Managing Toward Stream Equilibrium Conditions

A Case for Minimizing the Structural Control of Vermont Rivers

Structural Measures and Channelization

A "channelized" river has had structural measures, such as bank armoring and berming, applied to keep it from moving. Initially rivers in Vermont were channelized into straightened forms to hasten runoff and maximize the use of valley-bottom land. Structural measures and channelization have been used for decades to protect those investments and have created the public perception that rivers should not move.

More recently, structural measures have been used to achieve environmental objectives. Streams have been armored with rock (also called rip-rap) or other revetments to try to stop erosion and reduce nutrient loading and sedimentation. Streams have even been rip-rapped to protect existing or soon-to-be planted riparian vegetation. In lieu of rip-rap, bioengineering, using a combination of live vegetation, rock and/or wood materials, is being practiced to try to stop stream bank erosion. Some river restoration projects use structural measures to mimic the forms of naturally dynamic rivers, but are then maintained as static channels. This is yet another type of channelization.

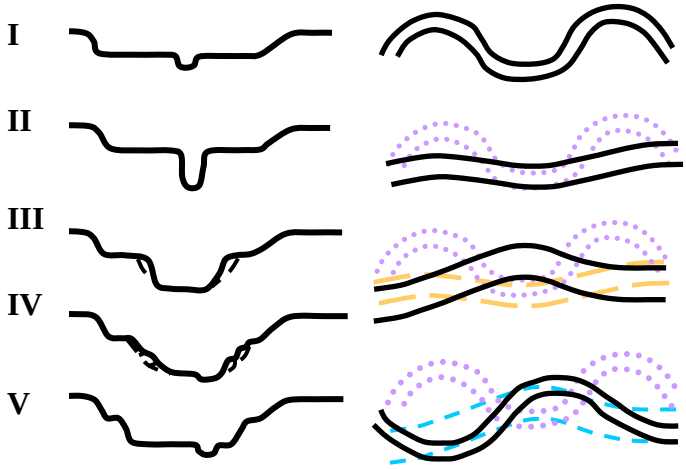
Historically, federal and state disaster relief programs provided the greatest financial support to landowners experiencing flood-related erosion. More recently, landowners needing help with controlling bank erosion have turned to other state and federal environmental programs. River channelization and structural controls are being done under the mantles of soil conservation, water quality, and habitat enhancement. People eager to stop the erosion threatening their homes or land have been the "willing landowners," ready to sign up for assistance under any environmental conservation program that will armor their stream banks.

But after a century or more of channelization with structural measures, erosion hazards have increased, aquatic and riparian habitat remain degraded, and nutrient loading from erosion is still increasing. Repeated and costly efforts to control long lengths of rivers as static channels is proof that channelization with structural measures is an unsustainable public policy. This paper will attempt to lay out an alternative program for Vermont. Some measure of structural control to protect public and private property will be necessary, but society will be better served if we start to loosen our grip on rivers.

Breaking the Cycle with Structural Measures

Government water quality programs have long emphasized the goal of reducing instream sediment loads. This may be pertinent for stream channels at or near equilibrium[1]. However, attempting to reduce instream sediment load through the control of streambank erosion during mid-stages of the channel evolution process (see diagram below), may result in short term reductions but will contribute to long term increases in sediment load.

Historically, public agencies have engaged in the practice of chasing incised streams with rip-rap only to have the entire stream network unravel during the next large flood. Relying on structural approaches, irrespective of channel evolution processes, has been counterproductive in the long term. Perhaps more importantly, this reliance has diverted limited public resources away from solving the underlying problems of land use encroachments, hydrologic and sediment regime alterations, and channel disequilibrium.



Channel evolution process showing channel down-cutting or incision in Stage II (cross-section), widening through Stages III and IV, and floodplain re-establishment in Stage V. Stages I and V represent equilibrium conditions. Plan view shows straightening and meander redevelopment that accompany cross-section changes. A flood-driven process taking place over decades.

Structural measures, and the knowledge to use them in environmentally-sound ways, will always be necessary. But there needs to be a greater understanding and agreement on the situations in which they are applied.

[1] *Fluvial Geomorphic Equilibrium*: The condition in which a persistent stream and floodplain morphology is created by the dynamic fluvial processes associated with the inputs of water, sediment, and woody debris from the watershed. The stream and floodplain morphology is derived within a consistent climate; and influenced by topographic and geologic boundary conditions. When achieved at a watershed scale, equilibrium conditions are associated with minimal erosion, watershed storage of organic material and nutrients, and aquatic and riparian habitat diversity.

For example, landowners in Vermont are permitted to armor stream banks to protect their property, but should be encouraged to forgo doing so if no substantial structures or investments are threatened, and the erosion is part of the stream's recovery from historic channelization. Stream bank revetments may warrant conservation program support when used to achieve and sustain equilibrium conditions, and when doing so, will promote the establishment of native riparian vegetation to minimize stream bank erosion over time. Otherwise, conservation programs will spend public funds trying to protect private property and improve water quality, when in the end, neither are served.

Landowners and local governments need to hear a consistent message about channelization practices from state and federal resource agencies. Cost share programs, technical guidance, and other land use incentives for local governments and private landowners that discourage river corridor encroachments will achieve the goals of the Clean Water Act faster than promoting "greener" structural measures to protect ill-conceived encroachments. Moreover, once state and federal agencies are in agreement, they will need to find the political fortitude necessary to change public programs so as **not** to intervene on every eroding stream bank, thereby allowing streams to evolve back to equilibrium conditions. Without a state-federal partnership, the traditional river management paradigm will persist; one that accommodates land use encroachments in the river corridor, a never-ending cycle of erosion hazards, and costly channel management imperatives that rely on traditional structural measures.

Encroachments on a straightened and incised channel that must now be maintained as a channelized river transferring its erosive energy and sediment load to downstream reaches.

Managing streams and watersheds toward equilibrium conditions presents a challenge far more vexing than the engineering of erosion control is capable of addressing. Geomorphic assessments to observe and explain the evolution of river channels and the failure of channelization practices to control natural processes, will be essential to increase public awareness and support.

Managing Toward Stream Equilibrium

The Vermont River Management Program (RMP) is documenting the physical condition of rivers throughout the state. The RMP is also assessing the erosion hazard, water quality, and habitat impacts associated with watershed and channel modifications. Assessment data are showing that berming, armoring, and dredging have modified the hydraulics of streams, have required ongoing maintenance, and have led to the systemic channelization of stream networks.

With a full appreciation for large scale fluvial processes and concern over the costs to society when physical river imperatives are ignored, the RMP is advocating for a change in direction. *It is the River Management Program's goal to manage toward, protect, and restore the fluvial geomorphic equilibrium conditions of Vermont rivers by resolving conflicts between human investments and river dynamics in the most economically and ecologically sustainable manner*.

The RMP seeks to minimize the need for structural measures. We are sharing the science and partnering with state and federal resource agencies to focus on the sources of sediment-related surface water impairments. These sources are the land use conversions, investments, and expectations within river corridors which result in: a) inundation and erosion conflicts with river dynamics, b) the application and maintenance of structural measures to resolve those conflicts, and c) the spiraling economic and environmental costs associated with fluvial erosion hazard mitigation.

Where feasible, the RMP promotes an avoidance strategy, one which involves the planning, designing, and protecting of river corridors to accommodate stream meander and floodplain processes, as the most economically and environmentally sustainable river management alternative.

Watershed Assessment and Project Planning

There is a great danger in project planning to weigh the effects of channel modification or "restoration" alternatives against the effect on <u>existing</u> conditions; particularly when existing conditions can be and so often are

profoundly removed from a sustainable equilibrium condition. The landscape is littered with failed channel management projects that considered the existing condition to be static or sustainable when in fact, the existing channel dimensions, pattern, and profile were just a stage of the channel's evolution toward equilibrium.

Traditionally, project proponents have supported virtually any desired channel modification practice simply by choosing the matching management objective. For instance, projects are commonly proposed on incised channels. These channels have lost access to their floodplains and need to widen in order to form new floodplains. The project proponent sets a management objective to "reduce downstream discharges of sediment from bank erosion." The proponent often selects armoring with rip-rap as the structural measure of choice. However, bank armoring typically forces the channel to incise deeper or lead to down-cutting and incision upstream. In this scenario, it is counterproductive to armor the banks to try to prevent the erosion that is necessary for the widening process. As is so often the case, the structural controls virtually guarantee an increase in future sediment discharges and erosion hazards downstream.

Managing toward equilibrium conditions and successfully implementing projects at the local scale, will require river corridor plans that consider watershed-scale changes. Plans should explain the cumulative impacts and set priorities for treating the multiple stressors that have altered the geometry and physical characteristics of streams. The physical condition of Vermont rivers is the result of over 200 years of channel and watershed manipulation, deforestation, and floods. Nearly every contemporary management decision should be made in this context and weigh alternatives based on larger spatial and temporal considerations.

The Vermont River Management Program is promoting an analysis of reference fluvial processes and geomorphic condition. The RMP is examining the watershed and reach-scale stressors which explain the departure (from reference) and sensitivity of existing conditions. Mapping the departure and sensitivity of reaches in the context of vertical and lateral channel constraints throughout the stream network can explain the type and rate of channel evolution processes underway, and how adopting certain management practices can accommodate, preserve, or restore equilibrium conditions over time.

The Vermont RMP is drafting a *"River Corridor Protection and Restoration Planning Guide"* to help its partners evaluate physical stressors, channel response, and river management alternatives.

The greatest challenge is to change the public's perception that the channel widening, floodplain and meander redevelopment, and erosion that goes along with these adjustment processes are **not always bad.** Helping landowners achieve a more sustainable relationship with straightened and channelized rivers would be a cost-effective management alternative.

In conclusion, society must acknowledge that public and private investment within Vermont river corridors is the driver behind expensive structural channel controls. Over-channelizing has led to repeated structural failures, increased fluvial erosion hazards, sediment and nutrient loading, and the impairment of aquatic and riparian habitat. Consensus and support for actions that promote sustainable river corridor land use may be accelerated, when these societal costs are fully recognized.

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River Scientist Program Web Page: http://www.watershedmanagement.vt.gov/rivers.htm