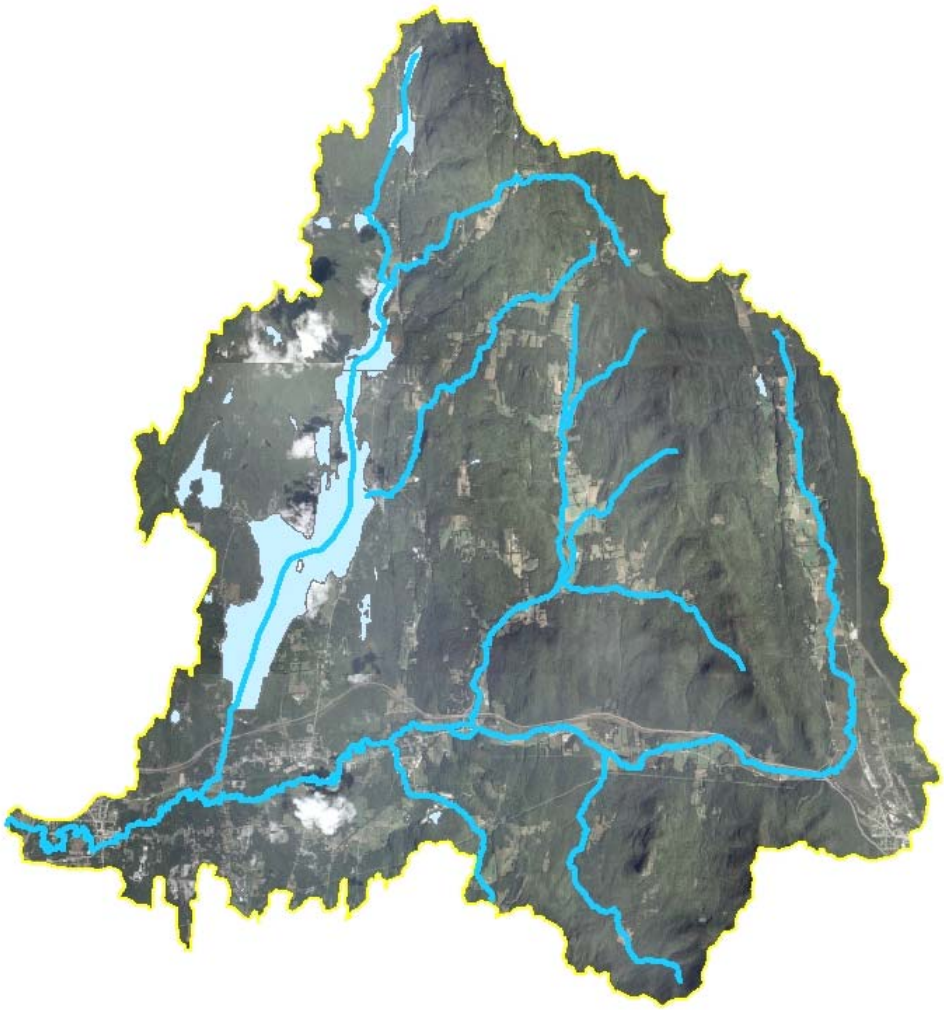
PHASE 1 STREAM GEOMORPHIC ASSESSMENT

Castleton River, Rutland County Vermont



Final Report

September 15, 2005

RUTLAND REGIONAL PLANNING COMMISSION

TABLE OF CONTENTS

MAPS, FIGURES AND TABLES

SPECIAL THANKS to: Shannon Hill, Vermont DEC River Management Section , Ethan Swift, Vermont DEC Watershed Coordinator, Kristen Underwood, South Mountain Research and Consulting , for technical support and quality assurance on this project. Photos courtesy of Ethan Swift (figures 1,2,3,5,6,7) and Kristen Underwood(figure 2).

INTRODUCTION

Fluvial geomorphology is the study of the interaction between streams and the landscape through which they travel. It is the science of understanding the physical interrelationships of the water, the sediments it carries and the lands it flows through. The phase 1 geomorphic assessment specifically looked at how changes on the landscape have translated to changes within the Castleton River Basin stream channels. The Rutland Regional Planning Commission(RRPC) used a number of different tools such as maps, public records and files, ortho-and aerial photos and digital mapping programs to survey the Castleton River in Vermont and six of its tributaries. Three major and three minor tributaries were assessed. The major tributaries surveyed included Pond Hill Brook, North Breton Brook ,and Gully Brook; the minor tributaries included Belgo Brook and two unnamed tributaries to North Breton Brook. Refer to MAP 1 for project location.

This study was conducted using the most current Vermont Geomorphic Assessment Protocols, which were designed to standardize geomorphic assessments conducted by different organizations around the state. Steps 1-4 of this study looked at deterministic watershed characteristics such as valley width, stream channel slope and prevailing soil types. Steps 5 and 6 looked at changes that have occurred on the landscape through human activities such as development, berms and roads and armoring placed along the river and creeks. Step 7 included a field survey of the Castleton River and select tributaries from public access points. The purpose of the field survey was to verify the remote sensing and mapping information used in this assessment.

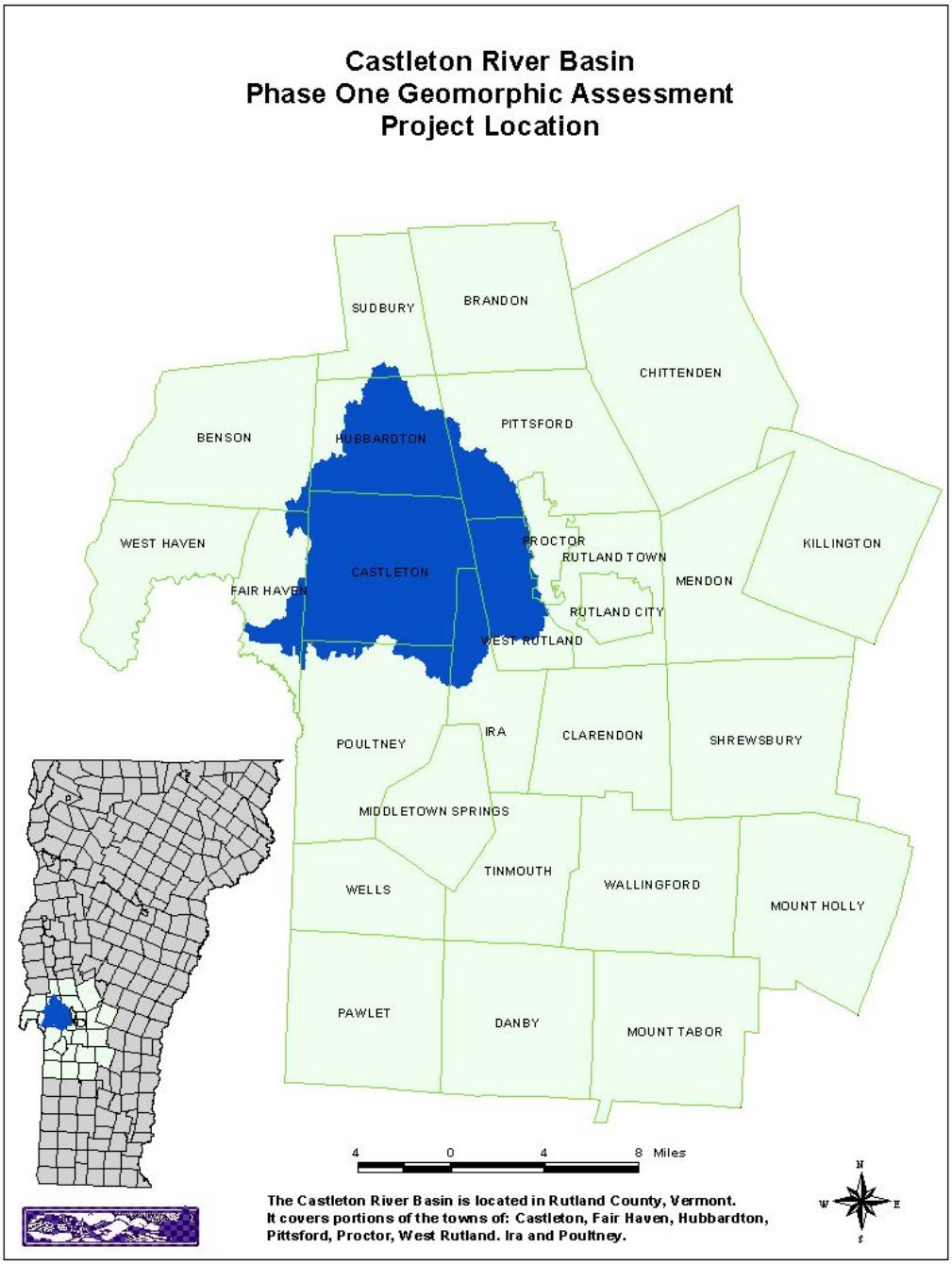
An additional and more in-depth field survey, or a phase 2 geomorphic survey, was conducted on selected areas of the study area during the summer of 2005. These areas included six reaches further broken into eight segments as follows: T2.12, T2.11A, T2.11B, T2.09-s1.05, T2.09-s1.04A, T2.09-s1.04B, T2.09-s1.02, and T2.09-s1.01. For more information on the phase 2 field survey, please refer to the online Database Management System(DMS).

Results from both the phase 1 and phase 2 studies will provide much needed baseline data about the current conditions in the Castleton River Basin. The data will be used to provide recommendations for future restoration project locations, planning and zoning decisions, tree planting sites and other types of restoration projects that may be successful.

Funding for the Castleton River Phase I geomorphic assessment was provided by Vermont's Clean and Clear Initiative (Corridor Management Grants from Vermont's Department of Environmental Conservation (DEC)) and a US Environmental Protection Agency (EPA) Federal Pass Through, 604b grant, through the VT Dept. of Water Quality.

The study was conducted by the RRPC with support from the Vermont DEC and South Mountain Research and Consulting (SMRC).

Remote sensing data used in this study was obtained from the Vermont Center for Geographic Information (VCGI), Vermont DEC, the Rutland Natural Resource Conservation Service (NRCS) and the Rutland Regional Planning Commission (RRPC). Information was also provided by officials from the towns of Castleton, Fair Haven, West Rutland and SMRC.



MAP 1: *Project Location*

CASTLETON RIVER BASIN: STUDY AREA BACKGROUND

The Castleton River Basin is comprised of fifty-four subwatersheds covering approximately ninety-nine square miles. It covers all of the town of Castleton and portions of the towns of Fair Haven, Hubbardton, Pittsford, Proctor, West Rutland, Ira and Poultney. It includes Lake Bomoseen, Glen Lake, Pine Pond, and several other smaller ponds.

There are numerous recent water related projects in the Castleton River Basin. Some of the bigger projects include: The West Rutland Marsh Restoration Project, Gully Brook/Traverse Farm Project, Route 4A Stabilization Project and the Castleton Area River Project(CARP). See Appendix A for more in depth information on each project. These other studies provided background data to help in our assessment.

METHODOLOGY

This assessment was completed using the methodologies outlined in the Vermont Geomorphic Assessment Phase I Handbook, dated April 2004. Computer mapping functions were completed through the automated GIS extension/tool, Stream Geomorphic Assessment Tool (SGAT), version 3.02.using ESRI's ArcView 3.2 software. This software and extension were used to create the initial data used to run SGAT. This data includes the following GIS databases: Subwatersheds, reach points, meander center line(thalweg), and valley walls. All data resulting from this study has been entered into Vermont DEC's online Data Management System (DMS) and checked for quality and reproducibility by qualified Vermont DEC staff.

DATA INPUTS/STUDY RESULTS

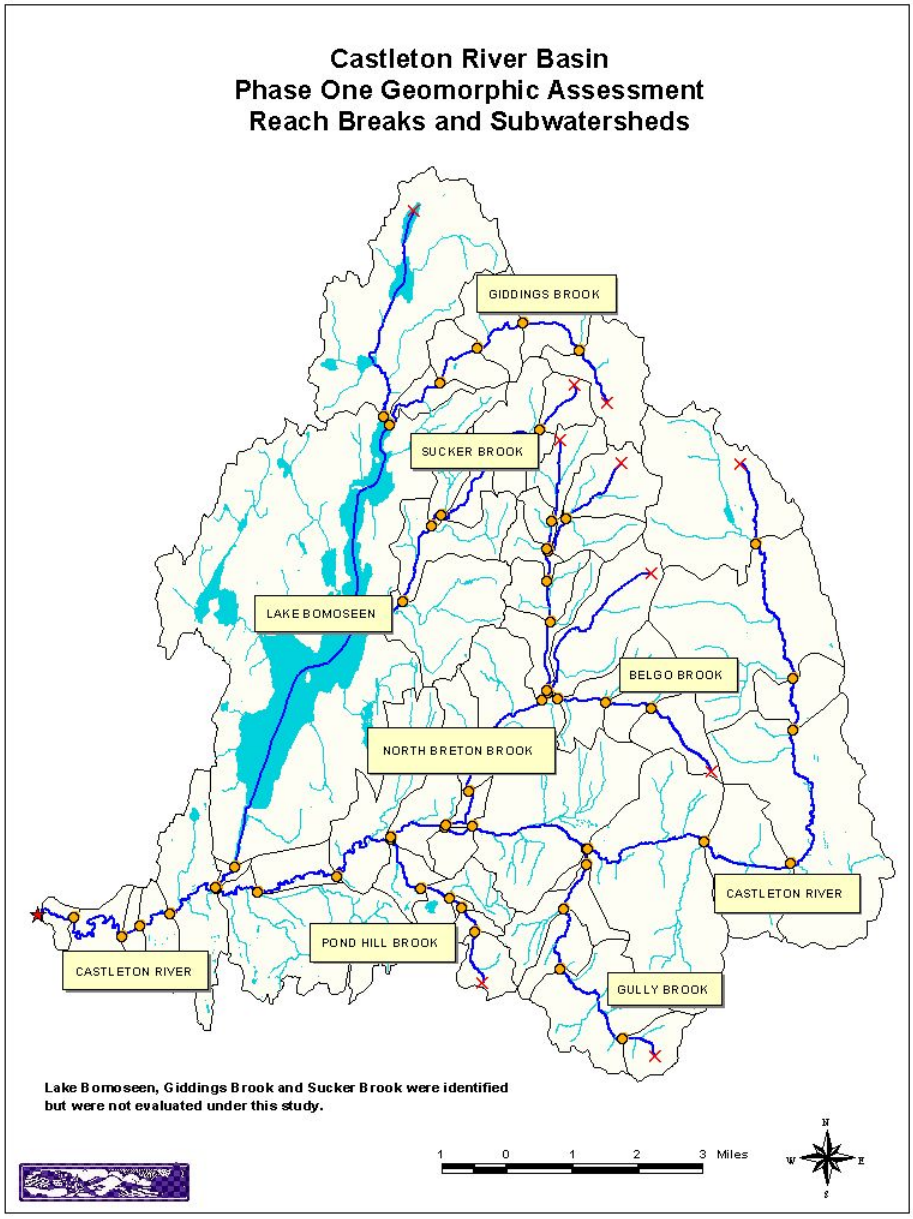
The results of this study are derived from the following data inputs: watershed location; valley and channel characteristics; soils data; land use and riparian buffer data; post-settlement changes to the channel, floodplain, stream corridor and watershed and a comparison of the expected stream channel characteristics to the measured characteristics. All of the phase 1 data (drawn upon in the following summaries) can be found in the online DMS.

<u>Reach Location</u>

The Castleton River Basin was divided into 54 reaches for the purposes of this study. Each reach is a like area studied as one geologic unit(Figure 1) The main stem of the Castleton River was divided into 17 reaches, the Gully Brook was divided into 5 reaches, North Breton Brook was divided into 8 reaches, Pond Hill Brook was divided into 5 reaches, Belgo Brook was divided

Figure 1*: Reach number T02.02 depicting wetlands in green, main stem of the river in royal blue, thalweg in dotted cyan blue, subwatersheds in pink, river corridor in red, valley walls in orange, reach points as yellow dots and bridges as yellow squares.*

into 4reaches, the unnamed tributary to Belgo Brook was divided into 1 reach and the unnamed tributary to North Breton Brook was divided into 2 reaches. Please refer to the online DMS for a complete list of the reaches and their locations within the basin. The following map details the location of each reach and a representation of it's subwatershed area. See MAP 2.



MAP 2*:Reach breaks and subwatersheds*

Stream Types

All stream reaches in this study were classified as Rosgen (1996) and Montgomery Buffington (1996) stream types A, B C, or E.

Stream type “A”-steep, cascading, headwater reaches Stream type “B”- include moderately steep, step-pool streams Stream type “C”- the most common stream type in the Castleton River Basin, “C” streams include less-steep, pool-riffle streams with floodplain access. Stream type “E” – very similar to type “C” but used only when sinuosity values are greater than 1.5 and supported by windshield surveys, The “C” stream type predominated, especially in the valleys.

Stream Type	Description	Channel Slope	Channel Length(Sum in feet)	Number Reaches	Percent by channel length
A	Cascade	Steep	17,826	3	5.6
A	Step-pool	Steep	10, 151	2	3.2
B	Plane bed	Moderate	6538	2	2.0
B	Riffle-pool	Moderate	1996	1	0.6
B	Step-pool	Steep	46,282	8	14.6
C	Plane bed	Moderate	4962	2	1.6
C	Riffle-pool	Gentle	146,407	26	46.2
C	Step-pool	Moderate	4802	1	1.5
E	Plane bed	Gentle	5092	1	1.7
E	Riffle-pool	Gentle	72,843	8	23.0

Table 1: *Stream type and percent of total channel length*

Basin Characteristics: Geology and Soils

As stated in the Vermont DEC protocols, “A stream carries not only water but also sediment. Geology determines the source material that the river is carrying, the way that material is carried and the rate of channel adjustments.”

The dominant geological materials in the Castleton River Basin are glacial till, ice-contact, and alluvial deposits. The characteristics of the dominant soil types in the watershed show infrequent flooding, but variable erosion rates across the basin, with some reaches having soil types throughout that show potential for very severe erosion.

Dominant Material	Number of Reaches	Range(% of reach)	Percent(of reaches)
Ice-contact	11	30.6-94.7	20.4
Alluvial	18	45.7 – 90.5	33.3
Glacial Till	20	55.0 – 100.0	37.0
Glacial Lake	1	100.0	1.9
Other	4	39.1 – 69.0	7.4

Table 2: *Geologic Material*

Land Cover and Reach Hydrology

Landuse in the watershed is mainly forested, with forest cover in each subwatershed ranging from 57.4 percent on one reach to 95.6 percent. Historically, a much higher percent of the watershed was cleared for pasture and croplands.

Landuse in the stream corridor is a mix of forested land, crops and fields and urban areas. Urban areas make up as much as 80.8 percent of the landuse along one reach of the Castleton River in Fair Haven. A total of 4 reaches have "Urban" as the dominant Land cover/Land use(LCLU), 1 reach as "Crop", 4 reaches as "Field" and the remaining 45 reaches as "Forest".

Woody vegetative buffers vary throughout the basin. 23 reaches have 0-25 feet of buffer on both sides of the river and an additional 5 reaches have 0-25 feet buffer on only one side. Conversely, 19 reaches have more than 100 feet of buffer on both sides with an additional 3 reaches having 100 feet of buffer on at least one side.

Groundwater and wetland inputs vary greatly by reach. Of the 54 reaches, 10 have no groundwater input, 21 have minimal groundwater input and 23 have abundant groundwater input.

Instream Channel Modifications

Instream channel modifications include the impact or frequency of bridges and culverts, bank armoring, channel straightening and dredging on the river.

Bridges and culverts seem to be the modifications effecting the river most. 19 reaches have no bridges or culverts, leaving 35 reaches with at least one bridge or culvert. Of particular interest is a 48 inch culvert on the main stem of the Castleton River on reach T02.12 which is completely filled in with woody debris and forces the river out of its banks. See Figure 2.

Figure 2: *Culvert blocked with woody debris, whirlpool caused by overflow, flooded roadway on the main stem of the Castleton River, reach T02.12.*

Bank armoring is present in 5 reaches with approximately 0.7 % of the total river length armored. Reach T02.03 in the town of Fair Haven is heavily armored with slate. See Figure 3.

Figure 3*: Bank armoring along the main stem of the Castleton River, reach T02.03*

Impacts from channel straightening effect 20 reaches with approximately 14.5 % of the total river length straightened. See Figure 4.

Figure 4: *Channel straightening on the Castleton River, reach T02.13.This reach also shows modifications to the floodplain, including roads, rail and some development.*

Gravel mining has occurred throughout history in numerous reaches along the main stem of the Castleton River. Today, gravel extraction is primarily performed by farmers abutting the river, few if any commercial operations exist. See Figure 5.

Figure 5: *Gravel deposition at the confluence with Gully Brook, Castleton River reach T02.11.*

Floodplain Modifications

Changes in the floodplain can also affect the river and its natural processes. Development in the floodplain alters the ability of the river to react to changes in the overall system. Houses, roads, rail and berms are the predominant floodplain modifications found in the Castleton River Basin. See Figure 4. 14 reaches have a high impact score relating to roads and berms while 10 reaches scored high due to development.

Depositional features appear in only four reaches with only one(T02.11-s1.01) having a high impact rating.

Windshield Survey

The windshield survey provided a means of limited field verification of the phase 1 data. Brief observations were taken at points of vehicular and/or public access along the rivers and creeks in the study. The windshield survey was in no way a comprehensive field verification and the results of the phase 1 study should be considered preliminary. The primary modification made to the data as a result of the windshield survey are changes in the reference stream type, eight of reaches were changed; most from a “C” type to an “E” type.

In addition, dominant bed form, bank height, bank erosion and ice jam potential were recorded in the windshield assessment. Based on bank data, 22 reaches(40.7%) had an impact of low, while 3 reaches(5.5%) had an impact of high and the remainder were not

significant or not evaluated. Most ice jam potential is from undersized culverts and/or low bridges, although some potential for jams exists at sharp bends and tight constrictions in the river.

Figure 6: *Areas of steep high bank erosion, Castleton River, reach T02.02.*

Figure 7 : *Ice beginning to build up on the Castleton River, reach T02.03.*

DATA ANALYSIS

Impact Ratings

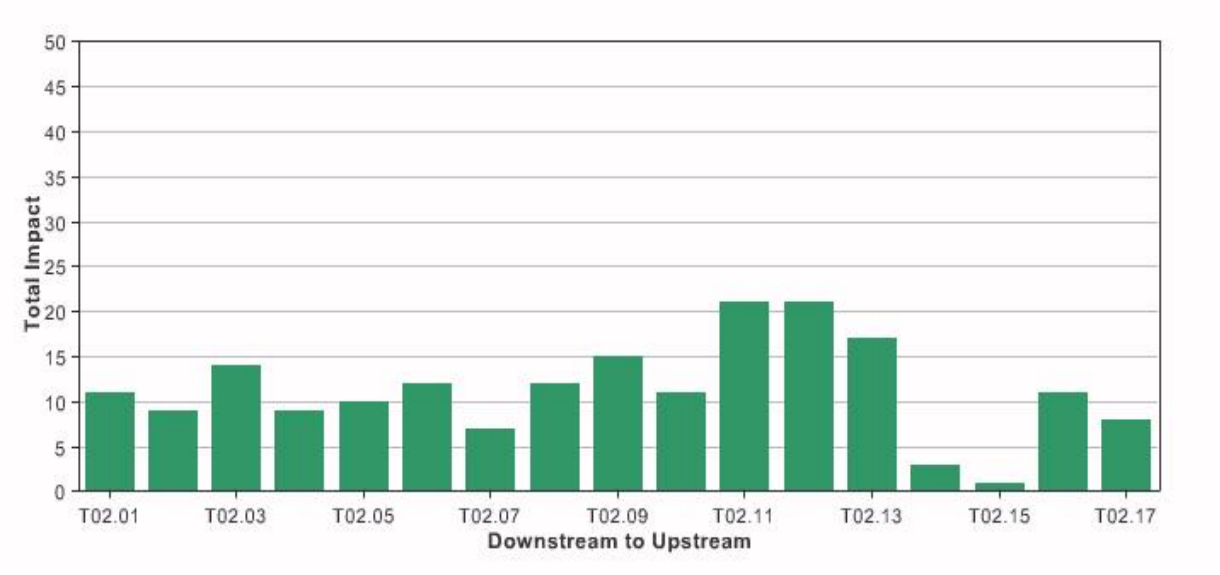


Figure 8: *Final impact ratings for the main stem of the Castleton River*

Stream and Watershed Provisional Impact Rankings

Reach ID	Stream Name	Total Impact Score	Reach Condition (Project)
T02.01	Castleton River	11	Fair
T02.02	Castleton River	9	Fair
T02.03	Castleton River	14	Fair
T02.04	Castleton River	9	Fair
T02.05	Castleton River	10	Reference
T02.05-S1.01	Lake Bomoseen	13	Fair
T02.05-S1.02-S1.01	Sucker Brook	11	Fair
T02.05-S1.02-S1.02	Sucker Brook	10	Good
T02.05-S1.02-S1.03	Sucker Brook	3	Reference
T02.05-S1.02-S1.04	Sucker Brook	1	Reference
T02.05-S1.02-S1.05	Sucker Brook	5	Good
T02.05-S1.02-S1.06	Sucker Brook	9	Good
T02.05-S1.02-S2.01	Giddings Brook	8	Good
T02.05-S1.02-S2.02	Giddings Brook	5	Reference
T02.05-S1.02-S2.03	Giddings Brook	9	Good
T02.05-S1.02-S2.04	Giddings Brook	6	Good
T02.05-S1.02-S2.05	Giddings Brook	6	Good

T02.06	Castleton River	12	Good
T02.07	Castleton River	7	Reference
T02.08	Castleton River	12	Good
T02.08-S1.01	Pond Hill Brook	12	Fair
T02.08-S1.02	Pond Hill Brook	12	Fair
T02.08-S1.03	Pond Hill Brook	4	Good
T02.08-S1.04	Pond Hill Brook	9	Fair
T02.08-S1.05	Pond Hill Brook	9	Fair
T02.09	Castleton River	15	Fair
T02.09-S1.01	North Breton Brook	15	Fair
T02.09-S1.02	North Breton Brook	8	Good
T02.09-S1.03	North Breton Brook	9	Fair
T02.09-S1.04	North Breton Brook	2	Reference
T02.09-S1.04-S1.01	Belgo Brook	4	Reference
T02.09-S1.04-S1.01-S1.01	Unnamed Tributary 1	4	Reference
T02.09-S1.04-S1.02	Belgo Brook	7	Good
T02.09-S1.04-S1.03	Belgo Brook	6	Reference
T02.09-S1.04-S1.04	Belgo Brook	2	Reference
T02.09-S1.05	North Breton Brook	2	Reference
T02.09-S1.06	North Breton Brook	9	Fair
T02.09-S1.06-S1.01	Unnamed Tributary 2	3	Good
T02.09-S1.06-S1.02	Unnamed Tributary 2	0	Reference
T02.09-S1.07	North Breton Brook	10	Fair
T02.09-S1.08	North Breton Brook	7	Fair
T02.10	Castleton River	11	Fair
T02.11	Castleton River	21	Fair
T02.11-S1.01	Gully Brook	13	Poor
T02.11-S1.02	Gully Brook	5	Reference
T02.11-S1.03	Gully Brook	5	Reference
T02.11-S1.04	Gully Brook	4	Reference
T02.11-S1.05	Gully Brook	2	Reference
T02.12	Castleton River	21	Poor
T02.13	Castleton River	17	Poor
T02.14	Castleton River	3	Good

T02.15	Castleton River	1	Reference
T02.16	Castleton River	11	Good
T02.17	Castleton River	8	Fair

Table 3: *Final Impact Ratings*

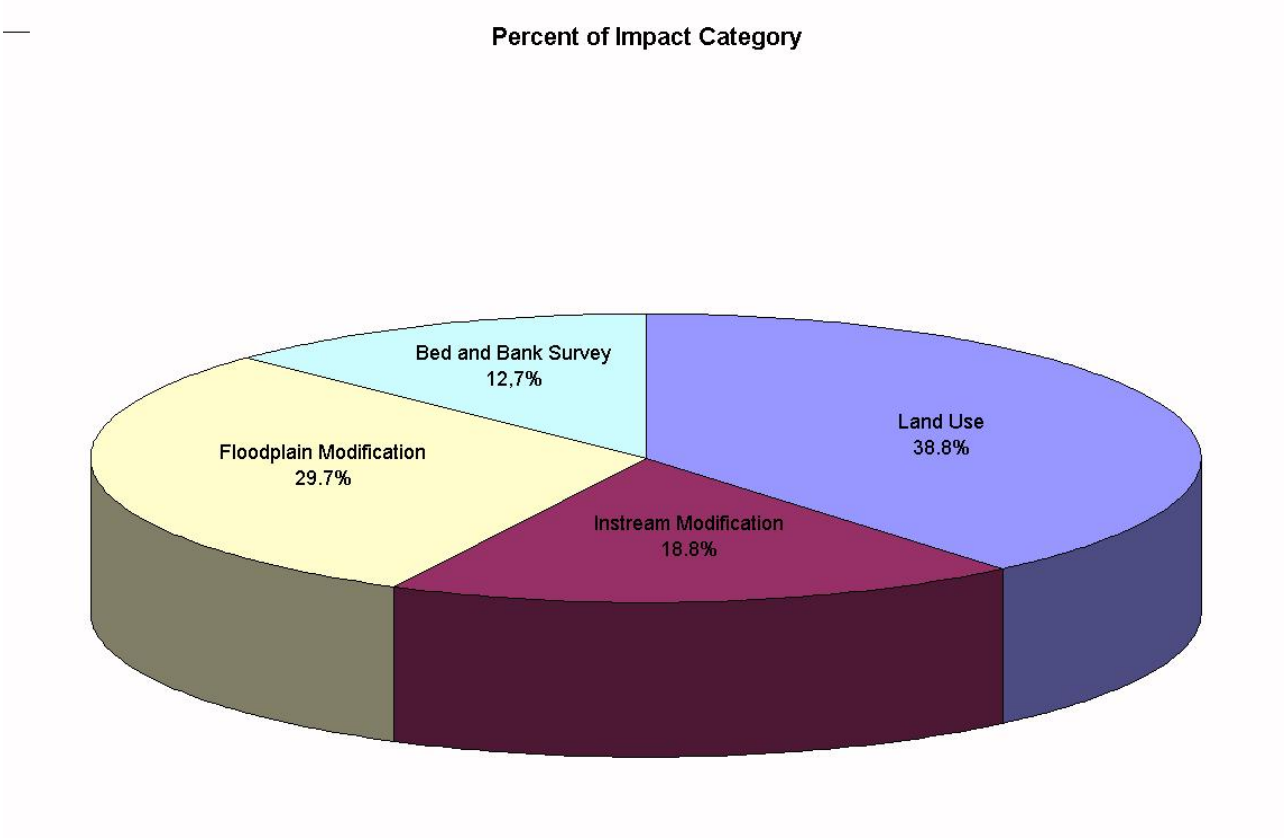


Figure 9 : *Percent of each impact category of the total impact score*

Adjustment Processes

SGAT predicted adjustment scores for each reach, it rated: degradation, aggradation, widening, and planform characteristics. Degradation, the scouring of the river channel and Aggradation, the storage of sediments, can be looked at together. In the Castleton River Basin, 18 reaches exhibit more degradation, 26 exhibit more aggradation and 10 reaches have equal amounts of aggradation and degradation indicating that both processes are occurring at the same time on different sections of the reach.

The Castleton River and its tributaries do not appear to be over widened. Only one reach, T02.11-s1.01, shows any signs of being widened. All other reaches exhibit no significant widening.

Five reaches(T02.09, T02.11, T02.11-s1.01, T02.12, T02.13) exhibited a high planform rating. This means in those reaches the river is actively trying to change its path.

Comparing reaches within the Castleton River Basin system showed that overall they are split quite evenly into the following groups: 15 reaches were identified as 'Good", 19 reaches as 'Fair", 17 reaches as "Reference" and only three ranked "Poor".

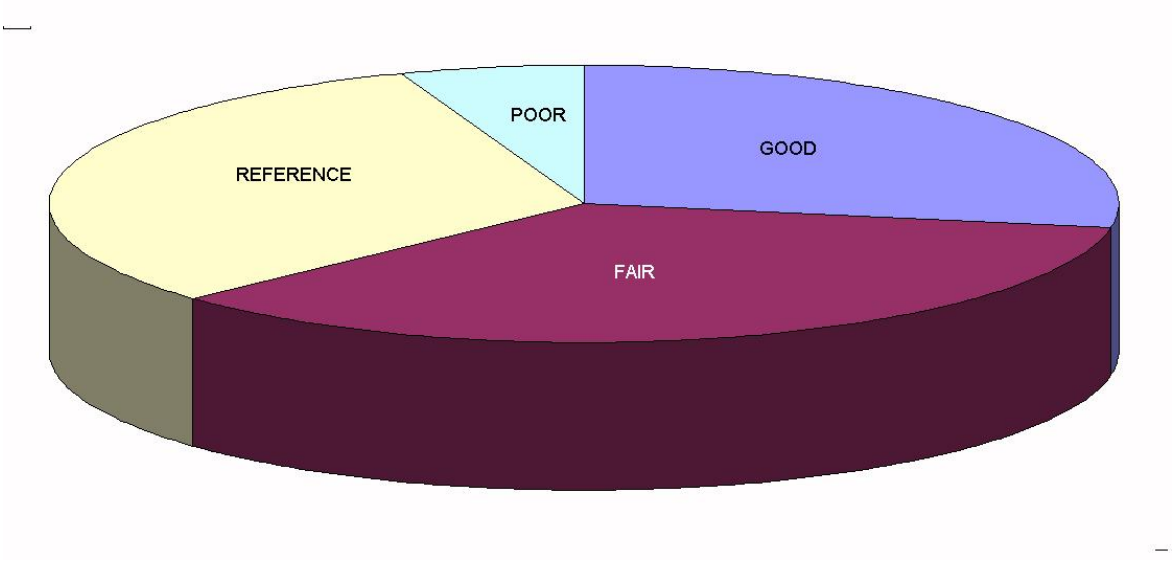


Figure 10: *Reach condition, percent of all reaches Castleton River Basin only!.*

CONCLUSIONS

Much of the watershed is forested and urban with the river corridor exhibiting the same characteristics. Most of the reaches in the forested area have riparian buffers of 100 or more feet on both sides of the river. More of the urban areas have little to no riparian buffers, less than 25 feet on one or both sides.

Over the years, there have been many attempts at bank stabilization. Most of this occurs in the more urban areas as an effort to alleviate damage to structures, infrastructure and transportation systems. Rip-rap seems to be a common practice as it exists in several reaches, thus confining the river to its banks. There has been significant development along many of the Western reaches of the Castleton River.

Based on the preliminary results of the phase 1 geomorphic assessment, system wide the Castleton River is fairly stable, however there are areas of localized instability on the main stem and the tributaries. The RRPC recommends phase 2 studies to further investigate these potential unstable reaches.

Appendix A- Projects in the Castleton River Basin

APPENDIX A

PROJECTS IN THE CASTLETON RIVER BASIN

Appendix A
Materials covered in the Corridor Plan