, below levels (5-10%) associated with decline of channel stability and biotic integrity in small watersheds in Chittenden County (Fitzgerald, 2007).

The surficial geology of the watershed is very similar to that described for the Governor Peck Road tributary; it is dominated by lacustrine clays in the lower watershed with areas of glacial till and alluvial substrates found in the headwaters zone and near the tributary outlet to the Winooski River, respectively. With the exception of two reaches, much of the watershed is characterized by steep topography and sediment transport reaches with A and B-type geometry. The lowermost reach upstream of the outlet (R8.S2.01) is a low gradient, sand-bottomed channel with E-type geometry. Reach R8.S2.05, found just upstream of the Jericho Road crossing, is moderate-gradient, gravel-bottomed channel with C-type geometry.

Below are narrative descriptions of three zones of the Jericho Road Tributary watershed summarized during the Phase 1 analysis:

Upper Watershed Zone (R8.S2.05, R8.S2.06, R8.S2.05-S1)

The upper watershed zone of this tributary area above the Jericho Road crossing is occupied by forested terrain that has been only minimally impacted by low-density residential development. Due to the steep topography of this watershed zone, A-type channels are found where the valley setting is more confined and substrates are coarser. However, the reach immediately above the Jericho Road crossing (R8.S2.05) is found in an unconfined setting with C-type geometry. Due to the channel straightening associated with an adjacent pond, this reach has a medium priority and has been recommended for further assessment.

Middle Watershed Zone (R8.S2.02-R8.S2.04)

The middle zone of the watershed is found above the I-89 crossing up to the crossing with Jericho Road. Throughout this watershed zone the mainstem reaches are characterized by coarse-bottomed channels with A and B-type geometry found in confined valley settings. The two subtributaries stemming from the second (R8.S2.02.S1) and third mainstem (R8.S3.02.S1) reaches are found in very steep terrain (channel slopes greater than 5%) in confined valley settings. Sedimentation impacts from road and ATV trail encroachment (Figure 5) and failing valley side slopes were observed in this watershed zone during the windshield survey. Although no reaches have been identified as having high impact ratings, four reaches impacted by the stressors described above have a medium priority for further assessment, and are included in the list of recommended reaches for Phase 2 assessment in Section 6.0 of this report.

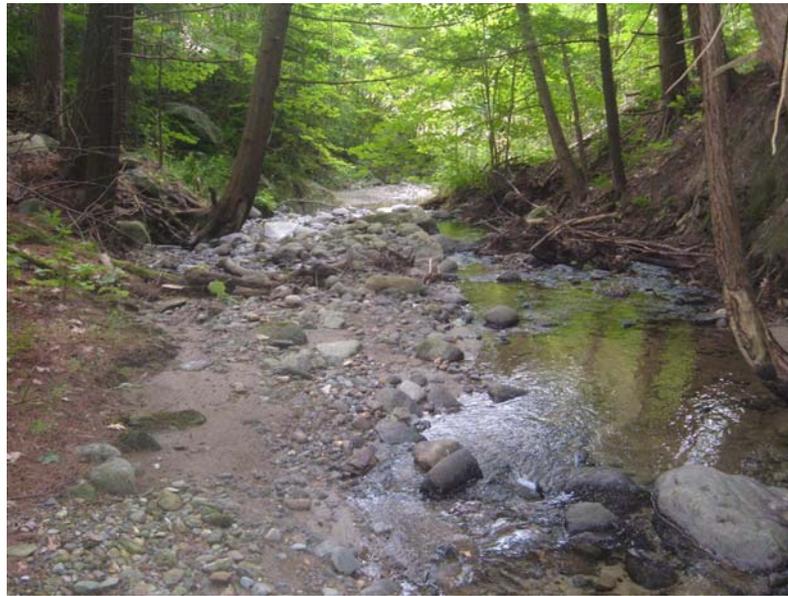


Figure 5. Deposition of fine sediments in R8.S2.02

Lower Watershed Zone (R8.S2.01)

The lower watershed zone is encompassed by a single reach, R8.S2.01. This reach is found in the alluvial setting of the historic Winooski River floodplain where the mainstem channel slope is much less than upslope reaches (reach slope is 0.6%) and agriculture has impacted the channel planform and buffer conditions for over a century. This reach has been identified as having a high impact rating and a high priority for further assessment.



Figure 6. Coarse substrate downstream of Rt. 2 crossing in reach R8.S2.01

- **R8.S2.01:** This mainstem reach is found from the outlet to the Winooski River up to the reach break approximately 150 feet downstream of the I-89 culvert outlet. The channel is characterized by E-type geometry with sand substrates, with the exception of an area of coarse substrate downstream of the Route 2 crossing (Figure 6). This reach has had severe historic impacts to the planform (68% of the channel has been straightened). In addition, much of the reach lacks a vegetative buffer greater than 25 feet, which likely contributes to the direct input of sediment and nutrients from the adjacent agricultural fields, and also elevates surface water temperatures during the summer months due to lack of canopy cover.

5.0 Stage Road Tributary Watershed (R9.S2)

The Stage Road Tributary watershed is found in the eastern part of Richmond and extends into the town of Bolton east of Stage Road (see map in Appendix A). The watershed encompasses an area of 1.4 square miles, with 2.1 miles of stream channel along the mainstem from the headwaters to the outlet. The overall slope of the mainstem channel is 5.0%, reflecting the very high gradient of a majority of the reaches in the watershed. One additional subtributary draining a forested area to the east of Stage Road was included in the analysis (R9.S2.04-S1).

The land use within this tributary watershed is dominated by forested areas, with some agricultural land in the lower watershed along Route 2 and some low-density residential

land along Stage Road. Currently the impervious cover of the watershed is 1.7%, well below levels (5-10%) associated with decline of channel stability and biotic integrity in small watersheds in Chittenden County (Fitzgerald, 2007).

The surficial geology of the watershed is very different from the two other tributaries to the west. With the exception of an area of alluvial soils associated with the historic Winooski River floodplain in the lower reaches, the watershed soils are dominated by glacial till and some areas of exposed bedrock where the terrain is very steep (slope greater than 15%). Upslope of the alluvial setting in the lower watershed, most reaches are characterized by coarse-bottomed (e.g., gravel and cobble) channels found in confined valley settings.

Below are narrative summaries of two zones of the Stage Road Tributary watershed summarized during the Phase 1 analysis:

Upper Watershed Zone (R9.S2.04 – R9.S2.07)

The upper watershed zone of this tributary along Stage Road is occupied by forested terrain that has been only minimally impacted by low-density residential development. Due to the steep topography of this zone, A and B-type channels are found where the valley setting is more confined and cobble, boulder, and bedrock substrates are present. Numerous grade controls were observed in reach R9.S2.04 during the field visit. One unconfined reach (R9.S2.06) with C-type geometry is found in the upper watershed to the west of Stage Road. Due to the limited human impacts in this watershed zone, and the absence of problematic stream crossings, no reaches have been identified from the Phase 1 analysis for further assessment.

Lower Watershed Zone (R9.S2.01-R9.S2.03)

The lower zone of the watershed is found from the tributary outlet to the Winooski River up to a change in valley slope at the reach break with R9.S2.04. The first (R9.S2.01) and third (R9.S2.03) reaches are similar in their confinement and stream type geometry. Both reaches are found in unconfined valley settings and have C-type geometry with coarse bed substrates. The second reach (R9.S2.02) has been severely altered by the I-89 culvert crossing, resulting in a straightened channel with a steep slope and confined valley setting. The channel impacts noted in this zone include channel straightening, encroachment from agricultural and residential land uses, and depositional features causing lateral

channel migration. From Phase 1 analysis, all three reaches from this watershed zone have been identified as having high impact ratings and high priorities for further assessment.

- **R9.S2.01:** This reach is found from the tributary outlet up to a 90 degree bend in the channel at the upstream reach break. The reach is characterized by a low-gradient, sand and gravel-bottomed channel with C-type geometry. This reach has received a high impact rating due to the observed changes in planform (20% of the reach has been straightened), the encroachment on the corridor by adjacent agricultural and residential land, and the depositional features causing lateral channel migration. In addition, the channel was observed to be dry during the field visit in August, 2007 (Figure 7).



Figure 7. Dry channel below Rt. 2 box culvert in reach R9.S2.01

- **R9.S2.02:** This mainstem reach is found from the downstream reach break up to the I-89 culvert inlet. The reach is characterized by a high-gradient, cobble-bottomed channel with B-type geometry. This reach has received a high impact rating due to the impacts associated with the I89 culvert, which has straightened over 90% of the channel. Although a Phase 2 assessment of this reach is only appropriate for the unchannelized lower section, this part of the reach (found in a residential area) should be

assessed to determine if fluvial erosion hazards exist downstream of the I-89 culvert outfall.

- **R9.S2.03:** This reach is found from the I-89 culvert inlet up to a change in valley slope and confinement at the upstream reach break. The reach is characterized by a low-gradient, gravel-bottomed channel with C-type geometry. This reach has received a high impact rating due to the observed changes in planform (40% of the reach has been straightened), the encroachment on the corridor by adjacent residential land, and the depositional features causing lateral channel migration.

6.0 Future Assessment Recommendations

Based on the results of the Phase 1 analysis, 15 tributary reaches and 1 subtributary reach have been selected for recommendation for further assessment (see priority rankings in Appendix B; Table 3) using the Phase 2 approach of the SGA protocols (including bridge and culvert assessments).

- **Governor Peck Road Tributary:** Seven reaches are recommended for further Phase 2 assessment in this watershed:
 - **Reaches R8.S1.01 to R8.S1.03 (high priority)** should be investigated in further detail to determine the impacts of historic straightening and a lack of vegetative buffer, and to evaluate the potential for stream corridor protection given the encroachment of agricultural, commercial, and residential land uses. This effort would also involve landowner outreach to assess the social constraints to stream restoration.
 - **Reach R8.S1.04 (medium priority)** should be assessed to determine the connectivity of adjustments along the channel network, as a high degree of lateral channel migration was observed in the upstream reach.
 - **Reach R8.S1.05 (high priority)** contains two culvert beneath Governor Peck Road which appear to be undersized. The culverts should be assessed to determine whether they are a priority for the replacement by the Town of Richmond. In addition, one problematic stormwater discharge was noted (previously described), and multiple depositional features were noted throughout the reach.
 - **Reaches R8.S1.06 & R8.S1.07 (medium priority)** are priority reaches for assessment due to the high degree of lateral migration observed in the downstream reach (R8.S1.05), and the possibility of these impacts being longitudinally-connected to reaches upstream. In addition, given that

brook trout appear to be using this tributary as cold-water refugia in the summer months, assessment of habitat in the upper reaches is recommended.

- **Jericho Road Tributary:** Six reaches are recommended for further Phase 2 assessment in this watershed:
 - **Reach R8.S2.01 (high priority)** should be investigated in further detail to determine the impacts of historic straightening and a lack of vegetative buffer, and to evaluate the potential for stream corridor protection given the encroachment of agricultural and residential land uses. This effort would also involve landowner outreach to assess the social constraints to stream restoration.
 - **Reaches R8.S2.02 to R8.S2.04 (medium priority)** should be assessed to investigate the sedimentation impacts from road and ATV trail encroachment and failing valley side slopes that were observed during the windshield survey. In addition, the I-89 culvert should be evaluated for impediments to fish passage, given that no brook trout were observed in this tributary during August (unlike in the Governor Peck Road tributary).
 - **R8.S2.05 (medium priority)** should be assessed to evaluate the impacts of channel straightening resulting from the construction of a pond in the stream corridor. The straightening through this depositional reach may be resulting in additional sediment delivery to downstream reaches.
 - **Reach R8.S2.02-S1.01 (medium priority)** is a small subtributary which drains a residential area along Southview Drive and Joan Ave. One headcut was noted in the channel just upstream of the confluence with reach R8.S2.02, and may be a source of fine sediment for the mainstem reaches.

- **Stage Road Tributary:** Three reaches are recommended for further Phase 2 assessment in this watershed:
 - **Reach R9.S2.01 & R9.S2.03 (high priority)** should both be investigated in further detail to determine the impacts of historic straightening and a lack of vegetative buffer, and to evaluate the potential for stream corridor protection given the encroachment of agricultural and residential land uses. This effort would also involve landowner outreach to assess the social constraints to stream restoration.
 - **Reaches R9.S2.02 (high priority)** should also be assessed to determine if fluvial erosion hazards exist downstream of the I-89 culvert outfall.

7.0 Conclusions

The Phase 1 approach for the Richmond tributary watersheds has provided initial data to describe the topographic, geologic and anthropogenic settings within the Town of Richmond. The overall conditions within the Governor Peck Road Tributary watershed vary significantly depending on the adjacent land use (historic and current) and the presence or absence of undersized culverts. Many reaches in this watershed are predicted to have significant channel adjustment processes with fair to poor geomorphic conditions. As a result, a total of 7 reaches have been recommended for future Phase 2 assessment. The overall conditions within Jericho Road Tributary watershed also vary significantly depending on the adjacent land use, historic channel straightening, and impacts from residential land use. Two reaches in this watershed are predicted to have significant channel adjustment processes with fair geomorphic conditions, and a total of five reaches have been recommended for future Phase 2 assessment. The overall conditions within Stage Road Tributary watershed are impacted in the lower watershed by the encroachment of agricultural and residential land use on the stream corridor, and by historic channel straightening. Three reaches in this watershed are predicted to have significant channel adjustment processes with fair to poor geomorphic conditions, and are recommended for future Phase 2 assessment.

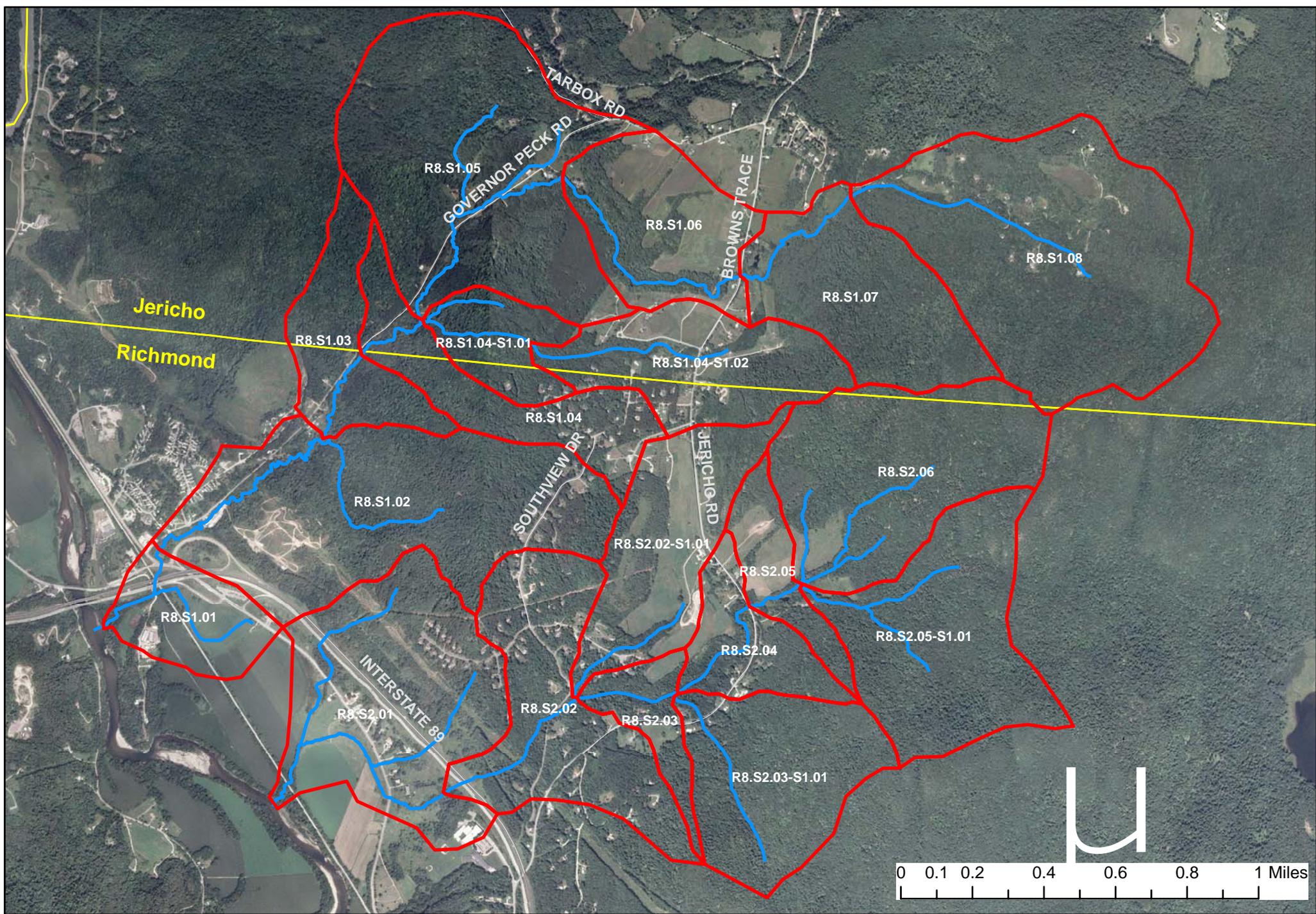
For the fifth mainstem reach in the Governor Peck Road Tributary (R8.S1.05), two undersized culverts appear to be dominant stressors on channel stability. Additional data describing the hydrologic regime (e.g., magnitude and frequency of discharge events) could be coupled with culvert survey data (ANR methods during Phase 2 assessment) to further evaluate and prioritize these structures. The Phase 1 data generated by this study provide a convenient basis for developing rainfall-runoff models (using the NRCS approach with the TR20 model) that can determine the peak flow rates through these structures during larger storm events. Much of the data required to develop these models is inherent in the Phase 1 results (including watershed areas, soils data, and land use), and little additional effort using GIS would be needed. It is recommended that discharge data for a spectrum of large storm events (10, 25 and 100 year return) be generated for these two stream crossings.

6.0 References

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APPENDIX A

SUBWATERSHED MAPPING



- Subwatershed Boundaries
- Surface Waters

Governor Peck Road and Jericho Road Tributaries Subwatershed Map



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