Appendix H — Dredging and Stream Channel Restoration

Mankind's intrusion into the natural environment in West Virginia began in earnest following the Civil War when extractive industries and settlement all increased dramatically. Since that beginning, our lack of understanding and appreciation for natural stream processes has resulted in ongoing activities that produce harmful impacts to the environment and eventually to us. Indiscriminate dredging of streams and rivers as a long-term solution to flooding has continued despite the harmful impacts on the aquatic/riparian environment and the limited effectiveness in reducing major flood damages.

Dredging, as perceived by the public, is the removal of sediment and streambed material in an attempt to confine all flood-flows within the reconstructed stream channel. Conversely, stream channel restoration is the removal of sediment above the level of the original streambed, along with other practices, to re-establish a stable alignment of the stream.

There are five accepted reasons to excavate a waterway channel. These activities are completed through the permit process of Section 404 of the Clean Water Act and the Division of Natural Resources, Public Land Corporation. They are:

- *To extract sand, gravel, or minerals from the streambed*. On occasion, regulatory permits are issued by the U.S. Corps of Engineers to allow removal of coal, sand and gravel from riverbeds for commercial purposes.
- *To maintain navigation*. The Corps of Engineers dredges rivers to maintain commercial navigation (i.e. Ohio River, Big Sandy River, Kanawha River, Monongahela River and Little Kanawha River).
- *To provide terminal/marina access*. River terminal and marina areas are dredged (by private companies with regulatory permits) to allow access for commercial shipping and recreation boating.

H-2

- *To restore stream habitat*. Stream habitat restoration occasionally requires removal of excessive sediment through channel excavation and, on an infrequent basis, such excavations may be used to restore deep-water habitat in tributary embayments of larger rivers (i.e. Ohio and Kanawha rivers).

- *To increase channel capacity.* Channels are excavated in an attempt to increase channel capacity to reduce nuisance flooding.

In some cases, dredged spoil material is used to create industrial or recreational development opportunities. For example, material dredged from the mouth of Elk River in Charleston has been deposited along the Kanawha River to create the popular recreation area known as Magic Island. Dredged material has been used to raise the level of industrial property within the flood fringe area in accordance with existing floodplain management ordinances. In some cases, this filling operation is in violation of the floodplain management ordinances when deposited within the regulatory floodway.

Channel excavation, as a part of stream restoration, has been used to restore stream ecosystems when the bottom of a stream is buried with silt. Silt fills in the crevices and interstitial spaces critical to supporting populations of benthic organisms. Sub-optimal benthic populations reduce fish diversity and population. Channel excavation seeks to improve the hydraulic carrying capacity of the waterway and confine floodwaters to the channel to reduce flooding and property damage.

Un-engineered dredging of small streams also occurs. This form of dredging can reduce the heights of high frequency, low-level flooding events that have a recurrence interval of 2 to 5 years. This nuisance flooding damages structures located immediately adjacent to the waterway, inundates roadways and leaves a layer of sediment and debris in the floodplain. However, this form of dredging does very little to reduce flood damages resulting from low frequency high volume floods. In some cases, this dredging can create more damage than it corrects when spoil materials are deposited in the regulatory floodway. To maintain channel capacity, frequent maintenance is required. In addition, deepening and/or widening channels can lead to channel instability causing bank erosion.

Channel dredging should not be confused with carefully planned stream restoration and channel modifications that are designed to accomplish specific purposes such as restoration of aquatic environments. Correctly engineered, constructed and maintained channel modifications meet their designed purpose of reducing damages from major flood events (see Figure H-1). Channel modification projects constructed by the Natural Resources Conservation Service (see Appendix L) have significantly reduced flood damages to residential and commercial development.

Dredging should not be confused with removing flood debris from the streams. Removing woody materials, propane tanks, manufactured homes, trailers, and other debris piled against bridge piers, trees and accumulated within the channel is necessary to recover the hydraulic efficiency of the waterway channel. Debris removal does not

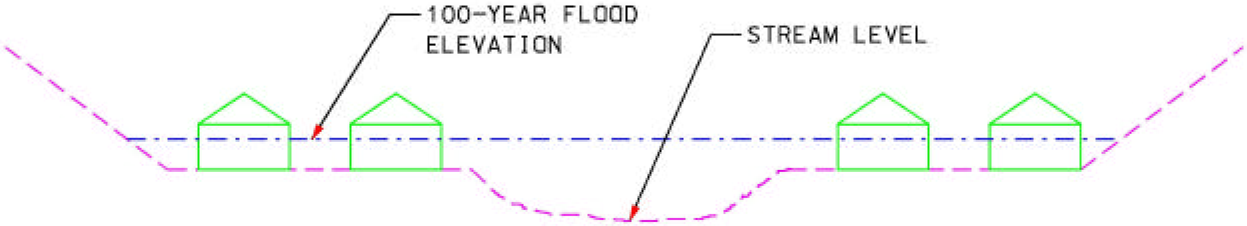
Figure H-1. Little Whitestick Creek channel modification project

normally include removing deposited sediment unless the sediment presents a major blockage at bridges that promotes additional scouring or erosion around piers and abutments. These projects are coordinated with natural resource agencies and utilize sound engineering principles and empirical data from successful channel modification and restoration projects.

River systems are highly dynamic and respond to land-use conversions in the watershed, channel modifications, floodway encroachments, structural encroachments (bridge piers), and modifications to stream bank and stream-bottom conditions. Some of these changes, which include dredging, can cause streams to become unstable and develop changes in stream flow, rates of bank and channel erosion, and sediment transport. Channel migration and bank erosion can occur as an unstable stream attempts to reach stability. The stream re-stabilization process can take several years and can result in many unforeseen changes to the channel location and flow before stabilization occurs.

The illustrations below graphically depict the effects of sedimentation and flooding on a typical small stream anywhere in the state. In-filling of the channel normally results in a dramatic increase in the elevation of subsequent floods.

Figure H-2. Effects of sediment on
100 year flood elevation



Stream Channel conditions prior to flood event.

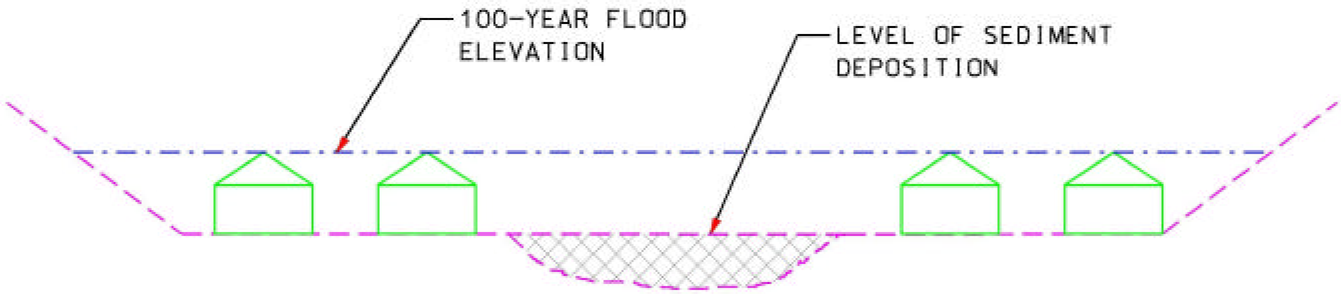
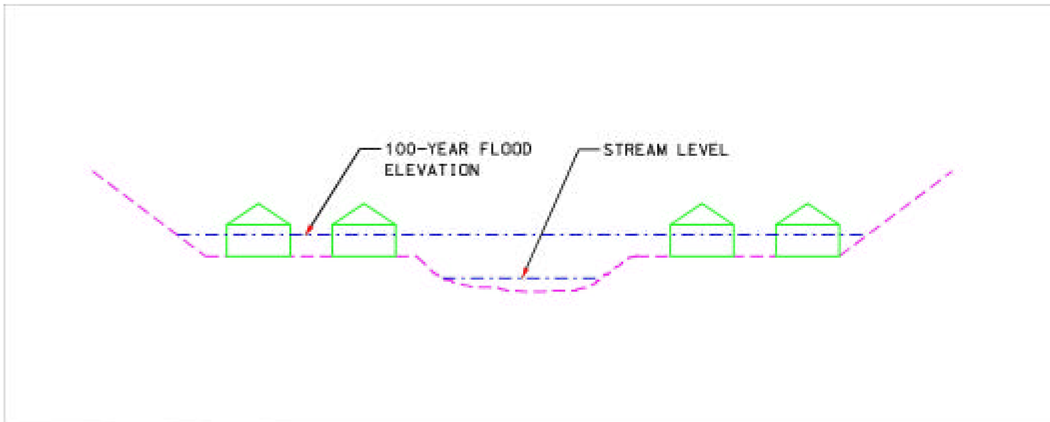
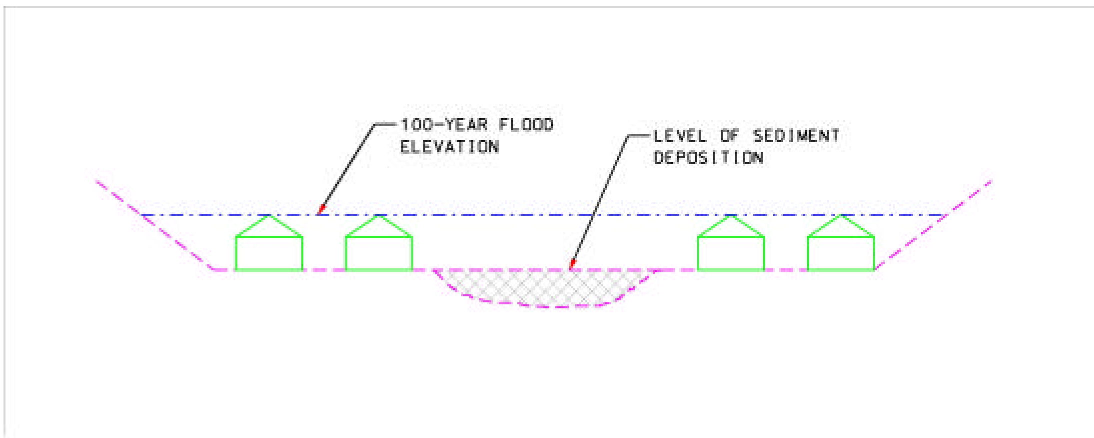


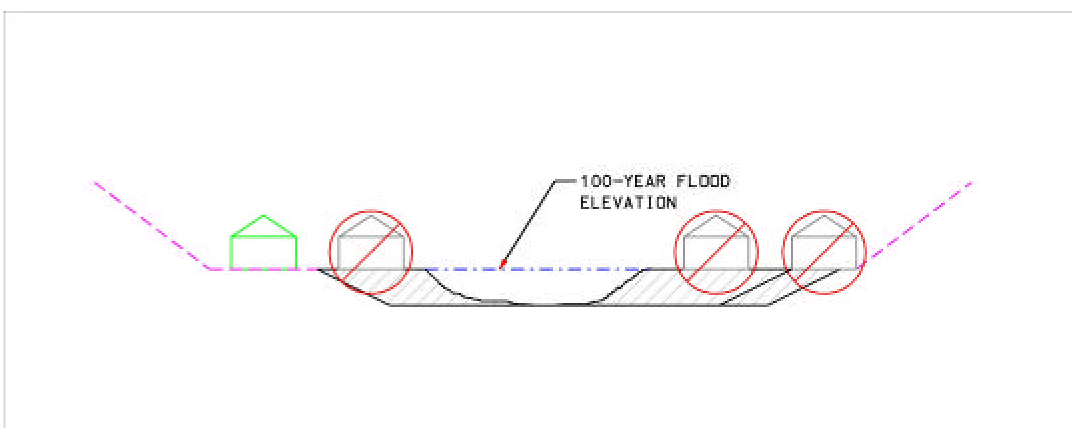
Figure H-3. Effects of Sedimentation and Stream Channel Capacity Modification on 100 Flood Elevation



Stream Channel Prior to Flooding



Stream channel filled after flooding



Stream channel after widening project

Stream channel modification project

After every flood, the Governor, legislators, and State and Federal agencies receive calls from landowners and local officials insisting that their streams and rivers be dredged as a quick solution to their flood problems. Frequently these callers fail to consider how modification of the stream channel by dredging will influence the stream hydraulic and ecological systems. Rather than calling for more stream dredging, the question should be, "Can the stream be restored or modified to a condition that will reduce the impacts of repeated flooding?" Some aspects of the complex relationships of river systems such as scour and sediment transport are poorly understood. Frequently, floodplain landowners use spoil generated by stream dredging to improve the development potential of their property. Where development has occurred and floodplains have been altered, dredging may be used to protect existing development.

Dredging to mitigate the effects of flooding is often proposed for areas where sediment and silt have reduced the carrying capacity of the stream. While localized stream dredging may increase the carrying capacity of the dredged reach for the short term, dredging may initiate erosion throughout a longer stream reach and produce excess sediment that fills recently dredged areas. Where stream dredging intrudes upon bedrock, groundwater levels can be lowered. This effect can occur adjacent to dredging operations and extend laterally to the extent of the floodplain, thereby reduce the amount of groundwater available for agricultural, industrial and residential well users as well as influencing adjacent wetlands.

Figure H-3. Dredging of a small stream

Generally speaking, simple dredging, as a long-term solution for reducing flood damages from large events, has proven to be neither effective nor cost-efficient. Each stream modification proposal must be evaluated on a case-by-case basis to determine if the flood damage benefits outweigh the costs (including damages/costs to the stream ecosystem both upstream and downstream of the dredged section).

In West Virginia, dredging is often a locally initiated operation where bulldozers, end loaders, backhoes or other excavators are used to remove deposited sediment and rock materials and reconfigure the stream into a trapezoidal channel. Spoil material removed from the streambed is often used to raise the level of adjacent floodplain property or used as construction materials. More often, dredged material is deposited on the stream banks within the floodway to act as makeshift levees (see Figure H-4). Since dredging for flood mitigation is intended to increase the carrying capacity of the stream, unconsolidated spoil material from these sites should never be deposited where it can easily reenter the stream (i.e. within the floodway). Some past stream dredging projects have unwisely used dredged material to construct levees that have limited or no flood protection capabilities and further constrict the floodway. These un-engineered levees provide a false sense of flood protection to floodplain residents.

Figure H-4. Dredged Material Used To Construct An Un-Engineered Levee

Dredging has both short and long-term effects on the natural and human environment. Some or all of the following may occur during or after dredging operations:

- increased water flows downstream and increased flooding,
- disturbance caused by vehicle and equipment access,
- destruction of stream bank and aquatic vegetation,
- disruption of the aesthetic values of the stream corridor,
- removal, release, or rearrangement of sediments,
- reduction of water quality,
- remobilization of contaminants,
- increased turbidity,
- lowered water tables,
- increased erosion and sedimentation,
- alteration of hydrology,
- alteration of hydraulics (current patterns and flow),
- increased bank instability and erosion,
- alteration of fish habitat,

• alteration of fish spawning habitat,
• alteration of benthic habitat,
• disruption or removal of benthic communities,
• reduction in height of high frequency, low- level flood events over the short term unless it is properly maintained, and
• false sense of security following dredging.

In addition to the effects at the dredge site, there will also be impacts resulting from disposal of the dredged material. These impacts will depend upon the location of disposal and the nature of the spoil (organic, inorganic, contaminated, nutrient enriched, etc.). In some major river systems (Ohio, Kanawha and Monongahela), the sediment may contain trapped contaminated materials that can be re-introduced into the water column during dredging operations. These contaminants could become a threat to aquatic organisms and humans using the river for recreation or as drinking water. Depending upon their nature, dredged contaminated material may be classified as hazardous material by USEPA and WVDEP. Proper disposal of contaminated dredged materials should be coordinated with WVDNR and WVDEP prior to dredging.

Several factors influence the magnitude of the effects of dredging:
• size of the dredging operation,
• frequency of dredging,
• stream channel size and depth,
• size of the material being dredged,
• background levels of water and sediment quality, suspended sediment, and turbidity,
• stream velocity,
• design of final contours,
• stability of channel up and downstream from the dredging operation.

Dredging for flood control is based upon the idea that sediment removal and deepening of the channel will provide a substantially larger channel capacity to allow a greater volume of water to flow downstream without causing an impact on the streamside environment. While this appears to be logical, it can easily be proven inaccurate (see Figure H-6).

The following illustration will show the shortcomings of dredging as a long-term solution to significant flood damages. Assume that a theoretical stream channel is 100 feet wide and 5 feet deep. Also, assume that the floodway for this stream extends 100 feet on each side. Finally, assume that the flood fringe zone extends 100 feet beyond the outer edge of the floodway on both sides of the stream.

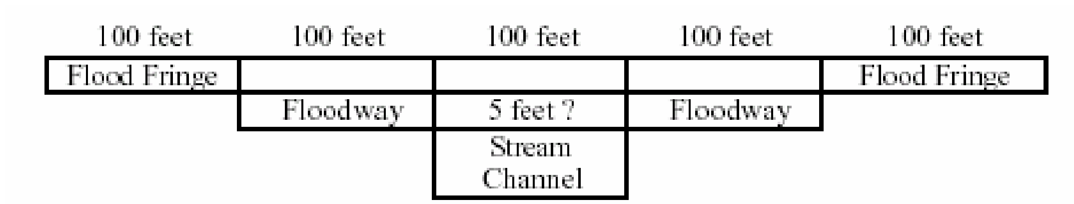


Figure H-6. Theoretical Stream Channel Dredging Operation

Normally this stream channel has 3 feet of water in it. During a 25-year flood, the stream channel is full and overflows a portion of the floodway zone. During a 50- year flood, the stream channel is full and the water extends into the flood fringe. During a 100- year flood, the stream would overflow the channel and the floodway and reach a depth of 5 feet in the entire flood fringe.

Dredging the channel to twice its current depth (no additional width) would reduce the height of water in the entire floodplain by 1 foot. To prevent water from encroaching on the flood fringe during the 100- year flood in this admittedly simplified event, it would be necessary to dredge the stream channel to a depth of 30 feet. In most West Virginia streams, this depth of dredging would require removal of bedrock material by blasting.

If we ignore the significant environmental and groundwater impacts of extensive dredging, then it is technically feasible to dredge to this depth. It would however, be extremely costly to remove bedrock. Environmental mitigation costs (both short-term and long-term impacts) and acquisition of long-term disposal areas for dredged materials would have to be included. Added would be the routine and repetitive cost of maintaining the channel to this depth. Without annual maintenance, the effectiveness of the new channel in reducing flooding would soon be lost. Realistically, dredging as a long-term solution for reducing damages from major flood events is not effective and certainly not cost efficient given other proven methods of reducing flood damages.

Stream Restoration:
An alternative to dredging and other stream modification is natural stream restoration. By examining the entire stream system and applying a broad range of natural stream restoration practices, it is possible to increase the stability of the stream and reduce the erosive effects of high flows on the channel without causing additional environmental harm. Figure H-7 shows a recently completed stream restoration project.

Figure H-7. Completed Stream Restoration Project

Natural stream restoration also has several other desirable attributes such as:

- Structural applications, such as "J" hooks, rock vanes, and root wads, can provide significant cost savings over traditional bank-armoring practices.
- Often restoration projects address the entire stream reach and not specific sites within the reach.
- The approach recognizes, accommodates, and restores the natural flow of the stream. This natural approach minimizes stream instability and reduces the likelihood of increasing damage elsewhere on the stream.
- Practices such as channel modification, realignment, and reshaping are used to recreate or restore the most stable stream form to appropriate dimension, pattern, and profile.
- The natural stream-restoration approach can contribute to the goal of reducing flood losses while preserving the natural-resource values of stream systems.

Applying the natural stream-restoration process to streams in West Virginia could result in the following benefits:

- A reduction in the magnitude of flood damage to property and infrastructure,
- A reduction in the cost of flood prevention, repair, and recovery operations,
- An improved stream system and increased stream-channel stability,
- Increased protection of both human investments and West Virginia's natural resources.

Generally speaking, use of single measures such as stream restoration or dredging to reduce damages from major flood events is not universally applicable, is not cost efficient and is only moderately effective. Flooding problems must be evaluated considering the particular circumstances of the flooding events and the location of the damaged properties to determine which measures are most appropriate.

Based on this information the Task Force recommends the following actions:

1. That requests for State or Federal regulatory permits for dredging operations as a means of reducing flood damages be approved only after documentation demonstrates that environmental impacts are not excessive and annual maintenance is assured through executed agreements. This should not hinder previously permitted channel modifications that are designed and maintained to reduce flood elevations of high frequency floods (low level), stream restoration, or restoration of aquatic environments. Nor should this hinder efforts by any Federal or State agency to address major flood events through an authorized and designed channel modification or a snagging and clearing operation where that activity is proven through engineering documentation to be an effective and cost efficient method for reducing flood heights and where annual maintenance is assured through local agreements.

2. That the State provide agency funds that serve to match existing Federal funds for stream restoration programs/projects.

3. That regulations for preservation of stable streams be developed through a collaborative effort of the WVDEP, WVCA and WVDNR. Candidate streams for restoration will be identified by the agencies participating in the recommended "2005 Stream Summit".

4. That State guidelines for emergency removal of stream debris be developed that would guide emergency response agencies and contractors during these removal operations. Such guidelines could be developed through a collaborative effort of the Task Force member agencies. These guidelines would ensure that in-stream debris removal following a flood event would not result in excessive, long-term environmental damage to the stream or river affected. The guidelines would increase awareness of the need for permits for in-stream work and ensure that debris disposal does not further inhibit floodwaters. Included within these guidelines would be information on the location of stable streams and high quality streams (when available) and a series of best management practices to guide response agencies and their contractors.