

VTrans Rivers and Roads Training

Considering the River in the Design, Construction and Maintenance of Transportation Infrastructure in Vermont

Tier 2: Assessing the River and Restoring Equilibrium



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Training Needs and Goals

As Tropical Storm Irene and many floods before have demonstrated, Vermont's transportation infrastructure is highly vulnerable to erosion, deposition and inundation hazards associated with river flooding. Traditionally, attempts to mitigate these vulnerabilities were limited to sizing bridges and culverts with regard to flow volume but not sediment and debris transport, dredging channels to contain flood flows, and armoring banks to resist the erosive forces of those flows. Repetitive flood damages and associated maintenance, reconstruction and accompanying impacts to adjacent rivers were accepted as a simple reality of inhabiting a mountainous state. However, society's increased dependence on the transportation network and growing concerns over the environmental impacts of roadway damages have made road damages increasingly less tolerable while increases in flood frequency and severity and general river instability have made them more prevalent.

The scientific understanding of rivers and the forces that drive their behavior has increased tremendously in the last 50 years or so. We have come to recognize that attempts to control rivers only increases the magnitude and scale of their instability, and that by working with their natural processes we can maintain more stable river systems, thereby providing for more stable riverside infrastructure. However, too few transportation infrastructure design and construction professionals in Vermont have a sufficient understanding of river processes to achieve the goal of reducing flood vulnerability of infrastructure statewide. The overarching goal of the Rivers and Roads Training Program is to create the basic knowledge and awareness amongst transportation infrastructure professionals necessary to steer the current trend of increasing flood-related road damage costs toward greater river and road stability.

Tier Two of the Rivers and Roads Training Program targets a wide range of state, municipal and private sector transportation infrastructure professionals from general maintenance workers and equipment operators to design and construction oversight engineers. Participants leave the training with the knowledge and skills required to distinguish between stable and unstable rivers, identify various types of river instability, forecast a rivers response to alternative structural treatments and build those treatments. The greater appreciation for physical river and floodplain processes and aquatic habitat developed through the Rivers and Roads training will leave participants better equipped to design and implement maintenance and repair projects that will enhance the stability of the adjacent river, minimize impacts to aquatic habitats and increase infrastructure longevity.

Tier 2 Training at a Glance

Rivers and Roads Tier 2 Agenda

Day 1 River Morphology and River Equilibrium (Stability)

- 8:00 AM Welcome and Introductions (what is your flood recovery experience)
- 8:15 AM Training Overview: Why a Rivers and Roads Training, What to expect
- 8:20 AM Introduction to Geomorphology Presentation
- 8:35 AM Field Manual Introduction
- 8:50 AM Habitat Introduction Presentation
- 9:15 AM Introduction to Pond Brook Exercises
- 9:20 AM Group Up and Travel to Berlin Pond Brook Field Site
- 9:50 AM Pond Brook Field Exercises and Breaks
- 1:50 PM Travel to VTTC
- 2:10 PM Pond Brook Recap and Data Summary, Morphology Presentation
- 2:40 PM Building an Equilibrium River Model Exercise
- 4:10 PM The Equilibrium and AOP Standards
- 4:20 PM Daily Summary
- 4:30 PM Break For the Day

Day 2 Rivers in Adjustment, Channel Evolution

- 8:00 AM Channel Adjustments and Evolution Presentation
- 8:15 AM Channel Evolution Exercises
- 9:45 AM Crossett Brook Introduction
- 10:00 AM Group up and Travel to Crossett Brook
- 10:30 AM Crossett Brook Field Exercise and Breaks
- 2:15 PM Travel to VTTC
- 2:45 PM Stabilization Structures Presentation
- 3:15 PM Building Stabilization Structures River Model Exercise
- 4:15 PM Daily Summary
- 4:30 PM Break for the Day

Day 3 Building and Maintaining Roads Along Rivers

- 8:00 AM AOP Presentation
- 8:30 AM Culverts Presentation
- 8:40 AM Designing the Reconstruction Exercises
- 9:40 AM Flood Recovery River Model Exercise
- 10:55 AM Travel to Culvert Sites
- 11:25 AM Culvert Field Exercises and Breaks
- 3:10 PM Travel to VTTC
- 3:25 PM Training Review
- 3:55 PM Wrap Up and Evaluation Survey
- 4:15 PM Training Concludes

Day 1: Stable Rivers and Aquatic Habitat

Day One introduces the topic of river morphology with a focus on river equilibrium and the components and processes necessary for maintenance of equilibrium. A second presentation provides an introduction to habitat needs of aquatic organisms and the features that make up aquatic habitat. Following the presentations, participants head into the field to assess the geomorphic condition and aquatic habitat value of several reaches of a small brook. After the field exercises, participants return to the class to report on their observations and conclusions. The last activity of the day is a river modeling exercise in which participants build a model of the river reaches visited in the field.

Exercises and Presentations

Training Overview

A quick presentation on why VTrans and ANR are partnering to provide state, municipal and private sector transportation infrastructure design and maintenance professionals this training program and what knowledge and skills participants should expect to gain during the workshop.

Introduction to Fluvial Geomorphology

This presentation will review and build on the concepts and principles that participants learned in the Tier 1 training. It will provide the foundation needed for the remainder of the training to be effective. Topics will include river morphology, equilibrium and bankfull flow.

Habitat Introduction

The physical characteristics of the river are the foundation of physical habitat. Deep pools, undercut banks and clean spawning gravels are all physical habitat features that require many of the same river processes and components that are necessary for river stability.

Assessing Geomorphic Condition and Habitat Value

This exercise takes participants into the field to examine examples of the processes and features they have been introduced to in the classroom. In-field observations and measurements strengthen participants' understanding of river morphology and aquatic habitat elements and their ability to assess a river's overall equilibrium condition. The exercise consists of walking equilibrium reaches that represent common river morphologies or types, making measurements and observations to characterize the valley and channel morphology, identifying habitat elements and using all the information obtained in the field to evaluate the overall equilibrium condition of the reaches.

Geomorphic Condition and Habitat Value Discussion

This classroom discussion leads participants through a process of synthesizing field observations to develop a consensus around the geomorphic condition and habitat value of the various reaches visited in the field exercise.

Building an Equilibrium River Modeling Exercise

This exercise has participants working in a physical river model to create detailed scaled replicas of the equilibrium river reaches they observed during the preceding presentations and field exercise. By replicating and combining individual components of a river to construct an equilibrium reach,

participants are forced to think in detail about the river as a system. Once the models are completed, flow is run through them, fluvial processes are observed and rigorous discussion and model refinement ensues. With the deeper grasp of equilibrium river systems and processes created by this exercise, participants will be better equipped to consider river stability when designing, constructing or maintaining infrastructure along rivers.

Equilibrium and AOP Standards Presentation

This short presentation introduces participants to the use of equilibrium and aquatic organism passage as criteria for permitting under the ANR Stream Alterations Permitting Program.

End of Day Discussion and Quick Quiz

The day concludes with a short review of topics covered throughout the day and a quick and informal quiz that encourages participants to actively think through the lessons of the day as means of improving their retention of the knowledge to which they've been introduced.

Day 2: Rivers in Adjustment, Channel Evolution

On day two the focus shifts to channel adjustment and channel evolution and techniques for constructing and maintaining transportation infrastructure while accommodating river equilibrium. The day begins with a presentation of the channel evolution process followed by a slide-based exercise and a flume demonstration, each focused on the channel evolution process. Following the classroom exercises, participants head into the field to assess the geomorphic condition and aquatic habitat of an adjusting reach of river. Upon return to the classroom participants are introduced to the design and construction of river stabilization structures and finish the day with a river modeling exercise in which they construct stabilization structures.

Exercises and Presentations

Channel Evolution Presentation

This presentation reviews and expands on the channel evolution material presented in Tier One. Participants are provided a more detailed explanation of the Schumm Channel Evolution Model, various stages of channel evolution in Vermont and an explanation of how historic land use and channel management activities led to the widespread occurrence of channel evolution throughout the state.

Identifying Channel Evolution Exercise

This slide based exercise tests participants' ability to identify the channel evolution stage of sites from around Vermont and hypothesize the cause of the evolution. Participants are provided site photographs, valley setting and drainage area information and asked what the equilibrium condition would be and to contrast that against the existing condition. The ability to identify the stage of channel evolution of a river reach is critical in designing recovery and maintenance projects that enhance river equilibrium.

Channel Evolution Flume Demonstration

This flume activity demonstrates the cause and effect relationship between a variety of channel management activities and channel adjustments. Giving participants the ability to observe process in

action, this demonstration greatly enhances their appreciation for the link between land use and channel management activities and river equilibrium.

Assessing the Morphologic Condition and Aquatic Habitat Value of an Adjusting River Field Exercise

In this field exercise participants will conduct qualitative and quantitative assessment of a dynamic reach of river including the valley, floodplain, banks, and channel in order to determine its morphologic condition and potential habitat value. The primary purpose of this exercise is to reinforce participant's knowledge and understanding of channel adjustment/evolution processes by providing them an in-field look at river adjustments. Participants will place their observations in the context of channel evolution examples provided in previous exercises and presentations to evaluate the severity of channel instability.

Stabilization Structures Presentation

This presentation reviews traditional stabilization structures and introduces the design and function of more recently developed and less familiar structures. Discussion will focus on appropriate use of these structures in the context of site conditions, project goals and river stability and aquatic habitat considerations. A fundamental knowledge of the full suite of stabilization structures enhances participants' ability to maintain and repair transportation infrastructure damaged by river adjustments.

Building Stabilization Structures Modeling Exercise

Building stabilization structures with adherence to design specifications in irregular rivers using irregular materials is extremely difficult. Following a presentation on stabilization structures, participants work in the river model to design and build the various structures presented. Structure design and layout considers stated project goals and channel morphology. The importance of construction techniques and adherence to typical specifications is emphasized. Once the structures have been built, flow is run through the channel, structure performance observed, and modifications made to improve performance. With a greater understanding of various stabilization structure options and the benefits and costs associated with each, participants will be better prepared for conducting stabilization work without technical assistance.

End of Day Discussion and Quick Quiz

Day Two concludes with a short review of topics covered and an informal quiz. In order to reinforce lessons from the previous day, the Day Two discussion and quiz includes topics covered in Day One.

Day 3: Building and Maintaining Roads Along Rivers

Day Three continues to focus on reconstruction, adding to the discussion the topic of bridges and culverts and their potential effects on river equilibrium and aquatic organism migration. The day starts with presentations on the effects of crossing structures on aquatic organism passage and river equilibrium. Following the presentations, participants engage in a river modeling exercise in which they reconstruct a multi-faceted flood damage site in a manner that enhances the long term stability of the river and infrastructure. Following the modeling exercise and discussion, the training heads back into the field to assess the geomorphic and aquatic organism compatibility of several crossing structures. The training concludes back in the classroom with a wrap-up presentation and pop quiz.

Exercises and Presentations

Aquatic Organism Passage Presentation

This presentation introduces participants to the migratory requirements of fish and other aquatic organisms, how road crossing structures can impact migration, Vermont ANR's work to identify structures that create migration barriers and to remove those barriers. With a greater appreciation of the migratory needs of fish and other aquatic organisms, participants will be more likely to ensure crossing structures provide organism passage.

Culverts and River Processes Presentation

This short presentation focuses on the impacts of culverts on sediment and debris transport and the implications for broader river equilibrium.

Evaluating the Reconstruction Exercise

In this exercise, participants are presented slides of flood recovery projects and asked to comment on the likely effectiveness of each project and how they could be modified to better accommodate river equilibrium and aquatic habitat. It is typical for several participants to be familiar with a particular project which adds vitality to the discussion.

Flood Recovery Modeling Exercise

This river modeling exercise requires participants to respond to infrastructure failure caused by vertical and lateral channel adjustments resulting from severe flooding. Participants utilize what they have learned about the physical characteristics of rivers in equilibrium, channel adjustment processes, and techniques for restoring channels to assess the existing channel condition against the equilibrium condition and design and build a reconstruction project that restores long term river and infrastructure stability. Once the reconstruction is complete flow is run through the channel, fluvial processes and project performance observed and discussed, and modifications made to improve project performance. The primary goal of this exercise is to strengthen the participants' ability to respond to complex post-flood scenarios.

Crossing Structure Assessment Field Exercise

In the crossing structure assessment field exercise, participants use abbreviated versions of the Vermont Geomorphic Compatibility and Aquatic Organism Passage assessment protocols to assess several culverts. This real-world look at the characteristics of crossing structures and how they can affect channel equilibrium solidifies participants' understanding of this topic.

Tier 2 Training Wrap-Up Discussion and Quick Quiz

The final activity of the Tier 2 Training is another end of day discussion and quick quiz. The discussion and quiz focus on all topics covered over the course of the three days. This discussion gives both the instructors and participants a last chance to identify and fill any gaps in participants' understanding of material covered.