Ashokan Watershed Stream Management Program

STREAM GUIDE

SEDIMENT MANAGEMENT

This Stream Guide explains the difference between the modern stream management practice of channel restoration to manage sediment transport and the historical practice of dredging. Catskill streams transport large amounts of sediment – boulders, cobble, and gravel for example, through the combined forces of gravity and moving water. Streams alternate between transporting sediment and storing sediment in channels and on floodplains.

Channel Restoration vs. Dredging

When we talk about stream work, we make the distinction between "channel restoration" and "dredging."

Channel Restoration uses the best available science and engineering to restore stream channel stability and floodplain function. Restoration uses knowledge of sediment transport to predict where sediment may be deposited or transported in the stream system. Good engineering reduces the risk of unintended consequences and improves project effectiveness and sustainability.

Dredging is the removal of gravel, usually by machine, to temporarily reduce risk to public infrastructure and property. This is often performed immediately after a flood event.

Stream channels in the Catskills are sometimes excavated and reshaped to protect infrastructure or reduce flooding. If not done with sufficient knowledge, channel modifications can easily affect sediment transport and trigger channel erosion near roads, bridges, homes, or businesses.

Why dredging instead of restoration is a problem

All too often, well-intentioned but improperly engineered dredging projects cause more problems than they solve. Dredging done without proper planning may leave streams too wide and shallow, reducing the power of streams to transport the sediment coming from upstream. The reduced power of overly widened channels causes gravel to deposit in the channel. Channels may then shift and erode around the new deposits, quickly negating any initial benefit of the dredging effort. It is almost always more effective to widen the floodplain rather than widen the channel.

Floodplains function as a natural "shock absorber" and as a sink for the greater volumes of gravel and cobble generated during large flow events.

Stream channel adjustments caused by dredging have been documented across the nation. If channels are made too deep, or too steep, dredging may trigger a headcut that erodes the bed and gouges its way upstream. In the process, formerly stable banks are undermined, causing them to erode and fail, which then drops trees into the stream. Eventually dredging may cause the stream to generate more new gravel and cobble than was initially excavated.

The destructiveness of dredging has led scientists and engineers to recommend that stream restoration approaches be used instead to reduce the threats caused by excessive gravel deposits.

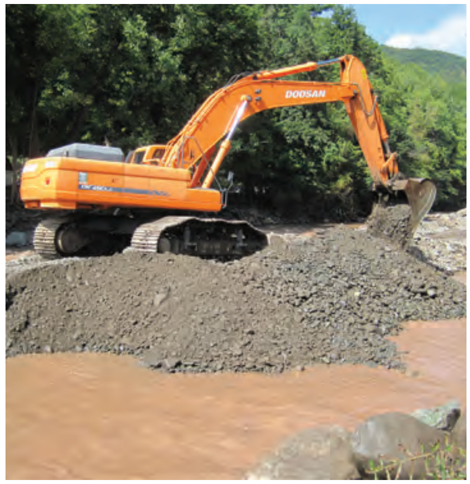
Even in the immediate post-flood period, we recommend stream work be guided by science and engineering. A stable stream reach has channel dimensions (a width, depth, and slope) that can be accurately predicted simply by determining the size of the watershed. These regional hydraulic geometry data are readily available from the local Stream Management Program office and should be used to dimension channels to a naturally stable configuration during post-flood work.

History of dredging

Dredging is the act of removing gravel, mud, silt, and other sediments from the bottom of a stream. The removed material is often used as fill for other construction projects or for structuring the stream channel or banks. Up until the 1950s, many municipalities and government agencies such as the Army Corps of Engineers dredged streams to remove sediment and woody material. By the 1960s, advances in stream science and engineering demonstrated that dredging often lead to excessive erosion or deposition of sediment, and severely damaged aquatic habitat. As a result, federal and state agencies have significantly reduced their support for dredging projects.

How wide? How deep? And when is channel restoration called for?

The shape of a stream influences the amount of force that flowing water exerts on the stream bed and banks. In nature, streams adjust their shape over time so that the power of flowing water in the channel roughly matches the force required to mobilize sediment on the stream bed. In stable streams, the mobilized bed sediment is replaced by an equal amount of sediment that has been transported from upstream during a storm event. This sediment balance is accomplished by stream processes that shape the width, depth, and slope of the channel.



Removal of a mid-channel gravel bar as part of planned channel restoration on the Stony Clove Creek in Phoenicia, NY, September, 2011.

Streams that are stable can effectively pass both water and sediment delivered from the watershed without excessive erosion or deposition.

There are places in streams where gravel deposits regularly form after large flows. High deposition areas are natural where there are changes in the topography of the stream corridor. Sediment deposits are common at the confluence of two rivers. Unnaturally high sediment deposition and gravel bar formation is very common at undersized bridges and culverts, especially after high flows. Gravel accumulations in these settings can force water over the roadway and push high velocity flows into stream banks, potentially undermining the footers of bridges and washing culverts downstream.

Where gravel accumulations create a documented flood or erosion hazard, channel restoration based on sound hydraulic and sediment transport analysis can help to reduce the risk of catastrophic channel shifts. Stream restoration at these locations can minimize the need for costly long-term maintenance such as repetitive dredging.

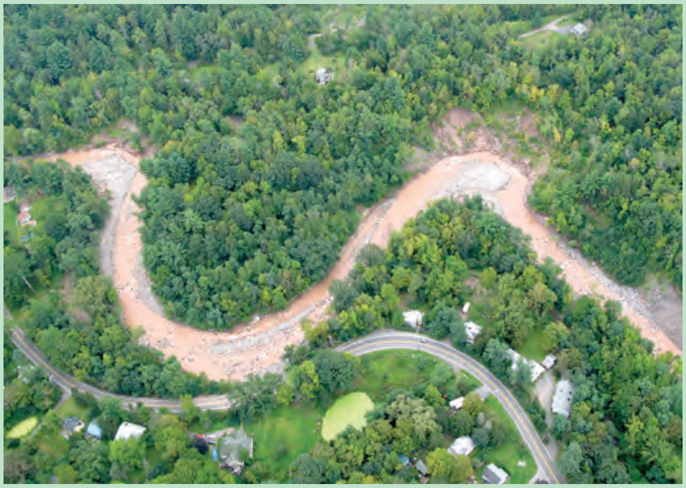
Each situation is unique, both in terms of how much deposition represents a real problem, as well as the appropriate channel width, depth, and slope used in the restoration design. Both the presence of a significant flood or erosion hazard and the effectiveness of a solution need to be confirmed by an engineering analysis prior to investing large amounts of time and money in a stream project. Relying on dredging without understanding the implications of channel modifications can create unnecessary risks to public health and safety.

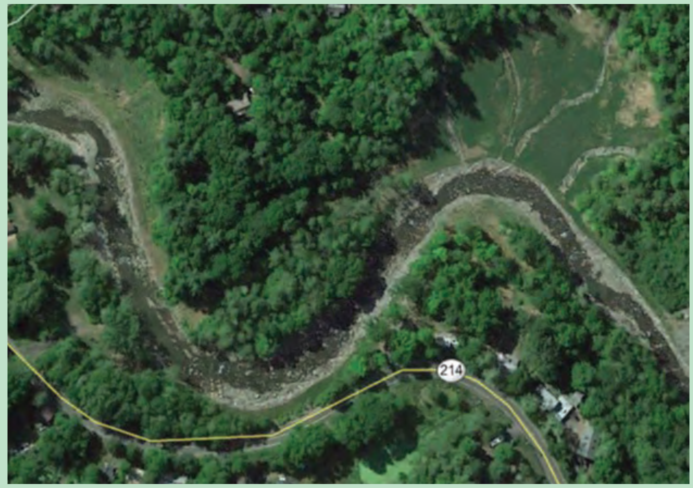
A watershed approach can help

Channel excavation is just one tool in the stream manager's toolkit. Managers also look at larger scale practices that are effective in terms of both time and cost. Two best management practices to be considered along with, or over channel excavation, include: 1) reducing the supply of sediment to depositional areas by treating upstream sources, such as eroding banks or incising channels; and 2) preservation or creation of sediment storage areas in undeveloped settings of the upstream watershed.

Where floodplains exist, they function as natural "shock absorbers" for the greater volumes of gravel and cobble generated during large flow events that are deposited onto floodplains. The stream will later remobilize gravel stored on floodplains over many smaller flows and the gravel moves through the system gradually.

CASE STUDY: STONY CLOVE CREEK RESTORATION





A long history of straightening, deepening, and manipulating the Stony Clove Creek in Chichester caused a variety of cascading problems. Channel bed erosion undermined steep hill slopes that began to slump and fail. Mid-channel gravel deposits pushed flows into stream banks. The resulting erosion into clay rich soils generated reddish and cloudy water for long periods of time. Bank erosion threatened the nearby road, homes, and water quality as far away as Phoenicia and the Ashokan Reservoir drinking water supply.

Using an engineered approach, the channel was resized and stabilized from 2012-2013 to better convey sediment and reduce erosive pressure on the bed and banks. The same planned approach has been successfully applied to smaller, less expensive projects such as bank stabilizations and bridge or culvert enlargements.

Dredging can't keep large floods off floodplains

A floodplain is part of the river, a part not used by the river all the time, but needed to convey the larger, less frequent, and yet inevitable floods. Sometimes dredging is practiced with the expectation that even very large flows can be contained entirely within the stream channel. This misconception ignores the fact that floodplains are created by centuries of repeated floods and will continue to be susceptible to inundation. During floods going back to the last ice age, the stream deposited cobble, gravel, sand, and silt in overbank areas and built the floodplain into what we see today.

Dredging the stream to protect homes and businesses in the floodplain is an expensive under-taking that ultimately can't prevent periodic flooding and deposition. The wiser choice is for municipalities, the real estate community, and landowners to minimize future development in high-risk areas. This is especially true in floodplains. Elevating or floodproofing structures and adopting responsible land-use controls are sustainable alternatives to dredging for reducing flood hazards.

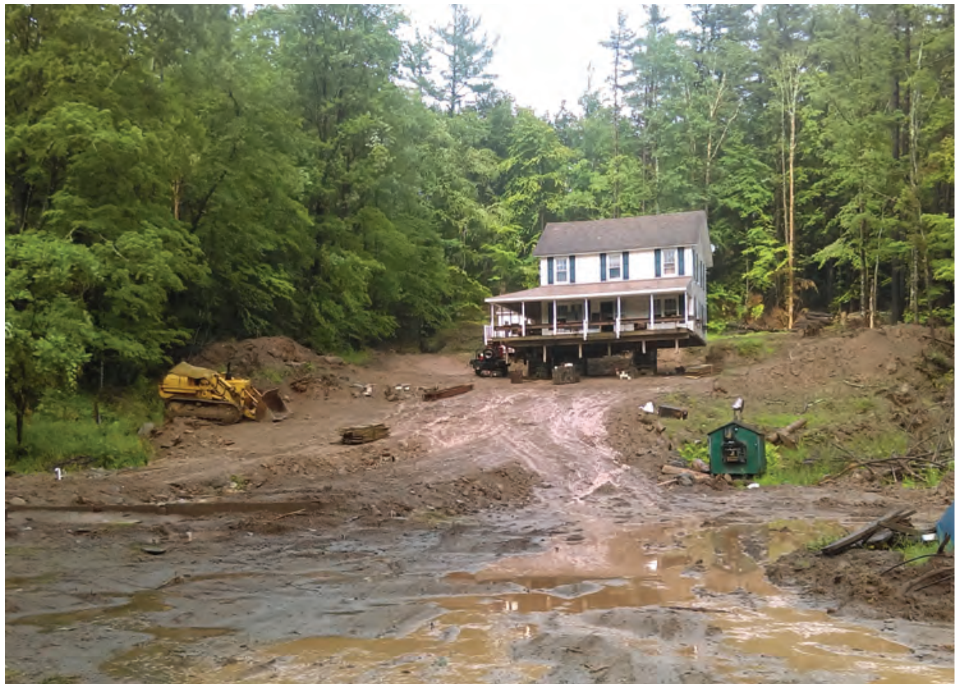
Shouldn't drainage ditches be dredged to keep a house dry?

Where drainage ditches are entirely artificial and are not naturally connected to the regulated stream system, common sense maintenance is in order. There's a difference between a drainage ditch and a small stream that flows year-round, transports sediment proportional to its dimensions, and maybe hosts brook trout with its spring-fed water. The local Soil and Water Conservation District staff can provide technical assistance with drainage ditch maintenance.

What about dredging to prevent flooding at bridges and culverts?

Dredging is often undertaken in settings where the floodplain is constricted or inaccessible to the stream, such as at undersized bridges and culverts, or where the grade (slope) changes and causes sediment deposition. The objective of dredging is usually to allow the channel to convey larger flows without overtopping the bridge. However, deepening a relatively short section of stream at a bridge doesn't necessarily reduce flood levels. Flood levels through the bridge will still be largely controlled by the stream bed's elevation at the downstream end of the dredging site and the amount of backwatering created by the bridge.

Another key factor is that even relatively small floods can carry large volumes of gravel and cobble that tend to fill in the dredged area quickly and return the bed to its pre-dredged elevation. Any benefit created by dredging is often short-lived. If repeated dredging is necessary, the associated costs and permitting requirements can make this an unsustainable maintenance strategy.



If you own property inside the Special Flood Hazard Area (or the FEMA "100-year floodplain" of a river), there is a 33% chance your property will flood over the course of a 30-year period. This home was elevated and moved to higher ground on the same parcel to prevent damage from flooding.

Finally, dredging has little if any water quality benefit. Actually, dredging carries significant risk to water quality by creating greater stream instability and more sediment from erosion.

Hydraulic modeling associated with channel restoration helps to determine where opportunities for effective gravel management do exist and optimizes the effect of any channel work done to restore channel capacity and bridge clearance. The effects of creating an accessible and properly sized floodplain can also be modeled. Proper analysis increases our understanding of where in the watershed excess sediment supply might be originating, so that over time, channel management practices can be implemented upstream to reduce excessive amounts of gravel travelling downstream. Addressing the sources of erosion and working to maintain natural gravel and cobble storage on floodplains can reduce the need to dredge in developed or otherwise challenging locations downstream. If you are experiencing erosion or flooding on your property and are looking for a solution, and you live in the Ashokan watershed, call the stream management program office to obtain guidance at (845) 688-3047.

Ashokan Watershed
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