

**Phase I Stream Geomorphic Assessment**  
**Moose River; Essex and Caledonia Counties**  
East St. Johnsbury, Concord, Victory, Granby, East Haven, Waterford, Kirby; Vermont

**Final Report**  
**August 2009**



Prepared By:

Tamara Colten-Stevens  
Essex County Natural Resources Conservation District

**Phase I Stream Geomorphic Assessment**  
**Moose River; Essex and Caledonia Counties**  
East St. Johnsbury, Concord, Victory, Granby, East Haven, Waterford, Kirby; Vermont

**TABLE OF CONTENTS**

- 1.0 Introduction
- 2.0 Background
- 3.0 Methodology
  - 3.1 Parameters
  - 3.2 QA Review
- 4.0 Results
  - 4.1 Reach Locations
  - 4.2 Stream Typing
  - 4.3 Land Cover- Reach Hydrology
  - 4.4 Historic Channel Modifications
  - 4.5 Floodplain Modifications
  - 4.6 Bed and Bank Windshield Survey
- 5.0 Data Analysis
  - 5.1 Impact Scores
  - 5.2 Adjustment Processes
- 6.0 Recommendations for Phase II
- References
- DMS Generated Reports Attached

**Phase I Stream Geomorphic Assessment**  
**Moose River; Essex and Caledonia Counties**  
East St. Johnsbury, Concord, Victory, Granby, East Haven, Waterford, Kirby; Vermont

**EXECUTIVE SUMMARY**

A Phase I Stream Geomorphic Assessment of the Moose River main stem and its major tributaries (Chesterfield Valley, Kirby Brook, Bog/Umpire Brook and Granby Brook) within the towns of East St. Johnsbury, Concord, Victory, Granby, East Haven, Waterford and Kirby) was undertaken by the Essex County Natural Resources Conservation District (ECNRCD) over the course of two years and completed in 2009. The watershed was divided into 68 reaches based on confinement, slope, soils, and tributary influence. Of the 68 reaches, one was identified as Stiles Pond in Waterford and not evaluated further. The Moose River (waterbody ID VT15-09), in the Passumpsic River Watershed (Basin #15), flows through both Essex and Caledonia Counties in the Northeastern corner of the State.

The study followed the protocols for Phase I Stream Geomorphic Assessment developed by the Vermont Agency of Natural Resources. Information for the assessment came from the Department of Environmental Conservation- River Management Program, the Natural Resources Conservation Service, the Vermont Mapping Program, the Vermont Center for Geographic Information, and windshield surveys.

The dominant surficial geology of the Moose River watershed is divided quite evenly into two (2) formations: the Gile Mountain Formation in East St. Johnsbury and the Albee Formation, present from Concord Village north. A small band of Meetinghouse Slate is found between East St. Johnsbury and Concord Village, and the Moose River main stem passes through this. The Gile Mountain Formation consists of gray slate, phyllite, and quartzite. The Albee Formation, found in the northern and eastern parts of the watershed

Consists of massive blue-gray quartzite, phyllite, mica schist, and slate. Soil mapping in the Northeast Kingdom is ongoing and should be completed within the next several years.

Watershed land cover-land use reports documented all reaches in the study area with at least 74% forest coverage.

Corridor land cover-land use reports documented crops and/or fields in 47 (70%) of the reaches in the study area, and forests present, to varying degrees, in all. Regardless of the extensive presence of forest in the watershed and corridor, 26 reaches (nearly 40 %) were determined to have less than 25' of buffering along their banks.

Roads, railroads, improved paths, and/or berms (Parameter 6.1; Berms and Roads), were documented in 39 reaches, with 27 (69%) of these rating a high impact. Corridor development was found to be significantly less; documented in 22 of the reaches in the study area. Six of these were documented with a high rating.

The within watershed condition generated from the Phase I database was a bit lower than the reach conditions found through observations during the Phase I windshield survey.

Reach conditions generated from the Phase I database varied from poor to reference. Five (5) received poor ratings (M2S1.02, M2S1.01, T1.02, M3S2.02 and M10). With the exception of T1.02, all experienced an impact from roads and corridor development. All five (5) were determined to be 'C' type streams.

Reaches M7-M13 on the Moose River main stem were recommended by the ANR-DEC River Management Program for Phase II assessment field work.

## **1.0 INTRODUCTION**

The Phase I Stream Geomorphic Assessment of the Moose River watershed was conducted by the Essex County Natural Resources Conservation District (ECNRCD) beginning in

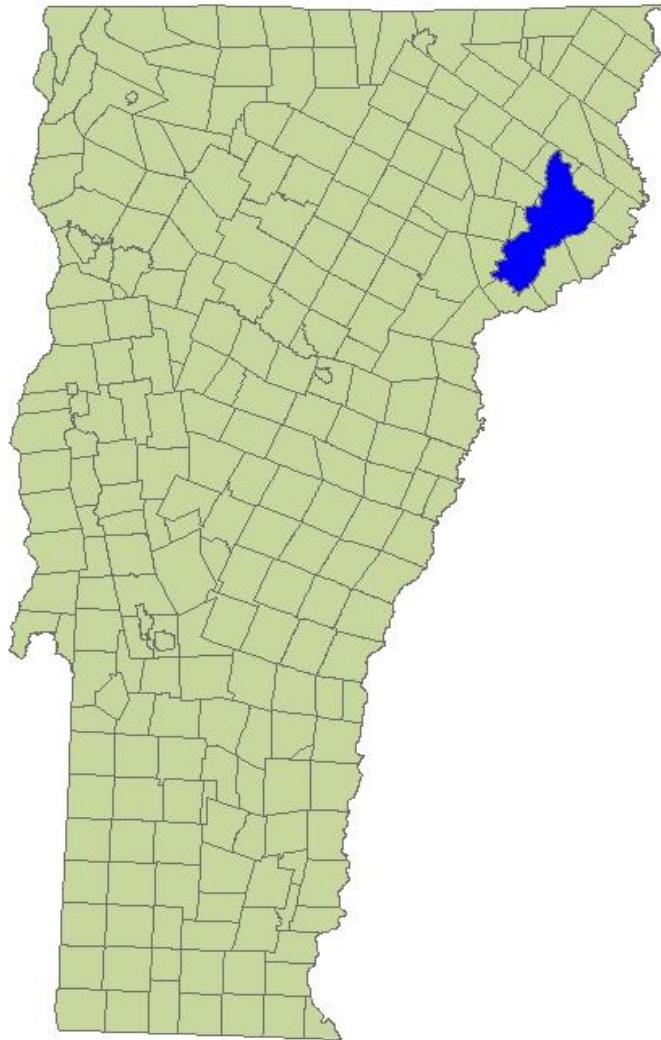
2007. The assessment was conducted on the main stem of the Moose River, its four (4) major tributaries and many lesser streams. Primary objectives of the study were to provide an overview of the general physical characteristics of the Moose River, select reaches to be included in a Phase II Stream Geomorphic Assessment, and ultimately assist adjacent towns and landowners with watershed planning and restoration activities.

Data and information pertaining to the Moose River watershed was obtained from the Department of Environmental Conservation- River Management Program, the Natural Resources Conservation Service, the Vermont Mapping Program, the Vermont Center for Geographic Information, and windshield surveys. Windshield surveys were conducted by Tamara Colten-Stevens and Staci Pomeroy.

## **2.0 BACKGROUND**



The Moose River (waterbody ID VT15-09), in the Passumpsic River Watershed (basin #15), flows through both Essex and Caledonia Counties in the Northeastern corner of the State. The Moose River main stem and its major tributaries (Chesterfield Valley, Kirby Brook, Bog/Umpire Brook and Granby Brook) are found within the towns of East St. Johnsbury, Concord, Victory, Granby, East Haven, Waterford and Kirby.

**Moose River Watershed  
Phase I Geomorphic Assessment Project Location Map  
Figure 1.**



50 Miles

**Legend**

-  Moose River Watershed
-  Vermont Town Boundaries

### 3.0 METHODOLOGY

The Phase I assessment followed procedures specified in the Vermont Stream Geomorphic Assessment Handbook Phase I (Vermont Agency of Natural Resources 2004), and used version 4.50 of the Stream Geomorphic Assessment Tool (SGAT) GIS extension for feature indexing. All assessment data were recorded on the Agency of Natural Resources (ANR) Phase I data sheets or in GIS database files, and were entered in to the most current version of the ANR Phase I online Data Management System (DMS). Staci Pomeroy (ANR) assisted with running SGAT.

### 3.1 PARAMETERS

The parameters in Table I were rated according to the following menu options (NS- not significant, low impact, high impact or No info- no information). A zero was scored for options NS and No info, a one for low impact and a two for high impact.

<b>STEP #</b>	<b>PARAMETER</b>
<b>4.1</b>	<b>Watershed Land Cover/Land Use</b>
<b>4.2</b>	<b>Corridor Land Cover/Land Use</b>
<b>4.3</b>	<b>Riparian Buffer Width</b>
<b>5.1</b>	<b>Flow Regulations and Water Withdrawals</b>
<b>5.2</b>	<b>Bridges and Culverts</b>
<b>5.3</b>	<b>Bank Armoring and Revetments</b>
<b>5.4</b>	<b>Channel Modifications</b>
<b>5.5</b>	<b>Dredging and Gravel Mining History</b>
<b>6.1</b>	<b>Berms and Roads</b>
<b>6.2</b>	<b>River Corridor Development</b>
<b>6.3</b>	<b>Depositional Features</b>
<b>6.4</b>	<b>Meander Migration/Channel Avulsion</b>
<b>6.5</b>	<b>Meander Width Ratio</b>
<b>6.6</b>	<b>Wavelength Ratio</b>
<b>7.2</b>	<b>Bank Erosion-Relative Magnitude</b>
<b>7.3</b>	<b>Ice and Debris Jam Potential</b>

**Table 1. Parameters Included in Impact Scores**

### **3.2 QA REVIEW**

The Phase I Quality Assurance Worksheet was completed by the ECNRCD to document:

(a) the tools used to collect the Phase I data, (b) the confidence level in the data, (c) the date the assessment was completed, and (d) the date each Phase I step was checked by state QA teams. The confidence level for Phase I data was rated from moderate to high. Many of the 68 reaches could not be accessed due to poor accessibility.

The ArcView shapefiles for the Moose River Phase I assessment were submitted to Staci Pomeroy of the VT ANR, River Management Division. SGAT generated data and database entries were made to the online Geomorphic Assessment Database for QA Review. Minor modifications were made to data following QA steps.

## **4.0 RESULTS**

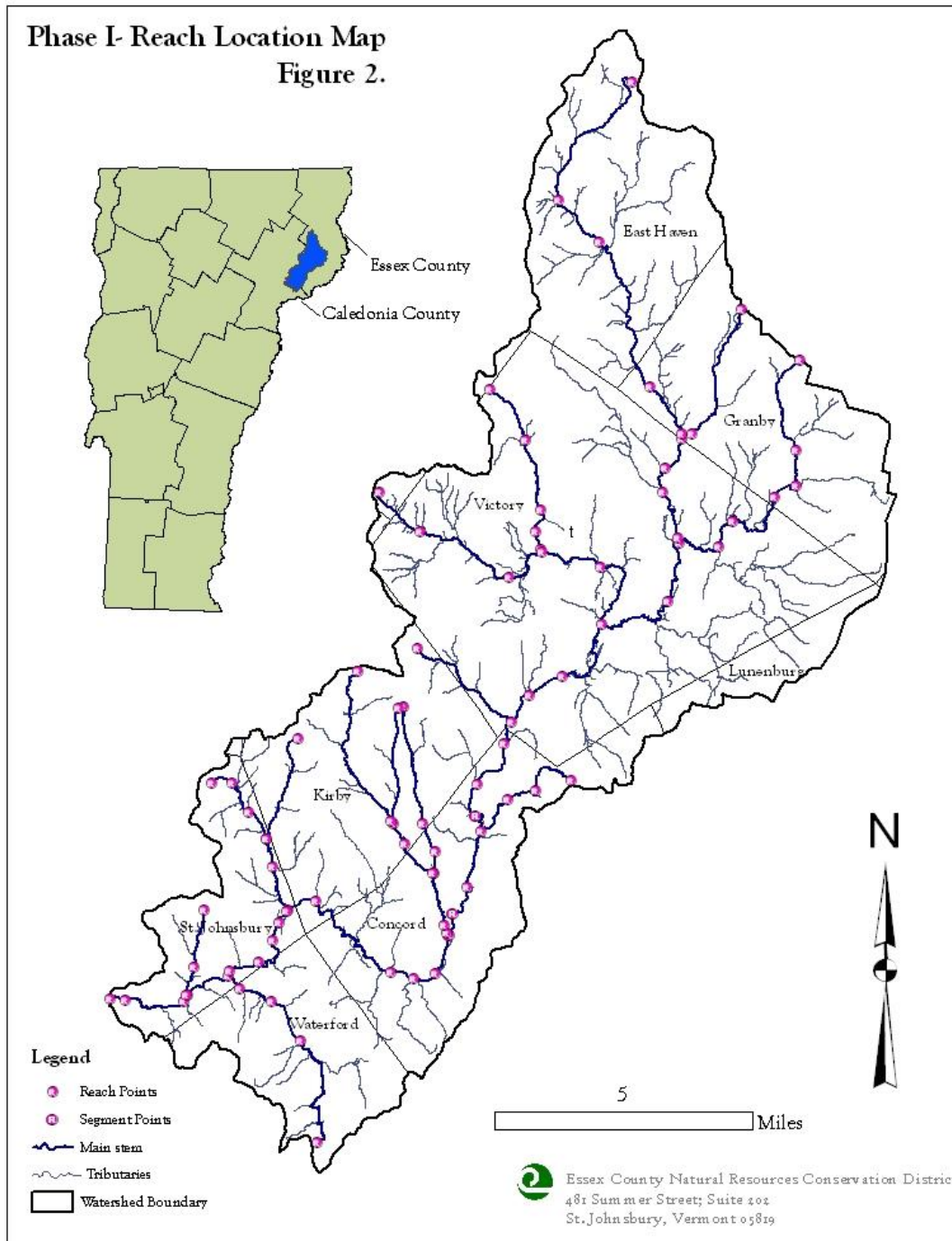
### **4.1 Reach Locations**

The Moose River Watershed was divided into 68 reaches for the Phase I Assessment.

(See attached Phase I- Step 1. Reach Locations) report.

This report documents the reach ID, stream name, town location, and reach description of each reach assessed in Phase I.

Figure 2 shows the location of study reaches used in the Phase I Assessment.



#### 4.2 Stream Typing

Reference stream types are defined as stream channel forms and processes that would exist in the absence of human-related changes to the channel, floodplain, and/or watershed.

Stream and valley characteristics including valley confinement, and slope determined through remote sensing were used to ascertain the stream type. The reference reach characteristics were later refined during the windshield survey. Reference reach typing was based on both the Rosgen (1996) and the Montgomery and Buffington (1996) classification systems.

(See attached Phase I- Step 2. Preliminary Reference Stream Type) report.

This report provides a complete listing of reference stream types for each reach within the project area. The majority of the stream reaches fall within the C stream type with varying confinements. (See Table 3.) Reaches that were not recommended for Phase II stream geomorphic assessment were not evaluated for bedform. 'Not evaluated' was entered into the DMS for each of these reaches, though reference stream type was determined for each. Natural confinement ratios (the valley width divided by the channel width) were calculated for all of the Phase I assessed reaches in this study, with Table 2 exhibiting the ratios below.

<b>Valley Type</b>	<b>Confinement</b>	<b>Ratio= Valley Width/Channel Width</b>
<b>NC</b>	<b>Narrowly Confined</b>	<b>≥1 and &lt;2</b>
<b>SC</b>	<b>Semi-confined</b>	<b>≥2 and &lt;4</b>
<b>NW</b>	<b>Narrow</b>	<b>≥4 and &lt;6</b>
<b>BD</b>	<b>Broad</b>	<b>≥6 and &lt;10</b>
<b>VB</b>	<b>Very Broad</b>	<b>≥10 -with abandoned terraces on one or both sides</b>

<b>REFERENCE STREAM TYPE</b>	<b>TOTAL CHANNEL LENGTH</b>	<b>CONFINEMENT</b>	<b>PERCENTAGE OF TOTAL</b>
<b>A</b>	<b>96,061</b>	<b>NC/ Narrowly Confined</b>	<b>22.1</b>
<b>A</b>	<b>27,796</b>	<b>NW/ Narrow</b>	<b>6.4</b>
<b>B</b>	<b>20,698</b>	<b>NC/ Narrowly Confined</b>	<b>4.8</b>
<b>B</b>	<b>43,436</b>	<b>SC/ Semi-Confined</b>	<b>10.0</b>
<b>B</b>	<b>22,648</b>	<b>NW/ Narrow</b>	<b>5.2</b>
<b>C</b>	<b>17,465</b>	<b>NC/Narrowly Confined</b>	<b>4.0</b>
<b>C</b>	<b>51,345</b>	<b>NW/Narrow</b>	<b>11.8</b>
<b>C</b>	<b>18,277</b>	<b>SC/Semi-Confined</b>	<b>4.2</b>
<b>C</b>	<b>53,444</b>	<b>BD/Broad</b>	<b>12.3</b>
<b>C</b>	<b>65,805</b>	<b>VB/Very Broad</b>	<b>15.1</b>
<b>D</b>	<b>3,351</b>	<b>NW/Narrow</b>	<b>0.8</b>
<b>D</b>	<b>14,307</b>	<b>VB/Very Broad</b>	<b>3.3</b>

**Table 3. Reference Stream Type**

#### 4.3 Land Cover- Reach Hydrology

As outlined in the Phase I handbook, impact ratings were assigned for watershed land cover/land use and stream corridor land cover/land use as follows:

<b>High</b>	<b>10% or more is crop and/or urban</b>
<b>Low</b>	<b>Between 2 and 10% is crop and/or urban</b>
<b>NS-Not Significant</b>	<b>Less than 2% is crop and/or urban</b>

Watershed land cover-land use reports documented all reaches in the study area with at least 74% forest coverage. Forty-nine (73%) had either crop or field Commercial/industrial (identified as urban and a moderate to high density of residential, commercial, industrial, and roads, was not identified in any of the reaches on the watershed level, but for corridor land cover (residential), was present in the majority of

reaches. The residential classification for corridor land cover (as opposed to the urban classification for watershed land cover) can consist of solely one small house, thus the differentiation between the two.

Corridor land cover-land use reports documented crops and/or fields in 47 (70%) of the reaches in the study area, and forests present, to varying degrees, in all. Regardless of the extensive presence of forest in the watershed and corridor, 26 reaches (nearly 40 %) were determined to have less than 25' of buffering along their banks.

Riparian buffers of trees, shrubs, and herbaceous plants prove critical to the health of a stream for a variety of reasons. In addition to providing bank stability and slowing of erosion, thus slowing sedimentation and run off, buffers provide critical habitat for birds and other wildlife, and assist in shading and temperature control of the stream itself.

#### **4.4 Historic Channel Modifications**

Channel modifications may impact a stream reach by affecting the hydraulics and sediment regime. Historic channel modifications were assessed in this Phase I study by evaluating flow regulations, bridges and culverts impacts, bank armoring, windrowing, straightening and dredging. The percentage of length of reach impacted by one or more of these channel modifications was estimated and is summarized in the attached (Phase I- Step 5. Instream Channel Modification) report.

#### **Flow Regulations**

None of the stream reaches were found to be currently impacted by flow regulation.

#### **Bridges and Culverts**

As part of the Phase I Stream Geomorphic Assessment, the number of bridges and culverts were counted by identifying stream crossings evident on topographic maps and orthophotos. These stream crossings, when accessible, were confirmed during the windshield survey. The percentage of the reach impacted by stream crossing structure was estimated during the windshield survey and orthophotos. Impact ratings for bridges and

culverts were evaluated by determining the percentage of the reach length that is channelized, has split flow, or makes a sharp “S” bend upstream or downstream of bridges and culverts. All of the bridges and culverts identified were found to have a low or non-significant impact on the streams, though upstream sedimentation, upstream & downstream scour and erosion was present to varying degrees. Many of the stream crossings were not accessible during windshield surveys, thus these stream crossing structures were assumed to be culverts, not bridges. Bridges/culverts were identified and confirmed in 16 of the 25 reaches assessed on the mainstem.

**Bank Armoring**

The amount of bank armoring within a watershed is often indicative of the occurrence of channel processes, which result in bank erosion. Bank armoring, also called revetments, can be made of a variety of material including wooden cribs, gabions, logs, and rock riprap. The most common type of revetment in Vermont is rock riprap. Stream alteration permits can typically be used to identify bank revetments within a watershed of interest. Rock riprap was the only type of revetment noted within the study area. The amount of revetment mapped from the Phase I windshield survey is undoubtedly an underestimation of the total amount due to the inaccessibility to many of the reaches during the windshield survey. The following criterion was used to provide an impact rating for human placed bank armoring.

<b>H</b>	<b>High- Greater than 30% of the reach length if armored</b>
<b>L</b>	<b>Low- Between 10 and 30% of the reach length is armored</b>
<b>NS</b>	<b>Not Significant- Less than 10% of the reach length is armored</b>
<b>No Info</b>	<b>Bank armoring has not been evaluated for the entire reach and the impact at the reach level is unknown.</b>

Rock riprap was identified along four (4) of the main stem reaches. All received an impact of low or non significant with the exception of M11. 2,212 feet of riprap was observed, totaling 78.9 % of the reach and resulting in a high impact score.

### **Channel Modifications (Windrowing and Straightening)**

During the windshield survey evidence of historic channelization projects were recorded. The total reach length (in feet) and the percentage of the reach length directly impacted by the channel modification were noted. Categories considered as part of the Step 5.4 (Channel Modifications) included the following menu options:

- Windrowing- pushing gravel up from the stream bed onto the top of either bank
- Straightening- Dredging, windrowing, and bulldozing the stream into a straight course
- Multiple- Multiple channel modification, where neither windrowing nor straightening is the dominant channelization type
- None- No known modifications

The only channel modification noted within the Moose River was straightening; limited to six (6) reaches. A high impact was attributed to four (4) of these.

### **Dredging History**

There is no record of significant gravel or sediment mining operations for the Moose River watershed.

### **4.4 Floodplain Modifications**

In this step of the Phase I assessment, careful attention is paid to infrastructure and other development which restricts access to the floodplain, resulting in vertical or lateral confinement of flood flows. The parameters included in this step are: Berms and Roads, River Corridor Development, Depositional Features, Meander Migration/Channel Avulsion, Meander Width Ratio, and Wavelength Ratio. Some of the primary factors, which may influence floodplain function in the Moose River, are discussed below.

### **Berms and Roads**

Using information from maps, orthophotos, and windshield surveys, the percentage of the river corridor length along which berms, roads, railroad, or other improved paths run

parallel to the stream was estimated. There were no berms identified in the study area, although this could prove an underestimation due to the inaccessibility of many reaches. Roads were identified in 38 of the reaches and railroad in 5 (along the main stem). 62.8% of the effected reaches received a high impact rating.

### **River Corridor Development**

The river corridor development parameter looks at whether or not developments within the river corridor (including houses, fill and parking lots) are decreasing the belt width of the stream. In the Moose River watershed, corridor development, to some degree, was identified in 22 reaches. Six (6) of these reaches (five (5) of these lying between the main stem's confluence with the Passumpsic River in St. Johnsbury, upstream to just above Concord Village in Concord) were scored as having a high impact. The remainder were determined to be of low impact or not-significant.

See attached (Phase I -Step 6. Floodplain Modification and Planform Changes) report.

### **Channel Bars**

The 1990's orthophotos series (1:5000) and results from the windshield survey were used to evaluate depositional features along seven (7) reaches of the Moose River mainstem. Depositional features for the remainder of the watershed were not evaluated. Of the six features (mid channel and point bars, deltas, side bars diagonal bars and islands) evaluated for these seven (7) main stem reaches, 86% of the reaches contained multiple features.

### **Meander Migration**

Orthophotos were used to evaluate areas where the River has migrated. While a certain amount of lateral migration will be found in most alluvial stream systems, an increased rate of migration may indicate a stream out of balance with its watershed inputs. Of the 67 reaches evaluated for migrational impact, 10 rated a low impact, eight (8) a high impact, and the remainder, an insignificant impact.

<b>H</b>	<b>High- Frequent occurrences of channel migration, flood chutes, bifurcation and braiding, channel avulsions and/or neck cut-offs along reach evident in historic orthophoto comparison</b>
<b>L</b>	<b>Low- Few occurrences of channel migration, flood chutes, bifurcation and braiding, channel avulsions and/or neck cut-offs evident in historic orthophoto comparison</b>
<b>NS</b>	<b>Not- Significant- No channel migration, flood chutes, bifurcation and braiding, channel avulsions and/or neck cut-offs evident</b>
<b>No Data</b>	<b>Unknown if there are channel migrations, bifurcations, or avulsions- due to forest cover and/or inability to access entire reach during windshield survey</b>

**Meander Width and Wavelength**

Utilizing orthophotos and data collected during windshield surveys, when applicable, the meander belt width was evaluated for reaches typed in Step 2.10 as C or E riffle-pool or ripple-dune reference stream types in narrow (NW) and unconfined (BD and VB) valleys. As defined in the Phase I Stream Geomorphic Assessment Handbook, meander belt width is “the horizontal distance between the opposite outside banks of fully developed meanders, determined by extending two (2) lines (one on each side of the channel) parallel to the valley (and parallel to each other) from the lateral outside extent of each meander bend along both sides of the channel.” Of the reaches applicable for meander belt width evaluation (39) in Phase I, 44% resulted in a high impact, 44% low impact and 13% non-significant in impact. All 34 reaches with a low or high impact ratio had meander width ratios of less than five (5).

As described in the Phase II Handbook, the wavelength ratio “can change radically within a reach due to channel constriction from floodplain encroachment, surficial and bedrock geology, small changes in valley slope, and other factors.” Reaches typed in Step 2.10 as C or E riffle-pool or ripple dune reference stream types in narrow (NW) and unconfined (BD and VB) valleys. Wavelength ratio is measure using orthophotos in conjunction with topographic maps to determine a reach’s average meander wavelength; dividing the average wavelength by the bankfull channel width. Of the 31 applicable reaches evaluated for wavelength ratio, 39% had a high impact, 23% scored a low impact, and 39% were non-significant in impact.

<b>H</b>	<b>High- calculated WLR is &lt;6 or &gt;16</b>
<b>L</b>	<b>Low- calculated WLR is <math>\geq 6</math> and &lt;8 or &gt;14 and <math>\leq 16</math></b>
<b>NS</b>	<b>Not Significant- calculated WR is <math>\geq 8</math> and <math>\leq 14</math></b>
<b>N/A</b>	<b>Not applicable for certain stream types</b>

#### 4.5 Bed and Bank Windshield Survey

As noted previously, much of the Moose River watershed and thus, many of the reaches designated for Phase I Stream Geomorphic Assessment, are not easily assessable due to their remote nature. When possible, the dominant bank material, bank erosion/bank height, and debris/ice jam potential were recorded during windshield surveys.

## 5.0 DATA ANALYSIS


### 5.1 Impact Scores

<b>REACH NUMBER</b>	<b>CONFINEMENT</b>	<b>TOTAL IMPACT SCORE</b>	<b>WATERSHED SIZE (sq. mile)</b>	<b>REACH CONDITION (From Phase I DMS)</b>
<b>M5</b>	<b>NW</b>	<b>12</b>	<b>116.5</b>	<b>Fair</b>
<b>M7</b>	<b>BD</b>	<b>8</b>	<b>115.3</b>	<b>Good</b>
<b>M13</b>	<b>BD</b>	<b>12</b>	<b>88.0</b>	<b>Fair</b>
<b>M17</b>	<b>VB</b>	<b>8</b>	<b>75.4</b>	<b>Reference</b>
<b>M18</b>	<b>BD</b>	<b>7</b>	<b>46.0</b>	<b>Reference</b>
<b>M19</b>	<b>BD</b>	<b>4</b>	<b>28.8</b>	<b>Reference</b>
<b>M20</b>	<b>NW</b>	<b>1</b>	<b>27.8</b>	<b>Reference</b>
<b>M21</b>	<b>BD</b>	<b>8</b>	<b>23.4</b>	<b>Good</b>
<b>M22</b>	<b>BD</b>	<b>4</b>	<b>19.9</b>	<b>Reference</b>
<b>M23</b>	<b>NW</b>	<b>4</b>	<b>17.7</b>	<b>Reference</b>
<b>M24</b>	<b>BD</b>	<b>5</b>	<b>5.4</b>	<b>Reference</b>
<b>M2S1.01</b>	<b>VB</b>	<b>8</b>	<b>2.0</b>	<b>Poor</b>
<b>M2S1.02</b>	<b>VB</b>	<b>12</b>	<b>7.2</b>	<b>Poor</b>

<b>M3S2.02</b>	<b>VB</b>	<b>10</b>	<b>7.2</b>	<b>Poor</b>
<b>M3S2.04</b>	<b>VB</b>	<b>8</b>	<b>5.2</b>	<b>Fair</b>
<b>T1.01</b>	<b>BD</b>	<b>7</b>	<b>6.9</b>	<b>Good</b>
<b>T1.02</b>	<b>BD</b>	<b>11</b>	<b>4.7</b>	<b>Poor</b>
<b>T1.03</b>	<b>BD</b>	<b>9</b>	<b>2.6</b>	<b>Fair</b>
<b>T1.04</b>	<b>BD</b>	<b>3</b>	<b>1.9</b>	<b>Good</b>
<b>T1.2S1.01</b>	<b>NW</b>	<b>7</b>	<b>1.8</b>	<b>Fair</b>
<b>T2.01</b>	<b>NW</b>	<b>6</b>	<b>7.8</b>	<b>Good</b>
<b>T2.02</b>	<b>NW</b>	<b>10</b>	<b>7.7</b>	<b>Good</b>
<b>T2.03</b>	<b>VB</b>	<b>10</b>	<b>5.3</b>	<b>Fair</b>
<b>T2.04</b>	<b>NW</b>	<b>9</b>	<b>4.8</b>	Fair
<b>T2.2S1.01</b>	<b>VB</b>	<b>5</b>	<b>1.7</b>	Good
<b>T2.2S1.02</b>	<b>VB</b>	<b>4</b>	<b>1.5</b>	Reference
<b>T2.2S1.03</b>	<b>NW</b>	<b>2</b>	<b>1.2</b>	Reference
<b>T3.01</b>	<b>NW</b>	<b>1</b>	<b>18.2</b>	Reference
<b>T3.02</b>	<b>NW</b>	<b>3</b>	<b>14.6</b>	Reference
<b>T3.03</b>	<b>VB</b>	<b>0</b>	<b>5.1</b>	Reference
<b>T3.05</b>	<b>VB</b>	<b>2</b>	<b>4.2</b>	Reference
<b>T3.06</b>	<b>VB</b>	<b>0</b>	<b>1.8</b>	Reference
<b>T3.2S1.01</b>	<b>NW</b>	<b>2</b>	<b>8.7</b>	Reference
<b>T3.2S1.02</b>	<b>NW</b>	<b>6</b>	<b>6.2</b>	Reference
<b>T4.01</b>	<b>VB</b>	<b>3</b>	<b>15.9</b>	Reference
<b>T4.02</b>	<b>VB</b>	<b>6</b>	<b>9.2</b>	Good
<b>T4.03</b>	<b>VB</b>	<b>6</b>	<b>8.1</b>	Reference
<b>T4.05</b>	<b>VB</b>	<b>3</b>	<b>5.4</b>	Reference

**Table 4. Reach Assessment for Unconfined Channels**

.....  
 NW- Narrow  
 BD- Broad  
 VB- Very Broad

 **Essex County Natural Resources Conservation District**  
 481 Summer Street; Suite 202 St. Johnsbury, Vermont 05819

<b>REACH NUMBER</b>	<b>CONFINEMENT</b>	<b>TOTAL IMPACT SCORE</b>	<b>WATERSHED SIZE (sq. mile)</b>	<b>REACH CONDITION (From Phase I DMS)</b>
<b>M1</b>	<b>NC</b>	<b>16</b>	<b>129.4</b>	<b>Fair</b>
<b>M2</b>	<b>NC</b>	<b>12</b>	<b>129.2</b>	<b>Fair</b>
<b>M3</b>	<b>NC</b>	<b>13</b>	<b>125.4</b>	<b>Fair</b>
<b>M4</b>	<b>NC</b>	<b>7</b>	<b>117.3</b>	<b>Good</b>
<b>M6</b>	<b>SC</b>	<b>11</b>	<b>115.7</b>	<b>Fair</b>
<b>M8</b>	<b>NC</b>	<b>9</b>	<b>108.1</b>	<b>Good</b>
<b>M9</b>	<b>SC</b>	<b>13</b>	<b>107.5</b>	<b>Fair</b>
<b>M10</b>	<b>SC</b>	<b>13</b>	<b>100.7</b>	<b>Poor</b>
<b>M11</b>	<b>SC</b>	<b>16</b>	<b>99.3</b>	<b>Fair</b>
<b>M12</b>	<b>SC</b>	<b>12</b>	<b>98.3</b>	<b>Good</b>
<b>M13.S1.01</b>	<b>SC</b>	<b>5</b>	<b>1.3</b>	<b>Good</b>
<b>M13S1.02</b>	<b>NC</b>	<b>0</b>	<b>1.0</b>	<b>Reference</b>
<b>M13S1.03</b>	<b>NC</b>	<b>0</b>	<b>0.6</b>	<b>Reference</b>
<b>M14</b>	<b>SC</b>	<b>10</b>	<b>83.5</b>	<b>Good</b>
<b>M15</b>	<b>SC</b>	<b>6</b>	<b>81.7</b>	<b>Reference</b>
<b>M15S1.01</b>	<b>NC</b>	<b>5</b>	<b>3.1</b>	<b>Good</b>
<b>M16</b>	<b>SC</b>	<b>4</b>	<b>76.4</b>	<b>Reference</b>
<b>M21S1.01</b>	<b>NC</b>	<b>3</b>	<b>3.0</b>	<b>Reference</b>
<b>M2.1S1.02</b>	<b>NC</b>	<b>2</b>	<b>2.9</b>	<b>Reference</b>
<b>M25</b>	<b>NC</b>	<b>1</b>	<b>3.7</b>	<b>Reference</b>
<b>M2S1.03</b>	<b>NC</b>	<b>5</b>	<b>1.6</b>	<b>Fair</b>
<b>M3S2.01</b>	<b>SC</b>	<b>7</b>	<b>7.3</b>	<b>Fair</b>
<b>T1.05</b>	<b>NC</b>	<b>5</b>	<b>.30</b>	<b>Fair</b>
<b>T2.05</b>	<b>NC</b>	<b>4</b>	<b>3.5</b>	<b>Reference</b>
<b>T2.4S1.01</b>	<b>NC</b>	<b>5</b>	<b>1.1</b>	<b>Fair</b>
<b>T3.04</b>	<b>NC</b>	<b>0</b>	<b>4.9</b>	<b>Reference</b>
<b>T3.2S1.03</b>	<b>NC</b>	<b>1</b>	<b>1.0</b>	<b>Reference</b>

<b>T4.04</b>	<b>SC</b>	<b>4</b>	<b>6.2</b>	<b>Reference</b>
<b>T4.06</b>	<b>NC</b>	<b>1</b>	<b>3.0</b>	<b>Reference</b>

**Table 5. Reach Assessment for Confined Channels**

.....  
NC- Narrowly Confined  
SC- Semi-Confined

“The Phase I assessment of the Moose River watershed first collected information on human-induced changes in the study area – on corridor land cover, riparian buffer widths, flow regulation, bridges and culverts, bank armoring, channel straightening, dredging history, berms and roads, corridor development, depositional features, meander migration, meander width ratio for C and E streams, wavelength ratio for C and E streams, bank erosion, and debris or ice jam potential. When entered into the River Management Program’s web-based Data Management System (DMS), those changes were each assigned a score of “2” or “high,” “1” or “low,” or “0” “not significant.” Those scores were then combined for a total impact score of from 0 (representing the least impact) to 32 (the most impact).”

Because the DMS assigns parameters not assessed a score of 0, lack of information on a certain kind of impact can skew an impact score lower than might be warranted. In this study, flow regulation wasn’t assessed on many reaches; meander migration wasn’t assessed at all; bed material information was lacking for most of the reaches; and bank erosion/bank height were not evaluated. (It is hard to accurately gather this information via a windshield survey.) Had it been possible to assess those parameters, total impact scores might have been higher. The DMS also makes use of parameter impact values to suggest which of four adjustment processes – degradation, aggradation, widening, and planform change – are most at work in any reach. A cut-off score of 4 was established to distinguish (very broadly) between streams in equilibrium and those in adjustment. In general, the two highest scores indicate the adjustment processes most active in the reach.

Finally, these scores are used to generate a reach condition score for each reach in two different contexts – within the project area (the reaches are compared to one another), and statewide (in which the study reaches are compared to adjustment statewide). In each context, “reference” (a score of 0.85-1.0) means the reach has suffered no significant channel or floodplain modifications and is well-buffered; “good” (a score of 0.65-0.84) means a stream is undergoing only minor adjustments or has adjusted to previous modifications and is nearly in balance again; “fair” (a score of 0.35-0.64) means a reach is already experiencing major or rapid changes or that those changes are imminent; and “poor” (a score of 0.00- 0.34) refers to a reach that is severely out of regime.”

### 5.2 Adjustment Processes

Adjustment scores for each reach are predicted by SGAT, and rated: degradation, aggradation, widening, and planform characteristics.

See attached Report (Phase 1- Step 9. Adjustment Process and Reach Condition).

## 6.0 RECOMMENDATIONS FOR PHASE II

Reaches M7-M13 on the Moose River main stem were recommended by the ANR-DEC River Management Program for Phase II assessment field work.

<b>REACH NUMBER</b>	<b>CHANNEL LENGTH (MILES)</b>	<b>CONFINEMENT TYPE</b>	<b>STREAM TYPE/BED FORM</b>	<b>REACH CONDITION</b>
<b>M7</b>	<b>.33</b>	<b>Broad</b>	<b>F/Riffle-Pool</b>	<b>Good</b>
<b>M8</b>	<b>.65</b>	<b>NC</b>	<b>F/Plane Bed</b>	<b>Good</b>
<b>M9</b>	<b>2.8</b>	<b>SC</b>	<b>B/Plane Bed</b>	<b>Good</b>
<b>M10</b>	<b>.50</b>	<b>SC</b>	<b>C/Riffle-Pool</b>	<b>Good</b>
<b>M11</b>	<b>.53</b>	<b>SC</b>	<b>C/Plane Bed</b>	<b>Good</b>
<b>M12</b>	<b>2.10</b>	<b>SC</b>	<b>C/Plane Bed</b>	<b>Good</b>
<b>M13</b>	<b>.78</b>	<b>BD</b>	<b>E/Plane Bed</b>	<b>Fair</b>

**Table 6. Reaches Selected for Phase II Stream Geomorphic Assessment**

## REFERENCES

Geology of the Concord-Waterford Area, Vermont

By John H. Eric and John G. Dennis. Published by the Vermont Development Commission. Montpelier, Vermont 1958.

Vermont Agency of Natural Resources. 2005. Vermont Stream Geomorphic Assessment Phase I Handbook. Watershed Assessment Using Maps, Existing Data and Windshield Surveys. Waterbury, Vermont.

Vermont Agency of Natural Resources. 2005. Vermont Stream Geomorphic Assessment Phase II Handbook. Rapid Stream Assessment, Field Protocols. Waterbury, Vermont.