

Fluvial Erosion Hazards Areas

Frequently Asked Questions and Answers



Cold River, Shrewsbury, 2000

Vermont River Management Program
Vermont Agency of Natural Resources

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Q & A on Fluvial Erosion Hazard Areas

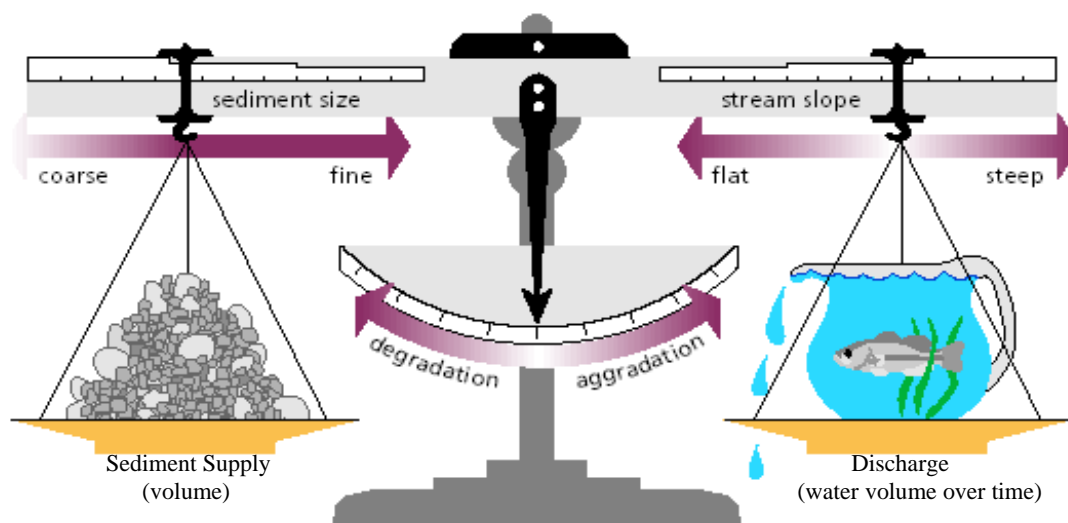
The VT Department of Environmental Conservation's River Management Program offers responses to frequently asked questions about fluvial erosion hazard areas. These questions were compiled from inquiries raised at numerous public meetings and conversations with municipal and regional planning commissions, selectboards, and consultants. This Q & A also incorporates the comments and questions received as part of a process in 2009 to update the ANR Technical Guidance for Determining Floodway Limits, pursuant to Act 250 Criterion 1(D) (to be referred to as the "ANR Technical Guidance"). If you have any further questions, please contact us directly or consult our website:

<http://www.anr.state.vt.us/dec/waterq/rivers.htm>.

Section 1: General Questions

Q1. What is a stable stream?

A1. A stable stream refers to a stream that has evolved to its most probable, least erosive form. It is in balance with its watershed inputs – water, sediment, and woody debris – given a certain depth, slope, and boundary sediment size. The term "equilibrium condition" is often used to describe a naturally stable stream.



Lane's Balance of Sediment Supply & Sediment Size **with** Slope (energy grade) & Discharge
(Lane, E.W. 1955. "The Importance of Fluvial Morphology in Hydraulic Engineering."
In Proceedings of the American Society of Civil Engineers 81(745): 1-17.)

Vermont stream geomorphic assessments (2004-2010) describe current physical stream conditions and the likelihood of channel adjustments. The data show that after 200 years of landscape changes that include channel, floodplain, and watershed modification, 75% of the field assessed stream miles are in an unstable condition. The increased power of larger floods, contained within these incised channels, has led to higher rates of systemic bed and bank erosion. These streams will continue to erode, deposit sediment, and adjust their slope, as they "evolve" to most probable stable forms. Anticipated channel adjustments are governed by the fundamental physics that streams will continue to do work until they come into balance with watershed inputs.

Q2. What are fluvial erosion hazards?

A2. Fluvial (or river-related) erosion hazards (FEH) refer to major streambed and streambank erosion associated with the often catastrophic physical adjustment of stream channel dimensions (width and depth) and location that can occur during flooding. Fluvial erosion becomes a hazard when the stream channel that is undergoing adjustment due to its instability, threatens public infrastructure, houses, businesses, and other private investments.

Q3. What is a Fluvial Erosion Hazard Area?

A3. An FEH area includes the stream and land adjacent to the stream. It identifies an area where stream processes may occur that enable the stream to re-establish and maintain a stable slope and dimensions over time. A stable stream slope occurs when a channel reaches a certain length. This length is accommodated by a corridor of floodplain area described as the meander belt. The fluvial erosion hazard area is a calculated belt width-based corridor where erosion is minimized when stream equilibrium conditions are achieved. FEH area boundaries attempt to capture lands most vulnerable to fluvial erosion in the near term and indicate the type, magnitude, and frequency of fluvial adjustments anticipated during flood events. The area can be mapped, and is based on quality-assured fluvial geomorphic data (i.e., data that describe the physical form and process of a riverine system).

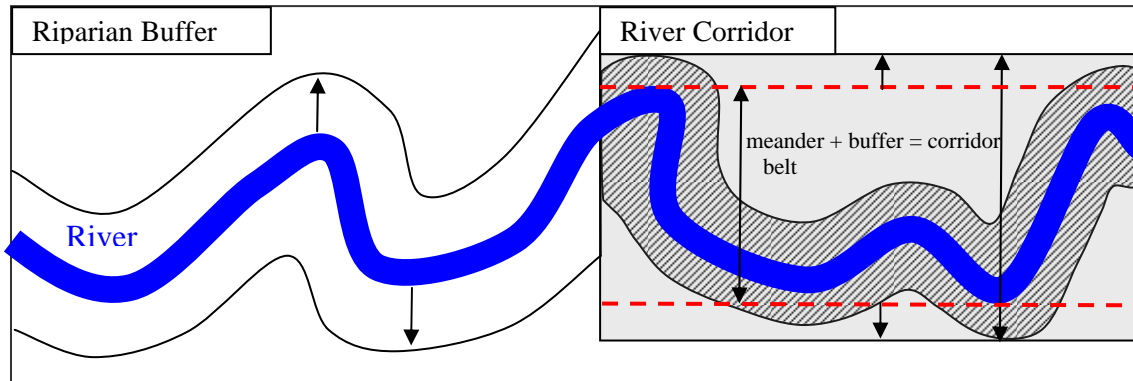
Q4. Are FEH Areas the same as buffers?

A4. Not quite. Refer to figure below. FEH areas and buffers both refer to land adjacent to streams. They differ in that FEH areas are specified structural setbacks necessary to accommodate the width and depth dimensions, meander pattern, and slope profile of a stream in its most stable, least erosive, “equilibrium” condition. The width of the FEH area is based on the stream meander belt, which is derived from fluvial geomorphic assessments, and extends to a width necessary to capture the outside bends of the naturally stable stream under equilibrium conditions.

A buffer is a specified, vegetated setback from the top of a stream bank or top of a slope. A buffer typically assumes that the river is a static, unchanging system, unless it is allowed to “float” (or move) with the river. It can contribute to stream bank stability, depending on its size and vegetation. How effective a buffer may be in enhancing stability is also dependent upon other physical parameters of the stream. For example, a deeply incised channel with high banks tends to be minimally influenced by streambank vegetation. However, the principal benefits of a buffer include providing water quality, habitat function, and shade for keeping water temperatures cool. (The term, “setback” is a specified distance from the top of a riverbank or shoreline, measured perpendicular from the waterway.)

Ideally, the FEH area incorporates the entire river corridor, which includes both the meander belt and a buffer, providing space for both the channel in its most probable, stable, equilibrium form and sufficient woody vegetation to naturally stabilize the banks. A healthy stream requires the attributes of both: (a) a river corridor to improve stream stability, enhance public safety, reduce flood losses, sustain high quality aquatic and riparian (riverside) habitats, and provide long term water quality benefits; and (b) vegetated buffer to provide bank stability, temperature moderation, and additional water quality and habitat function.¹

¹ See Appendix E: River Corridors, FEH Areas, Setbacks, and Buffers of the [Municipal Guide to Fluvial Erosion Hazard Mitigation](#) and the 2008 [River Corridor Protection Guide](#) for more information. References to both documents can be found at the end of this document.



Comparing a buffer setback to a river corridor. Adapted from Ohio DNR, Rainwater and Land Development Manual, 2006 Ed., Ch 2. Post Construction Stormwater Management Practices, p. 21.

Q5. Does the FEH capture every location where the stream had been historically?

A5. As described above, the FEH area consists of a floodplain corridor, the dimensions of which are determined using physical relations between the channel width and the meander belt width. These relations are supported by both published research and values empirically derived using peer-reviewed Vermont reference reach data. Unlike FEMA floodplain delineations which attempt to model exactly which lands would be inundated during the 100 year flood, FEH areas are not created to define all possible locations where flood-related erosion may take place. To do so would result in a corridor that would capture the entire valley floor. FEH areas provide the minimum space necessary for a stream to achieve and maintain a stable depth and slope, and represent a least-cost alternative to reducing severe erosion and flood losses that take place when streams are unstable due to encroachment and channelization.

Q6. How is a Fluvial Erosion Hazard Map used?

A6. Since avoidance is the most cost effective approach to mitigating fluvial erosion hazards, in comparison to a retrofit, removal of a structure, or a modification to protect the structure, an FEH Overlay District is an important municipal planning tool for limiting encroachment along rivers. The ANR uses FEH maps to help identify floodways under Act 250 Criterion 1(D). An FEH map can also be used to support other flood mitigation opportunities, including the identification of stream and floodplain restoration projects, bridge and culvert replacements, and river corridor protection opportunities. An FEH can be a critical tool enabling the establishment of a sustainable community relationship to the fluvial systems within its community and to permanently protect and enjoy the social, economic and ecological benefits of rivers, streams and their riparian areas.

Q7. Why should Vermont citizens be concerned with fluvial erosion?

A7. Of all the natural hazards experienced in Vermont, flooding is the most frequent, damaging, and costly, averaging \$14 million a year in damages. While some flood losses are caused by inundation (i.e. waters rise, fill, and damage low-lying structures), most flood losses in Vermont are caused by fluvial erosion. If one of the purposes of land use regulation is to protect public safety from known risks, then having a fluvial erosion hazard component as part of a municipal bylaw meets this requirement.

Q8. Why is the consideration of fluvial erosion hazard (FEH) areas in state land use permitting (Act 250) so critical?

A8. Similar to having local land use regulation to protect the public from known hazards, a fluvial erosion hazard component to the ANR floodway determination under Act 250 Criterion 1(D) provides a review of public safety from flood hazards for all projects under Act 250 jurisdiction.

The U.S. Congress passed the Disaster Mitigation Act of 2000, requiring the development of local and state all hazards mitigation plans in order to continue to receive FEMA disaster mitigation and post-disaster public assistance. The State of Vermont Hazard Mitigation Plan (2010) acknowledges fluvial erosion as a frequent and high risk hazard type and describes a statewide goal of reducing flooding and erosion hazards. Act 137 – the Vermont Legislature’s response to the series of large flood events in the 1990s – contained the overarching objective of promoting long-term river stability to provide both protection from flood damage and healthy riverine function (Act 137 Section 2 (1998), Sec. 210 V.S.A. §905b(3)).

ANR recently worked with Vermont Emergency Management to evaluate the amount of public assistance (federal and non-federal funds), including the flood recovery grants under the Hazard Mitigation Grants Program (HMGP), required to recover from the federally declared flood disasters between the years 1989 to 2008 (the years with more accurate tracking data). During this period, flood recovery cost \$148.3 million (in 2008 dollars). As described in the State Hazard Mitigation Plan, mitigation strategies that focus on conflict avoidance between land uses and fluvial processes are cost effective approaches that will lessen future flood losses. The inclusion of an FEH component in the State Act 250 floodway procedure in 2003 was to acknowledge the significance of fluvial erosion as a hazard in Vermont.

Q9. Is the National Flood Insurance Program (NFIP) floodplain maps sufficient for capturing most of the flood hazard?

A9. The NFIP is an insurance program, managed by the Federal Emergency Management Agency (FEMA) and available to property owners in towns that are enrolled in the program. The program provides property owners with flood insurance in order to receive financial assistance after a flood. Unfortunately, the NFIP maps are elevation-based, delineating *inundation* hazards only. The NFIP maps also represent a static impression of a dynamic system. The maps do not consider *fluvial erosion* hazards or the dynamic nature of river systems due to the physical channel adjustment processes, and thus, provide little guidance to a town or landowners assessing fluvial erosion-related flood risks. Moreover, communities need only adopt FEMA’s minimum standards for flood hazard area regulation in order for their residents to be eligible to purchase flood insurance. These minimum standards allow for extensive encroachment into areas vulnerable to fluvial erosion and often result in extensive loss of flood plain and riparian lands throughout Vermont.

To assume that the FEH area is mostly captured by the FEMA regulated inundation floodplain area may be dangerous and costly. In fact, the NFIP minimum standards allow for new development into mapped flood hazard areas without regard for the fluvial erosion hazard potential, which exacerbates flood loss, degrades river conditions, and increases costs associated with flood recovery.

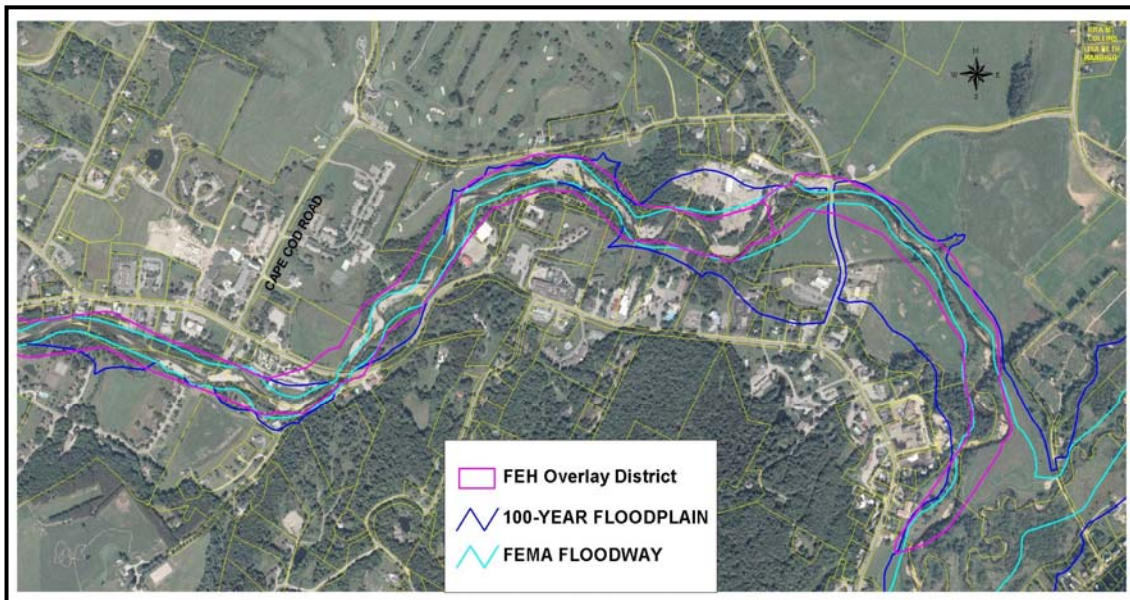
During 2008, one-third of all flood insurance claims nationwide were from areas outside of the 100-year floodplain. http://www.floodsmart.gov/floodsmart/pages/flood_facts.jsp. Over 75% of damages in Vermont caused by the five major floods of the 1990s were due to fluvial erosion. FEMA’s regulations recognize that the NFIP standards offer minimal protection against inundation and erosion hazards, and they explicitly encourage communities to adopt more protective standards:

“...The criteria set forth in this subpart are minimum standards for the adoption of flood plain management regulations by flood-prone, mudslide (i.e., mudflow)-prone and flood-related erosion-prone communities. Any community may exceed the minimum criteria under this part by adopting more comprehensive flood plain management regulations.... In some instances, community officials may have access to information or knowledge of conditions that require, particularly for human safety, higher standards than the minimum criteria.... Therefore, any flood plain management regulations adopted by a State or a community which are more restrictive than the criteria set forth in this part are encouraged and shall take precedence” (44 CFR §60.1(d)).

There are uncertainties associated with the NFIP maps, which raise questions about how protective they are from even an inundation hazard standpoint. With Base Flood Elevations (BFEs) being published to the tenth of a foot, a certain degree of accuracy is implied. Estimates of inundation-based flood risk are always uncertain because of limited data and the high spatial and temporal variability associated with hydrologic cycle, sediment load, and river mechanics. Moreover, the process of developing BFEs assumes clear water conditions, ignoring sediment, ice, and debris transport. Vermont’s typically narrow, steep valleys do not lend themselves to precise water surface elevation modeling exercises.

Q10. Why should a community adopt a Fluvial Erosion Hazard (FEH) Zone?

A10. Communities are considering FEH mapping and zoning as a cost-effective strategy to reduce flood damages over time. Keeping development out of the fluvial erosion hazard zone will serve to protect public safety, reduce damages to private property and public infrastructure, and minimize the recovery costs and misery associated with those damages. Moreover, adopting an FEH overlay district provides important sustainable social, economic, water quality, and ecological benefits that come from allowing a river to achieve a physically stable condition over time. The FEH zone enables the stream to re-establish floodplain function that will serve to attenuate flood waters, store sediment, enhance aquatic and riparian habitat functions, reduce the frequency of in-channel management and flood recovery operations, and reduce nutrient pollution during times of flooding.



Section 2: Costs and Benefits

Q11. Does an FEH Zone Affect Property Taxes?

A11. An FEH zone should not have any impact on property taxes. The value and associated property tax base of properties adjacent to rivers are already tempered by how susceptible it is to flood damages and whether the property owner is required to carry flood insurance.

Q12. Will the FEH Zone affect flood insurance rates?

A12. The FEH zone can overlay onto the FEMA National Flood Insurance Rate Maps (FIRM), but it does not affect the FEMA flood maps. Therefore, it will not affect flood insurance rates. It is important to understand that portions of the FEH zone may be outside the mapped high risk inundation zone on the FEMA flood maps. Flood insurance policies do cover damage from flood-related erosion, and thus purchase of flood insurance is highly recommended for structures located in the FEH zone. Moreover, flood insurance premiums for areas outside of the FEMA high risk flood zone are substantially lower.

Q13. Will the FEH Zone affect homeowner's insurance rates?

A13. No. The Vermont Department of Insurance verifies that homeowners insurance policies do not cover damages from flooding, and therefore, flood risks, such as those illustrated on an NFIP flood insurance rate map or a fluvial erosion hazard map, do not affect homeowner's insurance rates. Damages from flooding and flood-related erosion are insurable under a separate policy for residents in communities that participate in the NFIP.

Q14. What flood-related costs does an FEH zone help avoid?

A14. There are direct and indirect costs associated with flooding. A town with a designated FEH zone or overlay district minimizes these costs. Direct costs include evacuation, rescue and relief support, emergency preparedness, cleanup, restoring public utilities and facilities, rebuilding public infrastructure, rebuilding homes and businesses that are not insured or are underinsured, restoring destroyed bridges and culverts providing access to homes and property, and providing temporary shelter for flood victims. Indirect costs include interruption of business functions, loss of wages and sales, operation and maintenance of flood control facilities, cost of loans for repairing or replacing damaged investments, and subsidies for flood insurance.

Q15. Does it make good economic sense for the state to promote an avoidance policy that centers on an FEH area as a "no build zone?" Are the costs of such a policy being fully considered?

A15. Vermont's Floodway Procedure pertains only to development reviewed under the state's land use jurisdiction (Act 250), and therefore involves a limited land base. The decision to zone more extensive areas to achieve river stability and hazard mitigation is voluntary on the part of individual municipalities. Municipal adoption of FEH ordinances would be subject to local public review and would not be a state or federal mandate. The state is working to create incentives for towns to adopt FEH not only to reduce future losses of new capital investments but also to protect the existing built environment including critical transportation infrastructure. The State and towns may reduce future damage to public and private investments by maximizing channel stability and floodplain function within river systems. Providing for dynamic equilibrium within an FEH area reduces the risk that other valley-bottom lands outside the FEH may erode or be damaged by inundation or avulsion, and increases the value and security of any investments made on these lands.

The ANR believes that protection of FEH areas represents tremendous potential economic benefit in terms of reduction of damages and flood-related losses. Our transportation infrastructure suffers the bulk of flood disaster costs precisely because we failed to respect and maintain river corridors by encroaching upon, constraining, and dredging our rivers. Public and private transportation facilities will enjoy great benefit as unconstrained areas of the stream network are able to redevelop floodplain access and equilibrium channel slopes within protected corridors.

The built landscape, including transportation infrastructure, homes and businesses, and agricultural land uses, depend upon the long term stability of the State's river systems. The geomorphic-based FEH areas are the spatial context for restoring and maintaining river and floodplain processes. Failure to set aside a river corridor to accommodate river processes, continued encroachment into the FEH area, and channelization practices to protect these new investments will result in further stream disequilibrium and extensive channel adjustment extending upstream and downstream. The current pervasiveness of stream instability demands a longer term perspective, a watershed-scale evaluation, and cost-effective solutions.

Focusing only on the costs versus benefits draws attention to short-term economic variables. Such a narrow economic test discounts the future benefits of avoiding or mitigating flood damage. It also fails to adequately consider future benefits of greater public safety, greater resiliency from climate change, and mitigation of indirect and intangible losses associated with flooding, such as avoidance of water quality degradation, toxic contamination, damages to public water supply and waste water utilities, dispersion of household wastes and other debris, and outright misery. Discounting these future benefits in a way trivializes the long-term risks, and minimizes the real threat the public faces from flooding. The fundamental objective is to cost-effectively restore and maintain stable river processes, allow for re-connection of rivers and floodplains to attenuate flood waters, and reduce the discharge of sediment and nutrient pollution, and achieve the socio-economic benefits and ecosystem services that healthy, stable streams provide for their communities. The State is entrusted to achieve this objective.

Q16. What happens if there is major, human-imposed feature or infrastructure, such as a highway, adjacent to the stream channel? If the FEH area includes the highway, how would the FEH affect the State or municipality interests to maintain that infrastructure? Alternatively, if the FEH area is shifted entirely to one side of the stream to avoid including the infrastructure, doesn't it imply that boundaries have become somewhat arbitrary, no longer being based on science and natural land features?

A16. For the purposes of delineating river corridor, valley walls or side slopes represent the lateral extent to which the river will meander. These natural land features are used to delimit river meander belts. However, many of our roads and highways encroach on floodplains and cross streams, which is in part because of Vermont's mountainous landscape and the requirement that the rivers and road networks must share space in our narrow valleys. Therefore, ANR administratively treats these significant human-constructed features as the de facto "valley wall" or confining features. The FEH is shifted to one side of this feature to insure that the stream's meander belt has adequate width to accommodate the longitudinal slope of the stream at equilibrium, as well as to acknowledge and support societal interests to protect those public investments from flood damages.

ANR recognizes that certain infrastructure (e.g., engineered levees, highways) may be damaged during a flood. The ANR generally supports, is actively involved in, and is party to the societal interests to reconstruct these facilities and resolve the conflict with river dynamics, hopefully in a way that reduces rather than increases future subsequent losses.

The ANR acknowledges that protecting the public's interest in roads, in an FEH mapping context, may be perceived as shifting a portion of the near term burden of establishing FEH areas onto private individuals and other public interests, and as such, represents a public policy that warrants close examination. In moving forward, the State (through Act 137) considered the unstable condition of our rivers, the lack of land use planning to reduce flood hazards in Vermont, and the failure of structural approaches to keep rivers static. The State also realized failure to develop public policy to address this issue would result in unabated encroachment and an escalation of flood damage to both public and private property. With a "do nothing" policy being costly to everyone, the ANR adopted procedures and technical guidance that represents a "least cost" alternative for avoiding flood damages. The procedures do not suggest moving public roads, at a cost of millions. They do, however, provide voluntary, incentive-based opportunities for local officials to work with property owners and fashion local land use plans that include tailored FEH areas with an objective of minimizing costs to private and local interests.

Section 3: Development and Flood Risk

Q17. How will the FEH Zone affect existing development that is within the FEH Area?

A17. The model FEH Area Overlay District should have little effect on existing structures. The FEH overlay district has been written in such a way as to recognize that individuals and communities have already made encroachments into river corridors. If a person is interested in modifying an existing structure or adding an accessory structure, the proposed modification should be designed so as to not create or increase the level of the erosion hazard by encroaching further toward the stream.

Q18. How will an FEH Zone affect new development being proposed within the FEH Area?

A18. The model FEH Area Overlay District describes new development under three land use categories: a) permitted, b) conditional, and c) prohibited. Towns have some discretion in describing use restrictions and still remain eligible for support and incentives under the State FEH Program and FEMA pass-through funds. The fundamental goal of the FEH zone is to keep people, their investments, and taxpayer-supported public investments out of harm's way. Thus, the FEH zone discourages unwise development within the boundaries of the FEH map. Avoiding the placement of public and private infrastructure within the FEH area, based on the boundaries of the FEH map, will accomplish four objectives: (1) to protect public safety; (2) to reduce flood losses; (3) minimize public and private expenditures for flood recovery, and, (4) to minimize fluvial erosion hazards by affording the stream the space and time it needs to adjust toward and maintain a more stable, equilibrium condition.

Q19. Would FEH zones prohibit the placement of new bridge abutments, adding significantly to the costs of new bridges?

A19. ANR recognizes that roads and railroads must cross streams via a bridge or culvert. The ANR Technical Guidance does not prohibit the placement of new bridge abutments. It does, however, provide guidance that is consistent with the requirements of State stream alteration permits and U.S. Army Corps of Engineers' Section 404 permits to ensure that such structures are properly sized to span the bankfull channel (i.e., width of the channel during ordinary high water, or spring runoff). Transportation infrastructure is the largest single category of flood damages in Vermont, both in terms of costs and number of people affected. The three flood-related fatalities in Vermont since 1995 were due to washed-out culverts. Moreover, damaged crossings prohibit rescue workers from accessing homes and businesses during flooding. The State conducted a geomorphic assessment of nearly 1,700 culverts and

found that over 90% did not span the channel width. (The Vermont Culvert Geomorphic Compatibility Screening Tool, Feb. 2008). These structures often fail from their inability to accommodate flows, sediment, and debris during a flood.

Q20. Does the ANR avoidance strategy assign a zero risk tolerance to development within the designated fluvial erosion hazard area? Shouldn't there be the flexibility to balance the relative risks to the public and the impacts that a strict avoidance policy would have on land uses?

A20. The number of federally declared flood disasters has increased substantially in the last two decades. Between 1961 and 1990, Vermont experienced eight federally declared flood disasters. Since 1991, Vermont has experienced 19 flood disaster declarations. In fact, 2008 marks the first time that Vermont experienced three declared disasters in one year. The State is entrusted to protect the public from hazards and wisely spend Vermont taxpayer funds in disaster recovery. An avoidance strategy to minimize future conflicts and flood-related damages is a cost-effective solution, a fundamental goal of the State Hazard Mitigation Plan, and the objective of ANR technical guidance.

The State has made a concerted effort to balance risks and costs, i.e., the size of the FEH has been limited to only that area minimally necessary to accommodate equilibrium. This is a much contracted area compared to that which would be delineated were the state to try and evaluate *all* portions of the valley and valley side slopes that may be at risk to erosion hazards (e.g., the Channel Migration Zone approach popular on the West Coast would result in a valley-wide FEH area in Vermont). Given the watershed alterations associated with stormwater and other hydrologic changes (including climate change-related flooding), the belt width relations being used at present are conservatively skewed toward a minimal FEH area. The State has consciously chosen to keep FEH areas as small as reasonably possible (i.e., very little margin of safety) and still remain consistent with the science-based stream equilibrium objective. The State has also included the modified reference planning tool as another method for communities to balance risks and costs.

Similar to the NFIP, the FEH delineation considers systemic risk or risk at the community scale. If the State were to evaluate erosion risks and costs only borne by the individual landowner, we would be operating within the historic paradigm where channelization and hard armoring of the river would continue unabated. With enough structural engineering and disregard for the impact to others, one can reduce the personal risk to a very low level. The two lessons learned about this approach have been that:

1. The cumulative effect and result of piecemeal channelization has been systemic stream disequilibrium, loss of flood and sediment attenuation, and increasing vulnerability to and likelihood of disastrous flood losses; and
2. The cost of armoring river banks to arrest erosion, flood damage, and repetitive losses are being increasingly borne by the taxpayer and ratepayer. The individual landowner who built or bought property by the river is viewed and compensated as a "victim." The FEH policy will reduce the number of victims and the millions being spent annually to protect ill-advised encroachments.

The ANR Technical Guidance does not constitute a zero tolerance policy for new fluvial erosion hazard risks. For example, additional development is allowed adjacent to existing developed areas within the FEH provided it does not increase the encroachment dimensionally, regardless of how hazardous the site may be. Increased risk from erosion brought about by future channel management activities within the FEH area is also tolerated. While fewer conflicts with river dynamics lessens the perceived need for channelization practices, the State does not perfunctorily deny their use within a delineated FEH area, particularly where intractable conflicts between public and private investments and river dynamics exist. Only an FEH technical standard that prohibits all new development or channel management within the

entire valley and adjacent to valley walls with the potential for slope failure could approach zero risk tolerance.

Q21. Isn't it true that many facilities exist within the meander belt width of Vermont rivers and are managed without significant risk or cost?

A21. To say that pre-existing facilities within the floodplain or FEH areas in Vermont can be managed without significant risk or cost does not square with history. Structural stabilization measures are repeatedly financed and constructed to protect new or existing encroachments. These channel armaments have either failed or led to channel adjustment and erosion elsewhere on the river. Therefore, it is incumbent on the State to look at the risks and costs at much larger temporal and spatial scale. The cumulative effect of channelizing unstable, incised rivers to protect individual properties is contributing to the increasing rate of disaster declarations. At the watershed and state levels, the actual costs and risks are increasing at an alarming rate.

The reason why flood insurance is only available via the National Flood Insurance Program is because of the difficulty to predict the risk of flood damage. Flooding will continue to occur in Vermont, and flash flooding is considered the most common mode of natural disaster in the State. Unlike flooding in the Midwest where residents can predict the arrival of the flood crest, it is very difficult to predict flash flooding. It strikes with little warning, causing damage and property loss, community disruption, and threats to public safety. We have the moral responsibility to take steps to build resiliency in communities and drive down the risk of flood damages. By avoiding building in vulnerable locations, we reduce conflict between land use and the dynamic nature of our river systems, and cost-effectively mitigate or avoid flood damages.

The State understands that there are existing investments within the belt width that are at risk, just as there were developments within the regulated floodplain when the NFIP maps were first established. While the state and federal flood programs are not labeling pre-existing structures in mapped floodplain as "unacceptable," they do recommend the purchase of flood insurance. Where structures are repeatedly damaged, taxpayer-funded programs have been created to buy and remove them.

Q22. Does the area within the FEH zone face varying levels of risk from erosion, with some areas not experiencing erosion for hundreds of years, if at all? If so, should state policy focus on stopping erosion and protecting the more vulnerable land while allowing streams to access the lower elevation floodplain land adjacent to the stream and subject to inundation flooding?

Q22. It is important to point out that Vermont's NFIP inundation floodplain maps do not show variation of risk. There are areas on the NFIP flood plain maps that flood more frequently and to greater depths than other areas. Areas commonly perceived as less vulnerable from fluvial erosion include: (a) land on the outside edges of the FEH area; (b) elevated land beyond the belt width that will be mapped as FEH due to bank or slope failure; and (c) land outside of the historic floodplain or mapped flood inundation area. While these landforms would be at much less risk along a stable stream with a functioning floodplain, to assume they would be less risky next to an incised stream that has no access to historic floodplain would be disastrous. Similarly it would be a mistake to assume that a stream having a vertically stable morphology today would remain as such in the future. There are a number of opportunities within the ANR Technical Guidance for project proponents to conduct further studies to demonstrate equilibrium conditions and work with the State to configure the FEH areas accordingly.

Risk is a function of the probability of a hazard and its consequences (e.g., loss of life, property damage, social and economic disruption, environmental damage, and recovery costs). To understand the risk is

to closely examine the hazard. The likelihood that a flood will occur is great. The likelihood of experiencing a flood hazard depends on the steps we take as a society to build resiliency to the impacts of a flood event. By taking pro-active steps, we can mitigate and potentially avoid over time the destructive consequences of a flood event. Setting aside the portion of the floodplain to allow for the re-establishment of equilibrium conditions and avoid areas vulnerable to flood damage is the most cost-effective pro-active option we can take.

A person or community's sense of risk is associated with what they can afford, a level of comfort they seek, knowledge that they have of the hazards and the probability that those hazards will occur, and degree of concern for their neighbors. Structures represent large financial investments, and nearly every flood event in Vermont involves structures outside of the NFIP regulatory floodplain that have sustained flood damage. The State holds the public trust to ensure that we cost-effectively take steps to mitigate flood damages. Achievement of this objective requires protection of the FEH corridor which cannot be accomplished solely through state land use regulations (Act 250). This is why the ANR has an active municipal FEH support element, so that local regulation can be consistent with and supportive of Act 250 regulatory decisions.

Q23. Why not set aside the inundation floodway for the channel adjustment processes and stabilize the land outside of the inundation floodway but within the FEH using engineering practices? Wouldn't this option mitigate for potential future stream erosion and allow for development, achieving a balance between stream equilibrium, land uses, and protection of the public?

A23. Refer to Question/Answer #9 above. The physical relationship between the FEMA inundation floodway and the FEH floodway varies tremendously, and is influenced by the age and type of NFIP map, valley slope and confinement, and geomorphic condition. Thousands of miles of highly dynamic streams with significant associated fluvial erosion hazard exist across the state with absolutely no FEMA mapping data or delineated floodway.

FEMA inundation maps under-estimate the flood hazards, and thus, do not generally provide an adequate basis for mapping fluvial erosion hazards. The inundation floodway does not consider fluvial erosion hazards. Moreover, the inundation floodways are typically based on original FEMA inundation-based mapping in the 1970s and early 1980s, at a time when many of the State's rivers were altered, deeply incised, and disconnected from their floodway. Mapped floodways and floodplains in Vermont are therefore typically narrower than they should be, thereby allowing development to be placed in close proximity to stream channels, where risks from erosion hazards are very high.

The ANR does not discount the individual impacts to people's lives that can arise from efforts to reduce flood hazards, alleviate conflicts with rivers, improve public safety, and reduce flood damages to public and private investments. However, the goal of the FEH corridor is to keep people out of areas at risk of fluvial erosion. Additionally, the public costs of maintaining development in these flood prone areas is not sustainable. Much of the instability of Vermont's stream networks, illustrated by increased erosion, greater flooding, increased vulnerability of public infrastructure to flood damages, is a function of both the historic channelization practices, including the construction of berms, levees, and rock armoring of riprap along their banks, and the belief that such practices could allow for and protect greater encroachment into the river corridor. Continually fighting against the stream's natural tendencies is always a losing proposition and a guarantee of ever-increasing public costs.

Q24. I understand that the Slope Stability Allowance is a way to mitigate damages and public safety concerns regarding landslide hazards. Should a belt width determination include a margin of safety as part of the slope stability allowance in order to better capture the likely extent of bank retreat and avoid future conflicts?

A24. The slope stability allowance described in the ANR Technical Guidance is not intended to take into account bank retreat or stream channel migration. (The latter is dealt with by having a sufficient belt width). Provision of a slope stability allowance does not guarantee that channel management can be avoided if the river erodes over to the far side of the belt width. The slope stability allowance is intended to provide room for the bank to fail back to or be created at a stable angle if the stream reaches the edge of the belt width.

Q25. Many historic villages are situated in areas vulnerable to flood hazards, and streams have been historically channelized at these locations. If growth centers are to concentrate development around existing settlements, does it make sense to look at their benefits and costs in FEH determinations and figure out a way to accommodate them?

A25. The Modified Reference Condition described in the ANR Technical Guide was designed to accommodate municipalities with the interest to develop growth centers in historically developed areas along the river. The key to avoiding confusion during any Act 250 reviews is for town and regional planners to take advantage of this provision and develop Growth Center plans with fluvial erosion hazard mitigation in mind.

Section 4: Fluvial Geomorphology as the Basis of FEH Area Determination

Q26. Have the technical merits of the ANR Technical Guidance been properly vetted within the science and engineering community that include independent scientific studies?

A26. The ANR is confident in its application of sound science through its technical guidance. The Agency has welcomed any independent analyses or results of other studies that would help us refine and improve the guidance and make it more effective at achieving public objectives. This has been the case throughout the past ten years during which the geomorphic assessment and mapping methodologies has been developed.

From 1998 to 2002, a team of hydrologists and fluvial geomorphologists were contracted by the Vermont Geological Survey to identify geomorphically sensitive streams and draft State stream geomorphic assessment protocols. In 2002-03, the completed protocols were subjected to and subsequently approved in a national peer review process conducted by the Lake Champlain Technical Advisory Committee. A Quality Assurance Programmatic Plan for the Assessment Protocols was approved by the U.S. Environmental Protection Agency in 2003. The Army Corps of Engineers and EPA completed a national survey (2004) of physical stream assessment protocols for use in their regulatory programs and gave Vermont assessment protocols the highest overall rating out of the 45 protocols reviewed. During a 2005-06 pilot study, FEMA conducted a technical review and approved ANR's erosion hazard mapping methodology for inclusion of FEH areas on the digital NFIP maps. Vermont's erosion hazard mapping program in conjunction with 13 of 14 Vermont regional planning agencies have received over \$1.5 million in FEMA pre-disaster mitigation grants in three nationally competitive grant rounds. In the spring of 2010, the River Management Program authored a technical paper that has been published in the Journal of American Water Resources Association (AWRA) describing the science, Vermont's river data, and the development of the state hazard avoidance policy,

including its FEH initiative. AWRA's journal is arguably one of the most respected water science and engineering, peer-reviewed journals in the country.

The River Management Program has held three-day technical training programs on geomorphic assessment and FEH mapping methodologies and trained over 70 science, engineering, and mapping consultants. The interaction with fluvial geomorphologists, hydrologists, geologists, engineers, ecologists, and GIS specialists during these sessions have often been two-way exchanges of technical information. The ANR Technical Guidance is reflective of these discussions. Vermont's assessment and mapping methodologies have been subjected to constant feedback as river assessments and corridor plans are conducted by private technical consultants, subjected to a series of quality assurance checks, as well as public review and comment.

Q27. In comparing Vermont's approach with other jurisdictions, is the State's guidance stringent enough to adequately protect Vermont's environment and minimize public expenditures in flood recovery?

A27. For over 20 years, FEMA regulations have contained a provision to consider flood-related erosion hazards. FEMA reports that erosion is a national concern, noting that:

“Approximately one-third of the nation's streams experience severe erosion problems, and landslides and mudslides are commonplace in some areas. ... The average damage per year of extensive erosion-related damage is approximately \$450 million (in 1998 dollars).” (FEMA, Riverine Erosion Hazard Areas: Mapping Feasibility Study, 1999.)

Many states are attempting to identify and address this common type of flood hazard. Similar to Vermont, the Canadian provinces of Ontario and Alberta use the belt width to identify erosion prone areas. The Ontario Ministry of Natural Resources 2002 Technical Guide, “River and Stream Systems: Erosion Hazard Limit,” relies on meander belt allowance that is 20 times the bankfull channel width to determine the erosion hazard limit. Ohio uses approximately 6-10 channel widths as its “streamway width” (the width of the setback based on stream processes). Another example, is the Pacific Northwest which maps “channel migration zones,” representing the maximum belt width of a stream occupied by all of its historic channels. The Vermont ANR initially based the river belt width for lower gradient, meandering streams in alluvial settings at 6-8 channel widths, based a seminal study of 153 naturally stable streams in alluvial settings from around the world (Williams, 1986 and the 2007 US Army Corps of Engineers' Technical Supplement 14S: Sizing Stream Setbacks to Help Maintain Stream Stability). This range has since been verified through an empirical study of alluvial channels in Vermont assessed in good to reference geomorphic condition.

ANR acknowledges that there are consequences associated with its approach in determining fluvial erosion hazard boundaries. For example, it is conceivable that ANR's approach could under-estimate the actual meander belt width a gravel bed stream may need to restore and maintain equilibrium conditions. However, as noted in Answer #5 above, the FEH area is not intended to identify all the potential for erosion within a valley. Moreover, using the sensitivity rating from the fluvial geomorphic assessments, identifying vulnerable areas adjacent to the stream as described in Section G of the ANR Technical Guidance, and conducting boundary verification as the basis for the FEH area provide site-specific data on stream conditions and should serve to minimize the prospect of under-predicting and even over-predicting the extent of the FEH area. Section H of the ANR Technical Guide also provides some options if modifications to the FEH floodway are warranted. Thus, it is ANR's opinion that its method of determining the FEH floodway is valid, locally-verified, practical, implementable on a state-wide basis, cost-effective, and arrives at an acceptable balance between interests of land uses and stream stability.

Q28. Is Vermont considering the effects of climate change in flood hazard avoidance policy? Since flood events are already occurring with more frequency, shouldn't Vermont be prepared to make timely adjustments to floodway policies and procedures as data become available?

A28. The US Global Change Research Program reports that the observed trends of increases in precipitation, warmer air temperatures, decreases in snow pack, and greater frequency of extreme precipitation events will continue in the Northeast. The heightened frequency of severe precipitation events could increase runoff and geomorphic instream channel adjustment. The State's continued implementation of its Floodway Procedures should result in greater local resiliency to the impacts of a changing climate.

Q29. Have biological impacts been factored into Act 250 belt width determinations?

A29. With respect to Act 250 floodway determinations (Criterion 1(D)), the ANR objective is to ensure that proposed developments "...will not restrict or divert the flow of flood waters, and endanger the health, safety, and welfare of the public or of riparian owners during flooding" (10 V.S.A. §6086(1)(D)). Other Act 250 criteria address protection of biological resources.

Q30. Does the science and policy of managing streams toward equilibrium conditions support other public objectives such as preventing water quality degradation of Lake Champlain and other receiving waters?

A30. The protection of belt width-based corridors and dynamic stream equilibrium may be one of the most effective methods for enhancing and sustaining biological productivity in river systems including both aquatic (in-stream) and riparian habitats. The consequences of encroachment and channelization has been the profound loss of sediment and nutrient storage, and flood attenuation capacity within the river corridors, and degradation of habitat from both direct loss and in-stream, post-flood channelization disturbance. If phosphorus is not retained within floodplains throughout the watershed, it is transported downstream to receiving waters like Lake Champlain. Alternatively, if the phosphorus is captured and retained on floodplains, eutrophication of the rivers and ultimately the receiving waters, such as Lake Champlain, can be minimized. While this is not the purpose of Vermont flood hazard mitigation, the ANR is confident that anticipated outcomes are consistent with ecosystem restoration objectives of the Clean Water Act and the State's phosphorus discharge reduction and attenuation objectives.



Honey Brook, Barre, 2007

More Information

Visit the Vermont River Management Program website – www.vtwaterquality.org/rivers.htm – for more information about the Vermont Fluvial Erosion Hazard (FEH) Program and how your community can participate, river corridor protection, Floodplain Management, and other resources, including:

- The Vermont River Corridor Protection Guide and Technical Appendix;
- ANR Technical Guidance for Determining Floodway Limits, Pursuant to Act 250 Criterion 1(D);
- Municipal Guide to Fluvial Erosion Hazard Mitigation (includes a Model FEH Area Overlay District);
- FEH Fact Sheets:

- (a) NFIP & FEH: http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_NFIPFEHFactSheet.pdf
- (b) Page 3-4 of the Two Rivers/Ottawaquechee Regional Commission Fact Sheet entitled, “Using Freeboard and Setbacks to Reduce Damage: http://www.trorc.org/pdf/wq/floodsheet4_web.pdf

For answers to questions pertaining to property rights, local liability, and issues related to “Takings,” refer to the Vermont Law School, Land Use Institute booklet titled Preparing for the Next Flood: Vermont Floodplain Management. The document may be downloaded at: http://www.vermontlaw.edu/Documents/VLS.065.09%20LAND%20USE%20PAPER_PFF.pdf