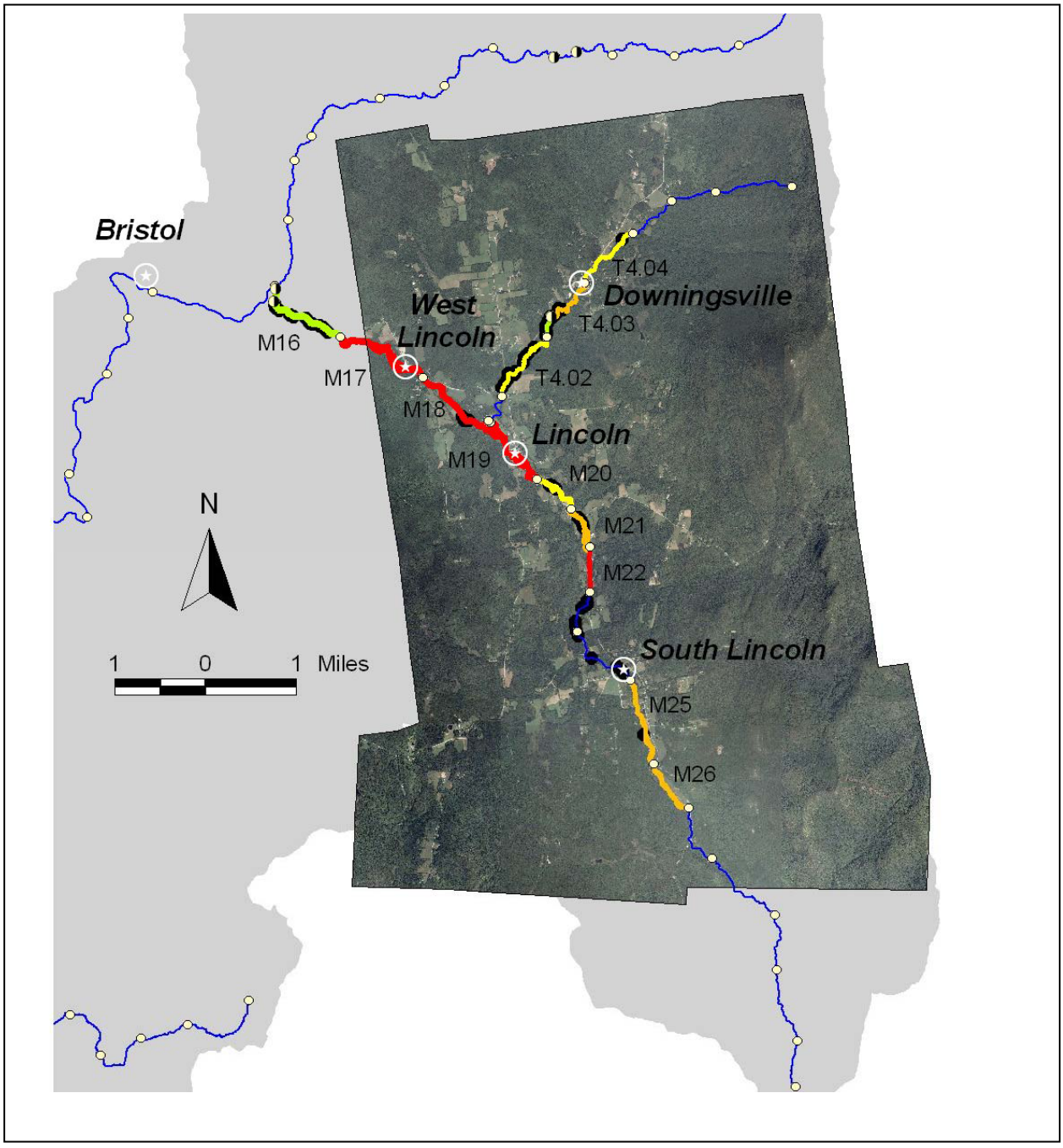
DRAFT River Corridor Plan
New Haven River: Town of Lincoln

Addison County, Vermont

February 2006



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ACKNOWLEDGEMENTS

This corridor planning project has been supported by a Vermont Agency of Natural Resources Water Quality Division, Category 2 River Corridor Grant (FY2005).

Recommendations in the plan are based upon the geomorphic condition of the river corridor revealed from assessment work previously completed by South Mountain Research & Consulting of Bristol, Vermont under FEMA Project Impact funding administered through the Addison County Regional Planning Commission.

The work presented in this document is the result of a huge collaborative effort by members of the technical working group, Lincoln Town officials, State and regional agencies, conservation organizations, interested community members, and open discussions with the many landowners who own property along the New Haven river and its tributaries. The process of developing this plan has been as positive as its outcome, thanks to the participation and cooperation of so many people. A special thanks is due to Mark Benz, for taking an idea and persevering with it, to get this whole project started.

EXECUTIVE SUMMARY

The Town of Lincoln received a grant (in May 2005) from the Vermont Department of Environmental Conservation (VTDEC) to develop a River Corridor Plan for the New Haven River and Beaver Meadow tributary. Funding has been appropriated through Governor Douglas' Clean & Clear Action Plan. This grant has funded a 9-month alternatives analysis process with the long-term objectives of reducing streambank erosion, sediment, and nutrient loading, by managing for the equilibrium channel.

This project is endorsed by the Lincoln Selectboard. The Technical Working Group assembled for the project includes Sally Ober, Project Director; Ethan Ready, Selectboard member; Mark Benz, grant administrator; Kristen Underwood, consulting geologist; and Shayne Jaquith, Ty Mack, and Ethan Swift from the VTDEC Water Quality Division. An invitation to the Technical Working Group has also been extended to the Town of Bristol, since choices made along the river through Lincoln have the potential to impact downstream communities.

In July 2005, a press release was sent to local newspapers, and a direct mailing was sent to at least 110 riverside landowners. These invitations for public participation were to ensure that the River Corridor Plan which results from this process, reflects the individual as well as public visions and goals, compatible with our highly dynamic and adjusting river reaches. Another press release was sent in October 2005 to the Lincoln Town e-mail list and the Lincoln Community School Newsletter.

The River Corridor Plan builds on results of a geomorphic study of portions of the river, that was completed in 2004 under FEMA Project Impact funding through the Addison County Regional Planning Commission. Results of this study were presented at the November 2004 River Forum, sponsored by the Lincoln Conservation Commission at Burnham Hall. This presentation was repeated for the Forest and Field Club (a local outdoor naturalist organization) in June, and again in August 2005 as part of the Lincoln Lecture Series at the Lincoln Library.

In August 2005, Lincoln's Hill Country Holidays included three sessions with a river flume provided by the VTDEC, River Management Section. This hands-on river simulator was a popular attraction for people of all ages, generating many questions and hours of discussion.

From July 2005 to January 2006, Sally Ober spent about 32 hours, meeting with approximately 67 landowners to discuss at least 33 riverside properties. Landowner interviews provided an opportunity to discuss the goals of this project, to gather information from landowners about river corridor constraints, land uses, concerns, and river management alternatives acceptable to the landowners. Most of these meetings were done in person; a few were done by telephone. Landowners were generally very willing to share information about their relationship with the river, and appreciative of the personal attention given to them.

During the fall of 2005, various members of the Technical Working Group for this project attended meetings of the Lincoln Planning Commission and the Lincoln Conservation Commission. Fluvial Erosion Hazard Corridor maps were introduced as a potential tool for protecting properties along the river corridor, as changes to zoning regulations are being discussed by Town officials. Assistance from the Technical Working Group to these organizations is continuing as needed.

A River Corridor Plan has been prepared for public review in February 2006. The plan identifies and ranks short-term and long-term actions for implementation, including potential river restoration projects. Questions or comments are welcomed by Sally Ober, Project Director, at 453-5220 or sallyober@gmavt.net.

NEW HAVEN
RIVER CORRIDOR MANAGEMENT PLAN:
TOWN OF LINCOLN

1.0 INTRODUCTION

The Town of Lincoln has completed a river corridor planning process funded by a Category 2 - Project Development grant through the VTDEC Water Quality Division, River Management Section (Grant Agreement No. 2005-RCG-02-10). This 9-month process has explored potential site-level, town-level, and watershed-level strategies for reducing streambank erosion and sediment and nutrient loading, by managing toward the equilibrium channel.

Through outreach to individual landowners and through a series of public forums, a Technical Working Group has identified river corridor management strategies which are sustainable along this highly dynamic river and which are compatible with public and individual goals and visions. The study area has focused on the New Haven River main stem through the Lincoln, West Lincoln, and South Lincoln village areas, as well as the Beaver Meadow tributary through Downingsville.

While focusing on the village areas of town, the process has considered consequences of channel and watershed management choices farther upstream and downstream, as informed by results of geomorphic assessments previously completed in the watershed (SMRC, 2004a, 2004b).

This draft plan is offered for public review and comment. It is anticipated that the final, publicly-approved plan would be incorporated by reference in the next update to the Lincoln Town Plan (current version adopted June 2002). This corridor plan should also be considered in the context of future updates to the Addison County Region-wide All Hazards Mitigation Plan (ACRPC, 2005) and its Lincoln section (Annex H). Acknowledgement of the science of fluvial geomorphology, the current geomorphic condition of the river, and the continuity of river networks, will help to ensure compatibility of this Lincoln Corridor Plan with New Haven River corridor plans that may be developed by adjoining communities (namely, Bristol and New Haven).

The Plan is intended to facilitate action, and contains a prioritization of various planning, restoration and conservation projects. General methods and resources are provided so that community members and landowners can follow-through on recommended implementation strategies, and secure funding and resources.

This Plan is intended to support an adaptive management approach to the river corridor, as conditions change and the community's understanding of river dynamics evolves.

2.0 BACKGROUND and PREVIOUS STUDIES

The main impetus for development of this River Corridor Management Plan has been the repeated flood losses experienced by Lincoln residents in recent years, including the large flood of 1998, and lesser floods of 2000 and 2004. On June 1, 2004 the Town of Lincoln Selectboard acted to encourage the formation of the Lincoln Flood Mitigation Alliance to serve as a clearinghouse for information and as a focal point for future pre-disaster flood mitigation actions. The current river corridor planning effort has grown from this initial Selectboard action.

In addition to concerns for flooding, the Lincoln "citizens have identified water quality as the most important issue for town planning" (Town Plan, adopted June 4, 2002). Goals identified in

the Town Plan relevant to water quality and habitat improvements, include:

- "Improve Lincoln's water quality so that the New Haven River can be consistently utilized for fishing, swimming and other recreational uses.
- Gather information about the River's current status and encourage all citizens to support regulations that will maintain or improve its ecological stability and recreational value.
- Explore and establish educational and monetary resources for remedying poor water quality due to human activity.
- Protect and restore riparian areas critical to the overall health of this river ecosystem" (Lincoln Town Plan, 2002).

2.1 Fluvial Erosion Hazards and Flood Losses

The Town of Lincoln is a participant in the National Flood Insurance Program, and the Federal Emergency Management Agency (FEMA) has delineated areas along the New Haven River main stem and Beaver Meadow brook which are at risk from flooding by inundation (rising water). However, there is increasing recognition within Lincoln, Vermont, and the nation, that flood damages in recent years have occurred not entirely as a result of rising waters, but also from sudden erosion of streambanks and channel avulsions during flood events (VTDEC Water Quality Division, 1999; VT Dept of Housing & Community Affairs, 1998; FEMA, 2003).

Figure 1.
York Hill Bridge, West Lincoln, following June 1998 flood.
(Photo Credit: Susan Tucker)

The risks of these fluvial erosion hazards are not adequately captured by the FEMA Flood Insurance Rating Maps (FEMA-FIRM). Often, properties and infrastructure located outside the boundary of the FEMA-FIRM floodway, or elevated above the predicted flood stage, are incurring losses as a result of streambank erosion. Often these are locations of repeated losses over the years – for instance in the 1927, 1938, 1973, and 1998 floods.

In the summer of 2004, a geomorphic assessment of portions of the New Haven River and Beaver Meadow brook was completed under a FEMA Project Impact Grant administered through the Addison County Regional Planning Commission (SMRC, 2004a; SMRC 2004b). The purpose of this study was to assess the present geomorphic condition of the river network, to identify local and regional stressors impacting the channel and watershed, and to characterize the sensitivity of river reaches to future adjustments. Assessments were also conducted to identify structures at risk from expected future channel migration. This study identified several reaches within Lincoln that were prone to lateral and vertical adjustments, and which were highly sensitive to future channel and watershed disturbances. Many of these highly sensitive reaches pass through established village areas of the town, including West Lincoln, Lincoln village, and South Lincoln, placing roads, bridges, homes, and commercial businesses at risk of erosion hazards in future flood events.

2.2 Water Quality

Summer-time water quality sampling (1993 to 2004) conducted by the New Haven River Watch has identified phosphorus and *E. coli* impacts in the New Haven River, as well as sedimentation from unstable stream reaches and road / culvert maintenance practices (ACRWC, 2004). Three Lincoln sites have been monitored on the New Haven main stem over that time period:

- York Hill Road bridge crossing at West Lincoln village;
- South Lincoln Bridge (Gap Rd.) in South Lincoln village; and
- A station ½ mile south of the South Lincoln Bridge.

Bartlett's Falls Pool is a fourth monitoring station which is located in Bristol township but is just downstream of Lincoln and sees regular swimming use by Lincoln residents.

E.coli is often detected above the State water quality standard (77 colony-forming-units per 100 mL) at each of these sampling stations – at least once per summer and usually more often (ACRWC, 2005). Total phosphorus concentrations have often been above levels that would suggest nutrient enrichment. No in-stream Vermont water quality standard exists for Total Phosphorus, at present. However, elevated phosphorus levels lead to algae production in the river and in the receiving waters, Otter Creek and Lake Champlain. The algae decomposition process consumes oxygen from the water, leading to reduced oxygen levels that may impair populations of fish and other aquatic organisms. In recent years, phosphorus has been linked to the production of toxic blue-green algae along the shores of Lake Champlain (LCBP, 2005).

Long-term water quality monitoring at the mouth of the Otter Creek has identified elevated phosphorous levels and sedimentation (VTDEC WQD, 2005; VTDEC WQD, 2004a). Phosphorous loading from the Otter Creek to Lake Champlain continues to exceed target levels outlined in the Lake Champlain Phosphorous Total Maximum Daily Load (LCBP, 2005). In addition to agricultural and developed land use practices, eroding streambanks have been identified as a contributing nonpoint source of phosphorus in rivers and streams of Vermont (VTANR, 2001; DeWolfe *et al.*, 2004).

2.3 Habitat

The State of Vermont has listed approximately 10 miles of the New Haven River main stem from the confluence with Otter Creek to the Village of Bristol as being in need of further assessment (Part C List of Waters; VTDEC WQD, 2004b) for sedimentation and habitat alteration as a possible result of morphological instability. While the town of Lincoln is upstream of this formally-listed segment, streambank erosion and channel instability within Lincoln township result in the production and delivery of sediments to downstream reaches in Bristol and New Haven. Part of the solution for channel instabilities and habitat degradation in Bristol and New Haven is reduced production and enhanced attenuation of sediments and nutrients within the Lincoln portion of the watershed.

3.0 VISION and GOALS

River corridor management planning, which acknowledges the dynamic nature of rivers and manages toward the equilibrium (or balanced) condition of our rivers, has been identified in the State of Vermont and elsewhere in the nation as an ecologically and economically sustainable means of addressing the above concerns for fluvial erosion hazards, and degraded water quality and habitats (VTDEC River Management Section, 2005a, 2005b, 2003; VTDEC Water Quality Division, 1999; USEPA, 1995). Managing toward dynamic equilibrium of river channels, can

reduce erosion hazards and improve channel stability in the long term, thereby reducing sedimentation and nutrient loading to our rivers. Reduced sedimentation and nutrients, in turn, will improve in-stream and Lake Champlain habitats.

A community-based river corridor planning process recognizes the public value of riparian areas and the need for public resources to support and facilitate stewardship of these lands in private and public ownership.

Acknowledging a town's place in the watershed and along the river network is also important. The consequences of Lincoln's channel and watershed management choices, with respect to increased flows and sediment and nutrient loading, are felt by downstream communities, Bristol and New Haven.

4.0 PLAN OBJECTIVES

The following objectives have been identified for this New Haven River Corridor Plan:

a) Improve water quality, restore habitats, and reduce erosion hazards by managing toward the equilibrium channel.

b) Analyze previous geomorphic assessment work, identify the causes of channel instability, and evaluate options for restoring long-term stability to the river.

c) Identify sustainable river corridor management strategies through continued outreach to individual landowners and through a series of public forums.

d) Review potential channel management choices for their effectiveness and potential consequences to downstream and upstream properties and infrastructure.

e) Prepare a River Corridor Plan for public review by February 2006. The plan will identifies and ranks short-term and long-term actions and approaches for implementation, including potential river restoration projects.

5.0 CORRIDOR PLANNING TASKS

The river corridor planning process in the town of Lincoln has included the following tasks: (1) establishment of a Technical Working Group; (2) delineation of a river corridor to define the spatial context for discussion of various management strategies; (3) development of public forums and outreach events; (4) individualized landowner outreach; and (5) analysis of existing geomorphic data to identify restoration and conservation strategies which will facilitate the river's ability to laterally adjust.

Identification of various site-level and watershed-level corridor management strategies followed from the consideration of the geomorphic condition at various locations along the river corridor and from the feedback received during individual landowner outreach meetings and public forums. The site-level and watershed-level strategies are outlined in Section 6.0. Select strategies and projects were prioritized, and short-term and long-term implementation plans are outlined in Section 7.0.

5.1 Technical Working Group

A Technical Working Group (TWG) was established to steward the river corridor planning process. A local representative was appointed by the Lincoln Selectboard to direct town activities for the project. The TWG convened seven meetings from June 2005 through January 2006. Meeting minutes are recorded in Appendix A.

The TWG has remained open to interested Lincoln citizens, and an invitation was extended to the Town of Bristol (through the Bristol Conservation Commission), since the condition of the New Haven River in these upper reaches through Lincoln will necessarily impact water and sediment loads conveyed to this next downstream community.

TECHNICAL WORKING GROUP	
Lincoln Project Director	Sally Ober 12 Creamery Street, Lincoln, VT 802-453-5220 sallyober@gmavt.net
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VTDEC River Management Section Fluvial Erosion Hazard Coordinator	Ty Mack VTDEC Water Quality Division 103 South Main St., Bldg. 10 North Waterbury, VT 05671-0408 802-241-1262 ty.mack@state.vt.us
VTDEC Water Quality Division Watershed Coordinator (Otter Creek)	Ethan Swift The Opera House PO Box 965 67 Merchants Row Rutland, VT 05702 802-747-5070 ethan.swift@state.vt.us

5.2 Corridor Delineation Based on Geomorphic Condition

To define the area within which management options would be considered, a riparian corridor was delineated. Corridor delineation is based, in part, on geomorphic condition and sensitivity as defined by results of the geomorphic assessment work previously completed in the watershed (SMRC, 2004a, 2004b).

At present, field-based geomorphic data exists for eight reaches along the main stem of the New Haven and for three reaches along the Beaver Meadow tributary (SMRC, 2004a) (see Figure 2). Accordingly, the corridor was developed for these reaches. Plans are underway to collect additional Phase 2 geomorphic assessment data along remaining main stem reaches and along additional tributaries in Lincoln as informed by feedback from the Lincoln Planning Commission (Lougee, 2005). Funding for this data collection is available as part of a FEMA Pre-Disaster Mitigation grant to the Addison County Regional Planning Commission. This data, available in the next couple of years, would be available to generate a geomorphically-based corridor for these additional sections of river channel.

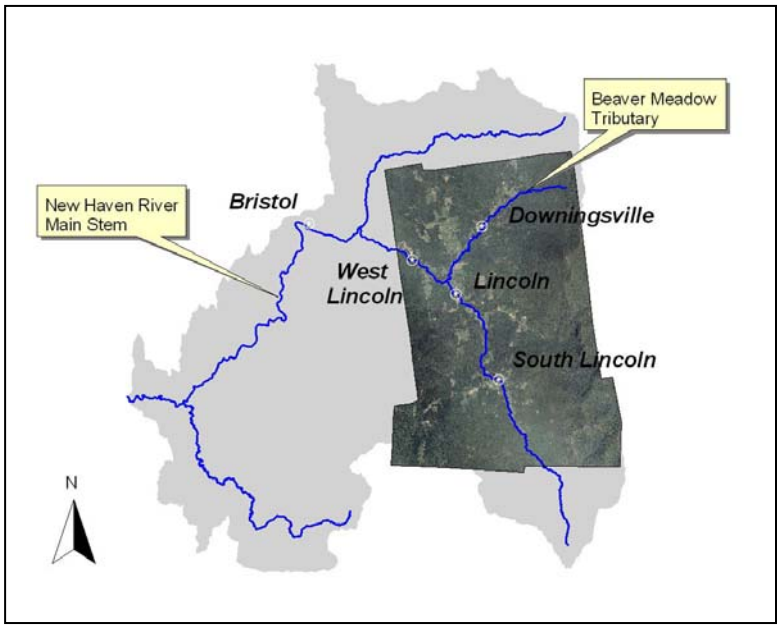


Figure 2. Location of New Haven River main stem and Beaver Meadow tributary in Lincoln portion of the New Haven River watershed.

Note: Since generation of the 2004 geomorphic report, local feedback has pointed out that upper reaches of the Beaver Meadow tributary as depicted here are actually referred to as Downingsville Brook, and Beaver Meadow actually extends to the east from Downingsville.

Results of the geomorphic assessment of the eleven reaches are briefly summarized in Appendix B. Details of the assessment are available in the *Phase 2 Stream Geomorphic Assessment, New Haven River Watershed, Addison County, Vermont* (SMRC, 2004a).

Specifics of the process for delineating the river corridor are summarized in Appendix C. This volume and its attachments also include a discussion of the methods, assumptions and limitations of this corridor delineation.

The river corridor has provisionally been supported by the Lincoln Planning Commission as a means for the Lincoln community to meet the objectives of reducing fluvial erosion hazards, reducing sediment and nutrient loading to the river, and improving water quality and riparian habitats. At present, Lincoln zoning regulations call for a 25-foot no-build set-back from all streams/rivers. A river corridor management area that acknowledges the dynamic nature of rivers and which is based on the geomorphic condition of the channel has advantages over a simple, no-build setback from the river.

River channels vary in width along their length, depending on the size and nature of the upstream watershed draining to a given location, and the valley setting of the channel. Rivers are also continuously adjusting their position in the landscape, both vertically and laterally, in an attempt to optimize their slope and channel dimensions to efficiently carry the water and

sediment loads supplied from the upstream watershed. A default setback is often inadequate and difficult to administer where a river is adjusting laterally at a rate of several feet per year.

A river corridor is a footprint in the landscape, which encompasses the dynamically-adjusting river channel. The corridor varies in width along its length, accounting for the actual width of the river channel at various locations, the size and nature of the watershed draining to that particular reach, knowledge of historic migration patterns of the river, and the position of the steep valley walls adjacent to the channel. For example, along the New Haven main stem just downstream of the Garland Bridge, a corridor width on the order of 350 feet may be optimal given the past channel migration history at that location. While a corridor on the order of 150 feet wide (50 ft for the channel itself, and approximately 50 feet on either side of the channel) may be more appropriate along the river near the old Town Garage where the channel is bedrock-controlled and is in a relatively stable geomorphic condition.

Definitions

Setback – a specified distance perpendicular to a channel or waterbody, in which specific standards are established concerning structures, land use activities, and/or vegetative conditions. For example, setbacks could be established to prevent new structures adjacent to waterways. While new structures would not be allowed, the area of land within the setback could be considered to count toward density requirements under zoning.

Overlay District – an area of variable size and width surrounding a channel or waterbody, in which specific standards are established concerning structures, land use activities, and/or vegetative conditions. Overlay Districts are informed by geomorphic assessments and developed to meet specific functions, such as reducing streambank erosion losses and reducing sediment and nutrient loading to receiving waters by managing toward the equilibrium channel.

Buffer – zone of undisturbed natural vegetation alongside a channel or waterbody, in which no new structures are permitted, and disturbance of the natural land surface is minimized. The vegetated buffer represents a transition zone which functions to protect the waterway from disturbances and adjacent land uses. Buffers can be established at a default distance perpendicular to the channel or waterbody. Ideally, for rivers and streams, buffer distances should be informed by geomorphic assessments, and will be wider for adjusting reaches, narrower for stable reaches (e.g., following VTANR Riparian Buffer Guidance).

5.3 Public Outreach / Education

Several public events were held to provide outreach and education to the Lincoln community relevant to this corridor planning process. Relevant background documents are provided in Attachment D. Several times throughout 2005 and 2006, the Lincoln Selectboard was consulted and kept aware of the activities of the technical working group for this project. The Project Director, Sally Ober, invested a total of 17 hours in public outreach.

June 2005 – an invitation was made to members of the Bristol Conservation Commission to join the Technical Working Group for this project. Due to time conflicts, they have been involved only through e-mail.

June 6, 2005 – Kristen Underwood gave a presentation to the local Forest and Field Club (an outdoor naturalists organization), about the geomorphic assessment study conducted on the New Haven River during the summer of 2004. *Approximate number of attendees: 20 - 25*

July 2005 –a press release was sent to local newspapers, to invite public participation in the project. This invitation was to ensure that the River Corridor Management Plan which results from this process, reflects individual as well as public visions and goals, compatible with a highly dynamic river. A copy of the press release is included in Appendix D.

August 5 and 6, 2005 – Hill Country Holidays, a local community event advertised by a mailing to all residents of Lincoln, included three sessions with a river flume provided by the Vermont Department of Environmental Conservation, River Management Section. This hands-on river simulator was a popular attraction for people of all ages, generating many questions and hours of discussion. A home-schooling parent carefully took notes. Two children even went home and talked their grandfather into helping them build their own version of a flume with a piece of metal roofing material and a garden hose. *Approximate number of attendees: 40 – 50.*

(a)

(b)

(c)

Figure 3. A river simulator exhibit set up in Burnham Hall during the Hill Country Holidays drew many interested community members.

August 15, 2005 - Results of the New Haven River geomorphic study were presented at the November 2004 River Forum sponsored by the Lincoln Conservation Commission at Burnham Hall, as part of a previous FEMA Project Impact grant. A repeat of this presentation was held on August 15, 2005 as part of the Lincoln Lecture Series at the Lincoln Library. *Approximate number of attendees: 30 – 35.*

October 2005 – repeated the July press release to the Lincoln Town e-mail list (town newsletters were no longer being published) and the Lincoln Community School Newsletter.

During the fall of 2005, various members of the Technical Working Group for this project attended meetings of the Lincoln Planning Commission. This included a "river education night" for the Planning Commission members (21 September 2005), as well as an introduction of Fluvial Erosion Hazard Corridors at a public forum about proposed changes in zoning regulations (19 October 2005; *Approximate number of attendees: 35 - 40*)**.** Follow up assistance to the Lincoln Planning Commission from members of the Technical Working group and Vermont River Management is on-going as proposed zoning regulation changes progress (21 December 2005; scheduled 15 March 2006).

On October 25, 2005, the Lincoln Conservation Commission held a community potluck and open forum to answer the question: "What do people value about Lincoln's natural heritage?" A brief presentation of the river corridor planning project was made by Sally Ober, and a collaborative opportunity became apparent with some other community members, who are spearheading a movement to promote conservation of land in the headwaters of the New Haven River. *Approximate number of attendees: 34.*

January 17, 2006 - The Lincoln Conservation Commission hosted a follow-up open forum to the October 25 meeting. This was a brainstorming session to identify strategies for conserving Lincoln's natural heritage. Technical working group members Kristen Underwood and Sally Ober attended. Many of the ideas discussed focused on the New Haven River and its tributaries. Over 60 different strategies were generated from this public discussion, and some of them have been incorporated into this plan. *Approximate number of attendees: 25*

February 2006 – the TWG submitted a feature article for inclusion on the front cover and inside pages of the Annual Report for the Town of Lincoln. This document is mailed to every Lincoln resident in preparation for Town Meeting. A copy of these pages is reproduced in Appendix D.

5.4 Individualized Outreach

Outreach was also conducted on an individualized basis to several riverside landowners.

July 2005 – A direct mailing was sent to at least 110 riverside landowners, introducing the project, the technical working group and inviting participation from landowners. The original plan was to send letters to landowners in project-specific reaches of the river, but the mailing was extended to areas beyond the focus of this project. A copy of the landowner letter is provided in Appendix D.

July 2005 – January 2006 – Sally Ober contacted or met with approximately 67 landowners to discuss at least 33 riverside properties. Landowner interviews provided an opportunity to discuss the goals of this project, to gather information from landowners about river corridor constraints, land uses, concerns, and alternatives acceptable to the landowners. Most of these landowner meetings were conducted in person; a few were done by telephone. Landowners were generally very open, willing to share information about their relationship with the river, and very appreciative of the personal attention given to them. At least 32 hours of Sally's time was spent discussing the project with landowners. More hours were spent informally chatting in a neighborly fashion, and establishing a friendly rapport, but were not billed to the budget.

A summary of current landowner concerns and corridor management alternatives acceptable to the landowner is provided in Table 1.

Table 1. Landowner Meeting Summary Table.

Current Landowner Concerns	Number of Landowners Mentioning Concern	Alternatives Acceptable to Landowner	Number of Landowners Interested in Alternative
Bank erosion and river channel adjustments	19	Vegetative buffer enhancement	11
Debris and sediment deposits	9	Land conservation easement	8
Trash, waste, septic from upstream	6	Leave natural, hands-off, no management necessary at this time	7
Flood damages from smaller tributaries	6	Road, culvert, or bridge improvements	6
Potential debris jamming up bridge	6	Channel engineering or dredging	6
Beaver activity	5	Other ideas, including floodproofing buildings, scenic roadway designation, not rebuild if river causes catastrophic damage	6
Trees falling into river	4	Rip rap or bank armoring	5
Road or culvert concerns	3	More educational opportunities	4
Japanese Knotweed	2	Post-flood debris clean-up assistance	2
Inundation of buildings	2	Japanese knotweed control	2
Ugly riprap	2	Zoning setbacks along river	1
Livestock accessing river	1	Improve fish/wildlife habitat	1

5.5 Analyze Existing Geomorphic Data to Identify Management Strategies

The Phase 1 and 2 Geomorphic Assessment data collected along the New Haven River main stem and Beaver Meadow tributary in 2004 (SMRC, 2004) were analyzed during the corridor planning process to identify corridor management strategies that could support the river's return to a more balanced condition, thereby reducing erosion hazards and improving water quality over the long term. The analysis follows recent guidance from the VTDEC River Management Section (VTDEC, 2005) and included:

- Classifying corridor reaches into general management categories based on their geomorphic condition. This step involves identifying, qualitatively, the sediment transport characteristics of the corridor reaches, to identify the major sediment deposition and transport modifiers.

- Acknowledging natural constraints (bedrock) and human constraints (roads, buildings, bridges) along the river corridor that limit the river channels' ability to laterally and vertically adjust in response to changing water and sediment conditions.

- Identifying sediment sources which may be impacting the sediment transport capacities in the watershed.

- Locating areas of active lateral adjustment and wetland areas contiguous to the channel which may serve important sediment and nutrient attenuation functions in the watershed.

Details of this geomorphic data analysis are summarized in Appendix B. The geomorphic conditions noted have informed the river corridor management strategies outlined in Section 6.

6.0 OPPORTUNITIES & RESOURCES: Selection & Prioritization of Management Strategies

Geomorphic studies (Appendix B) and landowner outreach efforts conducted to date have identified several opportunities for working toward the objectives of erosion mitigation, water quality improvement, and habitat restoration along the New Haven River and Beaver Meadow tributary.

Site and reach-level management options and watershed-level management options are presented in the sections below. Many resources at the private, municipal, state and federal levels are available to convert these opportunities into action. Appendix E provides a listing of some of these resources.

6.1 Site/Reach – Level Management Alternatives

Based upon the stream conditions summarized in Appendix B and Section 6, and feedback obtained from public outreach events and meetings, the TWG has identified discrete site-level and reach-level projects which could be most effective at reducing sediment and nutrient loading to the New Haven River watershed (see Table 2). Geomorphically-informed restoration and conservation projects were identified, and classified into "passive" or "active" approaches based on geomorphic condition. Technically-feasible projects were then prioritized based on landowner approval, gross measures of cost (low, medium, high), and the extent to which each project addressed the primary objective of sediment and nutrient reduction in the watershed.

Highest priority site-level opportunities are discussed in the sections below. Select conceptual designs were further developed by the Town of Lincoln for a 27 January 2006 application to the VTDEC Water Quality Division for a Category 2/3 River Corridor Grant. Funding for other high priority projects will be sought from FEMA or other state and federal agencies.

Table 2. Summary of Site-level / Reach-level Corridor Management Alternatives

Site Desription, Reach, Condition	Project Description / Objectives	Objectives Addressed short-term (ST) long-term (LT)	Technical Feasibility	Cost	TWG Priority	Landowner Approval	Potential Partners
Passive Geomorphic Alternatives - Protect Equilibrium/ Ecological Processes, Avoid Conflicts							
Private Parcels along T4.03-A Equilibrium - Stable	Conservation to preserve equilibrium and ecological functions of riparian corridor.	EQUILIBRIUM ECOLOGICAL AVOIDANCE	High	Mod	Mod	Unknown	MALT, VLT, VTRMS
Passive Geomorphic Alternatives - Restore Boundary Conditions, Protect Ecological Processes, Avoid Conflicts							
Parcels along T4.04, T4.02 Equil. - Minor Adjustment	Buffer Enhancements Conservation or other protection strategies	EQUILIBRIUM ECOLOGICAL AVOIDANCE	High	Low Mod	Mod	Unknown	Cons Comm MALT, VLT, VTRMS
Private Parcel(s): upstream end of reach across Lincoln Community School M20 Equilibrium - Minor Adjustment	Protect the corridor from future development/encroachments/ berming. Possible corridor easement. Riparian Buffer enhancement. Facilitate sediment attenuation / lateral adjustments at upstream extent near reach break with M21 - could relieve stresses on Lincoln village reach, M19	SED ATT; NUTR REDUC; FLOODPLAIN ACCESS; Accelerate return to Equilibrium channel (LT)	High	Mod	High **	Preliminary support from landowner at upstream extent.	VTRMS; MALT; Town; USF&W

Note: Double asterisk (**) in Priority column indicates project has been included in a 27 January 2006 application to a Category 2/3 River Corridor Grant (FY2006) by the Town of Lincoln.

Abbreviations: SED ATT = Sediment Attenuation; NUT RED = Nutrient Reduction; ST = Short-term; LT = Long-term

Table 2. Summary of Site-level / Reach-level Corridor Management Alternatives (continued)

Site Desription, Reach, Condition	Project Description / Objectives	Objectives Addressed short-term (ST) long-term (LT)	Technical Feasibility	Cost	TWG Priority	Landowner Approval	Potential Partners
Passive Geomorphic Alternatives - Restore Boundary Conditions & Channel Dimensions, Avoid Conflicts							
Parcel(s) at downstream end of segment T4.03-B Unstable - Moderate Departure	Protect the corridor from future development/encroachments/ berming. Possible corridor easements to facilitate sediment attenuation / lateral adjustments in channel and contiguous wetlands at downstream end of segment - could offset consequences of upstream channel management through Downingsville settlement. Riparian Buffer enhancement.	SED ATT; NUTR REDUC; FLOODPLAIN ACCESS; Accelerate return to Equilibrium channel (LT)	High	Mod	High	unknown	VTRMS; MALT; Town; USF&W
Parcel(s) at downstream end of reach M25 Unstable - Moderate Departure	Protect the corridor from future development/encroachments/ berming. Possible corridor easements to facilitate sediment attenuation / lateral adjustments in channel and contiguous wetlands at downstream end of segment - could offset consequences of upstream sediment contributions from Cow Brook and mass failure.	SED ATT; NUTR REDUC; FLOODPLAIN ACCESS; Accelerate return to Equilibrium channel (LT)	High	Mod	High	unknown	VTRMS; MALT; Town; USF&W
Large Mass Failure site M25 Unstable - Moderate Departure	Conduct alternatives analysis to determine cost/benefit and technical feasibility of stabilizing this landslide to reduce sediment inputs to the New Haven River.	SED ATT; NUTR REDUC; (ST)	High	Mod	High **	preliminary approval from major landowner	VTRMS; Town; VT Geol Surv

Note: Double asterisk (**) in Priority column indicates project has been included in a 27 January 2006 application to a Category 2/3 River Corridor Grant (FY2006) by the Town of Lincoln.

Abbreviations: SED ATT = Sediment Attenuation; NUT RED = Nutrient Reduction; ST = Short-term; LT = Long-term

Table 2. Summary of Site-level / Reach-level Corridor Management Alternatives (continued)

Site Desription, Reach, Condition	Project Description / Objectives	Objectives Addressed short-term (ST) long-term (LT)	Technical Feasibility	Cost	TWG Priority	Landowner Approval	Potential Partners
reach M25 Unstable - Moderate Departure	Protect the corridor from future development/encroachments/ berming. Possible corridor easements to facilitate sediment attenuation / lateral adjustments in channel. Riparian Buffer enhancement. Geomorphic assessment of Cow Brook tributary to understand flow and sediment dynamics.	AVOIDANCE; FLOODPLAIN ACCESS; Accelerate return to Equilibrium channel (LT)	High	Mod	High	unknown	Town; VTRMS; MALT; USF&W
reach M21 Unstable - Moderate Departure	Protect the corridor from future development/encroachments/ berming. Possible corridor easements to facilitate sediment attenuation / lateral adjustments in channel. Riparian Buffer enhancement. Geomorphic assessment of Cota Brook tributary to understand flow and sediment dynamics.	AVOIDANCE; FLOODPLAIN ACCESS; Accelerate return to Equilibrium channel (LT)	High	Mod	High	unknown	Town; VTRMS; MALT; USF&W
reach M21 Unstable - Moderate Departure	Possible corridor easements to facilitate sediment attenuation / lateral adjustments in channel and contiguous wetlands at downstream end of segment - could offset consequences of upstream channel management and relieve stresses on downstream reach M19 through Lincoln village.	SED ATT; NUTR REDUC; FLOODPLAIN ACCESS; Accelerate return to Equilibrium channel (LT)	High	Mod	High **	Preliminary support from landowner at downstream extent.	Town; VTRMS; MALT; USF&W

Note: Double asterisk (**) in Priority column indicates project has been included in a 27 January 2006 application to a Category 2/3 River Corridor Grant (FY2006) by the Town of Lincoln.

Abbreviations: SED ATT = Sediment Attenuation; NUT RED = Nutrient Reduction; ST = Short-term; LT = Long-term

Table 2. Summary of Site-level / Reach-level Corridor Management Alternatives (continued)

Site Desription, Reach, Condition	Project Description / Objectives	Objectives Addressed short-term (ST) long-term (LT)	Technical Feasibility	Cost	TWG Priority	Landowner Approval	Potential Partners
Passive Geomorphic Alternatives - Restore Boundary Conditions & Channel Dimensions, Avoid Conflicts							
Volunteer Fire Dept M19 Unstable - Moderate Departure	Review alternatives for relocation of this public resource in the floodplain of the New Haven main stem immediately downstream of an undersized bridge crossing.	FLOODPLAIN ACCESS; AVOIDANCE (ST)	High	High	Low	(Town) unknown	Town; ACRPC; FEMA
Lincoln Sports M19 Unstable - Moderate Departure	Protect the corridor from future development/encroachments/ berming. Corridor easement. Riparian Buffer enhancement. Possible road access for property to north would faciliate conservation of northern property.	SED ATT; NUTR REDUC; FLOODPLAIN ACCESS; Accelerate return to Equilibrium channel (LT)	High	Mod	High	(Town) unknown	VTRMS; MALT; Town; USF&W
Private Parcels: upstream end of reach across from Pallet Mill M19 Unstable - Moderate Departure	Protect the corridor from future development/encroachments/ berming. Corridor easement.	SED ATT; NUTR REDUC; FLOODPLAIN ACCESS; Accelerate return to Equilibrium channel (LT)	High	Mod	High **	preliminary landowner approval	VTRMS; MALT; Town; USF&W
Private Parcels: downstream of Lincoln village, west side of river near confluence with Beaver Meadow M18 Unstable - Moderate Departure	Replace forded access (and potential bridge crossing) with road from west, south, north; reestablish woody buffers along channel margins; protect the corridor from future development/encroachments/channel management. Corridor easement.	SED ATT; NUTR REDUC; FLOODPLAIN ACCESS; Accelerate return to Equilibrium channel (LT)	High	Mod	High **	likely; other Farm locations enrolled in CREP 10/2005	VTRMS; MALT; Town; USF&W

Note: Double asterisk (**) in Priority column indicates project has been included in a 27 January 2006 application to a Category 2/3 River Corridor Grant (FY2006) by the Town of Lincoln.

Abbreviations: SED ATT = Sediment Attenuation; NUT RED = Nutrient Reduction; ST = Short-term; LT = Long-term

6.1.1 Landowner-approved conservation of strategic sediment attenuation areas along the river corridor

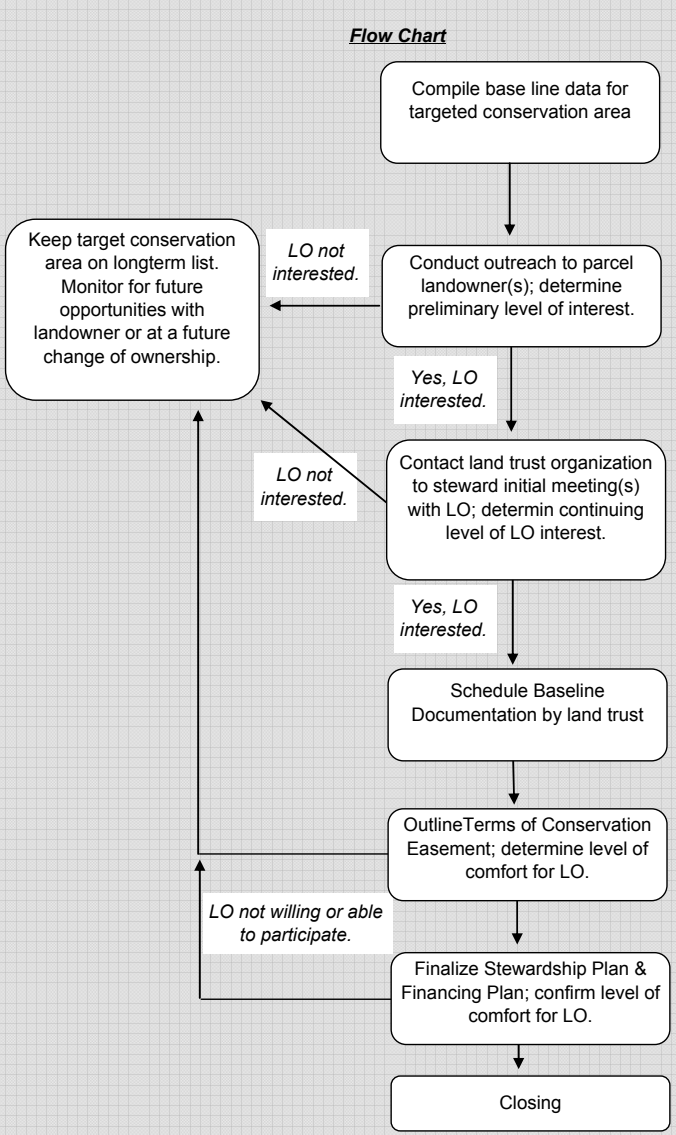
The TWG has identified several strategic locations in the New Haven River corridor and Beaver Meadow tributary that are critical to preserve floodplain access, allow the channel to laterally adjust, and provide opportunities for sediment and flow attenuation (see Appendix B). Conservation easements specifying appropriate management conditions, and ongoing stewardship of these easements, would preserve the floodplain and channel functions of these locations in perpetuity. Conservation of attenuation areas along the river corridor, will help to provide the river the space it needs for adjusting and managing its sediment loads. Sediment attenuation in these select locations will reduce stresses on the village areas of Lincoln that are presently developed along and within the river corridor, and have experienced significant erosion losses in recent flood events.

A more balanced river system will benefit all the citizens of Lincoln, leading to reduced erosion hazards and improved water quality. Because conservation of sediment attenuation areas by an individual landowner(s) will benefit the public good, application has been made by the Town of Lincoln to the VTDEC Water Quality Division for a FY2006 Category 2/3 River Corridor Grant. If awarded, funds from this source may support activities of a River Steward to work with landowners to further develop potential conservation projects. Through landowner outreach efforts associated with the River Corridor Plan, at least eight potential sites have landowners that are preliminarily interested in conservation. The TWG has narrowed these down to three critical sites for immediate exploration of conservation possibilities. Landowners wish to know more about the legal, financial, and logistical opportunities and implications associated with potential conservation easements on their property. The Town of Lincoln also would like to better understand the tax and other implications (Act 68) for conservation at these and other sites in the town.

Corridor grant funding could also potentially be used to reimburse the considerable expenses of the landowner(s) associated with conservation. These expenses include legal fees, appraisal fees, and land trust fees including baseline documentation reports and long-term stewardship endowments.

A general outline of the conservation process, including possible partner organizations and timelines is provided in Figure 4. The flow chart illustrates a phased approach and regular consultation with landowners. Each conservation project is very unique in terms of the identified logistical and legal considerations; financial aspects; local, State and federal tax implications; and willingness and affordability on the part of the landowner. Depending upon the unique attributes of a potential conservation parcel(s), and the preferences of landowners, any one of a variety of land trust organizations may be best suited to a given project. Land trust organizations may include: Vermont River Conservancy, Middlebury Area Land Trust, Vermont Land Trust, or Lake Champlain Land Trust, among others.

As a project proceeds to later stages, a landowner-approved appraisal firm will be hired to assess the fair market value of the property. Legal services will be retained to conduct the necessary title search and other legal tasks. Reimbursement of these expenses may allow a landowner, who would otherwise not be able to afford these fees, to participate and conserve a portion of their land with floodplain and sediment attenuation functions, which are of value to the town as a whole.



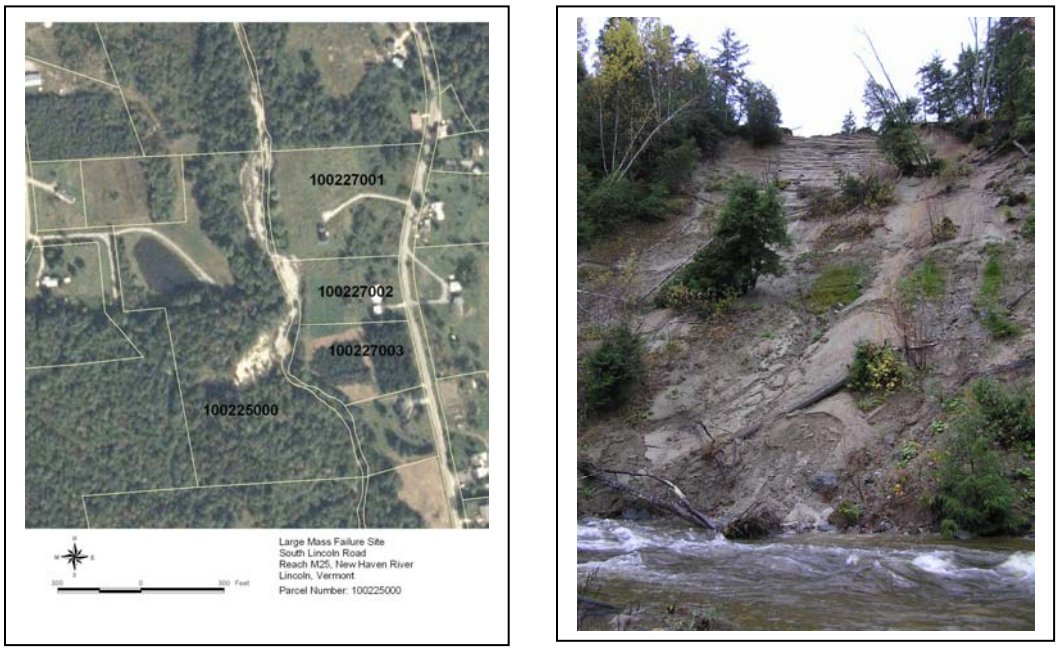
Flow Chart	***Partners***	***Approx. Duration***	***Task Descriptions***
			Compile Base Line data
	Proj Dir SMRC	2 wks	• map parcel(s) boundaries on ortho base map w/ corridor outline; • determine parcel(s) size; • determine zoning district(s), minimum lot size for development; • area of parcel(s) in each zoning district(s); • area of parcel(s) in river corridor; • list existing infrastructure / constraints in parcel(s); • determine landowner and contact info from grand list;
	Proj Dir MALT	6 wks	***Initial Meeting with Landowner*** • confirm parcel(s) boundaries on ortho base map w/ corridor outline; • share basic geomorphic concepts / data and importance of parcel(s) conservation to longterm equilibrium of river. • share possible mechanisms / logistics of conservation • identify data needs / concerns of the LO for decision-making
	Proj Dir MALT SMRC as needed	6 wks	***Land Trust Meeting with Landowner*** • discuss specifics of conservation process • understand LO needs / desires for future use of property • determine likely easement holder • identify other needed conservation partners for implementation / ongoing stewardship • preliminarily identify conservation values of property in addition to riparian health / river equilibrium
	Proj Dir Land Trust SMRC Contractors	2 mos	***Baseline Documentation by Land Trust*** • review legal property descriptions • outline conservation values/ functions incl. but not limited to sediment attenuation • review results with LO
	Landowner Land Trust Conserv Partners Proj Dir, as needed SMRC, as needed	4 - 6 mos	***Outline Terms of Conservation Easement*** • finalize conservation partners and roles • determine funding source(s) / tax implications • outline management areas and longterm stewardship plan • draft easement language
	Landowner Land Trust Conserv Partners Proj Dir, as needed SMRC, as needed	4 - 8 mos	***Finalize Stewardship Plan & Financing Plan*** • finalize easement language • finalize Stewardship Plan • compile conservation funding • set aside funds / mechanisms for ongoing Stewardship

Figure 4. General outline of conservation process, including partner organizations and approximate timelines.

6.1.2 Stabilization of landslide sites on Reaches M25 and M27

Two major landslides along the New Haven River main stem have been identified as active sediment sources to the river. One mass failure is located on the west river bank near the Cooley Glen trail access just downstream of the newly-replaced bridge on the Lincoln-Ripton Road (Reach M27). Mass failure at this site may have been initiated by erosion at the toe of the slope, as well as possible channel incising in this location. Field-based geomorphic assessments have not yet been completed along this reach of the river, but may be scheduled under upcoming Pre-Disaster Mitigation funding administered through the Addison County Regional Planning Commission.

A second mass failure of sands and gravels has occurred between 1995 and 2003 along the left (western) bank of the New Haven main stem in South Lincoln (Reach 25) - reportedly initiated by the 1998 flood (Figure 5). This mass failure is over 130 feet in height and is estimated to have yielded approximately 3,500 cubic yards of sediment into the river (estimate only, not surveyed). Excess sediment has accumulated downstream in the channel over an approximate 1000-foot length, causing braided conditions, development of mid-channel bars and enlarged point bars. Excess sediment from the landslide has also caused meander migration into the right bank (east) encroaching on two residential parcels. Maximum lateral migration (at the apex of the meander) was measured as 70 feet in the 8-year interval between 1995 and 2003, or an average of 9 feet per year. The on-site septic disposal system and drilled well servicing parcel number 100227001 are on the river side of the house which is located approximately 100 feet from the meander bend (see Figure 5).



(a) (b)

Figure 5. Mass failure site along left bank of Reach M25, New Haven main stem, South Lincoln, VT. (a) plan view: *Parcel boundaries in off-white. Parcel numbers noted for select properties. Base Orthophoto: 2003 (b*) photograph taken October 2005, view to southwest from driveway off South Lincoln Rd*.*

Left unaddressed, these mass failure sites will continue to be ongoing sources of sediments to the New Haven River. At this time it is unclear to what degree future land-sliding will occur and therefore what additional volumes of sediment can be expected to drop into the river. Under the corridor planning project, the Town of Lincoln invited George Springston, Research Associate with Norwich University, to view the landslide sites. Mr. Springston has made two field visits and has collected baseline data on geologic materials and properties; a summary report is provided in Appendix F. Mr. Springston's observations from these sites are being used to inform a landslide assessment and mapping protocol being developed by a partnership between the River Management Section and Vermont Geological Survey (represented in part by George Springston). The geologic assessments have yielded preliminary insight into the failure mechanisms of the slopes.

To identify an appropriate resolution for the mass failure sites, which serve as ongoing sources of sediment to the river, an Alternatives Analysis is recommended that will involve some baseline data collection to better define the cause(s) and mechanism of the failure and its influence on (and influence by) a laterally adjusting river channel. For the Town and affected landowners, this analysis would research and document a list of possible alternatives for resolving this continuing sediment source, identify the technical and financial feasibilities of various alternatives, and recommend a solution(s).

A land survey should be conducted to understand the full relief and profile of the landslide, encompassing adjacent land areas to which any sort of restoration would tie (i.e., the abandoned sand and gravel pit on the back side of the face and the steep, wooded slopes to the north and south). A Phase 3 Stream Geomorphic Assessment should be conducted (for the site on M27, a Phase 2 / 3 assessment) including a detailed survey of the river channel for a minimum length of 2000 feet and a maximum length necessary to:

- provide confirmation of channel adjustment processes and degree of floodplain connection, and;

- understand how the various alternatives considered for the landslide would influence or be influenced by the local and reach-wide channel dynamics.

The land survey of the mass failure site should be coordinated with the Phase 3 survey of the river channel, using common benchmarks.

Various alternatives for the landslide site should be considered, including (but not necessarily limited to):

a) The no-action alternative;

b) Soft-revetment techniques (tree revetments, rock veins, others) at the base of the slope to deflect flow velocities in the channel from undermining the toe of the slope;

c) Hard revetment techniques (armoring) of the toe of the slope and gabion basket or other stabilization efforts for the face of the slope;

d) Revegetation techniques for the landslide slope itself;

e) Excavation of the top portion ("knife-edge") of the landslide, filling the abandoned sand & gravel quarry to the immediate backside of the face (see Figure 6);

f) Soft-revetment techniques along the eroding streambank along right bank at the

residential property downstream of the landslide;

g) Hard armoring along the eroding streambank along right bank downstream of the landslide;

h) Other alternatives suggested by geomorphic and geotechnical consultant(s).

In a detailed cost-benefit analysis, each alternative will be considered for its technical feasibility, cost, acceptability to the landowner(s), consequences to upstream and downstream geomorphic conditions and properties; and overall effectiveness for reducing sediment and nutrient loading. Permit requirements would be outlined for each alternative. More than one of the above alternatives may be appropriate for the site.

The Town of Lincoln has applied for a FY2006 Category 2/3 River Corridor Grant to fund an Alternatives Analysis for the larger mass failure site at Reach M25. Other possible funding sources for various aspects of this site may include FEMA or private funds.

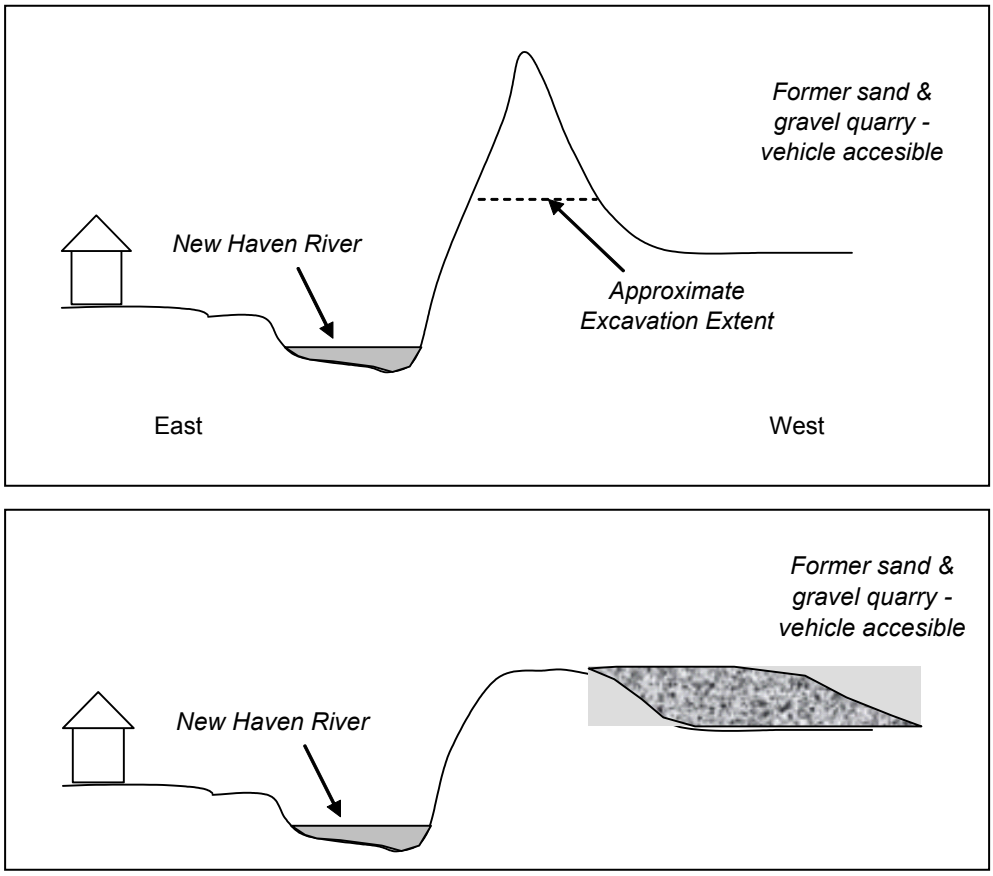


Figure 6. Possible alternative for stabilization of landslide, Reach M25, South Lincoln, VT (not to scale). (a) current profile, view upstream; (b) profile after excavation and fill.

6.1.3 Buffer Enhancement Projects

Buffer enhancement (restoring boundary conditions) has been identified as a key strategy, within an overall corridor-based river management approach, to improve water quality and reduce erosion hazards. Several locations along the New Haven River and Beaver Meadow tributary have been identified as needing enhanced buffers (see Appendix B). It is anticipated that future assessment work on additional reaches of the New Haven River and Isham Brook, French Settlement Brook, and Cota Brook will identify more buffer enhancement sites. Outreach conducted by Sally Ober during the River Corridor Planning project identified at least eleven separate property owners along the New Haven and Beaver Meadow tributary who have requested assistance with buffer enhancements on their river-side properties (see Table 1). Potential buffer projects range in river lengths from a few hundred to several hundred feet. Landowners noted that while they have a strong desire to improve buffer conditions on their lands, they lacked either the technical knowledge for plant selection, resources to acquire the planting materials, or (most often) the physical ability and time to accomplish the buffer plantings.

A recent (17 January 2006) public forum sponsored by the Lincoln Conservation Commission identified the strategy of a "volunteer bank" for accomplishing buffer plantings. Volunteers (landowners and citizens) would provide labor and tools for buffer plantings on individual properties. These volunteer hours would be "banked" and each participant could then draw on their "account" for help on a future project.

Establishment of a volunteer bank would match riparian landowners with the appropriate technical, financial, and "sweat-equity" resources to accomplish buffer plantings. The volunteer bank could be organized through existing town groups such as the Lincoln Conservation Commission. Recent projects lead by the Lincoln Conservation Commission to conduct demonstration projects for Japanese Knotweed control and to establish plantings under WHIP contracts have resulted in strong volunteer participation. It is anticipated that the identified buffer projects will benefit from the energy and dedication of many of these same volunteers. Under a volunteer-hour-banking structure, these volunteers will have the added reward of shared labor and resources to accomplish projects on their own lands.

Various partner agencies and funding sources are available to support the buffer enhancement work, depending on the nature of the projects, (e.g. USFW Partners for Wildlife; Natural Resources Conservation Service – see Appendix E). Trees/ shrubs and seedlings for smaller projects can be obtained from local and regional nurseries (e.g., Rocky Dale, Green Haven Gardens, The Intervale Conservation Nursery, Cobble Creek Nursery).

6.1.4 Reach-wide Alternatives Analysis through Lincoln Village (Reach M19)

Under a separate local effort, a FEMA Pre-Disaster Mitigation Grant has recently been secured by the Town of Lincoln through the efforts of Mark Benz to wet flood-proof Burnham Hall. While the tasks to be implemented will protect Burnham Hall from rising flood waters, this historic structure (and many others through Lincoln village) remains vulnerable to streambank erosion hazards.

Mark has looked to the technical working group of this River Corridor Management Plan Project, for ways to reduce the fluvial erosion hazards to Burnham Hall. Members of the working group felt that more information was needed to identify alternatives for this specific reach of the river in which Burnham Hall resides.

In a recent meeting with Mark Benz and Fred Vanderschmidt of FEMA, external site work for Burnham Hall was discussed. Fred recommended that we apply for a PDM planning grant to look at all the structures (including the Gove Hill Road bridge) within the village reach that are vulnerable to floods. The planning grant would ideally help the Town identify alternative river management options along with associated cost/benefit analyses

The Pre-Disaster Mitigation Competitive (PDM-C) grant process involves several steps: submitting a Letter of Intent, and a 3 to 6 month application development phase involving workshops, consultations with State agencies, etc. There is a selection done at the State level by the Hazard Mitigation Committee in February, prior to the applications being submitted to FEMA for the National Review portion in Washington in March. For FY2006 PDM-C grants, the deadline for submitting a Letter of Intent was in October 2005; the State deadline was February 10, 2006. Application could be made to the FY 2007 program in October of 2006.

Preliminary alternatives discussed by the TWG for reach M19 through Lincoln village have included a range of possibilities, including relocation of structures, formalizing a flood relief channel in the western side of the village, and conservation options on private and public lands (see Appendix B).

6.2 Watershed-Level Management Strategies

Several watershed-level management strategies were identified that should be undertaken to achieve nutrient / sediment reductions, reduce potential for future fluvial erosion hazards, and restore and conserve riparian habitats.

6.2.1 Town Planning

The present degree of residential / commercial development along the New Haven River main stem and its tributaries is significant. Village centers including South Lincoln, Lincoln, West Lincoln, and Downingsville are located on the river. Roads, homes, and businesses share narrow upland valleys with the river and its tributary channels. Future zoning changes being considered by the Town include concentrating development at higher densities adjacent to the existing village centers.

Armed with new information about river dynamics, and fluvial erosion hazards, the Lincoln community is presented with an opportunity to engage in a proactive planning process that supports the river's ability to move toward an equilibrium condition. Planning strategies can ensure that new development does not further encroach on the river corridor, reduce the sediment and flow attenuation functions of the floodplain area, and place infrastructure at risk of fluvial erosion losses. These "avoidance" strategies for future development can be supported, while still honoring the expressed community vision of "creating compact population centers separated by rural countryside" as a means of "maintaining open land and preserving scenic views" (Town Plan, 2002). To address existing development, innovative solutions may involve eventual relocation from the floodplain of some of the most-at-risk structures.

The TWG has recently (19 September 2005) collaborated with the River Management Section FEH Coordinator (Ty Mack) and the Addison County Regional Planning Commission (Adam Lougee) to work with the Lincoln Planning Commission (LPC) and introduce the concept of fluvial erosion hazard (FEH) corridors. The LPC had been considering the approach of setbacks and buffers for inclusion in subdivision regulations. Through ongoing TWG communications, the LPC was made aware of the functions and values of FEH corridors for longterm stability of the New Haven River. The LPC expressed support for the idea of town planning based on the belt-width

concepts inherent in the FEH corridor, and shared this information with Lincoln citizens in a public forum on 19 October 2005.

A preliminary FEH corridor has been developed by the RMS for select reaches of the New Haven main stem and Beaver Meadow tributary during this Corridor Planning project (Appendix C). Feedback received from LPC and TWG members following this meeting is being incorporated in a revised draft of the FEH corridor, scheduled for discussion at an upcoming LPC meeting (15 March 2006). The LPC foresees that additional outreach and public meetings will be necessary to introduce a possible FEH corridor overlay district to the greater community and proceed through subsequent technical and administrative processes for possible adoption into town zoning.

Currently, funding and technical resources are available to the town through Addison County Regional Planning Commission (FEMA Pre-Disaster-Mitigation funds) to support a public planning process to review the possible role of a corridor overlay district in town planning and to develop a viable draft ordinance for public review. These same funds are available to generate the geomorphic data to delineate a corridor in the remaining portions of the New Haven main stem, and additional tributaries identified by the LPC (Cota, Isham, French Settlement).

6.2.2 Improved Road Maintenance Practices to Mitigate Stormwater / Sediment Impacts

Several stormwater runoff / road maintenance concerns were identified in specific locations along the New Haven main stem and tributaries. Each site contributes volumes of sediment to receiving streams, based on observations during Phase 2 assessments and Category II grant project scoping; accounts from neighboring property owners; and discussions with town officials. If unaddressed, these sediment sources will continue to impact downstream sites, and potentially influence geomorphic adjustments and the success of restoration/conservation projects.

Road maintenance practices to mitigate for stormwater and sediment runoff to the New Haven River and tributaries may include: stabilization of road surfaces (different gravel materials), improvement of roadside ditches (excavation, stone lining and/or seeding and mulching), alternative grading practices (turnouts, check-basins); re-orientation of culvert crossings; and culvert header protection. At a minimum, project sites include:

Reach	Road
To be delineated	French Settlement Road
M26	Lincoln-Ripton Road
M23	Ripton Road

Grants are available from the Better Back Roads program (see Appendix E). Likely partners would include the Town of Lincoln, the Better Back Roads program, and the Addison County Regional Planning Commission.

6.2.3 Crossing Structures

Undersized or improperly sited bridge and culvert crossing structures were identified as contributors to localized channel instabilities in the New Haven River watershed. When these crossing structures are scheduled for rehabilitation or replacement, the geomorphic context should be considered. For future development, the town of Lincoln could establish ordinances or identify zoning requirements which would ensure adherence to proper siting and design practices for future development. The geomorphic context should be considered when designing new and rehabilitated structures.

- New or replacement bridges and culverts should ideally have openings which pass the bankfull width without constriction. Bankfull widths and flood-prone widths have been measured for the assessed reaches during the 2004 Phase 2 assessment and are available to the Town for future crossing structure designs.

- Bridges and culverts should be designed to cross the river without creating channel approaches at an angle to structures. Such sharp angles can lead to undermining of fill materials and structural components.

- The historic channel migration pattern of the river should be considered when installing new or replacement crossing structures, and when constructing new roads, driveways, and buildings. Corridor protection strategies that prevent or limit placement of infrastructure within the corridor will protect structures from future erosion and flood losses.

- Planned build-out for watershed communities and resultant channel enlargement (from increased percent imperviousness) should be considered when designing new or replacement bridges and crossing structures.

Potential funding sources to support public planning and development of such ordinances for crossing structures include: Better Back Roads grants, Municipal Planning Grants (VT Department of Housing and Community Affairs), or Vermont Watershed Grants (see Appendix E).

6.2.4 Education and Outreach

This plan, with supporting materials, will be housed in the town offices and library, so that community officials and members of the public can find information that they need.

Continuing education about corridor management will be crucial to maintaining interest and focus in the community.

- ♦ Continue to provide support for meaningful biomonitoring and water-quality testing that can inform water quality improvement plans
  (Selectboard, citizens, Addison County River Watch Collaborative, VTANR, schools)
- Facilitate community service activities such as buffer plantings in the corridor
  (schools, citizens, Lincoln Conservation Commission)
- Educate landowners about native and invasive aquatic and terrestrial species
  (Lincoln Conservation Commission, Partners for Wildlife, The Nature Conservancy)
- Support public education about water quality and habitat issues
  (Lincoln Conservation Commission, Lincoln Community School, Addison County River Watch Collaborative)
- Support a focused training session/ workshop through Better Backroads for road crew to gain knowledge of innovative road maintenance practices that reduce siltation to the New Haven River and tributaries
  (Selectboard, Addison County Regional Planning Commission, Lincoln Road Crew)
- Continue to inform landowners and the community about the New Haven River and tributary corridors
  (Lincoln Conservation Commission, River Steward)

7.0 PLAN IMPLEMENTATION

Implementation of this River Corridor Plan will be achieved through both short-term and long-term approaches.

7.1 Short-term

7.1.1 Review of the draft plan by riverside landowners and Lincoln officials

In the Winter of 2006, this draft plan will be shared with riverside landowners as well as Lincoln officials, including the Conservation Commission, Planning Commission and Selectboard. Feedback will be incorporated in a subsequent draft of the plan. Respective roles for continued stewardship of the plan will be determined through discussions with the Selectboard.

7.1.2 Public review and comment / Education and Outreach

Once the draft plan has been reviewed by landowners and Lincoln officials, public meetings will be held to share the revised plan with Lincoln citizens. The Lincoln Conservation Commission may assist in hosting a public forum(s) to obtain feedback on the plan.

7.1.3 Proceed with further development of a Fluvial Erosion Hazard corridor

The Lincoln Planning Commission will continue to work with the River Management Section and the Addison County Regional Planning Commission in a public planning process to review the possible role of a River Corridor Overlay District in town planning and to develop a viable draft ordinance for public review. In a 21 December 2005 Lincoln Planning Commission meeting, Adam Lougee, Executive Director of Addison County Regional Planning Commission (ACRPC), indicated that technical and financial resources to support this process could be provided under FY2004 FEMA Pre-Disaster Mitigation grant funds currently being administered by the ACRPC.

7.1.4 Proceed with identified conservation / restoration projects

As of 27 January 2006, the Town of Lincoln has made an application to the VTDEC River Management Section for a Category 2/3 River Corridor Grant to fund project development activities and implementation of: (a) conservation projects in identified sediment attenuation areas with interested landowners; (b) an alternatives analysis of the large landslide on the west bank of the New Haven in South Lincoln; and (c) buffer enhancement projects. Where landowner willingness is expressed, additional funding will be sought from appropriate partner agencies to proceed with projects identified in Section 7.1.

7.1.5 Seek grant for reach-wide alternatives analysis for Lincoln village (M19)

A planning grant through FEMA would identify alternative river management options in this developed portion of the corridor, along with associated cost/benefit analyses. Conceptual results could also be applied in concept to the other village areas settled within the river floodplain: West Lincoln, Downingsville, and South Lincoln. The deadline for application to the PDM-C FY2006 has passed; the deadline for submitting a Letter of Intent for FY2007 will be in the Fall of 2006.

7.1.6 Conduct geomorphic assessment work along additional main stem and tributary reaches

FEMA Pre-Disaster-Mitigation funding is also available to support additional geomorphic assessments on additional reaches of the New Haven River main stem and tributaries. As of 15 February 2006, Addison County Regional Planning Commission issued a request for proposals to conduct Phase 1 Stream Geomorphic Assessments on select New Haven River tributaries including the Cota Brook, Isham Brook, and Cow Brook (along French Settlement Road) in Lincoln. This Phase 1 assessment work (scheduled for completion in July 2006) will prioritize a subset of reaches for field-based assessment in Phase 2. Subsequent Phase 2 work will define geomorphic condition and sensitivity of these reaches which will be used to delineate additional river FEH corridors for the tributaries. Other channel disturbances and watershed stressors in the New Haven River watershed will be identified through this process – possibly those having an impact on conditions along the New Haven main stem. Additional restoration or conservation projects may become evident from this additional assessment work.

7.2 Long-term

7.2.1 Vermont Basin Planning

The VTDEC Water Quality Division will seek to incorporate the finalized New Haven River Corridor Plan for the Town of Lincoln within the larger Otter Creek Basin Plan. The intent of the basin plan is to be able to leverage resources that are needed for implementation of strategies outlined in the River Corridor Plan.

7.2.2 Periodic Plan Updates

Pending available funding, updates to the Lincoln River Corridor Plan will be performed periodically (approximately every 5 years) by the Town of Lincoln or other local stewardship organization to:

- Update management strategies with the results of geomorphic assessments on additional main stem and tributary reaches.
- Identify additional site-level and watershed-level management options.
- Report on ongoing needs of riparian landowners for financial and technical support to achieve plan objectives.
- Report on the ways in which the plan is supporting Lincoln officials and staff.

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APPENDIX A

Technical Working Group Meeting Minutes

Technical Working Group
Meeting Minutes

APPENDIX A
River Corridor Plan
New Haven River: Town of Lincoln

Addison County, Vermont

February 2006

Final Meeting Minutes

The Technical Working Group convened 7 meetings during the Lincoln corridor planning process:

- 7 June 2005
- 27 June 2005
- 9 August 2005
- 19 September 2005
- 25 October 2005
- 13 December 2005
- 10 January 2006

Minutes recorded during the above meetings by Project Director, Sally Ober, are presented on the following pages.

New Haven River Corridor Management Plan for Lincoln
Technical Working Group
Scoping Meeting 7 June, 2005
at Sally Ober's house, Lincoln

Present: Shayne Jaquith, Shannon Hill, Ethan Swift, Kristen Underwood, Sally Ober

1. It was agreed that the **name of the project** should be changed from the "Lincoln Flood Mitigation Project", to the *New Haven River Corridor Management Plan for Lincoln*. The reason for the change is that it clearly defines what we are doing. Sally will get a feel for the reception of this idea at the Lincoln Selectboard meeting (June 7), as well as with Mark Benz, and others in the community.
2. Shayne compared this project with other **similar projects** happening in Cabot, Fairfield, and on the Mad River. He indicated that we are keeping pace with other towns and may be ahead of some because Kristen has already completed the Phase 2 geomorphic assessments for Lincoln.
3. It was agreed that despite a bit of a late start, we would keep our goal in line with the project's **end date of February 2006**. We do not want to rush the process, but feel that it is possible to meet this goal.
4. The **main goal** of the Lincoln Community, is for this project to minimize flood losses and erosion hazards in reaches M19 (Lincoln Center) and M18 (West Lincoln). (I think these were Kristen's words.)
    a. Kristen recommended that we may also want to focus some efforts in the upper reaches of the river and its tributaries, in South Lincoln and Downingsville, to minimize sediment and run-off inputs to Lincoln Center and West Lincoln.
    b. Kristen and Sally reported that they met with the **Lincoln Planning Commission** on June 1, 2005. The Planning Commission is currently working on rewriting zoning regulations and they would like any advice we can give them as they define buffers, setbacks, etc. Kristen noted that the Town Plan and current zoning language are promising and may be helpful to our project.
    c. Kristen noted that Mark Benz is pursuing FEMA funds to **flood-proof Burnham Hall** from inundation. His work is not directly a piece of this project, but is rather paralleling our process.
    d. Shayne and Shannon seemed to think that four **public forums**, as described in the project outline may be too many, and our efforts could be better focused with smaller groups of interested citizens. It was suggested that a road crew educational forum might be useful to help minimize sediment and run-off from roads. Other topics suggested were gravel extraction, buffers, or a field trip to another watershed restoration site.

e. Shayne asked, "What are the **expectations of the Town of Lincoln** for this project?" Shayne asked whether the town wanted us to focus on inundation hazards, or fluvial erosion hazards and identification of buffers. Ethan pointed out the Selectboard Action on June 1, 2004, "to conduct pre-disaster flood mitigation actions, by forming this Technical Working Group, aka: The Lincoln Flood Mitigation Alliance. Sally will bring this up at the Selectboard meeting tonight. *(Note June 9, 2005 after the Lincoln Selectboard Meeting): I asked the selectboard this question, and they answered that they are really interested in both inundation and erosion hazards. Is the goal of minimizing both of these mutually exclusive, or can both concerns be addressed with similar treatments? Perhaps this answer is different for each distinct region of the river. I did get the impression that the selectboard was less concerned about the potential loss of roads than they were about loss of homes or other town infrastructure. I will put this on the agenda for our next meeting on June 27).*

f. Ethan suggested that our goal ought to be to strive for gaining equilibrium for the river through the village areas, and focus on specific places in the upper reaches of the river or its tributaries that need special attention, and/or where landowners are willing to participate.

g. Shayne envisioned a combination of both active (armoring, planting, etc.) and passive projects (such as acquiring property in critical floodplain areas), as are developing in the Cabot model.

h. We concluded that the **main goal** of this project is to **develop a River Corridor Management Plan, focusing as much as possible on the communities clustered in the Center of Lincoln and West Lincoln. At the same time we will identify opportunities that exist in other reaches upstream of these densely settled areas, to protect them from fluvial erosion. Fluvial Erosion Hazard (FEH) Map development is one of the main goals of this group.** FEH maps will be a useful addition of information to the FEMA FIRM maps for the Lincoln Planning Commission, to assist them in developing a strategy for guiding safe development near the river in the future. The New Haven River Corridor Management Plan will be a living document that will evolve as we talk with landowners, and interested town organizations. The document will be able to be revised over time as needed.

5. **Roles of each member of the Technical Working Group (TWG)**
   a. **Sally Ober:** Town of Lincoln Project Director—
      i. To serve as general coordinator of the group, keeping us on task and on schedule.
      ii. To organize and set agendas for our meetings.
      iii. To serve as a liaison between the TWG and the Lincoln Selectboard.
      iv. To serve as a primary contact person for Lincoln residents, connecting them to the work of the TWG, by conducting mailings, personal meetings, and public forums.

v. To assist the TWG, whenever possible, by gathering any information necessary to develop the River Corridor Management Plan, especially local knowledge.
vi. To prepare minutes of the TWG meetings, and keep documentation of public forums, landowner meetings, and general work completed within the scope of this project (a required deliverable under the grant agreement).
vii. To seek out one or two other interested citizens of Lincoln or Bristol to serve on the TWG.

b. **Mark Benz:** Contract Administrator from Lincoln for the Grant Agreement—
   i. To prepare documentation of how grant funds are spent.
   ii. To serve as liaison between the TWG and the Burnham Foundation.
   iii. To assist with grant writing for projects that are identified in the River Corridor Management Plan.
c. **Kristen Underwood:** South Mountain Research and Consulting—
   i. To share findings of her Phase 2 Stream Geomorphic Assessment Study completed in September 2004 with the TWG.
   ii. To serve as a Technical Consultant in developing the River Corridor Management Plan.
   iii. To assist Sally with technical knowledge for effective public outreach and education processes.
   iv. To compile and prepare the final River Corridor Management Plan, the primary deliverable of the grant agreement.
d. **Shayne Jaquith:** River Restoration Scientist, VT Agency of Natural Resources
   i. Grant Administrator from the State of Vermont. Oversee and guide the TWG toward meeting the agreements stated in the grant.
   ii. To provide technical assistance to the TWG
   iii. To network with River Management, and keep the TWG informed of ideas and plans in other watersheds (Cabot, Mad River, Fairfield)
   iv. To provide information about historic approaches to river management in Vermont
e. **Shannon Hill:** River Resource Scientist, VT Agency of Natural Resources
   i. Enter phase II data from Kristen into database
   ii. Prepare Fluvial Erosion Hazard Maps
   iii. Provide technical assistance to the TWG
f. **Ethan Swift:** Watershed Coordinator, VT Agency of Natural Resources
   i. Wants to stay informed of the TWG work
   ii. Assist the TWG as much as possible, especially with educational public forums
   iii. To provide knowledge of planning processes to the TWG

iv. To incorporate the New Haven River Corridor Management Plan into the Otter Creek Basin Plan

g. Sally will try to identify **other interested members** to invite into the Technical Working Group—one from Bristol and one from Lincoln

h. Kristen will prepare a draft **press release** to be circulated by Monday, June 20 via e-mail. The TWG will finalize it at our **next meeting on Monday, June 27, at 9:00 a.m. at Sally's house.** Kristen will also compile a summary of target sites for us to work on.

i. Sally will touch base with the Selectboard to get answers to some of our questions, as well as update Kristen's list of landowners along the river corridor.

j. After the meeting, Sally, Kristen, and Shayne did a watershed tour by car. Ethan and Shannon will try to schedule time to do a driving tour after our next meeting.

Minutes prepared by Sally Ober.

New Haven River Corridor Management Plan for Lincoln
Technical Working Group Meeting Minutes
June 27, 2005

Present: Shayne Jaquith, Shannon Hill, Ethan Swift, Kristen Underwood, Sally Ober, Mark Benz

1. Mark noted that we should be cautious about townspeople and their perceptions of State Agencies as top-down organizations telling people what they can't do. Our approach should be to help identify for people what they **can** do with their land. Perhaps we should bring out alternatives for solutions to problems first, before attempting to educate the public about what won't work.
2. Shannon noted that a **flume demonstration table** is available through the department, to show the results of dredging and other channel manipulations. It was suggested that we try to set this up at Burnham Hall during the Lincoln Hill Country Holiday weekend (August 5-7). Perhaps with Kristen and Sally's help, it could be available for 2 days.
3. Sally wanted to **clarify the goals of the project** as requested by the Lincoln Selectboard. The selectboard wants this working group to strive to minimize both inundation hazards and fluvial erosion hazards. Shayne explained that solving an inundation problem by expanding a channel, can at the same time increase the erosion hazard, for example. Mark and Shayne made an **analogy** with the concept of wet-proofing Burnham Hall vs. dry-proofing the building. Shayne indicated that **instead of trying to keep flood plains dry in a storm event, allow them to get wet so that when the water recedes, there won't be lasting damage.** This will be an important educational point for us to make. In some cases, it may involve a trade-off to a landowner (sacrifice a farm field, view, etc. in exchange for a building staying dry), in other cases, we may need to support the decisions a landowner is making to preserve the floodplain.
4. Shayne noted that this management plan will not <u>stop</u> floods from inundating Burnham Hall and other buildings in the flood plains. **The natural precipitation pattern is that the Lincoln reaches receive rather frequent, high intensity storms.**
5. Kristen noted that the **nearest precipitation gauge is on French Settlement Road in South Lincoln. The nearest flow gauge is in Brooksville.**
6. Shannon wanted to clarify that the **funding source for this project is the Governor's Clean and Clear funds. The primary goal of this program is to clean up the water quality of Lake Champlain, not to mitigate floods.**
7. **A 3-pronged approach** to the process of reducing future losses from the river was suggested:
    a. reduce fluvial erosion hazards
    b. reduce nutrient loading
    c. improve aquatic habitats
8. Kristen will revise the press release and landowner letters. Sally will get them out ASAP.

9. Mark mentioned that the Burnham Foundation received a check from the Department of Transportation for an easement to use their parking lot for a temporary bridge while the new Gove Hill bridge is built. A discussion about the bridge design followed. It was decided that **we should ask the Lincoln Selectboard to acquire an artist's rendition of the bridge design, to be shared with the public for review before the bridge is built**. If we see a need for a design change, we will need public support. *(Note: Sally went to the Selectboard on July 19, and they are looking into this.)*

10. Shayne noted that on our driving tour of the river on June 7, we identified places where we could correct management of tributaries by assisting with bridge sizing, road ditching, culvert sizing, etc. There is **great potential for improving the land use regulations for sound river management.**
11. Shayne also voiced the possibility of **creating a strong channel through the village** that can withstand floods instead of using flood plain access that is not readily available.
12. Shannon also noted that we should **identify sediment attenuation areas upstream of the village areas.**
13. A discussion of the **mass failure in South Lincoln followed**. Shannon offered the idea of it serving as a pilot project for the **VT Geologic Survey**, which may be working on sedimentation project funding.
14. Sally led a discussion of a number of **individuals from Lincoln who might be helpful to serve on the Technical Working Group.** Perhaps someone will surface after landowner meetings begin. Availability of time seems to be a challenge.
15. Sally asked for a discussion of **the purpose of the landowner meetings**, and what information we want to get from them. Here's what we came up with:
    - **a.** To introduce the landowners to the project
    - **b.** To identify the landowners' concerns, constraints, expectations, and future plans if they are willing to share them.
    - **c.** To understand the landowners' perception of the river and its processes
    - **d.** To get a feel for the landowners' commitment to the project and intent to participate in any Category 3 projects.
    - **e.** To offer assistance to landowners, by helping them find information about the river and to connect them with funding sources or other agencies that can offer assistance with projects.
    - **f.** To help the landowners identify incentives, financial or otherwise for river management.
    - **g.** To be prepared to present conceptual ideas about river management alternatives
    - **h.** To identify topics for community discussions and open forums
16. Kristen will share with Sally, a **landowner contact form** that she used on Lewis Creek for a similar project. We can adapt it for use in our project.
17. Shayne asked if we could focus on **Phase 2 data to identify stressors and opportunities for changes.**

18. Kristen offered that perhaps **more assessment work ought to be done on French Settlement Road.**
19. Ethan asked about an **Erosion Survey. Has the Town done a Bridge and Culvert Survey**? State funds may be available to the Lincoln road crew for these. Perhaps ANR, not AOT has the information about this.
20. Shannon mentioned that the State has developed a number of helpful **fact sheets** that may be useful for landowner meetings. Kristen has a lot of them and will give copies to Sally.
21. Shannon and Kristen will get together to **discuss stream typing** for the FEH zone mapping. They may need to get together in the field to go over differences in cross-sections to be sure that their interpretations are consistent.

Minutes prepared by Sally Ober.

New Haven River Corridor Management Plan for Lincoln
Technical Working Group Meeting Minutes

August 9, 2005

Present: Shannon Hill, Shayne Jaquith, Adam Lougee, *Addison County Regional Planning Commission*, Ty Mack, *VT DEC, Water Quality Division,* Sally Ober, Ethan Swift, Kristen Underwood

I. MINUTES

The minutes of the June 27, 2005 meeting were corrected. In item 11, the word *corridor* was changed to *channel.* Item 12, read: *Shannon said that we should be sure to deal with sediment if we contain the corridor (the word corridor should have been channel).* Line 12 was deleted, because it was redundant with line 13.

II. OUTREACH

1. Shayne, Sally, and Kristen reported that **the river flume simulation table** was a successful piece of outreach for the project. Flume demonstrations were offered in Burnham Hall during the weekend of Lincoln's Hill Country Holiday events. Demonstrations were offered once on Friday afternoon, and twice on Saturday. Although nobody except Sally's family attended on Friday, the Saturday showing had about thirty or more people attend at noon and about twelve more attended in the afternoon. The event also offered videos about unstable rivers, handouts of DEC materials, and a poster that Kristen made, depicting river processes. We passed out cold lemonade and had some good long discussions with Lincoln residents. The flume was a fun and valuable teaching tool. Even a few "nay-sayers" seemed to express great interest in the demonstrations. Kristen aided a small group in creating a simulation of the reach of the New Haven River through the center of the village. The group simulated changing the angle of the bridge abutments as is called for in the plans for the new Gove Hill Bridge. Eventually, the abutments undermined and gave way to the river. We recognized that the simulation was not entirely life-like due to various factors, but it made for interesting discussion about the bridge plans.
2. Sally has been advertising another piece of outreach for this project. On August 15, 2005, **Kristen will be giving a power point presentation about her Phase 2, Geomorphic Assessment work on the New Haven River Watershed from last year**. The event will be offered as one of the Lincoln Lecture Series discussions at the Lincoln Library. Ethan said that he would try to attend.

III. FEH MAPPING PROGRESS and LINCOLN PLANNING COMMISSION

1. Shannon shared a **draft of the Fluvial Erosion Hazard Maps (FEH Maps)** that she has created using Kristen's field data from 2004. Reaches 23 and 24 are not done, because we don't have data for these sections. The draft is not ready to share with the public yet, because she is still field checking the locations of the

valley wall. The draft included a 50-foot and 100-foot buffer, since these are ideas that the Lincoln Planning Commission is considering as they rewrite their zoning regulations. Shannon noted that in some cases, the 100-foot setback may go up the valley wall. Although it may not be necessary for the stability of the river, a benefit of this would be to preserve wildlife habitat.

2. Adam indicated that he has been meeting with the **Lincoln Planning Commission (LPC),as they work on rewriting their zoning regulations**. The LPC might be more receptive to FEH zoning than straight arbitrary setbacks.
3. Ty said that the **FEH setback is more "sellable"** to the public than an arbitrary distance.
4. Shannon said that in many places, the **FEH zone essentially ends up being the whole valley**, which may not "sell" well to landowners.
5. Kristen asked: **"What is the Town's goal for its zoning regulations?" The Town could take a composite approach.** Also, data do not exist for all tributaries in town.
6. Shayne recommended that if the FEH zoning route is clearly desirable to the Town, **Phase 1 and 2 work could be a goal for the tributaries that have not been included in our project so far**.
7. Ty stated that **there is a lot of flexibility in how these FEH zoning maps can be created. The maps are designed to fit the needs of the Town.**
    a. Ty handed out a **flow chart** entitled ***Fluvial Erosion Hazard Map Production and their use in Town Pre-Disaster Mitigation Planning***.
    b. **Lincoln** has mostly completed Phase 1 and 2 assessments, and **is currently at Draft 1 of the FEH Map** on the chart.
    c. **Ty and Shannon** are working on the next steps of **field checking the valley walls**.
    d. **Manual redraw** is the next step, looking at **field-verified stream sensitivity classes.**
8. Shannon indicated that in upstream areas especially in South Lincoln, **there are areas where the valley is wider than the river needs**, so the FEH corridor is narrower than the valley wall.
9. Ethan was concerned that **all the boundaries ought to be the same**. It might be confusing to have different boundaries, when looking at programs for funding river projects. In places where different processes are going on, it may be suggested that a beltwidth approach be used. Can FEH mapping do this?
10. Ty indicated that the NFIP (National Flood Insurance Program), based on inundation hazard, is a line on a map. We **could overlay the FEH zone with the NFIP zones and create a multi-hazard zone map.**
11. Adam updated us on the **Lincoln Planning Commission timeline**.
    e. Their **municipal grant for working on the zoning changes ends in April of 2006**.
    f. They have **already made changes to Chapter 117** regulations which will be going to the Selectboard for approval soon.
    g. Using their last planning grant, working with Kevin Behm, they looked at **150-foot setbacks from the centerline of the river** and some were not comfortable with that number.

   h. They have **discussed zoning districts and 50-foot or 100-foot setbacks along the river** as a compromise.
   i. The **LPC is planning a public hearing in September or October to ask for feedback from landowners.**
   j. Adam's sense is that the **main concerns of the Lincoln Planning Commission** are:
      i. Water quality
      ii. Wildlife habitat (to a certain extent)
      iii. Recognizing that it is not realistic to make wildlife corridors in village areas

12. Ty stated that this **FEH approach can narrow the boundaries administratively through the village areas.** If the Town goes with setbacks, instead, we should try to provide them with the best possible maps to help them define the size of the setback.
13. Adam talked about a **strategy and timeline for bringing information that we have to the Lincoln Planning Commission. The LPC is looking for an easily explainable and supportable plan for their zoning.**
14. Shayne said that we should get on the **LPC agenda** and **bring packets of Shannon's work**.
15. Adam indicated that the **LPC looked at the Cota Brook, Downingsville, the New Haven Main Stem, and Isham Hollow Brooks as the most important watersheds in town.** They didn't want to regulate every intermittent stream in town. We may need to find money to be sure that we have complete data for all of the tributaries.
16. Ethan didn't want to complicate things, but there is a **requirement to do water management typing on geomorphically stable mountain streams**. The reclassification process is coming up.
17. Adam didn't think the Lincoln Planning Commission would be overwhelmed too much by the reclassification piece. There is **currently a 25-foot setback on every stream** in town. LPC only wants to enhance this. **We ought to all get together for a "WATER MEETING NIGHT".**
18. Ty said that we ought to align funding sources from the State as a **package of incentives with benefits** including saving money and reducing loss.
19. Kristen thought that it ought to be made clear whether reducing a corridor size will mean losing **incentives as part of the cost/benefit evaluation process**.
20. Ty did not think the **State** would take a hard and fast, all-or-nothing approach to giving **funding for benefits**.
21. Shayne agreed that the **State probably would not penalize the Town for the choices it makes**.
22. Ty said the **State will consider what happened in past floods**, before funding a project.
23. Shannon wanted to be careful **not to limit a landowner's ability to renovate an existing structure in a FEH zone**, only to limit future new development in an FEH zone.

24. Kristen was concerned that **if we adjust the FEH zones administratively through the village, that people might think it's ok to develop in a sensitive area, which goes against what the scientific evidence suggests**.
25. Sally suggested that **if administrative changes are made to the FEH zone, a dashed line could be drawn to indicate the scientifically drawn corridor**. Only existing properties could be within the dashed line, but if the river wipes them out over time, they could not be rebuilt in the FEH zone.
26. Shannon thought that if the **FEMA** gets involved, the rules may change. A **wiped out building may not be rebuilt.**
27. Shayne reminded us that **the zoning decisions being made are not individually decided upon, they are community based**.
28. Shannon stated that a **scientifically drawn version of the FEH zone maps will be preserved**, even if the town decides to make administrative changes to it.
29. A plan was agreed upon by all that we would invite the members of the Lincoln Planning Commission to Kristen's talk at the Library, Shannon and Ty would work on adjusting the valley walls on the draft FEH maps and we would **all try to meet with the LPC in September to discuss the river corridor issues before their open hearing in October**.
30. Ethan said that he would try to do the typing for the New Haven in Lincoln by the September meeting, based on the chemical, physical, and biological data available, realizing that the Lincoln Planning Commission may try to change the typing during the zoning process.
31. Adam suggested that **PDMC (Pre-disaster mitigation competitive) grant funds may be available to help us with any extra field work that needs to be done to complete the FEH zone maps.**
32. Adam will talk with Kevin Behm, the GIS Manager for Regional Planning to **prepare maps for our meeting with the Lincoln Planning Commission.**

IV. LANDOWNER MEETINGS

1. Sally reported that she has **begun to meet with landowners** on an individual basis.
2. Kristen and Sally developed a **landowner meeting record form**, to use for recording information from landowners, and to act as an agenda for landowner meetings.
3. Sally asked about **how to share the enormous amount of information she is gathering from landowners** with the group? How do we filter through the information and prioritize projects? For now, Sally has been sharing details with Kristen and they have been prioritizing landowners to contact first. This seems to be the most efficient plan for processing landowner information. Kristen shared a **list of possible implementation projects** with the group. Several landowners have responded to the letter we sent them and have stopped Sally on the street, asking about the project.
4. Ethan thought that the biggest thing we can do is **identify projects** that landowners are willing or interested in and **link them with funding sources**.

5. Shannon wondered if **a highly visible demonstration project** could be found by the October Phase 3 deadline.
6. Kristen didn't think that high profile demonstration sites were clearly available.
7. Adam mentioned **moving Ripton's Fire Station** with FEMA grant as an example. Maybe we could **combine a few projects** to have a town-wide planting day or such, instead of individual projects here and there.
8. There was a **group discussion about moving the fire station** with lots of pros and cons, but no real conclusion until we meet with the fire company.
9. Kristen emphasized increasing **public awareness of floodplain zones**, and **giving the river more access to flood plains**. Possible projects were discussed upriver of town: Pallet, Bobbin Mill, Truchons and neighbors, near Garland Bridge.
10. **Private structure relocation** was discussed in general. Although highly visible, and often desirable for the river, it's not very economically feasible in most cases.

V. PERSONNEL

1. **Ty Mack,** the FEH Coordinator for the River Management Section of the VT Agency of Natural Resources, will continue to come to these Technical Working Group Meetings.
2. **Shannon Hill** will probably drop from the group after the FEH maps are completed. She will continue to stay in the information loop through e-mails from Sally.

VI. OTHER

1. Those who participated in the second **river windshield tour of Lincoln** with Kristen said it was worthwhile.
2. Kristen reminded us that **Category 2 & 3 grant deadlines are in September and October**.
3. Our **next Technical Working Group meeting is scheduled for September 19 at 9 am** at Sally's house.
4. The **Technical Working Group will try to meet with the Lincoln Planning Commission on September 21**.
5. **Kristen handed out an outline for a plan for the rest of this project with timelines**.

These minutes submitted by Sally Ober.

New Haven River Corridor Management Plan
19 September, 2005 Meeting Minutes

Present: Ty Mack, Shayne Jaquith, Kristen Underwood, Sally Ober

Outreach

Kristen's lecture at the Lincoln Library on August 15, was well attended. About 28 people were counted at one time. Ethan Swift was also present. **Gioia Kuss of Middlebury Area Land Trust** introduced herself to Kristen and me afterwards, and said that MALT was very interested in assisting our project in any way possible. Gioia sent me some information about MALT in the mail, and we are keeping in touch with them as conservation projects present themselves. Melita Bass, of the Lincoln Planning Commission, also attended and appreciated the information from Kristen. Several individuals had conversations with Kristen and me after the formal presentation was over. Kristen brought some posters about river processes for people to view and Sally had a table full of papers from VT DEC, about river issues such as gravel extraction and river management which some people took home with them. We also expanded our e-mail list with names of interested landowners.

Landowner Meetings

1. Sally has set a goal to try to meet with as many landowners as possible by the end of October.
2. **Many more landowners are interested in meeting with Sally** than she expected, and it is often difficult to limit meetings to less than 30 minutes, because it takes a little time with small talk for people to open up. Many landowners have launched into huge discussions with lots of questions or stories to tell about their experiences with the river. Overall, the meetings have been pleasant and valuable.
3. Most everyone was extremely grateful for the **personal attention and time given** to them in relation to this project. A few landowners have been happy to have phone conversations about their land, and interviews have been conducted that way.
4. Shayne wondered if **perhaps we need more funding to go door to door** and meet with landowners because that part of the process is so well received.
5. Sally discussed a few specific landowner meetings, Johnson's in Downingsville, Lincoln Sports, and some of the center properties that had not yet been scheduled.

Category 3 Grant Opportunities

1. **Lincoln Sports** was discussed as a property that may be a great **opportunity for a conservation easement.**

2. Kristen mentioned that **Starksboro has put their recreation field into conservation**, and we could see how that has worked for them.
3. Sally thought that the **incentive for conservation would have to be for the value of the floodplain and the example to the townspeople**, because the Lincoln Sports organization is already property tax-exempt. She said that the Sports Board saw no other use for the field than as a multi-use recreational field. The only future structure anticipated, might be an open-sided pavilion, or improved bleachers for the ballfield. Detailed consideration for these may need to be worded in an easement.
4. Sally thought that because the conservation easement would have to be approved by the **Lincoln Sports Board of Directors**, it may be too short of a time period to get an organization like this to apply for a grant by the Oct. 1 deadline. We agreed to try, anyway. Sally will call the president of the board, ASAP.
5. **Bob Bernstein's property across from the Pallet Mill was also discussed as a possible conservation project for Category 3 funding this fall**. Sally will call him, and Kristen will follow up with both Lincoln Sports and Bernstein's to put together a grant application if they are interested. Kristen will also contact Gioia Kuss at MALT to see if they will help.

Lincoln Planning Commission Meeting

1. A rough outline for our **discussion with the Lincoln Planning Commission** on Wednesday, Sept. 21 was agreed upon:
    a. Shayne will give a very brief **history of River Management in VT** and Lincoln.
    b. Ty will present a power point overview of **river science** and introduce the **Fluvial Erosion Hazard Mapping** concept and process.
    c. Kristen will discuss **different methods of protecting river corridors**, buffers, set backs, FEH, etc. and how they are applied. She will also be available to answer specific questions about applying these in Lincoln.
    d. Sally will call Ethan Swift to find out if he will attend the meeting and if he wants to discuss **stream typing**.
    e. Ty will touch base with Adam Lougee and be sure that **maps** are available to bring to the meeting.
2. Sally is pretty sure that our river group is the only thing on the Planning Commission's agenda for the evening, so we would probably have about 2 hours depending on how many questions are raised and how well the discussion develops.

Minutes prepared by Sally Ober.

New Haven River Corridor Management Plan—Lincoln
25 October 2005 Meeting Minutes

Present: Mark Benz, Ty Mack, Sally Ober, Kristen Underwood

South Lincoln Mass Failures:

1. On October 17, 2005, **George Springston**, a Research Associate at Norwich University and affiliate of the US Geological Survey who also works part-time for the State of Vermont, Agency of Natural Resources, **came to visit two of the mass failure sites in South Lincoln.** George's assignment from the State is to work on methodology for mapping landslide hazards. Ty, Sally, and Kristen were also present during the site visits. The properties visited were Tom Booska's, parcel #100225.000 on the Lincoln tax map, and Shelly Solworth parcels # 130112.000, 11.000, and 12.010. The Solworth slide is probably half owned by Green Mountain National Forest at the top, as it is located right on the edge of property boundaries.
2. **General surveys of the slides were taken.** Some soil samples were collected from the Booska site but not the Solworth site, because of high water and the danger of crossing the river that day. Sally mentioned that there were more slides further up river from the Solworth site along the Cooley Glen hiking trail, many of which are new since the 1998 flood. A head cut was noticed in the river right in front of the Solworth slide.
3. **Booska slide:** George described the Booska slide as comprising of glacial lake deposits. There is an old sand/gravel quarry on the back side of the slide which hasn't been used for at least 20 years according to Tom Booska. This slide is likely driven by toe erosion, a slow, continual process, which may have started with one big slump. Some large hemlock trees on the upriver edge of the slide are about to fall into the river, and may serve a purpose in self-correcting a bit of the problem by diverting flow.
4. Ty thought that **by armoring the toe of the slide, we could put Jeff and Heidi Masterson's property at risk** (landowner downstream of slide on opposite bank). The question is how much sediment input does this slide provide downstream?
5. **Possible solutions for Jeff Masterson's property:** perhaps armor the bank with riprap, enhance woody buffer, stop mowing to the edge.
6. Mark suggested that **perhaps a Lincoln Community School or Boy Scouts project could be to trace where marked sediments go**, either by adding white marble chips and following them, or by having the boy scouts survey soil loss, for a merit badge.
7. Kristen thought it would be helpful to put **bank pins into the slide to monitor how quickly it's moving** and give us more information to work with before we decide what to do about the situation. It would also be important to **identify sediment attenuation areas upstream** of the Mill Road bridge.

8. Ty thought we ought to **look upstream** of the slide areas to encourage good river management, minimizing impacts to the slide area.
9. Mark mentioned some **town/road crew issues that came up after the 1998 flood** and that it might be worth talking with Bill Masterson about the controversial work done at that time. Sally will follow up on this.
10. George Springston plans to do some **follow-up site visits and give us a write-up of his findings**. Ty will follow up with him.

Lincoln Planning Commission, October 19, open forum discussion:

1. On Oct. 19, the **Lincoln Planning Commission held an open forum** discussion concerning changes to the Lincoln Zoning Regulations as required by the State of Vermont Title 24, **Chapter 117** of the Vermont Statutes Annotated governing municipal planning and development. The secondary purpose of this forum was **to introduce to townspeople, some proposed new zoning overlay districts and the idea of using fluvial erosion hazard corridors along the river**. Sally, Kristen, and Ty attended this forum.
2. Ty was interested in the idea discussed that the **Town could encourage development outside a corridor** at higher densities than the overlay district would normally allow, if the landowner agreed to cluster the development into a smaller area, leaving more open space on the property. For example: if a landowner had 80 acres in an outlying district where 10-acre zoning regulations applied. The owner would normally only be able to place 8 homes on the land with 10-acre lots. If the homes were clustered into a planned unit development, perhaps 10 or more homes could be built, while keeping more open space, river corridor, or other valuable land development-free.
3. Mark asked what the **Town Listers would do with the value of conserved land**?
4. Kristen discussed conservation easements with Gioia Kuss of the Middlebury Area Land Trust, and she indicated that **tax breaks for landowners are a town-by-town decision** to make.
5. Mark asked **how our Town listers view floodplain/riverways in terms of property value?** Sally will follow up on this.
6. Mark mentioned that the **State of Vermont Current Use Program** allows the listers to make tax adjustments based on the recommendations that the State provides, and the State funds the tax break.
7. Sally said that the **Lincoln Conservation Commission will be holding an open forum/discussion** tonight, to discuss how best to protect the natural heritage of Lincoln. There will be someone from the Vermont Land Trust there to talk about conservation easements. Sally will attend, Kristen will try to be there too.
8. The **Lincoln Planning Commission** may be looking for **PreDisaster Mitigation Comptetitive (PDMC) grants** to get more data for developing FEH maps on other tributaries in Lincoln. Sally will keep in touch with the Planning Commission about this.
9. Kristen thought it might be interesting to **create maps** similar to the build-out maps presented at the Lincoln Planning Commission open forum**, to show how many houses could be lost to the river in the FEH corridors** as an incentive to consider the FEH overlay district concept.

10. Ty agreed that zoning is always a **trade-off decision between the general benefit to the community vs. the benefit of development**.
11. Mark mentioned that the **insurance pressure** on the homeowner adds impact to zoning policy in river corridor areas.
12. Kristen wondered, **if towns adopted FEH zoning**, **would FEMA expand its flood hazard maps to include FEH zones and then the insurance industry follow**, requiring more landowners to carry flood hazard insurance?
13. Ty added that if this occurred, **a new hazard zone could eliminate buildings** by insurance companies refusing to insure buildings in flood hazard areas.

Financial Discussion of Grant:

1. **Kristen** indicated that she is **about half way through the allotted funds for her position in this grant**. She seemed to think that there ought to be **enough remaining funds for her to complete the project**.
2. **Sally is over half way through her funds**. Landowner meetings have been taking a lot more time than expected, but have been very well received and will attribute to buy-in of the plan when it is presented to the town.
3. There are places where we have not spent **funds that may be shifted to cover Sally's or Kristen's salaries**. Mark understood that as long as we do not exceed the total budget for the grant, we may be able to shift funds around to perform different tasks as needed. We should check with Shayne Jaquith to confirm this.
4. Kristen discussed some things that she sees as **follow-up work** that will need to be done after this project officially ends in February.
    a. **Data collection, analysis, and development of FEH districts** for more New Haven tributaries in Lincoln if the Town acquires PDMC funds to do this work.
    b. Overseeing any **conservation projects** that evolve from this plan.
    c. **Buffer enhancements** where landowners and grant money allow.
5. Mark said that before this project began, he envisioned the formation of a so-called **Flood Mitigation Alliance** that would figure out what to do and how to do it.

Remainder of Project Plan:

1. **Sally will focus on finishing landowner meetings**, prioritizing by contacting key landowners first, and following up with others later (create a short list and a long list of those we would like to eventually speak with if time and funds remain).
2. **Kristen will frame up a draft plan to share with the group by November 15, to share with the group before or at our next meeting.**
3. Mark suggested **another news release** or update at least through the Town e-mail list. Sally will work on this.
4. Sally asked, what can this project do to change the outcome of a future flood? Aside from preserving floodplains, sediment attenuation areas, etc., **how is what we are doing, any different than what was in place before the 1998 flood?**
5. Mark said that **FEMA's answers to this question appear to be move it, raise it, or remove it.**
6. Kristen asked if Sally was questioning whether we should be working to **restore floodplain areas?** Restoring river function is not an easy fix either. Ideally, we

ought to move roads away from the river in the M26 reach, but this won't likely happen. At this time we can focus on the smaller tributaries, and work on road runoff management as possible solutions. We would need to collect more data to be able to model the costs/benefits of other actions.

7. Ty encouraged us to think that a **passive corridor management approach will restore sinuosity to the river over time.** Sinuosity lengthens the channel and roughness slows down the flow. The benefit of less encroachment on the river will more likely be noticed in a 100-year level flood. The 1998 flood was considered a 500-year event. **Slowing the progress of encroachment on the river requires the community to look at the river on a large systemic scale.** In the mean time, more funding will be necessary to protect buildings in town on a closer scale. Perhaps armoring/engineering will be necessary in these areas.
8. Kristen voiced another idea that was employed in the **Granville area of managing steeper slopes with pools**, and we could look at how **East Middlebury has managed its existing homes along the river**.

Burnham Hall Update from Mark Benz:

1. Mark is **struggling with getting FEMA support for flood mitigation to Burnham Hall**. He has applied for e-grants online but is getting a lot of run-around. They are trying to dry-flood-proof the building by installing watertight windows on the lower level.
2. The **Burnham Foundation is also considering armoring the riverbank behind the building** and needs advice about what it should be, stone rip-rap, concrete wall, what and how should it be done?
3. Mark asked **who should help design a barrier for behind Burnham Hall**, an engineering firm, are there other such sites in the state that we can visit to get ideas? **Ty will ask Barry Cahoon** about other historical or at-risk buildings in the state, and find out if there are engineering or construction firms that have experience with this.
4. Ty encouraged Mark to **make sure that FEMA knows about this river corridor management plan project when applying for grants**. He said that FEMA is helping fund FEH mapping through PDMC funds.
5. Kristen wondered if **a municipal planning grant might be a possibility** for doing a hydrological study to aid in the design of a barrier structure.
6. **Mark will continue to persevere with grant seeking for Burnham Hall**.

Minutes prepared by Sally Ober

New Haven River Corridor Management Plan—Lincoln
13 December 2005, Meeting Minutes

Present: Shayne Jaquith, Adam Lougee, Ty Mack, Sally Ober, Ethan Swift, Jackie Tuxill (Lincoln Conservation Commission member), and Kristen Underwood

FEH Mapping for Lincoln Planning Commission

1. Adam mentioned that he will be attending another one of the Lincoln Planning Commission's meetings on Dec. 21st, and wanted to know the **status of the Fluvial Erosion Hazard (FEH) maps**.
2. Ty said that **there are a few gaps**. Some areas do not have Phase 2 data, and the only tributary to the New Haven River that has phase 2 data is the Beaver Meadow Brook.
3. Adam said that the **Lincoln Planning Commission** has passed on the Chapter 117 changes to the Selectboard, and they are now looking at zoning districts again. There was a lot of feedback from residents at their fall open forum, and now they are discussing viewshed overlay districts and **possible FEH districts**.
4. Sally asked about availability of **PDMC funds** to fill in the blanks where Phase 2 data has not been gathered. Adam indicated that **Lincoln could be a likely recipient** for this purpose, if the Planning Commission wants to go ahead with FEH districts along other tributaries besides Beaver Meadow Brook.
5. Kristen asked about **how a FEH district would overlap in high-density areas in the village**.
6. Ty indicated that we can prepare maps showing where science-based hazards exist, then the Town can make whatever adjustments work for them, but **we need to be clear about places where changes are made**, so that people are aware of risk levels.
7. Ty and Shannon Hill are **still working on refinements** for roads and doing field verification. The version of the map that we have now, is still a draft version. If the Planning Commission wants final drafts, it won't take long to do it.
8. Kristen said that she would **look at the maps** with Ty, before the Planning Commission Meeting on the 21st.
9. Shayne suggested that perhaps someone like Steve Revell, of Lincoln Applied Geology, would be willing to act as the **Town's "agent",** to review the maps and look out for the Town's interests in this process.
10. Adam added that **perhaps PDMC funds could help to pay for Steve's time**.
11. Shayne noted that **a local person might be able to pick out areas where rock outcrops or other features** would narrow the FEH zone as drafted on the current maps.
12. Kristen believes there should be an "**appeals process**" clearly defined, in case a landowner takes exception to where the FEH line is drawn.

13. Sally asked that the **name of the Beaver Meadow Brook be confirmed on a USGS topographical map**, because some residents thought that we were calling Downingsville Brook the Beaver Meadow Brook.
14. Kristen asked if PDMC funds are to be sought for the field work portion of the FEH process, should this come out of the **draft proposal for Category 3 grants**? The consensus was, yes, remove this from the draft plan.

Lincoln Conservation Commission Open Forum, Oct. 25, 2005

1. The Lincoln Conservation Commission held an open forum on Oct. 25, 2005, to ask townspeople to answer **two questions: (a) What do you value about Lincoln's natural heritage? and (b) How do we, as a town, best protect what we value?**
2. There were some **guest speakers** who began the forum. **Marc Lapin** spoke about the Colby Hill Ecological Reserve, **Bob Linck** from the Vermont Land Trust, spoke about Conservation Easements, **Jackie Tuxill** presented information about a project called the New Haven River Headwaters Project, a local, community-based land conservation initiative**. Sally and Kristen** even had a moment to discuss the New Haven River Corridor Management Plan at the forum.
3. Attendees of the forum were broken into **working groups to answer the first question** about what we value, the second question of how to protect our natural heritage is going to be addressed at **another forum in January**.
4. Adam asked if the **results** of the first forum could be **shared with the Planning Commission** at their meeting on the 21st? Sally will bring this information.
5. Kristen was encouraged to think that as the various organizations in town seem to have **overlapping conservation goals**, more funding opportunities may be available.
6. **Sally will attend the follow-up Conservation Commission meeting in January.**
7. A discussion of **road crew education,** to promote best management practices for the river ensued.
8. Adam mentioned that another training for **"Better Back Roads",** a joint state/local program offered through the Agency of Transportation, could be set up.
9. Kristen wondered if the **issues in Lincoln might be different** than what is offered at the county level trainings, and if perhaps a special workshop for Lincoln might be more valuable.
10. Shayne thought that it is often best to get grants to do a special workshop, but that would require a point person. Sally indicated that it seems that the road crew is lacking a commissioner at this time. The selectboard oversees the road crew. Sally will follow up with the **selectboard about the best way to approach the road crew**.
11. Ethan mentioned that a new staff person, **Linda Boudette**, Resource Conservation and Development could be helpful. She is a "**Better Back Roads" technician** and can probably be reached through the State Water Quality Division.

12. Sally said that another topic that came up through landowner meetings, is that many people in town **dump yard waste into the river**. Some sort of general public outreach and education campaign might be helpful. Perhaps a municipal composting site would be helpful? Perhaps the Conservation Commission could help with this?

Follow-up questions from last meeting

1. Sally found out that Lincoln town **listers do not change the value of land because it has a conservation easement**, however Jackie indicated that neighboring land can increase in value if next to conserved land. Conserved land doesn't really change the value of the grand list. Deb Brighton might be able to help figure out cost-benefit analyses for questions about property values and conservation easements.
2. Sally is scheduled to meet with **Bill Masterson, a former road commissioner**, on Dec. 14 to discuss road work after the flood of 1998.
3. Ethan joined George Springston for a **second visit to the South Lincoln slide** on the Booska property. Survey stakes were put in and further measurements were taken. Ethan wondered about the possibility of **taking the top off the slide** to minimize sediment input to the river. George seemed to think that the idea was worth looking into.
4. Shayne added that this **might be a great solution without direct interference to the river channel**. River funding (possibly mid-winter category 3 grants) might be available to do a geo-technical engineering analysis for a **conceptual design** on this.
5. **Kristen said she would look into this further** for rough dollar costs and volume of sand/gravel for removal.
6. Ty brought some **information for Mark Benz**, a booklet published by FEMA about preserving historical sites. Sally will pass it on to Mark.
7. Mark Benz is applying for a **Pre-Disaster Mitigation Competitive (PDMC) grant for Burnham Hall**, and has asked this committee to support his request for funds. How can we help?
8. Kristen was concerned that armoring the bank behind Burnham Hall could have **implications both upstream and downstream**. A much bigger reach-wide scale project would be needed in order to support this.
9. Shayne echoed this, that the **whole village area must be considered** for creating a sediment transport reach, but only if sediment attenuation areas are located upstream and downstream of the area. The scale would need to be from grade control to grade control.
10. Both Kristen and Shayne agreed that this kind of work is **not a goal of the Clean and Clear program** funding for this river corridor project.
11. Ty asked what **can** we do to support Mark?
12. Shayne said that a **system-wide design** would be the only appropriate way to do this right.
13. Sally asked about the **East Middlebury/Granville models**, what happened there?

14. Shayne informed us that in those locations, **the local people forced the issue by dredging the channel in violation of State Statutes**. Political support put pressure on the Agency of Natural Resources, so instead of issuing a fine, a consultant was hired to design a channel. Local people contributed a lot of in-kind work to **a heavily engineered project**. Shayne thought it was unfortunate that the process happened this way, and that the potential consequences of failure in such a situation are really high.
15. Ty asked whether **the village area is already acting as a transport reach right now**? If a big engineered project is done, it won't be much different afterwards.
16. Kristen believes that the **village area is dynamic and river processes are occurring**. Another alternative might be **preserving the natural flood chute** to relieve pressure around Burnham Hall.
17. Ty thought that occasionally small spot-fixes are needed, and **if the town can do other things for the corridor on a broader perspective, we are more likely to succeed on small scale projects**.
18. Shayne thought that on some level we could support the Burnham Hall stabilization project, but only with **more details**. He would want to know about the affects on hydraulics and sheer stress, as well as a need to illustrate the potential for channel adjustment and build in grade control.
19. This seemed a bit like a chicken and egg situation, we need funding to do the studies to get more information, but can't support the project without more information. We agreed to **support the project with conditions** that it would include input from the State River Management Section and possibly Kristen.

Landowner Meeting Updates

1. Sally felt encouraged by the latest round of landowner meetings. Some **key landowners both upstream and downstream of the village said that they are interested in helping with the corridor plan**. Several are interested in learning more about conservation easements.
2. A **big futuristic discussion of village planning** ensued about the possibility of moving the fire station to give the Lincoln Sports field more space. If the Johnson property could gain access via a road through Lincoln Sports or from York Hill, a future crossing structure might be avoided downstream of the village.
3. Shayne indicated that even if a piece of **property is not in an FEH zone**, **funds might still be available for conservation support from DEC**.
4. Kristen handed out a **flow chart about the land conservation easement process** that may be a helpful tool for landowners. She envisions it as an appendix to the final river corridor management plan.
5. Jackie said that the Conservation Commission is looking for **grants to assist with outreach** efforts. We could possibly look to combine efforts after funding for this project ends in February. Sources being looked at are the VT Community Foundation, The Kelsey Foundation, Lake Champlain Basin Program, Colby Hill Fund, etc.
6. Shayne also suggested **municipal planning grants** available in the fall.

How to present the River Corridor Management Plan to the Town

1. Perhaps an **open forum**, inviting town feedback would be best, but time and funds are running out.
2. Certainly the **Selectboard, Conservation Commission, and Planning Commission** ought to receive copies of the final document.
3. Kristen **questioned whether dynamic equilibrium is achievable in Lincoln**? She wanted to be prepared if the concept is challenged by others. A technical discussion ensued with Ty and Shayne, and **more literature review** may help with answering this question.
4. Kristen will e-mail the **next draft of the plan by the first week of January**.

Next technical working group meeting will be on January 10 at 9:00 am at Sally's house.

Minutes prepared by Sally Ober

New Haven River Corridor Management Plan—Lincoln
10 January 2006, Meeting Minutes

Present: Shayne Jaquith, Ty Mack, Sally Ober, Ethan Swift, Kristen Underwood

Corrections to Minutes of 13 December 2005 Meeting

1. Page 1, Item #14 under FEH mapping: change the word "plan" to "proposal."
2. Page 2, Item #11 under Conservation Commission: Linda Bodette's name is spelled Boudette.
3. Page 3, Item #16 under follow-up questions: insert "preserving the natural" instead of sluiceway.

Follow-up from last meeting

A. Lincoln Planning Commission

1. Kristen indicated that at the 12 January 2006 Lincoln Planning Commission meeting (attended by Kristen, Sally, and Ty) the **Planning Commission** was discussing the possibility of a 50-foot from top-of-bank no-build zone, and using the FEH corridor for a conditional use area.
2. Ty will follow up with the Planning Commission on needed **mapping adjustments**. More work is needed on valley wall/road locations.
3. Sally asked about the **building restrictions associated with the FEMA flood plain areas.** It was clarified that designation of an area as *100 yr. floodplain* on a FEMA Flood Insurance Rate Map (FIRM) designation does not necessarily prevent new construction, although new structures may need to be elevated. Development is much more limited in *floodways*, where no development is allowed which would cause any increase in flood heights
4. Ty stated that the NFIP program relies on **local regulations and enforcement.** Communities must adopt certain minimum regulations to participate in NFIP (which allows residents to buy flood insurance). Communities are responsible for enforcing their floodplain regulations, and failure to do so can result in suspension from NFIP.
5. Kristen recommended that perhaps an **appendix to the FEH maps** should be made to distinguish between the scientifically drawn maps and the administrative adjustments made by the Town or Planning Commission. Any **changes made to the Data Management System should be documented**.
6. Shayne thought the maps ought to be presented to the public as documents that may experience an **on-going process of change** in the future.
7. Kristen asked how do we **incorporate the limitations of the FEH mapping process** in the Plan? (comments re: limitations were previously submitted by Kristen to the TWG in a memorandum dated 6 January 2006)
8. Shayne and Sally agreed that limitations **shouldn't be buried in a file** somewhere. There should be full public disclosure all along. This information should be in the report, perhaps in the form of an appendix.

9. Ty said that at some point, we go with the **best information we have, based on the limitations of time and money**. Someone could magnify these into a huge issue.
10. Ethan was optimistic that he **sees more overwhelming support for the FEH process**, and believes people will be less concerned about the limitations of the process.
11. Ty agreed that we should focus on the **intent of the FEH corridor.** Someone can always take the inherent uncertainty, to debate the use of science for establishing policy.

B. Mark Benz letter of support

1. Ethan inquired about the possibility of **restoring access to an alternative sluiceway through the reach in the Village of Lincoln (across the river and upstream from Burnham Hall).**
2. Kristen indicated that any project would need a **stream alteration permit**, and require more information to determine impacts to the channel both upstream and downstream.
3. Shayne asked **what channel adjustments are happening** behind Burnham Hall?
4. Kristen replied that **aggradation is occurring near Burnham Hall, and degradation upstream.**
5. Shayne pointed out that in the context of this corridor plan, we have conceded that **natural adjustment processes aren't available to this location**.
6. Ethan thought that perhaps **grade control or channel roughness considerations** should be accounted for.
7. Shayne indicated that these would depend on scale after a hydraulic assessment was done. The **most appropriate way to address fluvial erosion hazards to Burnham Hall, would be to apply for a grant to do a study/design for the whole reach**, then go for a grant to execute the project.
8. Ethan suggested looking into a **Category 2 grant for an alternatives analysis**.
9. Ty wondered about **FEMA PDM planning grants** being an appropriate funding source for a detailed, reach-wide study.
10. Kristen will ask Mark Benz if one FEMA grant is tied to the other.

C. Bill Masterson meeting

1. Sally met with Bill Masterson, former road commissioner after the 1998 flood. He indicated that the **current road crew could use some education** about improving drainage along roadways in Lincoln.
2. Ethan mentioned that there **might be a road surface drainage workshop coming up** in February.
3. Shayne asked about **funding for road crews to go to these**?
4. Sally will **inquire with the selectboard** about this.

D. South Lincoln Slide—Booska's

1. Kristen said that **John Lens, a geotechnical engineer**, might try to visit the Booska slide next week to **give us an estimate for an alternatives analysis**, including top removal of the slide. This would help us when we apply for a Category 3 river grant.

2. Sally will e-mail **George Springston to press him for his write-up about the South Lincoln slides** for our report.

Landowner Meetings

A. Lincoln Sports

1. Sally reported that the **Lincoln Sports** committee didn't understand why it would be important to put their river front property into conservation, if they **don't plan to do anything different with the property** anyway?
2. Some of the points made during this landowner meeting were that **the current board of directors is committed to keeping the ball field as open space, but different membership may not be**. Another point was that the Lincoln Sports Sledding Hill is a big liability for this organization. If someone got hurt and sued Lincoln Sports, they might be **forced to sell** the property and then there would be no guarantees about what future owners do. Another reason for pursuing a conservation easement now is that the **funding is potentially available now** to help with the process.
3. Lincoln Sports wanted to know how much of the process could be funded if a grant were awarded for conservation. Shayne indicated that **potentially the whole process, start to finish could be funded, and there would be no matching funds required**.
4. The **Vermont Rivers Conservancy and the Lake Champlain Committee Land Trust** were identified as possible partners in the conservation process for Lincoln.

B. Lincoln Volunteer Fire Company

1. Sally discussed the **possibility of relocating the Fire Station** as a way to alleviate pressure on the river and to make the Fire Station more reliably accessible in the case of another catastrophic flood event, especially if the bridge washes out.
2. Firefighters on the executive committee of the fire company agreed that the **relocation concept wouldn't be a bad idea for long-term future plans**, but didn't seem to think that it should be on a short-term list of things to do. They thought there were more important ways to spend taxpayers' money (fed. or state).
3. Firefighters were more interested in the idea of a **satellite station** for trucks on the opposite side of the river or out in South Lincoln.
4. Firefighters also asked if our working group would consider vehicle access or pull-offs along the river as we explore conservation easements in the river corridor. The more **opportunities for them to access the river for water** the better. Dry hydrants are even more ideal.
5. Ty thought it seemed timely to discuss the **fire station along with the new bridge design and reach-wide access to the natural alternative sluiceway**.
6. Although the **Fire Company and Lincoln Sports** were not immediately interested in our recommended alternatives, **our working group agreed to keep these ideas in the river corridor plan for long-term consideration**. Perhaps someday, an opportunity for change will arise and it would be valuable to have these ideas in the town's memory.

Draft Plan

1. Kristen said she moved geomorphic discussions and corridor delineations to the appendix to **make the plan simpler**.
2. Kristen will add **FEMA FIRM regulations** into the discussion of zoning language.
3. Ty thought there **might be incentives to decrease insurance costs** or change ratings based on zoning language.
4. Ethan has **updated floodplain regulations** that he can send to the working group.
5. Kristen passed around a handout **summarizing possible river corridor projects**.
6. Shayne suggested **separating feasibility from the priorities of the Technical Working Group**.
7. Sally said that some of the projects would be more feasible from the landowner perspective if there were a **local point person with energy and perseverance to keep the momentum going**, especially on conservation easements.
8. Ty suggested a **"River Steward" to serve this role for the Town**, perhaps an elected or appointed position to implement some of these actions.
9. Kristen mentioned some **active management possibilities**, such as protecting the Masterson property downstream of the South Lincoln mass failure sites and addressing the headcut near the Cooley Glen Bridge slide. Lincoln will apply for Phase 2 funds to better assess alternatives for these sites.

Getting the Word Out

1. Sally said that the **New Haven River will be featured on the cover and inside cover of Lincoln's Town Report**. The Town Report is a document published by the Town, containing information to prepare its citizens for the annual Town Meeting. Kristen and Sally will gather photos and prepare a two-page story about the river. Sally will also prepare a **one-page progress report** for our working group to be contained further in the Town Report document.
    2. The original title for the cover article was to be "The New Haven River: Friend or Foe?" The Tech. Working Group agreed that the **title needed a much more positive sound**, because of the extensive positive work that is being done in Lincoln in terms of our relationship with the river. Brainstorming came up with positive words and phrases such as: redefining our relationship, developing a better understanding, compatible relationship, dynamic resource, using the past to guide our future, life blood of the community. We will all try to work on a better title.
    3. Kristen and Sally are working toward a goal of **February 15** ***(hopefully now changing it to Feb. 17)*** **to complete the River Corridor Management Plan**, and officially end the grant.
    4. At Town Meeting, Sally will **provide copies of the executive summary** of our River Corridor Management Plan for people to review and invite them to an open forum in the end of March to present the plan and open it to

discussion. Perhaps we could coordinate with the Lincoln Conservation Commission's next meeting.

5. **This is the last meeting of the River Corridor Management Plan's Technical Working Group.** Thank you to all the members and guests who gave time and energy into this project!

Minutes prepared by Sally Ober.

APPENDIX B

Analysis of Existing Geomorphic Data to Identify Management Strategies

Analysis of Existing Geomorphic Data
to Identify Corridor Management Strategies

APPENDIX B
River Corridor Plan
New Haven River: Town of Lincoln

Addison County, Vermont

February 2006

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Analysis of Existing Geomorphic Data
to Identify Management Strategies

1.0 INTRODUCTION

In the Fall of 2003 and Summer of 2004 geomorphic assessments were completed on the New Haven River and portions of Beaver Meadow Brook (Figure 1) under a Federal Emergency Management Agency (FEMA) Project Impact Grant administered through the Addison County Regional Planning Commission (SMRC, 2004a; SMRC 2004b). The objectives of these studies were to assess the present geomorphic condition of the river network, to identify local and regional stressors impacting the channel and watershed, and to characterize the sensitivity of river reaches to future lateral and vertical adjustments. Assessments were also conducted to identify structures at risk from expected future channel migration.

The reader is referred to summary reports for these previous studies for details of the methodology and results (SMRC, 2004a, 2004b). Geomorphic condition and reach sensitivities revealed from these assessments are summarized in this Appendix B to the River Corridor Management Plan for Lincoln.

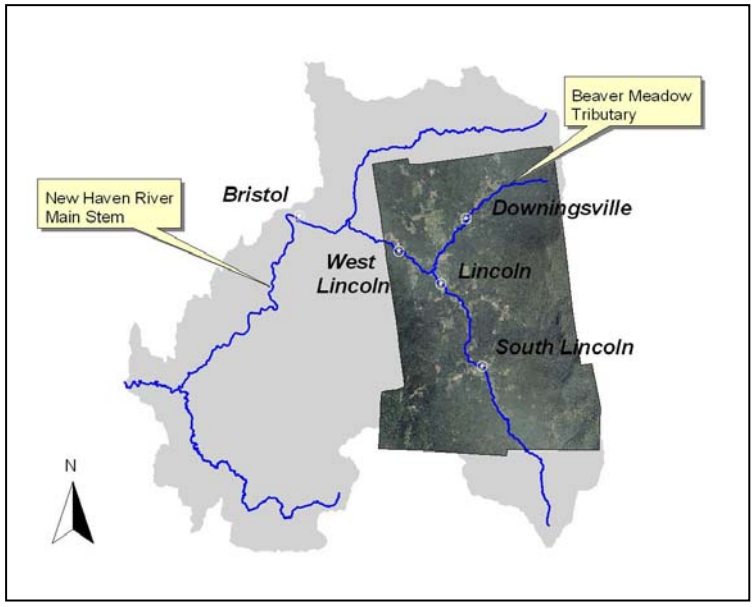


Figure 1. Location of New Haven River main stem and Beaver Meadow tributary in Lincoln portion of the New Haven River watershed.

The 2003 and 2004 Phase 1 and 2 Geomorphic Assessment data were analyzed during the corridor planning process to identify corridor management strategies that could support the river's return to a more balanced condition, thereby reducing erosion hazards and improving water quality over the long term. The analysis follows recent guidance from the VTDEC River Management Section (VTDEC, 2005c) and included:

- Classifying corridor reaches into general management categories based on their geomorphic condition. This step involves characterizing, qualitatively, the sediment transport characteristics of the corridor reaches, to identify the major sediment deposition and transport modifiers.

- Acknowledging natural constraints (bedrock) and human constraints (roads, buildings, bridges) along the river corridor that limit the river channels' ability to laterally and vertically adjust in response to changing water and sediment conditions;

- Identifying sediment sources which may be impacting the sediment transport capacities in the watershed.

- Locating areas of active lateral adjustment and wetland areas contiguous to the channel which may serve important sediment and nutrient attenuation functions in the watershed; and

This analysis has informed the specific management strategies and opportunities outlined for implementation in Sections 6 and 7 of the River Corridor Plan for Lincoln.

2.0 LOCATION OF CORRIDOR REACHES

Previous studies have assembled geomorphic data for eleven (11) reaches within the town of Lincoln: eight along the New Haven River main stem and three along the Beaver Meadow tributary. These eleven reaches constitute the extent of the corridor being considered at present in this corridor planning project. The location of these reaches and the geomorphic condition and sensitivity are described in the sections below, proceeding from upstream to downstream. For more details of the geomorphic assessment, refer to the *Phase 2 Stream Geomorphic Assessment report* (SMRC 2004b).

2.1 South Lincoln Village – Main Stem Reaches M26 to M25

Reaches M25 and M26 in South Lincoln occupy an isolated high-elevation valley between the upstream steeper slopes of the Green Mountains in Lincoln and Ripton and the downstream bedrock-controlled channel that flows from the vicinity of the Grimes Road bridge downstream along Mill Road. Residential and agricultural development has encroached on the floodplain somewhat along reaches M25 and M26.

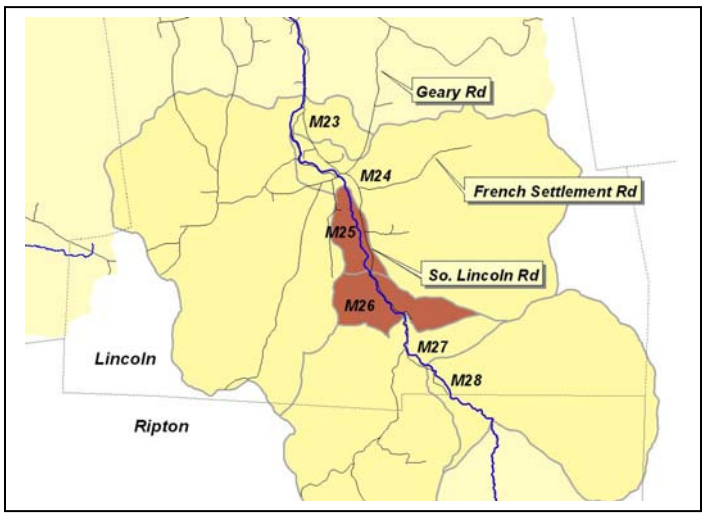


Figure 2. South Lincoln reaches assessed in Phase 2.

2.2 Lincoln Village and West Lincoln – Main Stem Reaches M22 to M17

Main stem reaches M22 through M17 pass through the villages of Lincoln and West Lincoln. These reaches represent the more moderately-sloped, broader-valley sections of river located between the highlands to the south and east and the Bristol-Lincoln Gap to the northwest. Given their topographic setting, these reaches historically have been associated with greater degrees of floodplain development and encroachment by roads.

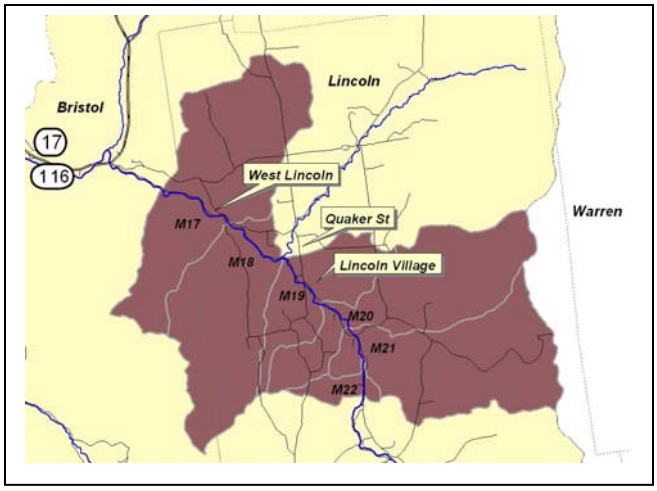


Figure 3. Lincoln reaches assessed in Phase 2.

The Lincoln reaches are largely bedrock-controlled with alluvial deposits dominating the immediate vicinity of the Lincoln and West Lincoln villages. Channel-spanning bedrock offers vertical grade control in reaches M21, M20, and M18, while bedrock is essentially absent in the intermediate reaches of M19 (Lincoln village) and M17 (West Lincoln village). Alluvial reach M22, positioned between the upstream bedrock gorge (reach M23) and the downstream bedrock control near Garlands bridge, also has a moderate degree of residential development. Not unexpectedly these alluvial reaches have experienced a greater history of floodplain encroachment, channelization, armoring, berming, and gravel extraction.

2.3 Downingsville – Beaver Meadow Reaches T4.02 to T4.04

The Beaver Meadow Creek drains approximately 10.6 square miles (or 9%) of the New Haven River watershed, and joins the main stem at the upstream end of reach M18 between Lincoln and West Lincoln villages. Phase 2 assessments along the Beaver Meadow targeted three contiguous reaches in the mid-portion of the profile in the village of Downingsville (see Figure 4). Currently these are the reaches of highest concentrations of floodplain development and corridor encroachment in the Beaver Meadow subwatershed.

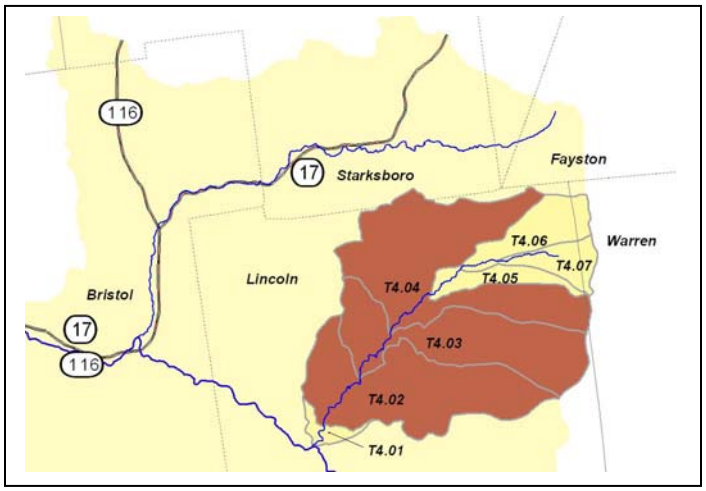


Figure 4. Downingsville reaches assessed in Phase 2.

3.0 SUMMARY OF GEOMORPHIC CONDITION – CORRIDOR REACHES

3.1 Geomorphic Assessment Results

Table 1 summarizes the results of geomorphic assessment data collected in 2004 for the reaches comprising the delineated river corridor in Lincoln, Vermont (SMRC, 2004b).

Table 1. Geomorphic Assessment Results for Corridor Reaches, New Haven main stem and Beaver Meadow tributary, Lincoln, Vermont.

South Lincoln – New Haven Main Stem

Reach	Channel Length (ft)	Channel Slope (%)	Drainage Area (sq. mi.)	Stream Type	RHA Condition	RGA Condition	Adjustment	Sensitivity
M26	3666	2.59	10.4	C3b-S/P	0.72 Good	0.51 Fair	Degradation / Widening	High
M25	5458	1.80	10.7	C3-R/P	0.76 Good	0.53 Fair	Widening / Aggradation	High

Lincoln and West Lincoln – New Haven Main Stem

Reach	Channel Length (ft)	Channel Slope (%)	Drainage Area (sq. mi.)	Stream Type	RHA Condition	RGA Condition	Adjustment	Sensitivity
M22	2687	0.97	21.8	F4-PB	0.69 Good	0.44 Fair	Widening	Extreme
M21	2702	1.00	25.3	C3-R/P w/ subreach of B4-S/P	0.68 Good	0.30 Poor	Widening / Planform Adjustment	High
M20	3083	1.14	28.5	B1-S/P w/ local B4c-R/P	0.74 Good	0.78 Good	None	Moderate (to reflect the alluvial subreaches)
M19	4981	0.82	30.2	F3-R/P	0.62 Fair	0.44 Fair	Widening	Extreme
M18	5332	1.03	43.8	F3-R/P	0.51 Fair	0.38 Fair	Widening, Aggradation	Extreme
M17	6452	1.38	48.2	F3-R/P	0.69 Good	0.24 Poor	Widening, Aggradation	Extreme

Downingsville – Beaver Meadow Tributary

Reach	Channel Length (ft)	Channel Slope (%)	Drainage Area (sq. mi.)	Stream Type	RHA Condition	RGA Condition	Adjustment	Sensitivity
T4.04	4858	2.08	5.2	B4-R/P	0.80 Good	0.69 Good	Widening / Aggradation	Moderate
T4.03-B	3704	1.3	5.2 to 7.6	C3-R/P	0.71 Good	0.63 Fair	Aggradation / Planform Adjustment	High
T4.03-A	1275	4.7	7.6	B1a-CS	NM	NM	None	Very Low
T4.02	5539	3.79	10.4	B3-SP w/ local B1-CS, B2-SP	0.81 Good	0.80 Good	Minor aggradation, widening	Moderate (to reflect the B3 subreaches)

Abbreviations:
CS = Cascade; S/P = Step/Pool; R/P = Riffle/Pool; PB = Plane Bed;
RGA = Rapid Geomorphic Assessment; RHA = Rapid Habitat Assessment.

3.2 Channel and Watershed Disturbances

Various watershed-scale and channel-level disturbances have served as stressors to the New Haven River main stem and Beaver Meadow tributary reaches (Table 2). These stressors have been identified through direct observation, limited historical research, anecdotal accounts from landowners and local citizens, as well as remote sensing. This is not a comprehensive list, but it begins to characterize the degree of natural and human disturbance to the watershed, that has caused variable and overlapping adjustment responses in the channel.

Table 2. Summary of Channel and Watershed Disturbances to Corridor Reaches

	M26	M25	M22	M21	M20	M19	M18	M17	T4.04	T4.03 B	T4.03 A	T4.02
Stressors	New Haven Main Stem								Beaver Meadow Tributary			
Watershed												
Deforestation in 1800s	√ (H)	→										→
Road Networks (1700s, 1800s)	√ (H)	√ (H)										
Flood events (1927, 1938, 1973, 1998, 2000)		√ (H)	→									→
Channel - Reach Scale												
Channelization / Straightening	√ (H)		√ (H)	√ (H)	√ (H)	√ (H)	√ (H)	√ (H)	√ (H)	√ (H)		
Dredging						√ (H)						
Berming	√					√		√	√	√		
Bank Armoring	√	√	√	√	√	√	√	√	√	√	√	√
Floodplain Encroachment	√	√	√		√	√	√	√	√	√		
Loss of Forested Buffers	√	√	√	√	√	√	√	√	√	√		
Impoundment (dam)					√ (H)							
Channel - Site Scale												
Gravel extraction			√ (H)	√ (H)								
Undersized Crossing Structure	√	√							√			
Ford	√	√				√		√				
Cattle in Stream												
Tile drains/ ditches to reach												

Notes: √ = existing stressor; √ (H) = historic stressor; √ (m) = minor condition

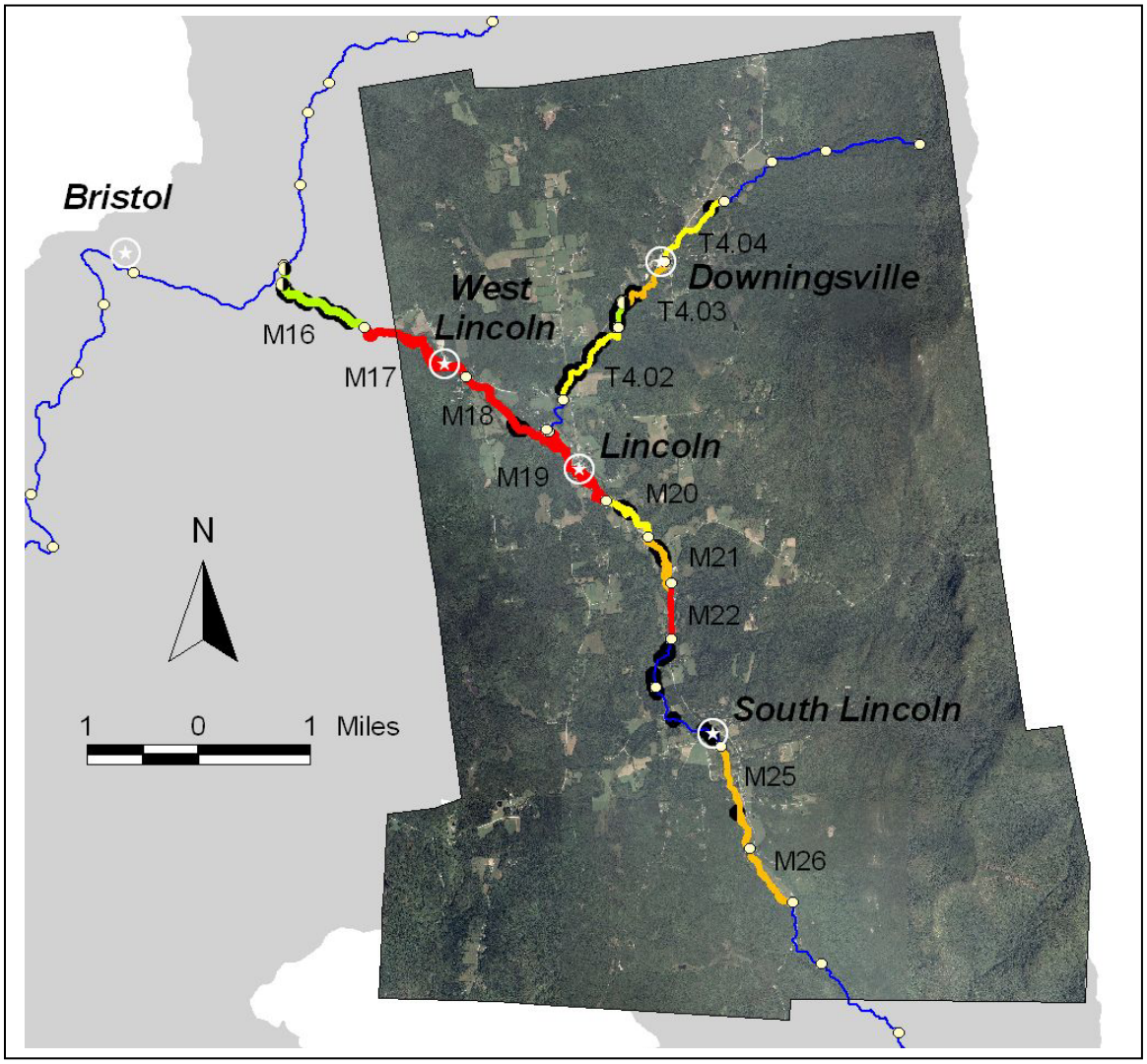
3.3 Summary of Geomorphic Sensitivity

The New Haven River and its tributary channels are responding to the above stressors through adjustment of their dimension, planform, and profile. Adjustments have occurred to varying degrees, as dependent on multiple factors (including channel sediment types, vegetative cover type and density, presence of grade controls, etc.). The relative magnitude of these channel adjustment processes, together with the topographic, geologic, and vegetative setting define the sensitivity of each reach /segment to continuing and future stresses.

Generally speaking, those channels with steeper gradients in confined valleys carrying coarser sediment loads (boulders, cobbles) and showing good vertical grade controls (e.g., channel-spanning bedrock) are considered to be most stable and least sensitive to vertical and lateral adjustments that may present conflicts with human investments in the corridor. In contrast, the more sensitive reaches (High, Very High, or Extreme), susceptible to future adjustments in response to current and future channel and watershed stressors, include the low- to moderate-gradient (less than 2% slope) channels dominated by gravels, without grade controls.

Sensitivities of the study area reaches/segments as defined in VTANR protocols (2005) are presented in Figure 5. For the most part, this Phase 2 purposely targeted lower-gradient, (reference C-stream-type) reaches through village areas that would be expected to exhibit higher sensitivity, and which have current constraints within the river corridor (SMRC, 2004a, 2004b). Therefore, it is not unexpected that study area reaches were defined as having sensitivities at the high end of the scale (except for M20, T4.02, T4.03-A, and T4.04 which are afforded greater stability by the underlying bedrock and have Moderate to Very Low sensitivities).

Note that the sensitivities assigned for two of the reaches during the Phase 2 assessment (SMRC, 2004b) were updated during this corridor planning process as presented here in Table 1 and Figure 5, (see Appendix C, Attachment 1 for a discussion). The sensitivity for reaches T4.02 and M20 were conservatively changed from Low to Moderate, to capture the brief subsections of these reaches with higher sensitivity than the bedrock-controlled portions of these reaches.



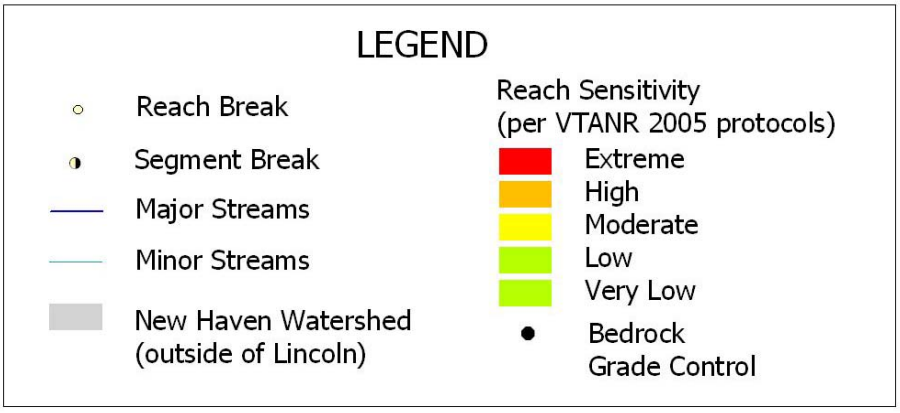


Figure 5. Sensitivity of New Haven River and Beaver Meadow tributary reaches.

4.0 CORRIDOR CONSTRAINTS

Natural boundary conditions (i.e., bedrock) as well as human boundary conditions exist within the Lincoln corridor and constrain the river's ability to laterally and vertically adjust in response to changing water and sediment conditions.

4.1 Bedrock

Because the Lincoln portion of the New Haven River watershed drains the Green Mountain province and is underlain extensively by bedrock, the river channel is constrained in many locations from vertical and lateral adjustments of channel width and depth, planform (sinuosity), and slope. Channel-spanning exposures of bedrock are present in seven of the 11 corridor reaches:

M25	T4.04
M21	T4.03
M20	T4.02
M18	

In reaches T4.02 and T4.03 (Segment A), the majority of the channel is formed directly on bedrock. The remaining reaches show relatively isolated exposures of bedrock separated by sections of alluvial channel.

Bedrock also constrains portions of the side walls of several of the corridor reaches, limiting the lateral adjustment potential of the channel:

M26 (left)	T4.04 (Left, Right)
M25 (Left)	T4.03 (Left, Right)
M21 (Left)	T4.02 (Left, Right)
M20 (Left, Right)	
M19 (Left)	
M18 (Left, Right)	
M17 (Left, Right)	

4.2 Infrastructure

Several reaches of the New Haven main stem and Beaver Meadow tributary share a narrow river valley with roadways (Table 3). Roads are located within the river corridor along over 50% of the river's length in the eleven reaches considered in this planning process. The corridor delineation is explained in further detail in Appendix C.

Road base material is often coarse and compacted and the armoring along the river side of the road would tend to resist erosion from river flows. However, the 1998, 1973, 1938 and 1927 floods have washed away substantial sections of the West River Road, East River Road and the South Lincoln Road along the right bank of reaches M17, M18, M19, M21, M22, and M26.

Table 3. Infrastructure located within the corridor along the New Haven River main stem and Beaver Meadow tributary.

Reach	No. of Buildings in Corridor	No. of Bridges/ Culverts in Corridor	Percent Roads in Corridor	Length Roads in Corridor (ft)	Reach Length (ft)
M26	2	2	95%	3,500	3,666
M25	2	1	0%	0	5,458
M22	4	1	68%	1,817	2,687
M21	0	1	71%	1,912	2,702
M20	3	1	68%	2,083	3,083
M19	21	1	82%	4,081	4,981
M18	3	0	100%	5,332	5,332
M17	4	1	85%	5,452	6,452
T4.04	0	1	16%	800	4,858
T4.03	3	0	13%	650	4,979
T4.02	1	1	5%	250	5,539
Totals:	43	10	52%	25,877	49,737
			(Miles:)	4.9	9.4

Nine bridges and one culvert crossing were identified within the 11 reaches considered under this corridor planning process (Table 3). Phase 2 assessments determined that the in-stream culvert and three of the bridges are bankfull constrictors, meaning that they have a narrower span than the width of the bankfull channel measured at the closest upstream or downstream crossing (SMRC, 2004b). Flow velocities are reduced on the upstream end of these crossings resulting in localized reductions in sediment transport capacity.

Portions of the town of Lincoln's village centers are located within the riparian corridor as presently mapped (Table 4.) Review of the 1995 orthophotos indicates approximately 43 buildings within the 11 corridor reaches (Table 3).

Table 4. Reach identifications for Lincoln's village centers

Village center	**Reach**
Lincoln village	M19 (New Haven main stem)
West Lincoln village	M17 (New Haven main stem)
Downingsville	T4.04, T4.03 (Beaver Meadow tributary)
South Lincoln	M25 (New Haven main stem)

5.0 River Corridor Management Strategies

Preliminary identification of corridor management strategies was conducted by the TWG following guidance contained in two recent documents published by the VTDEC River Corridor Management Section:

- *Alternatives for River Corridor Management* (VTDEC, 2003)
- *Using geomorphic assessment data to guide the development of River Corridor Management Plans to achieve: Fluvial Erosion Hazard (FEH) Mitigation, Sediment and Nutrient Load Reduction, and Ecological-based River Corridor Conservation* (VTDEC, draft Oct 2005c)

Landowners, Lincoln community members, and resource agencies, including the Addison County Regional Planning Commission, the Natural Resources Conservation Service, US Fish & Wildlife, and Vermont Agency of Natural Resources, can use geomorphic data to inform future management strategies within the river corridor. For a given reach or segment, the active adjustment processes, degree of departure from reference, and sensitivity ranking will define the short-term compatibility and long-term sustainability of various restoration or conservation options and future land use or channel management activities. VTDEC River Management Section has developed guidelines for classifying reaches / segments into potential management approaches based on geomorphic characteristics (VTDEC, 2005c):

- Equilibrium – Stable Reference (Conservation Reach)
- Equilibrium – Minor Adjustment (Eroding Banks, High Recovery Reach)
- Unstable – Moderate Departure (Moderately Unstable Reach)
- Unstable – Downcutting (Incising Reach)
- Unstable – Severe Departure (Highly Unstable Reach)

The Lincoln corridor reaches have been classified into the above management categories in the sections below.

Sediment Transport Characteristics

Geomorphic assessment results from 2004 were reviewed during this river corridor planning project to identify how the channel and watershed disturbances catalogued in this Upper Watershed may have modified (either increased or decreased) sediment transport capacities of the river channel within the known geologic and infrastructure constraints and vegetative boundary conditions.

Channel and watershed disturbances that exceed thresholds for change can upset the dynamic equilibrium of stream systems. Imbalance in the channel affects the sediment transport capacity of the stream system, and has significant consequences for erosion hazards, water quality and riparian habitats. Equilibrium can be disturbed locally and result in channel adjustments that are limited in magnitude and extent (for example, scour at an undersized culvert crossing). Alternately, the disturbance (or an overlapping combination of disturbances) can be of sufficient size, duration, or frequency to cause substantial channel adjustments that result in a system-wide imbalance extending far upstream and downstream through the river network.

Such imbalances, whether localized or systemic, interfere with the river's ability to efficiently convey its water and sediment loads. These interruptions are either expressed as a sediment transport deficiency where sediment accumulates in the channel (which itself may lead to further imbalances - e.g., flow widens and splits to erode streambanks on either side, or flow may

avulse or jump its banks in a flood event). Alternately, the imbalance can be expressed as an increased sediment transport capacity. For example, a channel that has been straightened, dredged, armored and bermed has a local increase in channel slope, which creates higher flow velocities, and an increased power to erode the streambed. The channel bed is scoured and this condition often leads to further channel adjustments including streambank collapse and widening.

Sediment transport capacity of the channel can be inferred from the geomorphic features observed during field work and from the stressors catalogued in Table 2. Even a qualitative understanding of these processes can help to identify and prioritize appropriate management strategies for the river that will facilitate a return toward a more balanced (dynamic equilibrium) condition.

Active vs. Passive Management Strategies

Active geomorphic approaches are typically appropriate for unstable reaches exhibiting active bed degradation and/or a severe departure from reference condition. Certain moderately unstable reaches can also be candidates for active geomorphic solutions, particularly where infrastructure may be at risk or where such active approaches are strategic in the protection of upstream stable or reference reaches. Active approaches are also relevant when there is a desire among stakeholders to accelerate the river's return to a more balanced condition. Cost of active approaches and their risk of failure are typically much higher than other alternatives.

A passive geomorphic approach involves long-term management and preservation of the belt-width derived river corridor (see Appendix C). Under this approach, the river channel is allowed to freely meander within the area defined as the belt-width-derived river corridor. For a reach that is already close to reference condition or exhibiting only minor adjustments, preserving a river corridor will ensure the river's ability to continue to meander through the valley unconstrained by human infrastructure. In turn, human investments in the landscape will be protected from future channel adjustments. For a reach that has seen significant channel management in the past, and has lost some measure of its sinuosity and balanced planform and profile, the channel is allowed to adjust unimpeded to a more sinuous, meandering planform closer to regime conditions. During ongoing adjustments, the river will re-establish greater floodplain access (where access has been lost) and adjust channel dimensions for optimum conveyance of its water and sediment loads.

Generally speaking, the river can achieve a sustainable and balanced planform, profile and channel geometry more successfully and much more cheaply than humans engaged in a series of active channel restoration projects. Floodplain access for the river can be maintained and enhanced by protecting the corridors from development and floodplain filling, and refraining from channel management activities that tend to cause the channel to become disconnected with its floodplain (e.g., channelization, dredging, berming).

Generally, passive approaches to channel and floodplain restoration and conservation are most appropriate for reaches / segments in the following stream condition categories:

- Equilibrium – Stable Reference - where conservation of the corridor can serve to protect stream equilibrium conditions and ecological processes within the riparian corridor.
- Equilibrium – Eroding Banks – High Recovery Reach where restoring channel boundary conditions (vegetation, to increase roughness elements
- Unstable – Moderate Departure.

Preservation of sediment attenuation areas along the river network is an important element in the passive geomorphic approach. The Lincoln portion of the watershed is largely bedrock-controlled, and channels tend to be steep and confined closely by the valley walls.

Given these topographic characteristics of the river and tributaries, there are fewer opportunities for sediment attenuation, as compared to the broader valley settings downstream in Bristol and New Haven. However, there are a few shallower-gradient sections of the New Haven main stem channel with good floodplain access identified for the potential role they could serve in sediment and flow attenuation. Also, wetlands contiguous to channel in tributary reaches of the headwaters were identified with a potential sediment and nutrient attenuation function. With the willingness of landowners, these sites may be good candidates for conservation, particularly where existing land uses do not appear to be in conflict with channel adjustment processes.

Within the belt-width defined corridor approach to passive geomorphic restoration, **enhancement of forested riparian buffer areas** along the channel margins should also be pursued. Buffer vegetation protects water quality by filtering sediments, nutrients, bacteria and toxins from overland runoff. Vegetation also increases the ability of soils to absorb water. Sediments are deposited at the land surface. Various biological and chemical processes remove dissolved pollutants from storm waters as they seep through the soil and before they discharge to the nearby stream channel. Undeveloped buffer areas allow for more distance between septic systems and the river, decreasing the chance that untreated bacteria, viruses and pathogens from septic waste will enter the river and its tributaries. Setbacks achieve this separation distance also, but undisturbed vegetated buffers promote the natural systems that are most effective at pollutant removal.

Forested buffers offer roughness elements to the channel margins and near bank areas, helping to dissipate the erosive energies of flood waters and contributing to greater flow and sediment attenuation in the floodplain. Naturally vegetated buffers in floodplains provide holding areas where the energy of flood waters can dissipate. Floodwaters can be taken up by buffer vegetation or slowly percolate down through buffer area soils to recharge our groundwater supplies. Pressures of floodwaters on downstream properties can be reduced by preservation of upstream floodplain buffers. Setbacks of structures from the river will help to prevent damage and loss from flooding and ice. However, the functions of flood protection and stormwater management are more effectively achieved with vegetated, undisturbed and undeveloped buffers. Buffers will help to restore and maintain dynamic equilibrium of the channel by increasing resistance to shear stresses along the channel boundaries.

Tree buffers will provide the additional benefits of organic matter, detritus, and large woody debris to aquatic and riparian habitats. Connectivity of buffer areas from reach to reach along a river network also provides for wildlife corridors.

Figure 6. High bank with no tree buffer along reach M18, visible from River Rd.

Tree buffers have deeper root systems than grasses and are better at stabilizing streambanks.

5.1 Equilibrium – Stable / Reference

Tributary	Reach	Segment	Stream Type	RGA Condition	Sensitivity
Beaver Meadow	T4.03	A	B1a-CS	0.80 Good	Very Low

This section of the Beaver Meadow tributary flows through a steep, narrow valley over bedrock. It is exhibiting negligible signs of adjustment and has a very low sensitivity to future channel and watershed stressors. This segment is functioning primarily as a natural transport reach, with very little opportunity for sediment or nutrient attenuation. Management approaches appropriate for reaches like this involve maintaining the geomorphic equilibrium and ecological functions of the riparian corridor through proactive planning strategies. With landowner willingness, parcels along reach T4.03-A may be good candidates for conservation. At the municipal level, consideration of setbacks, buffers and/or overlay districts can serve to protect the intact and functioning natural systems along the channel margins and riparian corridor.

5.2 Equilibrium – Minor Adjustment

Tributary	Reach	Segment	Stream Type	RGA Condition	Sensitivity
Beaver Meadow	T4.04		B4-R/P	0.69 Good	Moderate
Beaver Meadow	T4.02		B3-S/P	0.80 Good	Moderate
New Haven M.S.	M20		B1-S/P	0.78 Good	Moderate

These reaches are undergoing relatively minor widening and aggradation, with some limited planform adjustment. Channel stressors are minor in extent and degree in these Equilibrium-Minor Adjustment reaches. The reaches have exposures of channel-spanning bedrock which offer stability to the channel. While the main stem reach M20 has pockets of minimal or absent buffer along the left bank (River Road side), the Beaver Meadow reaches have well-developed forested riparian buffers which increase the channel's resistance to erosion. Floodplain areas along the Beaver Meadow reaches T4.04 and T4.02 are limited, and therefore opportunities for attenuation of sediment and nutrients are low. At the upstream extent of main stem reach M20, however, there is an opportunity for sediment attenuation near the reach break with M21 upstream of the Lincoln Community School.

Generally speaking these are High Recovery Reaches. Channel and corridor management strategies appropriate to these Equilibrium-Minor Adjustment reaches may include:

- Conservation to maintain ecological functioning of riparian corridor areas (T4.04, T4.02);
- Conservation to maintain floodplain access, and flow and sediment attenuation functions of floodplains and contiguous wetlands (upstream extent of M20);
- Private and municipal planning strategies to prevent placement of infrastructure within the corridor;
- Enhancement and maintenance of forested buffers to improve streambank and corridor erosion resistance, provide for sediment and nutrient buffering and filtration;
- Proper road maintenance to prevent stormwaters and road sediment from washing directly to the stream channel (T4.04 downstream end; T4.02; M20);
- Replacement of undersized crossing structures (Hall Road culvert crossing in T4.04);

Investing strategically in recovery of the Beaver Meadow reaches will prevent localized instabilities from migrating upstream or downstream to generate more network-wide imbalances,

Addressing recovery of the main stem reach M20 through buffer enhancements, avoidance of future encroachments, and conservation of sediment attenuation areas at the upstream extent of the reach, will relieve some of the compounded stresses on downstream reach M19 through the Lincoln village.

5.3 Unstable (Dis-equilibrium) – Moderate Departure

Tributary	Reach	Segment	Stream Type	RGA Condition	Sensitivity
Beaver Meadow	T4.03	B	C3-R/P	0.63 Fair	High
New Haven M.S.	M25		C3-R/P	0.53 Fair	High
New Haven M.S.	M21		C3-R/P	0.30 Poor	High

Unstable-Moderate Departure reaches exhibit a moderate degree of channel adjustment in response to current and past channel management and watershed-level stressors. Channel and corridor management strategies appropriate to Unstable-Moderate Departure reaches generally include passive geomorphic measures to restore channel dimensions and boundary resistance (VTDEC, 2005c). Active geomorphic measures at limited sites can be appropriate, particularly where infrastructure may be at risk or where such active approaches are strategic in the protection of upstream stable or reference reaches.

Reach T4.03 - B

Historic development in the Downingsville area along the upstream segment B of reach T4.03 has been associated with intensive channel management activities including channelization, dredging, armoring and berming (SMRC, 2004b). This channel management and associated floodplain encroachment have resulted in a loss of floodplain connection along the upstream end of this segment, and have contributed to the accelerated lateral adjustments and sediment deposition downstream of Downingsville.

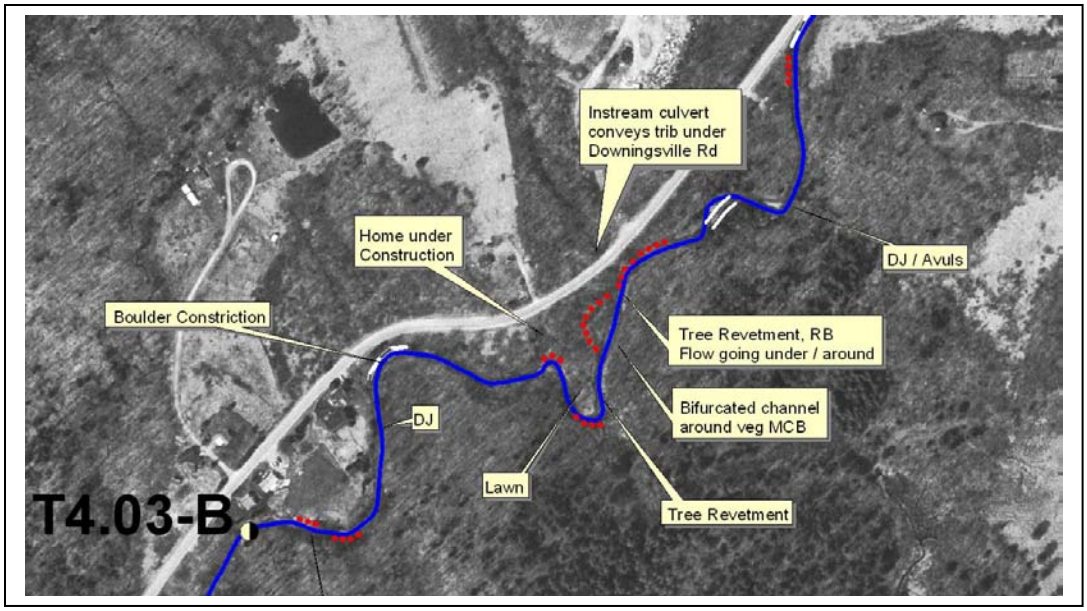


Figure 7. Observations recorded during geomorphic assessments in 2004, Segment B of Reach T4.03 downstream of Downingsville.

It is generally conceded that active channel management will continue in the upstream end of the segment to protect existing investments in the corridor at the Downingsville settlement. However, the consequences of ongoing channel management to downstream reaches can be offset by focusing on the following approaches in the downstream portion of T4.03-B:

- Conservation or other planning strategies to maintain floodplain access, permit lateral adjustments of the channel to return to a more balanced planform, profile, and channel dimensions, which will enhance flow and sediment attenuation functions in the reach and contiguous wetlands;
- Private and municipal planning strategies to prevent placement of infrastructure within the corridor;
- Enhancement and maintenance of forested buffers to improve streambank and corridor erosion resistance, reduce width/depth ratios, and provide for sediment and nutrient buffering and filtration;
- Proper road maintenance to prevent stormwaters and road sediment from washing directly to the stream channel (T4.04 downstream end; T4.02; M20).

Reach M25

Along the New Haven River main stem in South Lincoln, development has been more sparse than in the village centers of Downingsville, Lincoln and West Lincoln. However, there are some buildings located within the corridor of this reach, and the occasional private crossing to access properties on the west side of the river. Buffer conditions are excellent along the left bank, but minimal in width along the right bank. Localized channel widening and planform adjustments are occurring where tree buffers are absent along the right bank. Past channelization is inferred from the linear planform and close proximity of agricultural fields. The channel does not exhibit the full expression of sinuosity that would be expected in this valley setting.

Upland development along Cow Brook up French Settlement Road appears to have resulted in increased sediment loading to this brook which enters the New Haven near the downstream end of reach M25. A large mass failure is present along the west bank of reach M25 in the downstream third of the reach. Sediments are also being transported into the reach from instabilities in upstream reaches. These sediment sources appear to have resulted in localized reductions in sediment transport capacity within reach M25.

At the downstream end of reach M25 and into reach M24, the valley setting and proximity of wetlands appear to indicate a possible sediment attenuation area upstream of the bedrock gorge at the Grimes Road crossing. This area would be strategically located downstream of sediment inputs from the Cow Brook and the large mass failure.

Channel and corridor management strategies appropriate to reach M25 include:

- Address sediment source posed by the large mass failure: conduct alternatives analysis to determine cost/benefit and technical feasibility of stabilizing this landslide to reduce sediment inputs to the New Haven River.
- Complete Phase 1 & 2 geomorphic assessments along the Cow Brook to understand the current geomorphic condition and sensitivity and identify restoration / conservation / planning strategies that will reduce sediment loading from this tributary to the New Haven River.
- Private and municipal planning strategies to prevent placement of infrastructure within the corridor;
- Conservation or other planning strategies to maintain floodplain access, permit lateral adjustments of the channel to return to a more balanced planform, profile, and channel dimensions, which will enhance flow and sediment attenuation functions in the reach;
- Enhancement and maintenance of forested buffers to improve streambank and corridor erosion resistance, reduce width/depth ratios, and provide for sediment and nutrient buffering and filtration (especially along eastern bank);
- Proper road maintenance along French Settlement Road and side roads to prevent stormwaters and road sediment from washing directly to the Cow Brook (which joins reach M25 at the downstream end).

Reach M21

Reach M21 extends from the Cota Brook confluence to just downstream of the Garland Bridge. While the south Lincoln Road occupies the right bank of this reach through the mid-section, there is a wider floodplain available to the channel at the upstream and downstream extents of the reach. Overwidening and planform adjustments are evident in these two areas. As previously mentioned, the downstream extent of reach M21 and the upstream extent of M20 represent a possible attenuation area for sediment and nutrients.

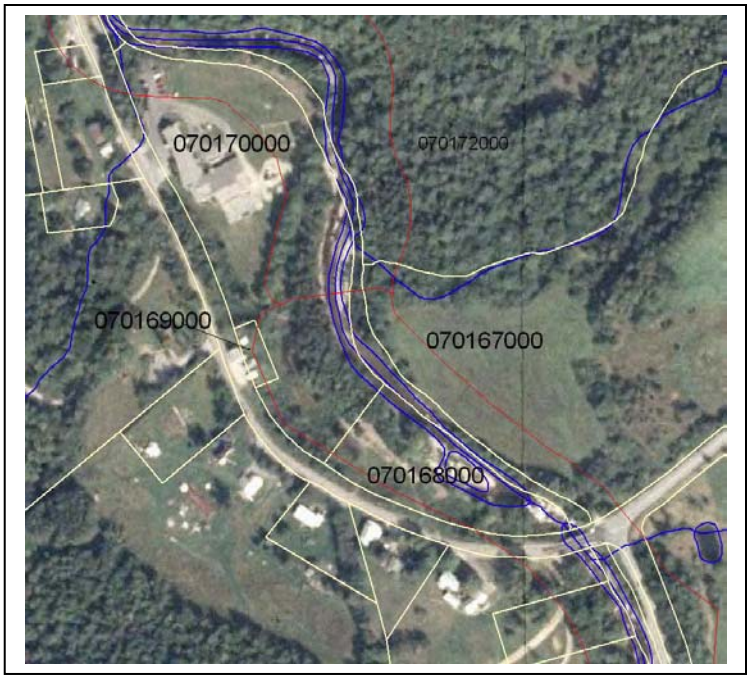


Figure 8. Possible sediment attenuation area downstream of Garlands Bridge Reaches M21 / M20.

Channel and corridor management strategies appropriate to reach M21 include:

- Conservation to maintain floodplain access, and flow and sediment attenuation functions of floodplains and contiguous wetlands (downstream extent of M20);
- Private and municipal planning strategies to prevent placement of infrastructure within the corridor;
- Conservation or other planning strategies to maintain floodplain access, permit lateral adjustments of the channel to return to a more balanced planform, profile, and channel dimensions, which will enhance flow and sediment attenuation functions in the reach;
- Enhancement and maintenance of forested buffers to improve streambank and corridor erosion resistance, reduce width/depth ratios, and provide for sediment and nutrient buffering and filtration (especially along eastern bank);
- Proper road maintenance along South Lincoln Road to prevent stormwaters and road sediment from washing directly to the New Haven River.

5.4 Unstable (Dis-equilibrium) – Downcutting (Incising Reach)

Tributary	Reach	Segment	Stream Type	RGA Condition	Sensitivity
New Haven M.S.	M26		C3b-S/P	0.51 Fair	High

Overall, reach M26 in South Lincoln had adequate floodplain access and the reach was therefore not classified as showing a stream type departure during the 2004 Phase 2 Stream Geomorphic Assessment. However, steep riffles and steps were observed in the upstream extent of the reach, and scour along both banks with leaning trees, suggesting active incision accompanied by widening. In October 2005, an apparent series of headcuts was observed in the next upstream reach, M27, at the mass failure site just downstream of the South Lincoln Road bridge near the

US Forest Service access road to the Cooley Glen Area. Reach M27 has not been assessed by Phase 2 Stream Geomorphic Assessment protocols; nor have reaches upstream of this on the main stem or the Blue Bank Brook tributary that joins the main stem at the site of the mass failure. Additional assessments in these upstream watershed areas would be required to understand the channel adjustment processes, sediment transport characteristics and possible sources of watershed and channel disturbances in this part of the river network.

Depending on the results of assessments, active geomorphic approaches may be warranted in reach M27 or M26, including installation of grade control structures to arrest channel incision, lowering of stream bank elevations in discrete sections to reconnect the channel with a floodplain, stabilization of streambanks with hard (armoring) or soft treatments (tree revetments for current deflection), and re-establishment of woody buffers where they are absent.

Long-term sustainability of restoration designs will be improved by certain land use changes within the corridor and upstream and downstream of the site. Such measures should include:

- improved road maintenance practices to reduce sediment and stormwater runoff to the channel along reaches M27 and M26;
- possible replacement of undersized crossing structures;
- enhancement of sediment and flow attenuation upstream of the reaches.

5.5 Unstable (Dis-equilibrium) – Severe Departure

Tributary	Reach Segment	Stream Type	RGA Condition	Sensitivity
New Haven M.S.	M22	F4-PB	0.44 Fair	Extreme
New Haven M.S.	M19	F3-R/P	0.44 Fair	Extreme
New Haven M.S.	M18	F3-R/P	0.38 Fair	Extreme
New Haven M.S.	M17	F3-R/P	0.24 Poor	Extreme

Not surprisingly, reaches which have seen the most intensive channel management over the years are exhibiting severe departure from reference. Most have reduced access to their floodplains due to historic incision and active berming, armoring, and floodplain encroachment along the channel margins. Development has occurred within the corridor and alongside the channel banks, and today represents an intractable conflict with an actively adjusting channel.

- Reach M22 which extends from the gorges along Ripton Road to the vicinity of the Cota Brook confluence, has historically been channelized, dredged, armored and bermed. Generally, this historic management has occurred following flood events to protect the South Lincoln Road which runs along its entire length and select buildings along the corridor.

- Reach M19 extends through the heart of Lincoln village.

- Reach M18 is constrained between steep valley wall along the left bank and River Road along the right bank.

- Reach M17 extends through the heart of West Lincoln village, but also includes some possible sediment attenuation areas at the downstream extent below the village.

These reaches are in a state of dis-equilibrium related to overlapping channel adjustments in response to historic and ongoing channel management and corridor encroachments. Generally, the channel management has resulted in sediment transport increases through these reaches. However, locally sediment transport capacity is reduced as evident from building sediment bars. The ability of this reach to adjust its slope, planform, and dimensions in response to these excess sediments is hampered by a combination of natural topography and human infrastructure.

Figure 9. Example of local reduction in sediment transport capacity, Reach M18 along River Road just upstream of the Forge Hill Road intersection. Flow in New Haven River is from lower right on the image to upper right.

It is generally conceded that active management of the channel will continue in these reaches to protect existing investments in the corridor, including roads, municipal buildings, residences, and commercial properties. However, the town of Lincoln and landowners should limit future development and floodplain filling within the corridor, to reduce flooding and streambank erosion losses. Continued channel management, such as armoring or channelization, should be considered in the broader context (both in time and space) for the channel adjustment processes such management will set in motion and for the consequences to upstream and downstream reaches. Corridor management strategies recommended for other reaches could help to reduce sediment delivery to these reaches.

Where a landowner, the community, or state or federal agencies choose to implement active channel management (e.g., armoring) within the corridor, this plan and the geomorphic assessment data on which it is based will provide enhanced understanding of (and accountability for) consequences of channel management to downstream or upstream properties. The channel in existing developed areas (e.g., Lincoln village along M19 or West Lincoln village along M17) could be stabilized or armored, where the upstream or downstream impacts of this active channel management are mitigated for by setting aside corresponding sediment and flow attenuation sites elsewhere along the corridor. Channel management activities will be subject to the appropriate permit reviews from Army Corps of Engineers or the VT Water Quality Division.

While current investments along these reaches limit the possible restoration / conservation opportunities, there are management opportunities particularly for reaches M19 and M17.

Reach M19

As a result of the geologic setting and the long history of channel management that has worked counter to the natural tendencies of the channel, M19 is considered to be one of the most sensitive reaches in the New Haven watershed. Decades of floodplain encroachment and channel management have contributed to a loss of floodplain connection in all but the highest flood events. Gravel has historically been extracted from the channel through the village,

particularly as a response action following past floods. The floodplain has been encroached upon by substantial development and construction of road networks since the mid-1700s. Armoring is present along both banks through the section of river just upstream of Burnham Hall and the Gove Hill Road bridge. The armored channel width was narrower than the bankfull width measured at an upstream cross section, resulting in constriction of flows through this location. The streambed is armored with a resistant layer of cobbles; however, these would be mobilized in a flood flow, and there is the potential for channel incision at higher flows with greater erosive energies. Residential properties just upstream of this location along the right bank incurred streambank erosion in the 1998 flood (Benz, 2004).

Reportedly, during the 1998 flood, some flow from the New Haven River "jumped" the left stream bank upstream at the Pallet Mill area flow passing parallel to Clark Road, crossing the Gove Hill Road and isolating the Fire Department before rejoining the main channel downstream of the Lincoln Sports ball field. While this flood chute impacted residences along Clark Road and Gove Hill Road and hampered the Fire Department's ability to respond to emergencies, it is likely that this diversion of flows from the main river channel saved residences and Burnham Hall along River Road from more devastating erosion impacts. If all the flood flows had been contained in the main channel, increased channel incision or catastrophic movement of streambanks may have undermined building foundations and the abutments for Gove Hill Road. The splitting of flood flows into multiple channels during the flood would have dissipated excessive flood energies.

To the extent that inundation impacts to residences along Clark Road and Gove Hill Road could be offset, it would be important to the Lincoln community to maintain the river's floodplain access upstream of the village, and formalize a "flood water diversion path" to the southwest of the village area for future flood events of the magnitude experienced in 1998. Future development within the floodplain in the village area should be avoided. Relocation of buildings in this floodplain area should be considered. Relocation of the Fire Department, in particular, would be recommended as a way to avoid damages and isolation experienced during the 1998 flood. And finally, management strategies for sediment and flow attenuation in reaches and tributaries upstream of the village should be pursued as a means of reducing the impacts to reach M19 through the village area.

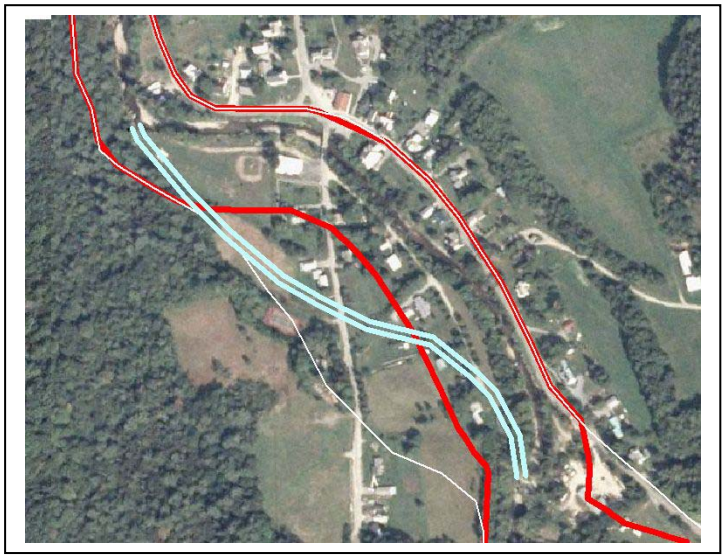


Figure 10. Reach M19 through Lincoln village. 1998 flood flows crossed the Clark Rd and passed down-valley to the south of the Fire House.

Red line = RMS FEH corridor (2005)

White line = RMS valley wall (2005)

Light blue double line = approx. path of 1998 flood waters.

Reach M17

Several flood chutes along left bank are accessed at high flows which would have the effect of dissipating erosive energies of the flood waters. These flood chutes are likely serving an important function in the flow attenuation and sediment attenuation in the watershed, relieving pressure on the armored Bristol-Lincoln Road along right bank. It is important to maintain river access to these flood chutes for the overall balancing of sediment and water loads in the river network.

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APPENDIX C

Delineation of Draft River Corridor

Delineation of Draft River Corridor
for Mitigation of Fluvial Erosion Hazards, Reduction of Sediment and Nutrient Loading, and Improvement of Habitats

APPENDIX C
River Corridor Plan
New Haven River: Town of Lincoln

Addison County, Vermont

February 2006

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Attachments

1. SMRC Review of Reach-based Hazard Rating Assignments for Preliminary River Corridor with respect to Geomorphic Condition and Sensitivity Assignments in Phase 2 Stream Geomorphic Assessment

2. SMRC Review of Preliminary River Corridor, December 2005

**Delineation of Draft River Corridor
for Mitigation of Fluvial Erosion Hazards, Reduction of Sediment and Nutrient Loading, and Improvement of Habitats**

1.0 INTRODUCTION

A draft river corridor has been generated by the VTDEC River Management Section for eleven reaches of the New Haven River main stem and Beaver Meadow tributary in Lincoln (Figure 1). This draft corridor has been delineated for the primary purpose of reducing hazards to the community from streambank erosion. In a future planning process envisioned by the Lincoln Planning Commission, the corridor will be considered by the citizens of Lincoln for adoption into zoning as a River Corridor Overlay District. Development of appropriate conditional uses within the corridor will be based on the objective of reducing fluvial erosion hazards, by allowing the river to adjust freely and unconstrained within the corridor, and avoiding placement of future infrastructure within the corridor.

This corridor is also being used to define a management area, within which additional planning strategies and restoration and conservation projects are being pursued with willing landowners to improve water quality and riparian habitats.

Development of this draft of the corridor for these eleven reaches has relied, in part, on results of previously-completed Phase 1 and Phase 2 Stream Geomorphic Assessments (SMRC, 2004a, 2004b). As described in the following sections, the process of delineating and refining the corridor has been a collaborative effort between the Lincoln Planning Commission, the Addison County Regional Planning Commission, and members of the Technical Working Group under the River Corridor Planning grant funded by the VTDEC Water Quality Division.

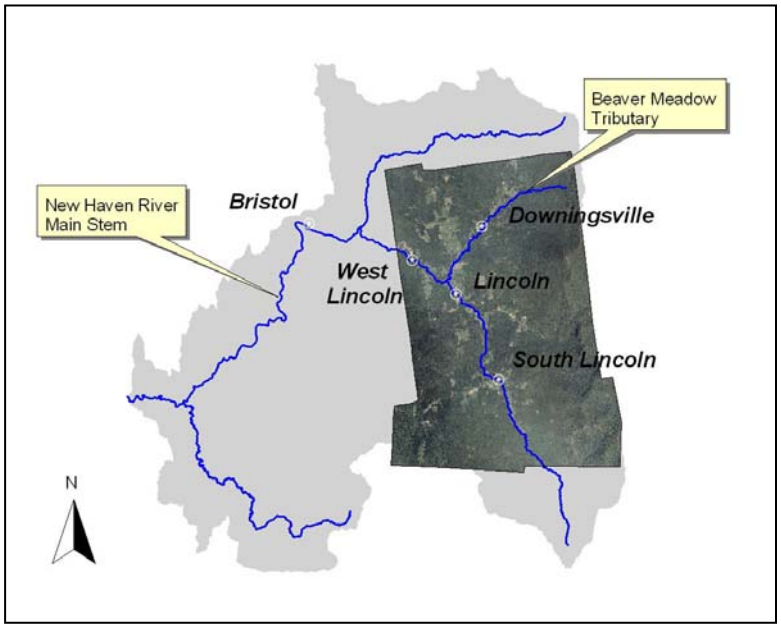

Figure 1.
Location New Haven River main stem and Beaver Meadow tributary within town of Lincoln.

2.0 LOCATION OF REACHES

Previous studies have assembled geomorphic data for eleven (11) reaches within the town of Lincoln: eight along the New Haven River main stem and three along the Beaver Meadow tributary. These reaches are located through Lincoln's village centers: South Lincoln, West Lincoln, Downingsville and Lincoln village.

These eleven reaches constitute the extent of the corridor being considered at present in this corridor planning project. For more details of the geomorphic condition of these reaches, refer to Appendix B of the *New Haven River Corridor Management Plan for the Town of Lincoln*.

3.0 DELINEATION OF BELT-WIDTH-DERVIED RIVER CORRIDOR

To define a river corridor overlay district for the town of Lincoln with the objective of reducing fluvial erosion hazards, the River Management Section ran the Fluvial Erosion Hazard module of Stream Geomorphic Assessment Tool (SGAT), an ArcView© 3.x extension (Geographic Information Systems mapping software). Various input data are required to run the SGAT software as detailed in Section 3.1.

Derivation of the corridor within SGAT follows guidance contained in:

> *Technical Guidance for Determining Floodway Limits Pursuant to Act 250 Criterion 1(D).*
> http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_floodwaytechguidance.pdf
> (VT Agency of Natural Resources, May 2003)

While this specific guidance pertains to the Agency's review of floodways under Act 250, the same science-based procedure is applied by the Agency when collaborating with towns who are voluntarily pursuing the preparation of a corridor for the purpose of reducing fluvial erosion hazard risks (or also reducing nutrient and sediment loading to their surface waters).

Generally, speaking this corridor delineation method relies on the meander belt-width concept as outlined in the following fact sheets:

> *River Corridor Protection and Management: Fact Sheet #1*
> http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_rcprotectmanagefactsheet.pdf
> (VTDEC River Management Program, 2005a)
>
> *Defining River Corridors: Fact Sheet #2*.
> http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_definingrcfactsheet.pdf
> (VTDEC River Management Program, 2005b)

A meander belt is defined by connecting the outside point of meander bends along the left and right banks of a channel. In a balanced river system that has not been subjected to intensive floodplain encroachment and channel management, the meanders will theoretically have full expression, and connecting the outside points of each meander will approximate an area which is subject to erosion hazards as the river channel migrates laterally and longitudinally through time.

Since many of Vermont's streams have been channelized and straightened with the meanders removed or significantly reduced in amplitude, connecting the points at the outside edge of these straightened meanders would result in a narrow "meander belt" that was insufficient in width to describe the area at risk of future lateral adjustments. Therefore, Vermont guidance calls for the

meander belt width to be buffered at a specified distance off the meander center line. The meander center line, is a line connecting each successive meander cross-over point, proceeding down-valley (see the above fact sheets for more detailed explanation).

The distance buffered off the meander center line is determined by the (1) approximate channel width in the reach and (2) by the present geomorphic condition and sensitivity of that reach to further adjustments. Channel widths and sensitivity ratings are determined during Phase 1 and Phase 2 Stream Geomorphic Assessments. The Sensitivity ranking (from Very Low to Extreme) is dependent on the stream type (e.g., steep, narrow channels in mountainous settings versus shallow, meandering channels in broader valley settings) and the geomorphic condition of the reach (Reference, Minor Adjustment, Major Adjustment, Stream Type Departure). Further details of the Phase 1 and 2 Stream Geomorphic Assessment protocols are available at: http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_geoassesspro.htm

Following VTDEC guidance documents, the reach Sensitivity is used to define a Fluvial Erosion Hazard rating from Very Low to Extreme. Depending on the Sensitivity (FEH) Rating, the channel is buffered to varying widths, which increase with increasing sensitivity.

Table 1. Belt Width Dimensions based on Geomorphic Sensitivity

FEH Rating (Sensitivity)	Belt Widths based on reference channel widths
Very Low	Equal to the reference channel width
Low	Equal to the reference channel width
Moderate	Four (4) channel widths
High	Six (6) channel widths
Very High	Six (6) channel widths
Extreme	Six (6) channel widths

Reference: Vermont Fluvial Erosion Hazard Mitigation Program
VT DEC River Management Program, 2005d (14 February draft)

The process of corridor delineation in GIS, as outlined in VTANR guidance (2003) and automated in SGAT, will identify where the above meander belt width impinges on a valley wall. In those cases, the meander belt width is clipped to the valley wall and the clipped area is re-distributed to the opposite side of the channel. In some cases, as for many reaches in Lincoln, the valley walls are so narrowly-confining, that the full dimension of the meander belt width is not expressed, and the corridor width becomes defined by the left and right valley walls.

The meander belt width is a close *approximation* of the area surrounding an alluvial channel which is at risk of fluvial erosion hazards in the short term. To comprehensively map fluvial erosion hazard risk with greatest confidence and accuracy would require detailed survey work along the entire river section of interest; field-based evaluation of soil types, geotechnical properties and erodibilities; analysis of historic channel positions; as well as hydrologic and hydraulic modeling (FEMA, 2003; Rapp & Abbe, 2003). Such an intensive study would be cost-prohibitive for most towns, and such an endeavor Statewide would require resources beyond what is reasonably available at the present time.

The meander belt width provides a first approximation that can be quickly derived with reasonably limited resources. As suggested in *Defining River Corridors: Fact Sheet #2*, the belt-width derived corridors "provide an area within which channel adjustments may occur, in order to re-establish an equilibrium condition, and there can be a reasonable expectation that fluvial erosion hazards will be minimized" (VTDEC RMS, 2005b).

3.1 Input Data

Reach-based channel widths

Since the corridor is defined based on a multiplier of the channel width, a channel width value is identified for each stream reach in SGAT. Because most of the channel reaches in question through Lincoln are in a state of adjustment, the measured channel widths from Phase 2 field-based assessment (SMRC, 2004b) were not used (Mack, 2005). Instead the regime-based channel widths from Phase 1 geomorphic assessment were used (SMRC, 2004a). These are approximate channel widths estimated in relation to drainage area, based on Vermont Hydraulic Geometry Curve data (VTDEC WQD, 2001).

Hazard Indices based on Geomorphic Condition and Sensitivity

Hazard Ratings were assigned to each of the eleven (11) Lincoln reaches of the New Haven River and Beaver Meadow tributary based on geomorphic condition and sensitivity, as follows:

Table 2. Recommended Belt-width Dimensions for Select New Haven River main stem and tributary reaches based on Geomorphic Condition and Sensitivity.

Reach	RGA Condition (a)	FEH Rating (Sensitivity) (a)	Belt Width (b)
M22	Fair	Extreme	6x
M21	Poor	High	6x
M20	Good	Moderate	4x
M19	Fair	Extreme	6x
M18	Fair	Extreme	6x
M17	Poor	Extreme	6x
M26	Fair	High	6x
M25	Fair	High	6x
T4.04	Good	Moderate	4x
T4.03-B	Fair	High	6x
T4.03-A	Good	Very Low	Reference W
T4.02	Good	Moderate	4x

a - as per VTANR Stream Geomorphic Assessment protocols (2005)
b - as per 14 February 2005 *Vermont Fluvial Erosion Hazard Mitigation Program*

In the case of M20 and T4.04, the sensitivity assignment in Table 2 reflects an update from those ratings assigned in the Phase 2 Stream Geomorphic Assessment (SMRC, 2004b) (see Attachment 1 of this Appendix).

Delineation of Meander Center Line

For this first draft of the corridor, VTDEC River Management Section delineated a meander center line along the New Haven River main stem and the Beaver Meadow tributary defined as a GIS shape file "***newmcl.shp***". This shape file is available for review through the VT River Management Section.

The multipliers of channel width defined in Table 2 were then buffered off this meander center line to define the belt-width-derived corridor.

Delineation of Valley Wall

VTDEC River Management Section delineated a valley wall along the New Haven River main stem defined as "***Phase2vw.shp***". This shape file is available for review through the VT River Management Section.

Where the meander belt width impinges on either left or right valley wall, the belt width area is clipped to the valley wall and the clipped area is re-distributed to the opposite side of the channel in GIS. In portions or all of the several reaches in Lincoln, the valley walls are so narrowly-confining that the full expression of the meander belt width was truncated along both the left and right valley walls.

In a provisional draft of the corridor it should be noted that the valley wall in some main stem reaches was delineated at the major road (River Road) along the stream valley, rather than the natural toe of the valley wall beyond the road. Further discussion of this point is included in Attachment 2.

3.2 Review of Preliminary Corridor

Lincoln Planning Commission

A provisional draft of the corridor was presented at the 21 December 2005 Lincoln Planning Commission meeting. This corridor was mapped by Addison County Regional Planning Commission (ACRPC) from GIS data supplied by River Management Section. The meeting was facilitated by Adam Lougee of ACRPC and attended by members of the Lincoln Planning Commission (LPC) and members of the River Corridor Planning Technical Working Group. The concept of incorporating a River Corridor Overlay District into zoning was preliminarily supported by the LPC, subject to review and approval by the Selectboard and ultimately the Lincoln citizens. Tentatively, the River Corridor Overlay District would serve as a conditional use district, and supplement a 50-foot No-Build Setback already being considered by the LPC for the New Haven main stem, Isham Brook, Cota Brook, and Beaver Meadow Brook.

Through discussions in this 21 December 2005 meeting, several existing investments with community value were noted inside the preliminary corridor (e.g., River Road, bridge crossings, village centers). The likelihood for continued maintenance of these investments, irrespective of the fluvial erosion hazards, was acknowledged by the group. The need for administrative adjustments of the corridor, as outlined in Vermont Hazard Mitigation Program document (VTDEC RMS, 14 Feb 2005) was identified. The TWG representatives noted that administrative adjustments to lessen the area of the Overlay District adjacent to established investments in certain locations along the river, should be offset by accommodations for the full corridor width and town-sponsored implementation of floodplain restoration and conservation projects elsewhere along the corridor, particularly upstream of these constrained areas.

The Planning Commission also identified the need to address the following concerns, in a fair, equitable, and cost-efficient way which places the lowest possible burdens on landowners in those town locations impacted by the Overlay District, and on Town staff reviewing potential development in and near the Overlay District. For example:

- How is the boundary location identified on the ground? *Ty Mack of the River Management Section responded that the boundary will be displayed on maps with 1995 orthophoto base and depicting the property boundaries. In addition, the boundary can be located with GPS in the field.*

- There will be a need for technical support to the Lincoln Zoning Administrator in review of site plans for development within or near the River Corridor Overlay District. *Ty Mack of the RMS responded that his position as Fluvial Erosion Hazard Coordinator and other resources of the River Management Section are available to towns for such technical support, similar to how the Agency now supports questions concerning inundation hazards and interpretations of the FEMA-FIRM mapping relative to proposed developments.*

- There will be a need for technical support in developing appropriate Conditional Use language for the River Corridor Overlay District. *Ty Mack of the RMS distributed model language for Fluvial Erosion Hazard Overlay Districts and noted that RMS would be available to communities and Lincoln in particular to work on zoning language for their Town's consideration.*

- There will be a need for technical support in refining, administratively, the boundaries of the River Corridor Overlay District, and conducting the public outreach and education required for the town to consider this District in future zoning regulation and Town Plan revisions. *Ty Mack of the RMS and Adam Lougee of the ACRPC responded that FEMA Pre-Disaster Mitigation grant monies have been secured for Addison County communities and would be available to support some of these activities.*

- There are currently data gaps in the corridor record – i.e., reaches within town on the New Haven main stem, Isham Brook, Cota Brook, Beaver Meadow Brook for which a preliminary corridor has not yet been developed. *Ty Mack of the RMS and Adam Lougee of the ACRPC responded that the FEMA Pre-Disaster Mitigation grant monies would be available to fund Phase 1 and Phase 2 Stream Geomorphic Assessments and corridor development for additional reaches to provide more comprehensive coverage for Lincoln surface waters. These data would be available over the next couple of years.*

Technical Consultant

The provisional draft of the corridor was also reviewed by the Technical Consultant for the River Corridor Planning Technical Working Group, Kristen Underwood of South Mountain Research & Consulting (SMRC). For more details see Attachment 2 of this Appendix. SMRC briefly reviewed the valley wall and meander center line delineations by RMS, and the delineation of a preliminary draft FEH corridor with respect to known and reported areas of flood hazards experienced in the town of Lincoln in the 1998 flood. This review was conducted in the context of public education / outreach tasks and assistance to the Town of Lincoln in preparing a River Corridor Management Plan. Given budget constraints, the review did ***not*** constitute an assessment of fluvial erosion hazards along the New Haven River main stem or tributaries, or a comprehensive technical review of the preliminary draft corridor with respect to how accurately it encompasses areas of actual fluvial erosion hazard risk to the community.

4.0 FUTURE STEPS

Feedback received from LPC and TWG members following this meeting is being incorporated in a revised draft of the FEH corridor, scheduled for discussion at an upcoming LPC meeting (15 March 2006). The LPC foresees that additional outreach and public meetings will be necessary to introduce a possible FEH corridor overlay district to the greater community and proceed through subsequent technical and administrative processes for possible adoption into town zoning.

Currently, funding and technical resources are available to the town through Addison County Regional Planning Commission (FEMA Pre-Disaster-Mitigation funds) to support a public planning process to review the possible role of a corridor overlay district in town planning and to develop a viable draft ordinance for public review. These same funds are available to generate the geomorphic data to delineate a corridor in the remaining portions of the New Haven main stem, and additional tributaries identified by the LPC (Cota, Isham, French Settlement).

5.0 REFERENCES

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VT DEC River Management Program, 2005a, *River Corridor Protection and Management: Fact Sheet #1* http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_rcprotectmanagefactsheet.pdf

VT DEC River Management Program, 2005b, *Defining River Corridors: Fact Sheet #2*. http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_definingrcfactsheet.pdf

VT DEC River Management Program, 2005c (26 October draft), *Using geomorphic assessment data to guide the development of River Corridor Management Plans to achieve: Fluvial Erosion Hazard (FEH) Mitigation, Sediment and Nutrient Load Reduction, and Ecological-based River Corridor Conservation.*

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VT DEC Water Quality Division, 2001, *Vermont Regional Hydraulic Geometry Curves: 2001 Provisional* http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_hydraulicgeocurves.pdf

Attachment 1

SMRC Review of Reach-based Hazard Rating Assignments for Preliminary River Corridor with respect to Geomorphic Condition and Sensitivity Assignments in Phase 2 Stream Geomorphic Assessment

Attachment 1.
SMRC review of Rapid Geomorphic Assessment Scores and Sensitivity for Eleven New Haven River and Beaver Meadow tributary reaches.

Originally transmitted to Ty Mack and Shannon Hill of the VTDEC River Management Section via email on 20 December 2005.

Hi Shannon & Ty,

I finished my review of the RGA scoring and Sensitivity assignments for the eleven reaches of the New Haven main stem and Beaver Meadow trib that are in the Town of Lincoln.

Re: RGA scores
Until the May 2005 training from you folks, I had not correctly been scoring the RGAs. Even though the 2004 protocols specified in Step 7 that one is to rank the aggradation, widening, and planform adjustment processes in the Poor category ONLY if BOTH of the boxed metrics are checked in the Poor category, I had not consistently been doing that. When I reviewed the New Haven River (NHR) results I found that for M17 (Steps 7.2, 7.4), M21 (Steps 7.3, 7.4), and M22 (7.3), I had ranked an adjustment process in the Poor category when only one of the two boxed parameters for each step was ranked as Poor. If I go through and correct these scores, the M17 RGA ranking (Poor) and M22 ranking (Poor) do not change. Thus, their assigned Sensitivity would not change. The RGA score for M21 ***does*** change (from 0.30 to 0.35). The Stream Condition therefore changes from Poor to Fair, but it's right on the cusp. The Sensitivity ranking, however, would NOT change. Sensitivity would be HIGH whether the Stream Condition was Fair or Poor, and whether the stream type was C3 or B4 (because there is a brief subreach of B4 stream type within the reach).

I am therefore inclined not to change any data in the database, unless you feel this would be important simply from the standpoint of accuracy and compliance with the protocols.

Re: Sensitivity assignments
Following a strict interpretation of the Sensitivity assignment table in the Phase 2 protocols and in the *Vermont Fluvial Erosion Hazard Mitigation Program* document dated 14 February 2005, I have incorrectly assigned "Extreme" ratings to three of the Lincoln reaches: M18, M19, and M22. These should have been "Very High" as they are F3s or F4s with a Fair RGA stream condition. However, given the stream type departures, I subjectively assigned "Extreme" sensitivity ratings to them in my 2004 Phase 2 Stream Geomorphic Assessment report - to err on the side of caution, and not knowing that these sensitivity ratings would be used to define the magnitude of corridors for management of fluvial erosion hazards. It may be a moot point, since corridors for both the Extreme and Very High sensitivity channels are developed as a 3 times channel width buffered on the meander center line. However, they would be assigned different FEH hazard ratings (9 for Very High and 10 for Extreme). Again, I am inclined to leave the ratings as they are (but document my conservative choice in the Corridor Plan). However, are there management implications for a 9 hazard rating versus a 10 hazard rating that may result from this choice that the Town or landowners should be aware of?

Also, I just wanted to note that for two reaches with some bedrock controls within them, the FEH corridor you have developed is based on a more conservative Sensitivity rating than was defined in my Phase 2 summary report. Reaches M20 and T4.02 have stretches of channel that are bedrock-controlled B1-SP, B1-casc, and B2-SP in an otherwise B4c or B3 channel. Both reaches have a Good RGA score. I had assigned a Low sensitivity to "split the difference" between a Very Low assignment for the bedrock stretches and the Moderate sensitivity of the non-bedrock sections. I noticed that the FEH corridor is built on a Moderate assignment for these reaches. I don't necessarily disagree with this approach – especially given my conservative assignment of

Extreme to the other reaches discussed above. I just think we should document this (and I will in the corridor report). Also, we may want to point out to the Town the option to shrink the corridor down to the reference channel width dimension in these bedrock-controlled sections of each reach, consistent with a Very Low rating – if you think that would be appropriate. The extents of these bedrock-controlled areas are reasonably documented in the reach maps in Appendix E of my report. We could GPS them more accurately for the Town if necessary.

Let me know what you think.
Thanks,
Kristen

Note: Ty Mack and Kristen Underwood later agreed that RGA scores and Sensitivity assignments should be updated in the VTDEC web-base data management system.

Attachment 2

SMRC Review of Preliminary River Corridor, December 2005

MEMO

To: Lincoln Technical Working Group
From: Kristen L Underwood, PG, South Mountain Research & Consulting
Date: 29 December 2005
Re: Draft Fluvial Erosion Hazard corridor, New Haven River, Lincoln

The first draft of a river corridor, defined as a Fluvial Erosion Hazard (FEH) corridor, has been generated by Shannon Hill and Ty Mack of the VTDEC River Management Section for eleven reaches of the New Haven River main stem and Beaver Meadow tributary in Lincoln.

Specific elements of the derivation of this first draft of the corridor for these eleven reaches have relied on results of Phase 2 Stream Geomorphic Assessment data collected by SMRC in 2004 (2004a, 2004b). For example, geomorphic condition and sensitivity ratings assigned by SRMC at the reach level have been utilized to define, in part, the magnitude of the corridor (higher sensitivity reaches buffered wider than lower sensitivity reaches). Other steps in the derivation of this first draft of the corridor have been generated by the River Management Section. For example, a valley wall and meander center line (supporting steps in the development of the corridor) have been delineated by the River Management Section (RMS).

SMRC has quality-assured the assignments of sensitivity to each of the reaches made by SMRC in 2004 under 2004 protocols, to ensure compatibility with sensitivity assignment under 2005 protocols, and to comment on the influence of sensitivity assignments in the context of defining fluvial erosion hazards (see Attachment 1). SMRC has also briefly reviewed the valley wall and meander center line delineations by RMS, and the delineation of the draft FEH corridor with respect to known and reported areas of flood hazards experienced in the town of Lincoln in the 1998 flood. This review has been conducted in the context of public education /outreach tasks and assistance to the Town of Lincoln in preparing a River Corridor Management Plan (under contract to the Town of Lincoln with funding from a FY2005 Category 2 River Corridor Grant).

The following does ***not*** constitute a comprehensive review by SMRC of fluvial erosion hazards along the New Haven River main stem or tributaries. SMRC has not been formally authorized under any budget or specific scope of work to provide technical review of the draft FEH corridor delineated by the River Management Section with respect to how accurately the corridor encompasses areas of actual fluvial erosion hazard risk to the community. To define the fluvial erosion hazard risk to a community with a high degree of accuracy and confidence would involve detailed survey work along the entire river section of interest; field-based evaluation of soil types; geotechnical properties and erodibilities; analysis of historic channel positions; as well as hydrologic and hydraulic modeling (FEMA, 2003; Rapp & Abbe, 2003).

I acknowledge that such intensive study would be cost-prohibitive for most towns (including Lincoln), and that such an endeavor Statewide would require resources beyond what is reasonably available at the present time. I support the River Management Section's desire to provide an interim planning tool that can help a community mitigate fluvial erosion hazards – namely the use of the Fluvial Erosion Hazard module to the Stream Geomorphic Assessment Tool which has been used to generate this draft FEH corridor. I support the efforts of the River Management Section and the Town of Lincoln to educate the public regarding potential risks to infrastructure and lives from fluvial erosion hazards. I support the development of an overlay district and various planning strategies such as buffers that can reduce the future risk of fluvial erosion hazards.

It would be important to all concerned, however, to understand the methods, assumptions, and limitations of the FEH mapping tool for identifying fluvial erosion hazard risk.

This memo provides a record of my limited review, and attempts to address many of the assumptions and limitations inherent in this approach as it is being applied on these eleven reaches of New Haven River

watershed in the Town of Lincoln. It also serves as a means of documenting for the record these issues as they have been raised in our Technical Working Group discussions and public meetings during this Corridor Planning Process.

DRAFT CORRIDOR DELINEATION AND FILES REVIEWED

To define a river corridor overlay district for the town of Lincoln with the objective of reducing fluvial erosion hazards, the River Management Section ran the Fluvial Erosion Hazard module of Stream Geomorphic Assessment Tool (SGAT), an ArcView© 3.x extension (Geographic Information Systems mapping software). Derivation of the corridor within SGAT follows guidance contained in *Vermont Agency of Natural Resources Technical Guidance for Determining Floodway Limits Pursuant to Act 250 Criterion 1(D),* 1 May 2003. While this specific guidance pertains to the Agency's review of floodways under Act 250, the same science-based procedure is applied by the Agency when collaborating with Towns who are voluntarily pursuing the preparation of a corridor for the purpose of reducing fluvial erosion hazard risks (or also reducing nutrient and sediment loading to their surface waters).

Generally, speaking this corridor delineation method relies on the meander belt-width concept as outlined in the following fact sheets:

> VTDEC River Management Program, 2005a, *River Corridor Protection and Management: Fact Sheet #1*
> http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_rcprotectmanagefactsheet.pdf
>
> VTDEC River Management Program, 2005b, *Defining River Corridors: Fact Sheet #2*.
> http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_definingrcfactsheet.pdf

This process of defining the corridor requires delineation of the valley walls along the channel sections in question, and delineation of the meander center line.

In 2005, VTDEC River Management Section re-delineated a valley wall along the New Haven River main stem defined as "**Phase2vw.shp**" and a meander center line "**newmcl.shp**".

Note that the valley wall and meander center line digitized by VTDEC River Management Section are separate from and substantially different from those digitized by SMRC in 2003. SMRC digitized a valley wall and a meander center line along the New Haven River main stem and major tributaries in 2003 during operation of the Stream Geomorphic Assessment Tool (SGAT) to delineate the Appendix E Phase 1 corridor for a Phase 1 Stream Geomorphic Assessment. These ArcView 3.x shape files were defined as *"S00vallwallnhr.shp"* (valley wall) and *"S00meandctrnhr.shp"* (meander center line). The Phase 1 Stream Geomorphic Assessment was conducted by SMRC in the Fall of 2003 under contract to the Addison County Regional Planning Commission with funding from a FEMA Project Impact grant. The sole purpose of the Appendix E Phase 1 corridor (of which delineation of the valley wall and meander center line were a part) was to define an area contiguous to the river channel for identification and summary of soil types and land cover / land use at the reach-based corridor scale, in support of Steps 3 and 4 of the Phase 1 Stream Geomorphic Assessment protocols (VTANR, 2003 version). Use of the *"S00vallwallnhr.shp"* and *"S00meandctrnhr.shp"* shape files for purposes of developing a fluvial erosion hazard area, or management boundary for mitigation of fluvial erosion hazards, was not identified or anticipated at the time of their digitization.

REVIEW COMMENTS

In general, most of the comments below speak to more clearly articulating the purpose and definition of the corridor referred to as a "Fluvial Erosion Hazard corridor". Given the limitations discussed below, the corridor being developed is more correctly called a River Corridor Overlay District with the management

objective of reducing fluvial erosion hazards to the community. This is a subtle, but very important distinction, as the corridor developed from this planning process will not comprehensively or accurately represent the aerial extent of lands at risk of fluvial erosion. This is due to: (1) technical limitations associated with applying a belt-width derived corridor to represent fluvial erosion hazards, and (2) possible administrative adjustments to the management corridor resulting from the public process of adopting the boundary as an overlay district in local zoning regulations with attendant conditional uses.

It should also be noted that fluvial erosion hazards as defined under VTANR policies do not include risks from geotechnical (landslide) hazards, even though these two erosion processes are often interrelated. A separate mapping protocol is underway to delineate landslide hazards in Vermont communities. This corridor planning process has focused on two landslide sites in South Lincoln that are tied to fluvial erosion hazard issues along the New Haven main stem.

1. Limitations of the belt-width derived corridor in representing fluvial erosion hazards

The meander belt width may be a close *approximation* of the area surrounding an alluvial channel which is at risk of fluvial erosion hazards in the short term. To comprehensively map fluvial erosion hazard risk with greatest confidence would require substantial additional resources for communities. The MBW provides a first approximation that can be quickly derived with reasonably limited resources. As suggested in *Defining River Corridors: Fact Sheet #2*, the belt-width derived corridors "provide an area within which channel adjustments may occur, in order to re-establish an equilibrium condition, and there can be a reasonable expectation that fluvial erosion hazards will be minimized" (VTDEC RMS, 2005b).

However, there are limitations associated with using the meander belt width (MBW) alone to define fluvial erosion hazard that should be identified to the community. These include: (1.1) the fact that dimensions of the corridor are empirically derived, rather than being generated by intensive field-based study along the specific river reaches in question; (1.2) the inability of a regime-equation-based belt width to consistently encompass known streambank erosion sites, known avulsion sites, historic channel migration zones; and (1.3) the inherent limitations of scale, resolution, source data and age of remote-sensing resources utilized in the GIS methodology to delineate the corridor. Examples of these limitations specific to the New Haven corridor are provided in the sections below.

It should be noted that the corridor delineation method proposed by VTANR provides for technical review of the belt-width-derived corridor and adjustment of corridor boundaries to account for outliers where they are known (page 7 of *Vermont Fluvial Erosion Hazard Mitigation Program* document, VTDEC, 14 February 2005). Later map amendment steps outlined in this process also allow for more detailed information to be collected for site-specific locations along the corridor.

1.1 Empirical relationships rather than field-based intensive study

As noted in *Defining River Corridors: Fact Sheet #2* (VTDEC RMS, 2005b), recommended belt widths for Vermont Streams are based on the Williams (1986) equation derived from data sets of 153 gravel-bed, low gradient (< 2%), alluvial channels flowing through narrow to broad valleys underlain by reasonably homogeneous surficial deposits. A regression equation relating meander belt width to channel width, for these river reaches suggests that, on average, river channels in these settings have meander belt widths approximating 6 times the channel width.

Use of this empirical relationship introduces limitations when applying it to define an area of erosion hazard risk along river corridors in Vermont or for that matter to define an area theoretically needed by the channel to restore or maintain a dynamic equilibrium. These limitations are related to: (1.1.1) the inherent variability in the equation itself; and (1.1.2) application of the belt-width equation to non-alluvial channels; (1.1.3) use of Vermont Hydraulic Geometry Curve data to define channel width upon which the meander belt width is buffered.

1.1.1 Inherent variability of the equation

The Williams' equation represents an average condition, a best-fit line through several data points with considerable scatter about the line. Therefore, the equation will underpredict meander belt width for many gravel-bed, low-gradient, alluvial reaches and overpredict meander belt width for many of these reaches (Ward et al, 2002). Overprediction is probably of lesser concern, but underprediction will have important consequences if the meander belt width concept is applied as the sole measure of delineating fluvial erosion hazards.

1.1.2 Application to non-alluvial channels; (channels of gradients steeper than 2%; channels with cobble, boulder or bedrock-controlled beds; channels confined by their valley walls; channels flowing through inhomogeneous materials, such as the mix of substrate types and layered lithologies common in previously glaciated terrain).

All of the eleven New Haven River reaches would fall into one or more of the above categories of non-alluvial channels. Non-alluvial, bedrock-controlled channels with highly erosion-resistent beds and banks are not free to adjust their channel width, depth, planform, or gradients to the degree that alluvial reaches are (Schumm, 1977; MacBroom, 1998). Many sediments comprising the bed and banks are relics of large-scale bedrock weathering and glacial erosion/ deposition cycles, and large boulders and cobbles are unable to be mobilized in the current hydrologic regime except in large magnitude flood events, if at all (Example: reach M16 through Bartlett's Falls and upstream reach M17). So the channel form and planform are controlled by these relic structures rather than being self-formed by the river channel in response to changes in water and sediment loads.

The meander belt width relationships (Williams, 1986) were not developed for glaciated, bedrock-controlled stream valleys in moderate to steep gradient settings, such as Lincoln (and many watersheds of Vermont). In narrow bedrock-controlled valleys like M20 or M16, the belt-width derived recommendations for corridor delineation may be too wide. To some extent this is addressed by the fact that the SGAT FEH module clips the corridor to the bedrock-controlled valley walls – (emphasizing the importance of accurate delineation of the toe of the valley wall – see section 1.3.1). Also, steeper, narrowly-confined, bedrock-controlled stream reaches would be expected to demonstrate minor degrees of adjustment (Reference or Good geomorphic condition, and therefore Moderate to Low Sensitivities) where a corridor of a 1- to 4-times-channel-width dimension would be appropriate (following guidance contained in VTDEC RMS, 2005b; VTDEC RMS, 2005d; VTANR, 2003).

To SMRC's knowledge, the 1 to 4-times channel width recommendations for meander belt width in these steeper-gradient, bedrock-controlled, confined valley stream reaches were not developed based on review of any hydraulic geometry data for regional or global stream reaches in similar settings; and thus may be somewhat arbitrarily defined. This subjective determination is better than no recommendation at all, but the arbitrary-ness of this determination should be recognized for the uncertainty it imparts on delineating fluvial erosion hazard areas.

1.1.3 Use of Vermont Hydraulic Geometry Curve data to define channel width upon which the meander belt width is buffered.

Since the belt-width-derived corridor is defined based on a multiplier of the channel width, a channel width value is identified for each stream reach in SGAT. Because most of the channel reaches in question through Lincoln are in a state of adjustment, the measured channel widths from Phase 2 field-based assessment (SMRC, 2004b) were not used (Mack, 2005). Instead the regime-based channel widths from Phase 1 geomorphic assessment were used (SMRC, 2004a). These are approximate channel widths estimated in relation to drainage area, based on Vermont Hydraulic Geometry Curve data (VTDEC WQD, 2001).

Vermont hydraulic geometry curve data were developed for 14 reference or minimally-disturbed reaches around Vermont with drainage basins ranging from 8.9 to 139 square miles in area. Data from these 14 reaches were used to develop an equation that predicts channel width from drainage area for Vermont streams in Phase 1 geomorphic assessments. Just like the William's equation, such an equation is a best-fit-line through scattered data points with considerable variability about the line. The equation will therefore underpredict channel widths for some stream and overpredict for others. Furthermore, the equation will best predict channel widths for reaches that are in similar topographic settings and conditions to the reaches on which the equation is based. The VT hydraulic geometry curve relationships are based on data from 14 gravel or sand bed channel sections located in broader valley settings (C or Bc stream types) with slopes ranging from 0.04 to 1.32 % (geometric mean of 0.26%) (VTDEC WQD, 2001).

The New Haven reaches in question are gravel, cobble, boulder, and bedrock channels in narrow to confined valley settings, with slopes ranging from 0.82 to 4.7% (geometric mean of 1.5%). Six of the eleven reaches (M26, M25, M17, T4.04, T3.03, T4.02) have slopes greater than the high end (1.32 %) of the range of applicability of the VHGC regime equations. Two of the eleven reaches (T4.04, T4.03) have drainage areas less than the low end (8.9 square miles) of the range of applicability of the VHGC regime equations. Thus, there may be significant inaccuracies in the VHGC predictions of regime channel width

for the New Haven reaches. It is likely that the curve equation will overpredict regime channel widths for bedrock-controlled and/or steeper-gradient New Haven reaches in confined to semi-confined valley settings. The meander belt width, calculated as a multiplier of this predicted channel width will then also be overpredicted. To a great extent, however, this overprediction will be offset in those reaches where the corridor is subsequently clipped to the confining valley walls.

1.2 Inability of a regime-equation-based meander belt width to consistently encompass known streambank erosion sites, known avulsion sites, and historic channel migration zones

Skidmore, *et al*. (1999) concluded that a combination of methods was warranted to establish the area around a channel subject to lateral adjustments, including review of the historic channel positions, and analysis of geologic features (alluvial terraces), as well as the meander belt width.

Rapp & Abbe (2003) define this area of lateral channel adjustment subject to fluvial erosion hazards as the combination of the areas with evidence of historic channel migration, evidence of recent avulsion, and potential for streambank erosion and landslides or mass wasting. In many cases, a meander belt width corridor will adequately capture these various potentials for lateral channel adjustment, but not in all. A further limitation of the meander belt width is that, while this area may maintain a relatively constant width (or area surrounding the channel), the footprint of this constant area can itself meander across the landscape over longer time frames (Rapp & Abbe, 2003), particularly in broader valley settings.

Along the Lincoln reaches subject to corridor planning, there are a few instances where the river is known to have occupied flood chutes or avulsion channels located outside of the meander-belt-width defined corridor. During the 1998 floods, for example, the New Haven River reportedly occupied flood chutes that were outside the belt-width derived corridor (at 6 times channel width dimension) (see Figure 1).

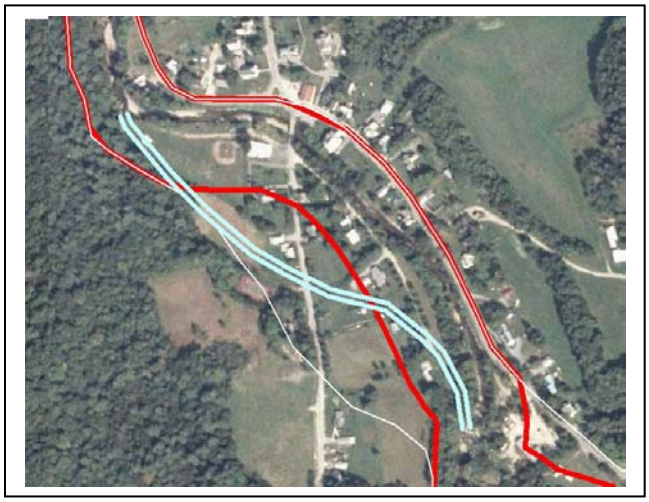
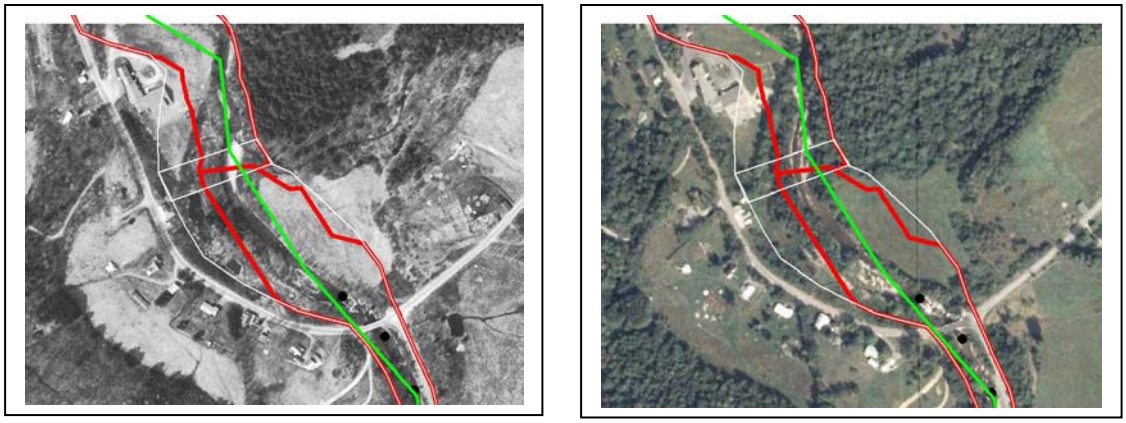


Figure 1. M19 Example. 1998 flood flows crossed the Clark Rd and passed down-valley to the south of the Fire House.

Red line = RMS FEH corridor (2005)
White line = RMS valley wall (2005)
Light blue double line = approx. path of 1998 flood waters.

As another example (see Figure 2), at the reach break between M21 and M22 downstream of the Garland Bridge, 1998 flood waters occupied the left bank (western) flood chute on the outside of this meander bend (following the left valley wall marked by the white line). The FEH corridor (in red) was buffered on the meander center line (in green) which passes to the northeast of the current channel. The channel planform (meander patterns) in these two reaches are governed in large part by laterally- and vertically-confining bedrock outcroppings upstream and downstream of this meander. This meander bend downstream of the Garland Bridge is one local opportunity for the river to extend its meander amplitude and possibly attenuate some of its flow and sediment load. In recent history, fluvial erosion has occurred at locations along the left bank outside of the belt-width-defined "Fluvial Erosion Hazard" corridor. This example also introduces the influence of the meander center line delineation on representing fluvial erosion hazard risks.



(1995) (2003)

Figure 2. Reach break between M20 (top half of picture) and M21 (bottom half of picture) downstream of the Garland Bridge.

In a broad alluvial valley of relatively consistent soil types without bedrock controls, meanders from a previously managed channel may be expected to grow and extend to approach a meander belt width and wavelength predicted by regime equations. A belt-width-derived corridor approach buffered on the meander center line assumes that meander extension and development of future sinuosity will proceed equally unconstrained along the entire meander center line.

In a bedrock-controlled laterally-confined valley, however, meander extension processes will proceed wherever there are no constraints. Existing meander patterns in Lincoln and other bedrock-controlled settings are partly a function of past channel managements (e.g., straightening), and partly a function of those constraints imparted by the lateral and vertical bedrock controls and the heterogeneities of glacial and post-glacial soil types. Further, meander extension cannot be expected to proceed equally along the valley in a bedrock setting. Lateral adjustments will occur to a less than expected rate in constrained sections of the valley and will likely occur to accelerated rates where there are no constraints, perhaps to occupy a meander belt width that is greater than a 6-times-channel width dimension.

For example (see Figure 3), in reach M25 in South Lincoln, meander extension has already occurred to the limits of a meander-belt-width defined corridor within a
5-year time span since the 1998 flood, and could reasonably be expected to continue outside the corridor. Lateral channel migration in this location undoubtedly has also been influenced by sediment delivery from an upstream mass failure of sands and gravel along the left valley wall.

(1995) (2003)

Figure 3. Reach M25 in South Lincoln downstream of the large mass failure. Meander extension has occurred to the limits of the "FEH" corridor within a 5-year time span since the 1998 flood.

1.3 Limitations of scale, resolution, source data and age of remote-sensing resources utilized in the GIS methodology

1.3.1 Importance of Valley Wall Delineation in Corridor Definition

In a bedrock-controlled watershed where narrow valleys constrain the floodplain, the valley wall delineation becomes the overriding element in delineation of the FEH corridor. In the Lincoln main stem reaches (on the first draft of the FEH corridor), the valley wall delineation overrides the belt-width derived corridor width along both banks for a majority of the reach length on seven out of the eight main stem reaches (all but M26 in South Lincoln). Accurate delineation of the valley wall then becomes a critical element of the corridor definition.

This valley wall delineation is along the approximate toe of the bedrock-controlled slope in some cases; in other cases a decision has been made to delineate the valley wall coincident with the nearby roadway. (This latter point is discussed in the next section).

SMRC review has noted a location where the valley wall should be adjusted along reach M17, upstream of the prominent meander bend at the downstream reach extent and downstream of West Lincoln village (see Figure 4). The RMS valley wall (white line) (and therefore the FEH corridor in red) turns northward to a knoll identified on the topographic maps. Field based observations from Phase 2, however, indicate a flood chute which flows around this knoll and which is active at annual flows or higher magnitude flood events (see M17 annotated reach map, reproduced as Figure 5). A simple redelineation of the valley wall in this location, and re-running of SGAT, would result in the corridor being located outside of (to valley left) of this flood chute.

Accurate delineation of the valley wall is limited by the scale and resolution of the topographic and orthophoto resources used in the delineation process. The topographic maps depict elevation changes to the nearest 20 foot contour. This resolution is often insufficient to identify the valley wall with any more accuracy than several 10s of feet. If GPS units are used in field-based support of valley wall mapping, the accuracy of these units can be on the order of +/- 30 to 50 feet.

This is a picky point, but there are concerns over slight mismatches of the projections of the topographic base and orthophoto base in GIS, as these may impact accurate placement of the valley wall (and

subsequently the FEH corridor that gets delineated). At the scale of these projects, this mismatch could account for distances on the order of tens of feet, misrepresenting the area defined by the belt-width methodology as having risk from fluvial erosion hazards.

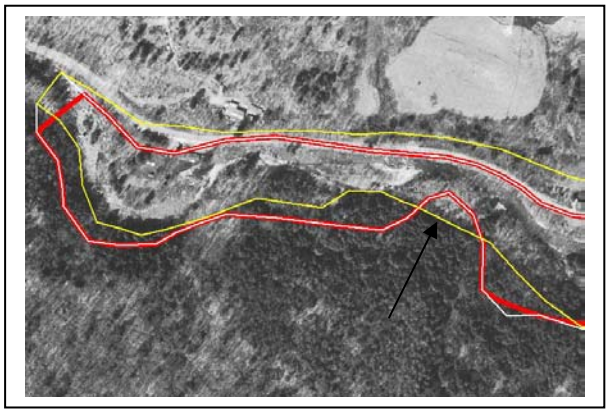


Figure 4.
M17 – site of valley wall needing adjustment (arrow)

Red line = RMS FEH corridor (2005)
White line = RMS valley wall (2005)
Yellow line = SMRC valley wall (2003)

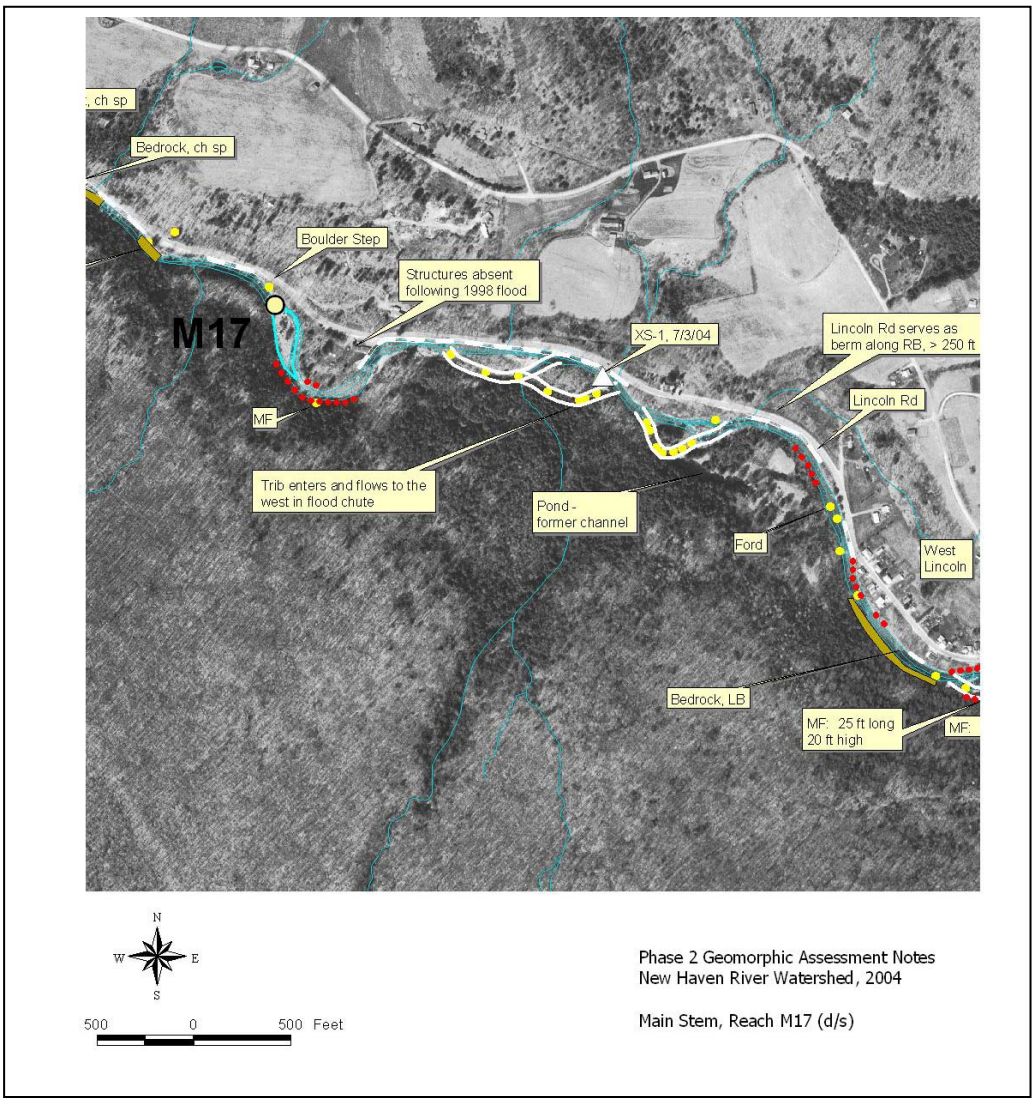


Figure 5. M17 – annotated reach map
Phase 2 Geomorphic Assessment results, 2004.

1.3.2 Transition point between reaches of substantially different Sensitivity ratings

These transition points can under-represent risks of fluvial erosion hazards in the area local to the reach break. The corridor width is defined based on sensitivity (absent constraints of valley walls). At the transition point between reaches of substantially different Sensitivity ratings, the corridor width changes from, say, 6 times the channel width (for a High Sensitivity) to 4 times the channel width (for a Moderate Sensitivity). Channel width itself may be dropping substantially from upstream reach to downstream reach, and so the total corridor width decreases substantially.

An example would be Reach M20 (Moderate Sensitivity) and Reach M19 (Extreme Sensitivity) (see Figure 6). The transition in corridor width from M20 to M19 is somewhat abrupt. While the risks of fluvial erosion hazard from Point A to Point B would arguably be the same (given equal distance perpendicular to the channel), they are depicted in this example as having some measurable concern and no concern, respectively, for fluvial erosion hazards. This is another example of why we should be cautious about identifying this boundary as a "Fluvial Erosion Hazard" boundary.

Also, if a corridor ends up being adopted by the public as an overlay district, the depiction of this boundary will have great significance to the landowner at Points A & B, in terms of potential conditional uses placed on his/her property.

There are a few ways to address this concern about the transition from reach to reach. One would be to adjust the corridor to "smooth" the transition from reach M20 to M19 (probably during generation of Draft 1 or Draft 2 of the FEH map as defined in VTDEC, Feb 2005). Alternatively, the Town could choose to handle this eventuality through an appeals process where the responsibility would lie with the landowner to demonstrate (through field data collection or additional analysis) that a proposed development use would not be at substantial or added risk of fluvial erosion hazards. This appeal could occur during a site review process in town zoning and result in an FEH map amendment as referenced in the VTDEC, Feb 2005 document flowchart.

There is one additional point about these transition points between reaches of different assigned Sensitivity – raised by Ty Mack in a recent meeting with the Lincoln Planning Commission (21 December 2005). The reach/segment ratings (and associated color legends) of Very Low to Extreme sensitivity, reflect the geomorphic condition and propensity for future adjustment in response to channel and watershed disturbances. The sensitivity rating defines the magnitude of the corridor width, following guidance in VTANR, 2003. These sensitivity ratings should not necessarily be interpreted to suggest that property within the corridor in an Extreme sensitivity reach has a higher risk of fluvial erosion hazard than a property within the corridor of a lesser-sensitivity reach.

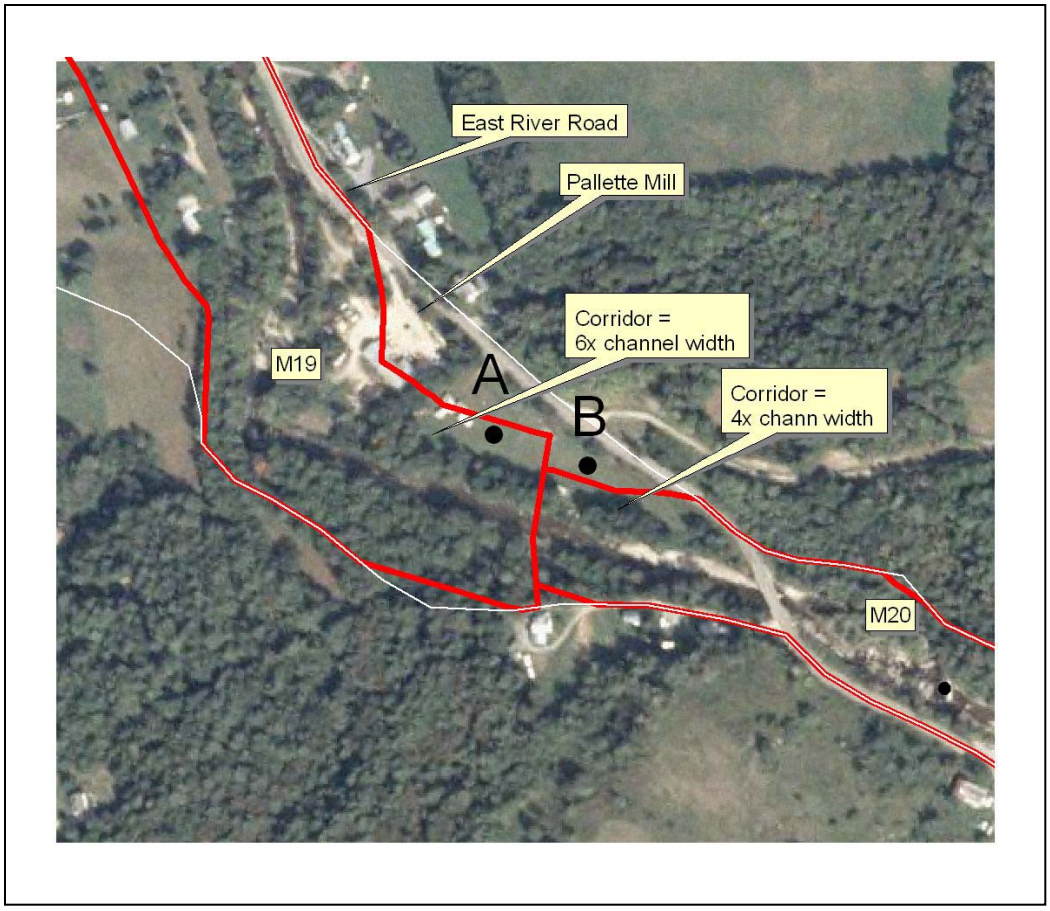


Figure 6. Corridor transition from reach M20 to M19.

2. Distinction between Fluvial Erosion Hazard boundary and an administratively-defined Management Boundary (Overlay District) with the objective of reducing fluvial erosion hazards.

The flowchart (pages 10-11) of the *Vermont Fluvial Erosion Hazard Mitigation Program* document (VTDEC, 14 February 2005) allows for a community to review and adjust the position of the corridor so as not to restrict development (or impose whatever conditional use conditions the town is considering for their overlay district) on the properties within the boundary in certain locations. Listed as a possible step between Draft 1 and Draft 2 of the FEH Map is an "adjustment of valley walls to account for roads and infrastructure". Between Draft 2 and Draft 3 of the FEH corridor is the possibility for "adjustments in response to locally relevant plans and zoning administration needs".

Existing infrastructure, such as Town and State roadways, are identified as a human constraint that may need to be considered in the context of developing river corridors for management of fluvial erosion hazards (*Defining River Corridors: Fact Sheet #2*; VTDEC RMS, 2005b).

For example, if a town's existing village district or proposed growth areas are within the boundaries of the FEH corridor (as they are in Lincoln's village centers), the public may wish to acknowledge and absorb the risk of fluvial erosion hazards to future occupants in this developed area and not restrict development there, opting for short-term economic well-being over the chance for fluvial erosion hazards in the short or long-term. Given the public process that is necessary to enact zoning restrictions, this may be a realistic compromise position.

However, such an administratively-adjusted boundary no longer reflects fluvial erosion hazards (to the extent that the belt-width approach defines areas of fluvial erosion hazard). It would be inappropriate to label the administratively-adjusted boundary as an FEH overlay district (as suggested in VTDEC, 14 February 2005, p. 11: "Draft 3 of the FEH Map"). This label could inappropriately give the impression that locating development anywhere outside the management boundary will mean that such development is free from any fluvial erosion hazards. This could expose the Town and all those involved in the development of the corridor to liability in the event of future fluvial erosion hazard losses, without appropriate disclaimers.

Related to this point, the valley wall delineated by RMS for the New Haven reaches in support of this first draft of the River Corridor appears to represent the road along the stream valley in the main stem reaches, rather than the natural toe of the valley wall beyond the road. Road base material is often coarse and compacted and the armoring along the river side of the road would tend to resist erosion from river flows. However, the 1998, 1973, 1938 and 1927 floods have washed away substantial sections of the West River Road, East River Road and the South Lincoln Road along the right bank of reaches M17, M18, M19, M21, M22, and M26.

Placement of the valley wall coincident with the roadway may be an appropriate management boundary – i.e., a managed valley wall. That is, the Town of Lincoln may choose to continue to manage the river to stay within the boundary represented by the road. However, it would be misleading to represent that roadway / managed valley wall as a Fluvial Erosion Hazard boundary, or the extent of lands at risk of fluvial erosion hazards. Past flood events have shown us that the river erodes beyond this roadway boundary. Therefore, it would be more appropriate to identify this managed valley wall as a management boundary, rather than a Fluvial Erosion Hazard boundary (see Section 2).

If the first draft of the FEH corridor is to reflect purely the science-based view of fluvial erosion hazards (to the extent that a belt-width approach can achieve this), irrespective of current investments in the corridor, the valley wall delineation should reflect the natural valley wall here and not the road.

That said, there are a few locations where the roadway is actually coincident with what would be the natural valley wall. The road is on bedrock in these cases, or elevated well above the channel on the valley wall. Examples would include:

- M20 where the valley wall along left bank, coincident with East River Road is on bedrock high above the channel;
- M17, for portions of its length.

The above points raise the need to include on any final product (River Corridor Overlay District) the appropriate caveats / limitations, such that it is properly interpreted as a planning tool, and not an exact depiction of fluvial erosion hazard risks.

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APPENDIX D

Outreach Materials

Outreach Materials

APPENDIX D
River Corridor Plan
New Haven River: Town of Lincoln

Addison County, Vermont

February 2006

Press Release

New Haven River Corridor Management Plan--Lincoln

The Town of Lincoln has received a grant from the Vermont Department of Environmental Conservation to develop a River Corridor Management Plan for the New Haven River and Beaver Meadow tributary. Funding has been appropriated through Governor Douglas' Clean & Clear Action Plan. This grant will fund a 9-month alternatives analysis process with the long-term objectives of reducing streambank erosion and sediment and nutrient loading, by managing for the equilibrium channel. This project will consist of an analysis of previous assessment work, identification of the causes of channel instability, and an evaluation of alternatives for restoring long-term stability to the river. A River Corridor Management Plan for public review will be prepared by February 2006. The plan will identify and rank short-term and long-term actions and approaches for implementation, including potential river restoration projects.

The study area will focus on the New Haven River main stem through the Lincoln, West Lincoln, and South Lincoln village areas, as well as the Beaver Meadow tributary through Downingsville. From July through September, members of a Technical Working Group will meet with landowners along the river corridor. Through outreach to individual landowners and through a series of public forums, the Technical Working Group will identify river corridor management alternatives which are sustainable along this highly dynamic river and which are compatible with public and individual goals and visions. Potential channel management choices will be reviewed for their effectiveness and potential consequences to downstream and upstream properties and infrastructure. Lincoln citizens with questions or comments are encouraged to contact Sally Ober, Project Director, at 453-5220 or sallyober@gmavt.net.

Word count to this point: 262

This project has been endorsed by the Lincoln Selectboard. The Technical Working Group assembled for the project includes Sally Ober, Project Director; Ethan Ready, Selectboard member; Mark Benz, grant administrator; Kristen Underwood, consulting geologist; and Shayne Jaquith, Shannon Hill, and Ethan Swift from the VTDEC Water Quality Division. An invitation to the Technical Working Group has also been extended to the Town of Bristol, since choices made along the river through Lincoln have the potential to impact downstream communities.

The River Corridor Management Plan will build on results of a geologic study of the river that was completed last year under FEMA Project Impact funding through the Addison County Regional Planning Commission. Results of this study were presented at the November 2004 River Forum sponsored by the Lincoln Conservation Commission at Burnham Hall. A repeat of this presentation will be held on August 15, 2005 at 7 pm as part of the Lincoln Lecture Series at the Lincoln Library.

Total Word count: 421

Released July 17, 2005

Landowner Letter

12 July 2005

Dear Landowner:

The Town of Lincoln has received a grant from the Vermont Department of Environmental Conservation to develop a River Corridor Management Plan for the New Haven River and Beaver Meadow tributary. This grant will fund a 9-month alternatives analysis project with the long-term objectives of reducing streambank erosion and sediment and nutrient loading, by managing for the equilibrium channel. This project will consist of an analysis of previous assessment work, identification of the causes of channel instability and an evaluation of alternatives for restoring long-term stability to the river.

The Town would like to invite your participation to ensure that the River Corridor Management Plan which results from this process reflects the individual as well as public visions and goals for prosperity compatible with our highly dynamic and adjusting river reaches. The project will focus on sections of the New Haven River through the Lincoln, West Lincoln, and South Lincoln village areas, as well as the Beaver Meadow tributary through Downingsville. This letter is reaching you as a landowner identified along the river in one of these areas.

A Technical Working Group has been assembled to conduct the alternatives analysis: Sally Ober, Project Director; Ethan Ready, Selectboard member; Mark Benz, grant administrator; Kristen Underwood, consulting geologist; and Shayne Jaquith, Shannon Hill, and Ethan Swift from the VTDEC Water Quality Division. An invitation to the Technical Working Group has also been extended to the Town of Bristol, since choices made along the river through Lincoln have the potential to impact downstream communities.

In the next few weeks, I will be contacting you by phone or in person to share more of the details of this project, and have a discussion about possible alternatives to alleviate streambank erosion and reduce sediment and nutrient loading. This feedback will be incorporated into our analysis of alternatives. In the meantime, if you have questions or comments, please contact me at 453-5220 or sallyober@gmavt.net.

Thank you,

Sally Ober, Project Director

Annual Town Report

ANNUAL REPORT
OF THE BOARD OF OFFICERS

TOWN OF LINCOLN
VERMONT

FOR THE YEAR ENDING DECEMBER 31, 2005

New Haven River in West Lincoln downstream from York Hill Road bridge
Photo: Kristen Underwood, 2004

PLEASE BRING THIS REPORT WITH YOU
TO THE TOWN MEETING TO BE HELD
AT BURNHAM HALL
MONDAY, MARCH 6, 2006, AT 7:00PM

Childcare and Transportation to Town Meeting Available
Call 453-2980 for Reservations

Our changing relationship with the New Haven River

The town of Lincoln owes its genesis to the New Haven River and tributary streams. To the earliest town residents, the river provided water for drinking and subsistence gardening, and served as a travel way through the dense forest cover of the mountains.

Large dam at bedrock exposures in the New Haven River at the former Grist Mill location along River Road southeast of Lincoln village and northeast of the Lincoln Community School (1909; Vermont Historical Society).

Early settlers took advantage of the bedrock exposures along the New Haven and its tributaries to establish dams for hydro-power to operate saw mills, grist mills, shingle and clapboard mills, sash and door factories, chair factories, trip hammers, carding and clothing factories, woolen factories, forges, and axe factories (Reed, 1980; Beers Atlas, 1871). By 1886 fifteen mills were operating on the New Haven River in Lincoln; as many as eight mill sites were located on the Beaver Meadow and Downingsville Brooks (Smith, 1886; Reed, 1980).

Today's growing village centers of Lincoln, West Lincoln, South Lincoln and Downingsville have their roots in these early mill centers, though the community no longer relies as directly on the river for water power and industry. A network of roads and driveways has been established, widened and improved. The natural floodplain of the river in many locations is now filled with roads, homes, and businesses. While Lincoln's close proximity to the New Haven River and its tributaries in many ways defines our scenic character and recreational opportunities, this same proximity has resulted in substantial and repeated damages to public and private property. The floods of 1830 and 1869 washed out many of the mills and associated industry. In our more recent memory, road and crossing wash-outs and substantial property losses occurred during the floods of 1927, 1938, 1976, 1989, and 1998. These damages occurred, not entirely from rising waters, but also from sudden erosion of stream banks that undermined bridge and culvert footers, road base material, and building foundations. The risks of these fluvial erosion hazards are not adequately captured by the FEMA-Flood Insurance Rating Maps. Often, buildings or properties located outside the boundary of the FEMA-FIRM floodway, or elevated above the predicted flood stage, are incurring losses as a result of stream bank erosion.

York Hill Bridge, West Lincoln, following June 1998 flood. Photo Susan Tucker

In our village center areas, a shifting river channel is not easily tolerated. The channel has been dredged periodically to remove gravel deposits and straightened to protect roads and buildings. Stream banks have been armored to keep the river in a straightened position and guard against erosion. While these activities work for a time, at best they represent a short-term, "band-aid" approach to maintaining channel stability. These channel management activities can actually cause more extensive damages during flooding, as they tip the natural balance of river systems and constrain the river's ability to self-adjust to a slope, width, depth and meander pattern that can most effectively transport the water and sediments from the watershed. Excess stream bank and streambed erosion is leading to water quality impacts from sedimentation, phosphorus and bacteria.

Annual Report compiled and edited by auditors: Mark Benz and Jason Oleet
Production by Cindy Kimball, **Printing** by Reprographics, Colchester, VT
Cover by Pam Dunne, **River Article** by Kristen Underwood and Sally Ober

Lincoln citizens are taking actions that change the way we relate to the river – efforts to reduce erosion, improve water quality, and restore natural habitats.

RIVER CORRIDOR MANAGEMENT—In 2005, a local planning effort has been undertaken to reduce future flood erosion losses and develop a River Corridor Management Plan (for a full report of the Lincoln New Haven River Corridor Management Project, see the Reports—Lincoln Section). Armed with new information about river dynamics and fluvial erosion hazards, Lincoln citizens are identifying planning strategies that are more accommodating of natural river dynamics. Geomorphic studies and landowner outreach efforts conducted during this planning process have identified several specific opportunities for reducing erosion, improving water quality, and restoring habitats along the river. Community and landowner needs have been matched with appropriate technical and financial resources. Planning and outreach efforts have included the participation of the Planning Commission, Conservation Commission and the Selectboard. **Photo:** River Education Outreach during Lincoln Hill Country Holidays, August 2005, Kristen Underwood.

LINCOLN CONSERVATION COMMISSION—In 2004, members of the Conservation Commission initiated the Japanese Knotweed Control Project. Choosing 2 sites in Lincoln, they are demonstrating how land owners along the river can use non-chemical methods to control the growth of this invasive plant and restore natural habitat. **Photo:** Savannah Mayo on a mountain of Knotweed, Summer 2005.

DEVELOPMENT ALONG THE RIVER—The Lincoln Planning Commission is working with several professionals in the area of river science to become familiar with different methods of protection and management of Lincoln's waterways. This consideration extends beyond the Town itself, as the consequences of our waterway management impact areas above and below Lincoln. The commissioners are reviewing river management options and discussing how they may be applied to Lincoln's Zoning Regulations.

BURNHAM HALL FLOOD PROJECT—Built on the bank of the New Haven River, Burnham Hall has been flooded several times. The Flood Mitigation Assistance Grant, recently received from Vermont Emergency Management, calls for wet floodproofing the lower floor of Burnham Hall to minimize flood damage requiring repair of the building and replacement of the contents.

WATER QUALITY—Since 1993, three sites along the New Haven River in Lincoln have been monitored at least four times a Summer by the New Haven River Watch, a partner of the Addison County River Watch Collaborative. Summer-time water quality sampling has identified total phosphorus and *E. coli* impacts in the New Haven River. Monitoring efforts have been financially supported, in part, by the town of Lincoln. Water quality results are available to Lincoln citizens in an annual report, copies of which are available at the Lincoln Library, or by visiting the NewHavenRiverAnglers.com web site. **Photo:** Lillian Seibert and Finnian swimming at the Pallet Mill, 2005, Andrea Seibert.

Landowner Contacts

APPENDIX E

Resources

Resources

APPENDIX E
River Corridor Plan
New Haven River: Town of Lincoln

Addison County, Vermont

February 2006

GRANTS / RESOURCES

Northern Vermont Resource Conservation and Development Council
617 Comstock Road, Suite 2
Berlin VT 05602-8498
http://www.anr.state.vt.us/cleanandclear/bbroads.htm
Vermont Better Back Roads Grants
Up to $7,000 with 25% local match

VT Department of Housing & Community Affairs
National Life Building, 6th Floor, Drawer 20
Montpelier, VT 05620
http://www.dhca.state.vt.us/Planning/MPG.htm
Vermont Municipal Planning Grants
Single town: $15,000
Consortium (Multiple towns): $25,000

VT Department of Environmental Conservation
River Corridor Management Section
103 South Main St./ West Bldg.
Waterbury, VT 05761-0403

Vermont River Corridor Restoration & Protection Grants
http://www.anr.state.vt.us/dec/waterq/rivers.htm
Clean and Clear Water Action Plan
Available FY2006. to Lake Champlain Basin watersheds
Category I: Project Identification: $100,000
Category II: Project Development: $300,000
Category III: Project Implementation: $850,000

Vermont Watershed Grants
http://www.anr.state.vt.us/dec/waterq/lakes/htm/lp_watershedgrants.htm
Mini-grants: $200 to $1000
Grants: $1,000 and higher

Nonpoint Source Management Grants
EPA - Clean Water Act Section 319
Rick Hopkins rick.hopkins@state.vt.us
802-241-3769

PUBLICATIONS

Geomorphic Assessment and Corridor Delineation

River Corridor Protection and Management: Fact Sheet #1. VT DEC River Management Program, 2005. http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_rcprotectmanagefactsheet.pdf

Defining River Corridors: Fact Sheet #2. VT DEC River Management Program, 2005.
http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_definingrcfactsheet.pdf

Alternatives for River Corridor Management: Vermont DEC River Management Program Position Paper. VT DEC River Management Program, 18 April 2003.
http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_mngmntalternatives.pdf

Procedure on ANR Floodway Determinations in Act 250 Proceedings
http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_floodwayprocedure.pdf

Vermont Agency of Natural Resources Technical Guidance for Determining Floodway Limits Pursuant to Act 250 Criterion 1(D) 2/21/03
http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_floodwaytechguidance.pdf

Buffers

VTANR Riparian Buffer Guidance – Adopted 20 January 2005
http://www.anr.state.vt.us/site/html/buff/buffer-final-2005.pdf

VTANR Riparian Buffers and Corridors Technical Papers, 2005
http://www.anr.state.vt.us/site/html/buff/buffer-tech-final.pdf

Sources of Native Plant Materials in Vermont. Compiled by Erin Hanley. VT DEC Water Quality. Report #209. 2005.
http://www.anr.state.vt.us/dec/waterq/wetlands/docs/wl_nativeplants.pdf

Water Quality

Citizen Water Quality Monitoring Program: 2004 Final Report. Addison County Riverwatch Collaborative. 2005.
See interactive map hosted at Addison County Regional Planning Commission web site that allows historic water quality data to be downloaded for a given sampling site.
http://207.136.225.66/acrwc/wqsitegraphsave.php

State of the Lake: Lake Champlain in 2005--A Snapshot for Citizens. Lake Champlain Basin Program, 2005. Available at: http://www.lcbp.org/PDFs/sol_web.pdf

Lake Champlain Long-term Monitoring – Tributary Station Summary Statistics. VT DEC Water Quality Division 2005.
http://www.anr.state.vt.us/dec/waterq/cfm/champlain/tribstats_results.cfm

Beavers

Best Management Practices for Resolving Human-Beaver Conflicts in Vermont. Vermont Fish and Wildlife Department. Vermont DEC. Revised 2004.
http://www.anr.state.vt.us/FW/FWHOME/library/factsheets/Fish_and_Wildlife/Best_Management_Practices_for_Human-Beaver_Conflicts.pdf

CONTACTS

Conservation

Middlebury Area Land Trust - http://www.greenmountainaccess.net/~hkarlson/malt/

Gioia Kuss: (802) 388-1007

Vermont Land Trust - http://www.vlt.org/

Leslie Ratley-Beach: (866) 457-2369

Lake Champlain Land Trust – http://www.lclt.org/ (802) 862-4150

Vermont River Conservancy - http://www.vermontriverconservancy.org/

Steve Libby: (802) 434-2592

The Nature Conservancy of Vermont - (802) 229-4425
http://nature.org/wherewework/northamerica/states/vermont/

Stream Permits

To find out about stream-crossing structures or gravel extraction permits, see the VT DEC website, under River Management and Permits. http://www.vtwaterquality.org/rivers.htm.

Contact Chris Brunelle, Stream Alteration Engineer with questions. (802) 879-5631 or chris.brunelle@state.vt.us

Restoration

USDA Natural Resources Conservation Service – http://www.nrcs.usda.gov/

Keith Hartline, NRCS Addison County (802) 388-6746 x27

Craig Miner, FSA Addison County (802) 388-6746 x15

US Fish and Wildlife Service /Partners for Wildlife - http://www.fws.gov

Chris Smith (802)-872-0629 x 20

APPENDIX F

30 Jan 2006 Memo from George Springston, Norwich University

To: Sally Ober, Project Manager for Town of Lincoln River Corridor Management Plan
From: George Springston, Norwich University Department of Geology
Date: 1/30/2006
Subject: Two landslides on the New Haven River in Lincoln, Vermont

This report describes visits that I made to two landslides on the New Haven River near South Lincoln, Vermont. I first visited the sites on October 17, 2005 with you, Ty Mack of the Vermont River Management Section, and Kristen Underwood of South Mountain Consulting and Research. I subsequently revisited the first site on November 16 and 18. Ethan Swift of the Vermont River Management Section accompanied me on the latter visit. The stream reaches refer to those specified in the Phase 2 Stream Geomorphic Assessment Report prepared by South Mountain Consulting and Research (September, 2004).

1. The first site is located on the west bank of Reach M25 on land owned by Thomas and Leah Booska.(Figure 1). The slide is about 136 feet high and 180 feet wide and is composed of about 41 feet of dense, gray, glacial till overlain by 5 feet of stiff, laminated silt and clay, overlain in turn by about 90 feet of medium to fine sand with some pebble gravel. Behind the crest of the slide is an abandoned sand pit. The glacial till consists of a mix of fine sand and silt with pebbles, cobbles, boulders, and probably a little clay. It is very hard because of compaction by the massive weight of the overriding ice sheet. The laminated silt and clay formed in a glacial lake after the retreat of the ice. The overlying sands appear to be formed in a delta where a stream flowed out into this former lake.

Although only the lower portion of the slide consists of the glacial till, this material appears to control the form of landsliding at the site in a pattern that I have observed at several other sites in the state: The river has been able to cut back a few feet into the till, probably because the outer few feet were somewhat weathered. Erosion slowed as the river reached less weathered material. Thus there was a relatively shallow (although very high and wide) collapse of the glacial till. Once the weathered till was removed, the very weak materials up above also failed. Further erosion at the site has been at least slightly slowed by the very hard unweathered till that is now exposed in the slide. However, even this material can be eroded during floods and after being softened by alternate freezing and thawing during the cold months.

One development to watch for at this site is a shift of the stream. If the river bend migrates against a new part of the landslide (either upstream or downstream), there may be additional dramatic slope failure as the weathered material is eroded. In order to track future changes at the site I established 8 monitoring points around the margin of the slide. I would like to check the slide in the spring and undertake some additional surveying.

We also looked at an eroding bank that is on the east side of the river and downstream from the landslide. The river is cutting into the easily erodible gravel and sand of an alluvial deposit. Although the river is not very close to the house on this lot, I expressed a concern about whether or not the septic system for the house might be closer to the eroding bend. If so, it may be

prudent to try to limit erosion on this bank.

2. On the October 17 visit we also viewed a large landslide on the west side of the river, downstream of the Cooley Glen Bridge. We were unable to access the slide due to high water conditions but the material appears to consist of dense, gray, stoney, glacial till overlain by imbricated boulder and cobble gravels (Figures 3 and 4). The gravels in the upper part of the section may be stream gravels deposited by the New Haven River before it cut down to its present level.

As at the previous site, the driving force behind continued failure of the slope appears to be toe erosion and/or vertical incision by the river. I'd like to look at the material at this site more closely and to check the slopes nearby for signs of cracking and slumping.

As we discussed while out at the sites, there is probably no easy fix for sites like these. Many of the traditional "fixes" either don't work very well or else they cause problems somewhere else on the stream. I would like to see the sites this spring to see how they've changed over the winter and it may be helpful to track changes to these sites over time to see whether they are becoming more stable or less so. Feel free to pass this on to anyone interested and let me know if you have any questions.

Figure 1. Mass failure or landslide on west bank of Reach M25, looking upstream from east shore.

Figure 2. View of eroding bank on east shore of Reach M25 located downstream of mass failure shown in Figure 1. The bank is composed of highly erodible alluvial gravel and sand.

Figure 3. Mass failure or landslide on west bank of New Haven River below Cooley Glen Bridge. Looking across from east bank. The glacial till is gray and the overlying gravel is light brown.

Figure 4. Landslide below Cooley Glen Bridge looking upstream from east bank

cc: via email: Larry Becker, Ty Mack, Ethan Swift, Kristen Underwood

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