

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. We have come to recognize that attempts to control rivers only increase 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 river's 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

Day 1 River Morphology Equilibrium and Evolution

- 8:30 AM Welcome and Introductions
- 8:45 AM Training Overview: Why a Rivers and Roads Training, What to Expect
- 8:50 AM Standard Practices and Field Manual Introduction
- 8:55 AM Introduction to Geomorphology Presentation
- 9:25 AM Habitat Introduction Presentation
- 9:45 AM Channel Adjustments and Evolution Presentation
- 10:00 AM Channel Evolution Exercises/Demo
- 11:00 AM Introduction to Field Exercises
- 11:10 AM Lunch
- 11:40 AM Group-up and Travel to Field Site
- 12:00 PM Field Exercises
- 2:30 PM Travel to Classroom
- 2:50 PM Building an Equilibrium River Modeling Exercise
- 3:50 PM AOP Presentation
- 4:15 PM Culverts Presentation
- 4:30 PM Break for the Day

Day 2 River Management and Flood Recovery Practices

- 8:30 AM Standard Practices Presentation
- 9:00 AM Standard Practices River Model Exercise
- 9:40 AM Lessons From Irene
- 10:15 AM Implementation Standards for Emergency Protective Measures
- 10:45 AM Field Exercises Introduction
- 10:55 AM Group-up and Travel to Field Site
- 11:15 AM Field Exercises and Break
- 2:40 PM Travel to Classroom
- 3:00 PM Flood Recovery River Modeling Exercise
- 4:00 PM Daily Summary
- 4:20 PM Evaluations
- 4:30 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 the Vermont Standard Principles and Practices for Stream Alterations and the Rivers and Roads Field Manual

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.

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 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.

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.

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 that 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.

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 on infrastructure that began at the end of day one with discussion of culverts is continued. Participants are introduced to the river management practices contained in the Vermont Standard River Management Principles and Practices Document and given an opportunity to implement those practices in the river model. Next a presentation on past flood recovery projects provides participants an opportunity to critique past projects. Another presentation introduces participants to ANR's new Emergency Protective Measures authorization process and standards. Participants then head into the field for a tour of the Great Brook in Plainfield for a first-hand look at the impact of historic river management practices on river adjustments, how those adjustments affect surrounding infrastructure over time, and an opportunity to consider how alternative practices may have fared. Upon returning to the classroom, 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. The day wraps up with a quick quiz that reviews topics covered over the two days of training.

Exercises and Presentations

Standard Practices Presentation

This presentation provides an overview of the river management practices contained on the Vermont Standard River Management Principles and Practices Document. Discussion will focus on appropriate use and construction of these practices in the context of site conditions, project goals and river stability and aquatic habitat considerations. A fundamental knowledge of the full suite of the practices enhances participants' ability to maintain and repair transportation infrastructure damaged by river adjustments.

Implementing Standard River Management Practices Modeling Exercise

Implementing river management practices with adherence to design specifications in irregular rivers using irregular materials is extremely difficult. Following a presentation on the standard practices, participants work in the river model to design and build the various practices 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 practice options and the benefits and costs associated with each, participants will be better prepared for designing and implementing sound river management practices without technical assistance.

Lessons from Past Floods Slide 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.

Implementation Standards for Emergency Protective Measures Presentation

Among other things, the 2012 Rivers Bill establishes standards for the implementation of emergency measures approved by a municipality. This presentation presents those standards in detail and provides a larger overview of Vermont's new Emergency Protective Measure permitting process.

A Tour of River Management Practices Along Great Brook Plainfield

Great Brook in Plainfield is a rapidly adjusting river bordered by many houses and town roads that run along most of its 5 miles. Over the past 25 years it has caused perhaps the most extensive flood damage of all rivers in Washington County. Properties and infrastructure have incurred repeat damages, multiple houses and bridges have been completely destroyed and 12,000 linear feet of rip rap have been placed along the river. This tour of the Great Brook provides participants with a first-hand look at the impact of historic river management practices on river adjustments and how those adjustments affect surrounding infrastructure over time and an opportunity to consider how alternative practices may have fared.

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 is observed and discussed, and modifications are made to improve project performance. The primary goal of this exercise is to strengthen the participants' ability to respond to complex post-flood scenarios.

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 two days. This discussion gives both the instructors and participants a last chance to identify and fill any gaps in participants' understanding of material covered.