Lamoille Valley Rail Trail Engineering Assessment

INTRODUCTION

Project Background:

The General Assembly of the State of Vermont passed legislation effective in June 2002, and 2003, authorizing the state to enter into an agreement with the Vermont Association of Snow Travelers (VAST), and to construct and operate a year-round, multi-use recreation path. After federal railbanking legalities were concluded in 2004, VAST signed a lease agreement with the State of Vermont, Vermont Agency of Transportation (AOT or VTrans), on 10 February 2006 to construct, operate and maintain the rail trail. An interim management plan submitted by VAST was approved by VTrans on 14 March 2007 allowing VAST to begin activities associated with trail development. VAST is working under the supervision of the Local Transportation Facilities Section (LTF) of VTrans to develop the trail. Project development will comply with the LTF Guidebook and additional rules and procedures required by the Federal Highway Administration (FHWA) to qualify for, and utilize the federal funding available from the SAFETEA-LU (project # 2557), and authorized for this project.

The purpose of the **Engineering Assessment** (Part I) was to discover, document, and evaluate existing field conditions of all assets along the entire right-of-way (ROW) with respect to their utilization in, and impact on a proposed shared-use trail project. The purpose of the P**roposed Trail Alternative Description** (Part II) portion of this document is to provide a project work scope and construction methodology for the trail for use in project permitting, public comment, cost estimation, and eventual project design and construction.

Brief Railroad History, ROW characteristics, and Geography:

To appreciate the existing conditions of the ROW, and their impact on the project and its eventual construction, it is useful to review the history and geography of the St. Johnsbury and Lamoille County Railroad (StJ&LC). After the Civil War, railroad growth in the United States was rampant, and the Transcontinental Railroad would be completed in 1869. Dynamite was invented in 1867, and in that year a group of wealthy businessmen in St. Johnsbury, including scale magnate Horace Fairbanks, decided to build a railroad. Vermont in 1867 was, visually, a different state than now. The sheep raising period was past its peak, but most of the state had been cleared of trees by that time. The railroad envisioned would be built through predominately cleared areas, fields, and cropland. The railroad couldn't be justified on the basis of local freight or passenger traffic, but the possibility of becoming part of a “through route” between Portland, ME, and Ogdensburg, NY generated enough local interest to fund the construction of the line. After considerable fiscal difficulty the line between St. Johnsbury and Swanton was completed in 1877, in Fletcher.

A short geographical description of the line, written for the Abandonment and Discontinuance Document by VTrans: “The easterly terminus is in an industrial area on the south side of the village of St. Johnsbury (elevation 600 feet) which is located in the Passumpsic River valley. From St. Johnsbury the line climbs westward through hilly rural country. The line gains elevation for about 28 miles until Greensboro Bend (elevation 1,700 feet) where it crosses the Green Mountain range, passing from the watershed of the Connecticut River to that of Lake Champlain and the St. Lawrence River. Just west of Greensboro Bend the line begins to descend along the westward flowing Lamoille River, which it follows westerly for the next 36 miles to Cambridge Junction (elevation 462 feet). Just west of Cambridge Junction the line turns in a northwesterly direction proceeding across rolling countryside a distance of about 20 miles to Sheldon Junction (elevation 347 feet). At Sheldon Junction, the line begins to follow the westward-flowing Missisquoi River, along which the line continues another 12 miles to its westerly terminus at Swanton (elevation 157 feet) near Lake Champlain”.

The fiscal difficulties would not go away, and the railroad continued to struggle through a period of time in the country where, for everybody else, rail was king. By about 1920 the only significant upgrades on the line were to bridges, and that marked the end of any substantive work on the line’s infrastructure. By 1972 traffic on the line had to travel below 10 mph, and derailments were very common. The state assumed ownership in 1973 and limited attempts were made to improve the ballast and track but no significant work on drainage or clearing occurred. Most traffic had disappeared by about 1980; the track between Morristown and Swanton became inactive in the ‘80s and between St. Johnsbury and Morristown in the mid ‘90’s. Track and tie removal occurred in 2005.

The impacts of historic funding problems, and the landscape of Vermont, imprinted several important engineering characteristics on the ROW. Drainage structures- culverts- were probably designed for higher flows than are present today because the cleared lands of the mid-1800’s shed water at higher rates than the forests of today’s landscape. The tight curves, steep grades, and narrow ledge cuts and embankment fills of the railroad, especially the eastern half, were difficult and expensive to operate on, and maintain. Instability present in soils and slopes in some locations where cross-section geometry involved combination cut and fill was minimized or not considered by the designers. Regeneration of forests and the reintroduction of beavers to the state have altered the hydrologic playing field on many stretches of the ROW. The cuts, and some embankments, depending on their makeup, are very narrow, and hardly wide enough for one set of tracks. The ROW never received anything more than light ballast, and, most importantly, was only rarely maintained after 1920. Some tree diameters adjacent to the tracks now exceed 10" and the lateral ditch systems are, in many areas, silted out. Considerable damage to the ditches and the ballast has also occurred since the cessation of train traffic. Grading work done by the track and tie removal contractor, along with the truck traffic necessary to remove the track and ties, pushed ballast into the saturated subgrade, and the adjacent ditches. Today the majority of the ballasted surface resembles that of a town's Class 4 graveled road, rather that of a properly ballasted railroad bed. New steel bridges installed between the 1890's and the 1920's were painted with red lead paint primer, and an overcoat of coal-tar paint. This coating system is exceptionally long-lasting, but on all the StJ&LC bridges is almost completely worn away to bare steel. Rust on a few of these structures is beginning to pop rivets.

References and Acknowledgements:

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PART I: TRAIL ASSESSMENT

Assessment Methodology:

The VAST Reconnaissance Team utilized to investigate the ROW generally consisted of a GPS specialist, an engineer- photographer, a feature locater, and an individual 'local' to the area being traversed. These 'locals' were of great assistance in identifying roads and trails, private property, and other unique aspects of the local needed to accurately portray the conditions in the field. Activities began in St. Johnsbury on 10 May 2007, and wrapped up with an 18th day of work on 13 August. The first six miles were walked by the crew, but all reconnaissance after that was accomplished on a "Ranger" ATV.

A high-quality GPS unit was used in tracking progress and logging data points. The unit utilized was a Trimble Navigation Limited Pro XR Receiver with a TSC1 System Controller and integrated GPS/MSK Beacon Antenna. The system is back-packable, and also easily mounts on the roof of the ATV. System Asset Surveyor Software recorded a point every three seconds while walking, and every second when driving, and triangulated 3 iterations for each data point identified and recorded. High resolution digital photographs were taken and written notes were also recorded for each feature or condition encountered. Data and photographs were downloaded at the end of each session to incorporate comments, and guaranty preservation. Also of significance, the Valuation Plans (Val Plans) were used to find culverts, and the culvert's locations were used to check the accuracy of the Valuation Plans. Individuals utilized as local 'experts' included, from east to west, Mr. Bryant Watson, Mr. Craig Kneeland, Mr. Ken Hoeppner, Mr. Irving Pollander, Mr. Dan Favreau, and Mr. Richard Thompson.

The results of this data collection effort are located in Part III; Appendices: Section A, Map Plans, Section B, Master Feature Listing, and Section C, Detailed Assessment Spreadsheets; 1) Culvert Listing, 2) Master Bridge Listing, 3) Saturated and Failed Ballast Listing, 4) Washout Listing, 5) Encroachment Listing, 6) Crossing and Contractor Access Listing, 7) Trash and Debris Listing, and 8) Preliminary Trailhead Listing. Assessment photos are listed in the appendices in Section D.

In general the Valuation Plans were found to be highly accurate. In many cases of extremely heavy vegetation the distance between a known and unknown culvert as indicated on the Valuation Plans would be entered into the GPS unit and the survey would stop at that distance only to find the unidentified culvert buried in the undergrowth. Errors between the Val Plans and the field are probably attributable to several drafting errors when the field data was transferred to paper.

Baseline References:

To put into perspective what to expect during the LVRT reconnaissance, visits were paid to the Northern Rail Trail in New Hampshire, and the Missisquoi Rail Trail in Vermont. The Northern Rail Trail is under development with some sections completed, and some sections still under construction. The “pre-rail trail” ROW in New Hampshire was in much better condition than the LVRT ROW, and the granite structures and accoutrements were of higher quality. Both cut granite mile markers were present as well as the “latest” generation (probably circa 1950) of such markers made of concrete specifically for the line. Granite culverts were of extremely high quality and signs of older maintenance activities on the structures were clearly evident (see Northern Rail Trail photos, Appendix D). Abundant ballast was present, and the cleared way was quite open and easy to walk. The Missisquoi Rail Trail, completed about ten years ago is holding up well, but is showing disturbing signs of a lack of maintenance (see Missisquoi Rail Trail photos, Appendix D). The bridges on the line are in good condition and the new bridge across the Missisquoi along with the guard fences at the ends are in excellent condition. However the gravel surface has largely grown over with grass, albeit mowed, and the ditches have been lost to underbrush. Small trees and saplings are growing out from the sides and the branches protrude into the trail area. Gates and traffic control devices had been installed on both trails at points intersecting town roads and state highways. In all cases, on both trails, the gates were damaged and broken, and open. New Hampshire representatives indicated they were no longer installing such equipment because of the cost, vandalism, and irrelevancy.

Existing LVRT Conditions:

In general the survey crew was very successful in finding or confirming the presence of all the features noted on the Val Plans, unlike past Edwards and Kelcey and VTrans investigations that only found about 32% of the culverts, and missed some of the bridges. Further, the condition of some of the bridges was better, and the number and severity of the washouts was less than expected (Many of the minor washouts were repaired as part of the track and tie removal project).

The crew had been warned to look for granite mile markers but none were observed. Most mile markers were found, but consisted either of 1940's-type concrete guard rail posts with a painted mile number or an "Agway" fence post with an aluminum plate bolted to the post with plastic mile lettering (see photo 395). Milepost 40 (photo 557), or what was found at about that location, appears to be granite, but also may be a broken fragment from a larger granite carving that was damaged, and used for embankment "fill". Of note was evidence that something hanging from a past train smashed into many of the mile markers of both types leaving only pieces on the ground. A few whistle posts were also found, but all were made of wood (probably cedar) and are in an advanced state of decay. Some culvert markers were in evidence also. They appear to be sections of 2 ½" iron pipe with one end stamped flat to accept a painted indicator.

Two "historic" structures were noted during the assessment. The first was a section house at station 1824+00, photo 506. In the entire 93 miles of trail, this was the only identified section house, and its overall condition, fair, made it stand out. It is on the ROW but well off the ballast and would not be influenced by any trail work. The second structure is the "Fisher Bridge", station 2037+16, photos 581-585, and its position on the trail is hard to ignore. Some maintenance and repair work is necessary on the western embankment, but the bridge would not be affected by the trail, except for the rails on the deck of the bridge. That will be covered in the Alternatives section of this document. There may be other structures having significant historic value within the ROW of the StJ&LC Railroad but their physical location is well off the ballast, and they weren't identified.

Another indicator of Vermont's past, old wire fencing, was found almost everywhere, including the middle of remote forests, along the edge of the ROW, generally on the ground, but sometimes in the middle of very old trees. This is a further verification of the activities and landscape present when the railroad was constructed. Several miles of newer, barb-wire fencing was also observed in the western reaches of the LVRT. This fencing, placed by abutting farmers, serves to keep their livestock from roaming free. Much of this fence is located at the edge of the ballast, and will have to be moved further away, beyond the lateral ditches, to allow construction and operation of the trail. A small cache of old track was also found in East Hardwick (photo EPT 9004). It appears to be the original weight rail used to construct the line, perhaps in the 1800's. Further investigation will be needed to confirm the weight and age, and the rail will need to be secured to keep it from being stolen for its scrap value.

Road Bed Conditions:

Probably the first canon a civil engineer learns is, "A road is only as good as its subbase, and water is its natural enemy". Owners and maintainers of the StJ&LC have ignored this dictum for decades, and, barring missing bridges, wet and failed (as in: structurally failed) ballast is the single worst problem of the ROW today. An analysis of the visual data collected on the survey indicates that an average of 16% of the stationing on the line have wet or failed ballast. On the eastern end this percentage is over 25% (see next page, and Appendices, Section C. 3). The situation in some areas is serious enough that only tracked equipment can likely navigate the ballast surface without getting stuck. Visual inspections usually miss many subsurface problems so the actual amount of ballast unable to support any traffic may be much greater.

As previously stated, this is not a recent problem. Anecdotal evidence in the history of the railroad points to a historic lack of funding for ballast, and to sufficiently grade, drain, compact the ballast and subgrade. Also, the subgrade materials exposed in some embankments reveal that the builders used some very unsuitable material in the construction of these works. Recent rail and tie removal activity caused additional damage, although had the roadbed been dry these activities would likely not have been a problem.

Once ballast has been pushed into a wet subgrade there are no easy or inexpensive solutions for recouping the ballast. The first concern must be to dry the subgrade, and then regrade and recompact the material. To dry the subgrade, its section must be significantly higher than the bottom of the lateral ditches alongside the ballast.

A more recent threat to the roadbed is the reintroduction of the beaver to Vermont and the damage that is occurring on many sections of the ROW. Of particular note is the seven mile stretch between the route 109 crossing at Cambridge Junction (station 3394+00) and the ROW crossing of Lost Nation Road in Bakersfield (station 3768+00). Within that area almost entire valley floors have been turned into shallow wetlands in some locations and beaver dams parallel the ballast, sometimes crossing it, for hundreds of feet. Remarkably, bearing capacity hasn't been completely compromised and beaver activity hasn't placed much of the ballasted surface under water (see photos 1032-1110).

Floodplain Restoration Projects:

The Vermont Agency of Natural Resources (ANR) Department of Environmental Conservation (DEC) River Management Program has initiated a series of floodplain restoration projects (FRPs) on the Lamoille River between Hardwick and Sheldon. Their purpose is to return to the river historic areas of floodplain cut off by the construction of the railroad embankments along the river in the late 1800's. The projects collect and store what remains of the stone ballast, remove and lower the railbed embankment along the ROW to adjacent field elevations, and reapply the ballast after the embankment has been removed. Once completed the railbed surface looks remarkably like a new stretch of constructed railbed, without the overgrown vegetation, or debris on the ballast.

The locations, construction year, and status of each project are listed below (photos of some of the completed projects are included in Appendix D):

Wolcott Prototype: station 2172+04 to 2182+38, completed

Wolcott Site 1: station 2249+25 to 2264+12, completed

Johnson Site 1: station 2837+68 to 2860+93, complete

Cambridge Site 1: station 3196+60 to 3235+06, complete

Fletcher Site 1: station 3614+40 to 3629+22, complete

Bakersfield Site 1: station 3711+80 to 3729+03, under construction

Bakersfield Site 2: station 3756+05 to 3767+42, under construction

Fairfield Site 1: station 3843+20 to 3857+96, under construction

Fairfield Site 2: station 3966+70 to 3972+37, 2008

Fairfield Site 3: station 4003+10 to 4026+50, completed

Fairfield Site 4: station 4050+70 to 4077+48, completed

Eight other sites have been identified (Hardwick Site 1, Hyde Park Site 1, Johnson Sites 2 and 3, Bakersfield Site 3, and Fairfield Sites 5, 6, and 7) but are not yet funded, and will be accomplished as funding and permitting allow.

Ditches:

There are three types of ditches present on a railroad. The first of the three are the **cross-ditches**. Their purpose is to carry permanent and intermittent streams across the ROW in conjunction with culverts. They are located at every location water is observed to cross the ROW at the time of construction. Their flows can be almost any amount from a seep to a large brook. The second are the **lateral or side ditches** along the edge of the ballast. Their purpose is to keep the water table well below the ballast and the subgrade to maintain the subgrades soil bearing capacity. Normally they are not expected to collect water from crossing streams, only to carry away water accumulating near the subgrade to a nearby cross ditch. Their flows are generally very low and may rise and fall with the local precipitation. The third type are **intercepting ditches** and they are only found in locations where very high water tables have resulted in sheet flows of water towards the railroad across areas of land adjacent to the ROW; these areas are usually wetlands or wet hillsides. They are located parallel to the tracks, but at much greater distances than the side ditches. Their intercepted water is diverted to the nearest cross ditch.

The cross-ditches on the LVRT are, in general, in good condition. Forest debris and trash have blocked some channels, as have beavers, but most of the obstructions are easily removed, or are off the ROW and pose no threat to the LVRT. There is little or no evidence of erosion or silt buildups in the vast majority of the channels. An exception to this is the culverts that have had beaver dams erected in a semi-circular pattern around their upper entrances. The dams have not obstructed water flow through the culvert or the ditches, but have resulted in considerable deposits of silt behind the dams. These silt deposits may, in some locations, be referred to as "Legacy Deposits" as they are likely to be from the time in Vermont when farming caused the erosion. In some cases along the ROW these deposits are over five or six feet high, and fill the bottoms of small valleys. In a few cases extreme storm flows have pushed woody debris over the top of the dams, or down stream channels, and blocked some culverts. Such blockages have resulted in several washouts, removing the culvert structure and the embankment.

The lateral or side ditches on the LVRT are in very poor condition. On an active, well-maintained ROW one would expect to find wide, open channels at least 12 to 18 inches deeper than the **bottom** of the ballast. On the LVRT the channels are shallow, and generally full of silt, woody debris, and ballast. **Generally, any water flows in these ditches appear to be the result of man-made changes to the landscape or drainage patterns, including encroachment activities, and not drainage from wetlands or intersected streams**. In many locations, due to a combination of the rail/tie removal activity, other vehicular traffic, or silt deposition from adjacent land disturbances, the ballast surface is lower than the bottom of the ditch channel, causing lateral drainage to flow through the ballast. This, in turn, has resulted in several washouts where water running down the ballast has ultimately washed out the side of an embankment when the ballast could no longer contain the flow. Finally, these are conditions observed where the side ditches are visible. A larger problem exists in the invisibility of many of the side ditches because of the growth of forest and brush right up to the edge of the ballast. In many locations the survey team could not safely find the ditches because of the density of the undergrowth. In any project to reclaim the ballast and side ditches the first priority would be to re-clear enough of the ROW to assess ditch conditions, drainage patterns, and repair methodologies.

Intercepting ditches on the LVRT are in very poor condition. These ditches were observed in only one location on the ROW and at that location they were almost invisible; filled with silt and undergrowth. There may be other locations where they were constructed, but the density of the vegetation keeps the ditches from being identified. There are locations where one would expect to find these ditches but the survey crew didn’t. The reason may be that a damp, sunny, meadow hillside, or an area the farmer had to tread lightly when cutting the hay every summer in 1870, has reverted to a wet hillside today with the addition of forest and shade. From observing the drainage patterns along the ROW, the importance of these ditches, given the nature of a rail-trail, is very much lessened if the side ditches are kept clean and functional.

Culverts:

The culverts originally constructed on the StJ&LC Railroad were generally stone box and cast iron pipe culverts. After the railroad was constructed small wooden box culverts were introduced between the ties, in the ballast layer, or immediately below, to deal with minor local drainage conditions missed when assessing the original culvert needs. Today, all of the wood culverts are gone, except one combination stone-wood culvert at station 1295+27 (photos 332, 333). A “subset” of culverts along the ROW is the “cattlepass” or passage for sheep and cattle belonging to farmers owning or leasing grazing land on both sides of the ROW. Since construction, a variety of culvert materials have been used to supplement or replace culverts on the ROW including sections of old boiler casings, corrugated metal pipe (CMP), high density polyethylene (HDP), and concrete. **Appendix Section C.1 lists all the culverts and cattlepasses on the LVRT, their makeup, condition, and priority of maintenance and repair.**

Stone box culverts were made of local ledge stone, generally schist, or cut granite. In general the granite culverts are in better condition than the ledge culverts because of the variability of the quality of schist. In both cases parallel stone walls were constructed on a stone bed, and topped, or capped with large flat stones in the case of the schist culverts, and cut granite blocks on the granite culverts. Chock stones, and likely mortar, were introduced in the irregular spaces between the capstones to stop embankment, subgrade or ballast material from "leaking" into the culvert. The mortar has leached out over the years, and some culverts have lost some chock stones resulting in the loss of subgrade and/or ballast. This has manifested itself in the form of funnel-shaped depressions or cavities on the surface over the hole in the culvert. This condition is easily repaired and does not necessarily signal the loss or failure of the culvert.

A more serious source of damage to these structures is the return of trees to the ROW, and the presence of trees and roots growing on the structures. The roots, seeking water, have pried walls and capstones loose. On many culverts the first and sometimes second capstone is laying in front of the end of the culvert where tree roots pushed it (photo 247). Capstone displacements and inlet/outlet repairs are documented in both the **Culvert Listings** and the **Critical Culvert Conditions and Locations Summary in Part II, Proposed Alternative Description.**

Cast iron culverts are made of sections, generally twelve feet, of old bell and spigot-type pipe. Diameters range from 4" to 36". All of the cast iron pipe culverts on the LVRT are in good condition although a few have pipe sections that have separated at the joint under the roadway. Cast iron culverts were utilized in locations where the culvert would be near the surface, so repair of these deficiencies should be reasonably easy.

It appears that the vast majority of stone culverts originally installed are still functional and working. Losses tend to be from washouts caused by trash blockages, cracking and failing of the capstones, and severe loss of the chockstones resulting in a large inflow of silt and mud. Losses have also occurred from the deterioration of the stone. Many of the larger stone box culverts and cattlepasses are in excellent condition and the quality of the workmanship, although primitive, is still evident. That craftsmanship, the beauty of the stone work, and their remote locations make them significant early engineering achievements and structures well worth preserving and maintaining. A review of the photos in Appendix Section D makes this very clear.

New or replacement culverts of the aforementioned materials have been installed in many locations. Some are now so old that they have rusted out on the bottom or simply disintegrated. Many of the culverts of all types are blocked with silt or debris, or are completely silted out. The silt appears to be excess silt from off the ROW, and/or silt that has settled out in the culvert from minor channel blockages (brush, weeds, etc) below the culvert and the quiescent condition that creates within the culvert. The **Critical Culvert Conditions and Locations Summary** (see Part II) lists the culverts in especially poor condition, culverts needing replacing, culverts impacted by state highway or bridge drainage, and locations needing minor new culverts.

Bridges:

In accordance with the Vermont Pedestrian and Bicycle Facility Planning and Design Manual, the minimum structural design loading the bridge structures on the LVRT were evaluated against is an AASHTO H-10 loading (10,000 lbs per axle, 2 axles). Existing bridges were generally required to have at least ten more years of usable life. Some bridges may need additional load capability if they must be used by heavy construction equipment to access remote sites.

Defining what constitutes a bridge is the first problem of this assessment. From the Valuation Plans, or from the physical assessment, there **were** 86 locations where the structure in that location might have been considered a bridge. Some of those structures do not meet the state criteria for a bridge, but the work necessary on those structures for their structural integrity or for safety issues is so similar in nature to that needed on the majority of bridges that it seemed logical to call them bridges.

Of the 86 locations, 8 have been eliminated through the historic removal of the structure (generally to at-grade crossings), and 1 has been classified as a “normal” culvert, leaving 77 structures to evaluate (see Master Bridge Listing, Appendix C.2). It should be noted that the one defining characteristic that kept several of these structures on the “bridge” listing was the eventual need for guardrail work at the site. The 77 structures are broken down into the following categories:

Stone/Concrete Culverts- 2 ea

Cattlepasses- 20 ea

Metal Pipe-Arches- 3 ea

Concrete- 6 ea

Stone-Arch- 4 ea

Wood Stringer- 2 ea

Steel I-Beam- 11 ea

Steel Deck Plate- 3 ea

Steel Through-Plate- 4ea

Steel I-beam, Pile Bent- 7 ea

Steel Beam/ Plate, Wood Piling- 4 ea

Steel Through-Truss- 5 ea

Missing, Need Replacing- 6 ea

The condition and repair work needed for each structure may be found in Appendix Section E, Individual Bridge Sheets, and a short summary of those sheets is provided below:

Stone/ Concrete Culverts: Good condition but narrow enough to require guard railing.

Cattlepasses: Generally adequate to support LVRT trail loadings (FHWA H-10) as noted, except for one (BR 91), a wood stringer and pile structure, completely and dangerously rotted out, which should be demolished and filled in. (There is one other structure identical to this one (BR 67A) that is salvageable at station 3224+50, photo #'s 972-974)

Metal Pipe-Arches: Good condition but some are narrow enough to require guard railing.

Concrete: Generally adequate to support LVRT trail loadings. Bridge 57 was severely down- graded in the Edwards and Kelsey report through the misinterpretation of concrete deterioration. A closer examination revealed that although the bridge has a headwall problem the abutments and the roof slab are in good condition.

Stone-Arch: The arches of all four structures are in excellent condition and are more than capable of supporting LVRT and construction loadings. The headwall systems on all, and specifically Bridge 90, are in need of repair. At the time of their construction the masons did not adequately tie the wing walls into the arch structure- very difficult in mass-granite masonry- and the wings , and some portions of the top headwalls, have moved or separated from the bridge body over the years. This has been exacerbated through the allowance of trees, and their roots, to grow into the walls, further pushing the blocks off their foundations. Bridge 90 has lost an entire wing wall, and is close to losing two more.

Wood Stringer: There are only two short span bridges of this type and, if minor repairs are made, will easily support the LVRT loadings.

Steel I-Beam: With the generally minor repairs indicated, nine of the eleven structures in this class should perform adequately. Bridge 31 has adequate steel members for an H-10 loading- the bridge has two intermediate wooden bents that are unnecessary- but the wooden abutments and decking are rotted out. Further, the bridge may not have sufficient road clearance. The bridge underwent further evaluation to determine whether repair or replacement is the wisest solution. Bridge 65- a 16 foot span- is still a mystery. When found it appears to have been filled in with gravel (there is no evidence of a channel and this may have been a cattlepass), although the bridge deck is still present and is in good condition. Further investigation will be necessary this spring.

Steel Deck Plate: With the generally minor repairs indicated all three bridges will easily support the LVRT loadings.

Steel Through-Plate: With the exception of Bridge 63 these bridges are all capable of supporting LVRT loadings. Bridge 16L over VT Rte 2B has severe rust problems but appears adequate to supporting H-10 loadings. Further inspection would be necessary if construction loadings were anticipated. Bridge 63 has lost a small granite wing wall- probably to roots and frost- and some partial support of the steel superstructure, and must be repaired before it handles anything more than a pick-up truck. The necessary repairs are relatively minor in cost and magnitude.

Steel I-Beam, Pile Bent: Generally these bridges are in excellent condition and can easily support the LVRT loadings.

Steel Beam/ Plate, Wood Piling: All the bridges in this class are in an advanced state of deterioration for the same reason; wood piling. Bridge 35 is salvageable but the intermediate pile bent will require cap and beam pad replacement, steel beam realignment, and continued surveillance of the piling condition. Bridges 68, 77, and 83 have serious piling problems, but the severity is unknown. Further, Bridges 77 and 83 have wood abutment systems that are rotted- out and failing. Increment borings of all the piling will be done this spring to determine whether they have sufficient life left to use, or whether new piling or complete replacement will be necessary. The steel superstructure on all the bridges is in fair condition and is salvageable. **None of these bridges (68, 77, and 83) is judged adequate to support H-10 loadings in their present condition.**

Steel Through-Truss: With the recommended repairs these bridges are more than adequate to support H-10 loadings. Bridge 59's southeast granite abutment has settled in the far past and a shim pad was added some time ago to correct the situation. The bridge corner elevations should be checked again to determine if the settlement has stabilized or that the shim pad be elevated.

Missing, Need Replacing: There are 5 structures that were destroyed or removed on the line; the washout at culvert 17D is so large and remote that a bridge is the only practical solution (see photo #75). Of the 5 missing spans Bridge 13, at the eastern end of the LVRT, requires a new eastern abutment, which was removed when the span was removed to improve the travel line of sight. Bridge A27, including abutments, was removed by VTrans about ten year ago because of very poor bridge alignment and width restrictions on VT Rte 15. The abutments on Bridges 34 and 48 are intact and usable. Bridge 49 was severely damaged by a flood several years ago and was removed by the Water Quality Division of the Vermont Department of Environmental Conservation (DEC) as part of their Floodplain Restoration Program (FRP). A location was constructed as part of that project for a replacement bridge pad on the western side of the Wild Branch. Remnants of the eastern abutment are still present.

Washouts:

There are several washouts on the ROW of varying severity and origin. Causes include culvert failure (type I), lateral ditch failure (type II), river or stream scour (type III), and washout depositions on the ROW (type IV). **Appendix Section C. 4 lists all the washouts, their locations, and causes.** Culvert failures, almost all of which are stone boxes, appear to be caused either through a structural failure of the stonework, or debris (many times from beavers) blocking culvert entrances, causing an impoundment and eventual overflow over the railbed embankment. Lateral ditch failures refer to a ditch filled completely and overrun with silt, causing the water to travel down the railbed until it can find escape. The point of escape becomes a washout. River or stream scour washouts refer to locations where the railbed is directly adjacent to the river or stream. The river scours away material along the bank ultimately removing portions or all of the railbed. Washout deposition washouts occur when an event, usually rainfall, off and above the ROW washes material down onto the ROW.

Given the narrow width of the land within the ROW, Type III washouts, adjacent to a running river, were thought to be the most serious to try to restore, especially considering their probability of recurrence, permitting, remote locations, and cost.

Observations of all Type III washouts indicate that all are in an advanced state of natural healing, are not wide enough to impact the width of the ROW, and are not as numerous as originally thought. There are only five such washout sites. The Type III washout at station 4157+75 is not adjacent to the Lamoille River. In this location the river, in flood stage, removed approximately 80 feet of the entire Type I embankment several hundred feet beyond the nearest contact with the river. This washout will be covered as a special FRP site in the Alternative Document, Part II.

Of particular note, because it does not fit into any of the four categories, is the washout that has occurred at station 243+66, near St. Johnsbury. Stormwater along route 2B above the LVRT Route 2B bridge overpass used to drain through a ditch built specifically for this purpose by the StJ&LC Railroad. The valuation plans show the ditch and the "rights" owned by the Railroad. The ditch ran from a point above the overpass west to culvert 16J under the LVRT. At some time within the past 20 years (?) this system was changed by VTrans to drain the water north to land between route 2B and the LVRT, but not into any ditch leading to a LVRT culvert. Over the years this water has eroded and damaged several acres of private land, and ultimately drained onto the ROW at station 252+53, where there is no culvert to carry the water under the railbed. The additional silt and water eventually filled the lateral ditches and washed out the railbed at station 243+66.

Encroachments:

An encroachment on the ROW is a physical intrusion or trespass on the state property by an abutter in the form of any change from its original condition. Typical encroachments encountered during the assessment include leaves, trash, soil, tires, or junk dumped on the ROW, removal of ballast stone or trees from the ROW, construction of crossings or driveways across the ROW without AOT permission, running fences or sap lines on the ROW, planting of crops (corn) on the ROW, landscaping activities, conducting commercial operations on the ROW, and discharging contaminated water or septage on the ROW.

Appendix C. 5 lists all the encroachments encountered on the LVRT, their location, description, and severity. Of particular note are the priority 1 and 2 encroachments which are the most serious. There are 10 priority 'I' (critical, "showstoppers") and roughly 42 priority 'II' (serious) encroachments identified. While the Priority II are important and may be difficult to cure or eliminate, the priority I listings are such that a trail cannot be built through those areas until the conditions are corrected.

Details on the Priority I's:

Station 1328+91; Site of an unregulated dump, including garbage, trash, rugs, furniture, brush and degradation of approximately 400' of ballast with silt and mud: photo #'s 340-343. The erosion from this individual's property has also caused the washout at the west end of the encroachment.

Station 1516+00 to 1523+64; The Michaud Farm, site of several serious problems: The farm appears to have structures sited on the ROW, has degraded several hundred feet of ballast, regraded some sections of the ROW, and most serious, appears to be draining dairy manure and other farm septage into the ROW lateral ditch directly into the nearby Lamoille River: photo #'s 401-404.

Station 1798+10 to 1804+58: Site of a local sawmill, which appears to be closed, that has degraded several hundred feet of ROW, including loss of grade, ditching, ballast, and the destruction or damage to two stone culverts: photo #'s 493-499.

Station 1914+46: This is the site of a farmer's road adjacent to the Lamoille River and the LVRT. Because the river has cut into his road, the farmer has cut into the LVRT to maintain his traveled way, damaging the LVRT embankment and wasting considerable ballast: photo 547.

Station 2224+64 to 2226+10: This is the site of an individual's degrading of the ROW, and the theft of ballast which is clearly visible from Rte 15! The abutter has piled junk (hundreds of old bicycles) along the ballast on the ROW, dumped debris on the ballast, and constructed his driveway with the ballast! Photo #'s 644-649.

Station 2879 to 2890: A local resident described this as the "Old Patch Farm". It is the site of a decrepit dairy operation that has spilled onto the ROW. There's a manure pit which appears to be edging on the ROW, several pieces of equipment on the ROW, and at least one renegade crossing: photos #'s 858-860.

Station 2928-2937: Site of a large gravel pit operation east of Johnson. The operation has encroached on the south side of the ROW with vast quantities of soil and gravel, and is posing a serious threat to a critical culvert belonging to the state (# 60A; sta 2936+50): photo #'s 878-881.

Station 2698+49 to 2974+50: Site of the Town of Johnson's garage and roads department. The town has destroyed several hundred feet of ROW to include embankment, drainage structures, and ballast: photo #'s 893, and 896 to 899.

Station 3032-3052: Site of a large gravel pit operation that has degraded several hundred feet of ROW with silt (completely covering the ballast), silted out an LVRT stone culvert, and possibly damaged wetland: photo #'s 916-920.

Station 4537+57: Site of a residential landowner with attitude issues. The encroachment includes loss of ballast and the inclusion of the ROW as part of the owner's lawn and back yard: photo #'s 1380 and 1381.

There are a few priority "II" encroachments of note also:

Station 79+45: The VTrans rte 2B overpass over the LVRT has seriously damaged the LVRT due to the uncontrolled storm water runoff from the bridge. Damage includes 200' of saturated trail bed, silted out ditches, and loss of ballast: photo #'s 13-15.

Station 844+93 (but there are several more Joe's Pond encroachments almost as bad): Site of damage to the ballast and ROW from the abutter's actions in dealing with drainage and development: photo # 213.

Station 1017+96: A growing dump behind a residence: photo # 245.

Station 2042+70 to 2050+02: Site of P & R Lumber operations encroaching on the ROW right up to the ballast: photos 587-589.

Station 2590+35, and 3241+27: VTrans garage encroachments on the LVRT: photo #'s 765, 766, and 977 (the first station is not listed in the encroachments, but in the culvert problems listing)

Station 4229+59: Site of a full- blown dump being created in a wetland adjacent to (and possibly on) the ROW. Locals are using the LVRT to bring garbage and trash to the dump site: photo #'s 1262-1264.

Station 4457+20: Site of a dairy operation encroachment similar to paragraph 3b, except that there are no structures on the LVRT. Farmer is draining feed septage into the LVRT lateral ditch, which then flows into the Missisquoi River: photo #'s 1344-1347.

Station 4463+70 to 4484+23: Site of another dairy operation encroaching various aspects of its operation on to the LVRT. Damage includes a stream contaminated with a dairy operation, and over 1000' of trail with loss of the south lateral ditch, and large piles of silt against the edge of the ballast: photo #'s 1354, 1357, and 1360.

Station 4879+92: Site of Vermont Brick's operations on both sides of the LVRT, including a renegade crossing, rubbish, seconds, and piles of dirt: photo #'s 1472, 1473.

Encroachments are not only a legal, and a construction issue, they also represent an environmental challenge. Many of the encroachments have changed natural drainage patterns, or have resulted in sites contaminated with soil, animal or feed wastes, and trash that will make permitting, remediation, and trail construction much more complex.

Crossings:

There were a large number, and variety of crossings noted during the survey; Appendix Section C.6 lists all the state and town road, private, and renegade crossings on the LVRT, as well as potential contractor access points noted during the reconnaissance. Private crossings are the driveways, farm crossings, and other trails acknowledged and permitted on the Val Plans. Renegade crossings are those found in the field that are not shown on the Val Plans. A few of the renegade crossings are actually town roads, but most are driveways, and in the western portion of the trail, most are from ATV usage of the trail.

ATV usage of the trail was significant, with the majority of the usage at the western end. Little serious damage to the trail was noted. Also of note was the use of the trail by farmers, primarily from Morrisville to Highgate, to travel from one field to another (tractors and cattle), or to avoid the use of state or town roads. The extent of the damage from farmer usage is unknown. The ballast in these areas is generally dirty and well-infiltrated with silt, but this could also be the result of poor track maintenance or the activities of the track and tie removal contractor.

Refuse and Waste Deposits:

The refuse and waste material found during the assessment may be categorized into two distinct sizes: large, purposeful deposits, and small, random incidents. The large deposits seem to occur as extensions on to the ROW from private property, or involving the ROW as a point of access to the dump locations. Because of their size and location they were considered encroachments and were identified and described in that section of the assessment report. With respect to the small, random incidents, the assessment team found a score or more locations where a few tires, a small pile of scrap lumber, a derelict bicycle or other appliance, some scrap metal, or all of the above were found adjacent to the ballasted surface. Even more common were the old metal buckets the railroad used to carry the spikes, and the miscellaneous hardware associated with track construction. None of these deposits appeared to include any hazardous substances, or incidence of spills. Some of the very old cars (model A's and T's) and other large objects observed near the edge of the ROW may actually have some historic significance. All of the small, incidental deposits would be easily removed and disposed of. The sites are also noted on the Master Feature Listing (Appendices, Section B), and “Trash Listing”, Appendices Section C. 7.

Old Railroad Ties:

The track and tie removal contractor did an excellent job of removing all the ties on the line. However, there are still thousands of ties along the ROW in many large piles off the edge of many of the embankments. These ties date from past iterations of maintenance activities by past owners well before the recent project. An examination of these ties reveals that many were creosoted, but that the biological digestion of the preservative is almost complete and all that remains is a shell of cellulosic material. The high level of vegetation growing up through the piles would also seem to indicate that no poisoning of the soil or environment remains from the presence of the ties. Most of these piles will finally disappear naturally within the next few years.