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Stream Reclamation Basics

An introduction to the key concepts contributing to the rehabilitation of fisheries habitat and how miners can achieve success using materials onsite.

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Cover Photos

Background photo: *Completed reclamation at Wade Creek (Mile Post 87).*

Inset photo left: *Placer miners preparing for reclamation.*

Inset photo center: *Miner building a riffle-step structure.*

Inset photo right: *Completed riffle-step-pool sequence constructed by a miner in the Fortymile region.*

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Introduction

Successful stream reclamation or reconstruction has proven difficult in Alaska and, as a result, has been the subject of multiple efforts ranging from working groups to the development of various forms of stream reclamation guidance. This document provides an overview of the regulatory requirements and key concepts regarding stream reclamation to help ensure stream reclamation success. This document also outlines specific techniques and recommendations that can be used to reduce the risk of failure based on materials and equipment typically found on most mining sites. These recommendations are based on techniques proven to work in Alaska. Improved reclamation outcomes ensure both a sustainable placer mining industry and fulfillment of BLM's multiple-use and sustained yield mission.

Policy

BLM's Surface Management regulations (43 CFR 3809) require that reclamation activities incorporate riparian mitigation measures, provide for rehabilitation of fish habitat, and comply with water quality standards. National policy outlined in BLM Handbook H-3809-1 provides further guidance stating that stream reclamation should provide a stable channel form with adequate vegetation to reduce erosion, dissipate stream energy, and promote the recovery of instream habitats. Achieving these outcomes is a fundamental requirement of BLM regulations, yet a variety of factors have contributed to mixed reclamation results in Alaska.

Past Placer Mine Stream Reclamation

The factors that challenge the recovery of placer mined streams have not only been described in research and academic literature but have been the focal point of multiple working groups dating back to the early 1980s. Before 1980, little emphasis was placed on the post-mining recovery of streams. Research findings since 2000 have concluded that stream channels left after mining, and in many cases after reclamation efforts, are unstable, requiring decades or more to recover. The prolonged period of instability results in impacts to water quality, degraded fisheries habitat, and the loss of other stream functions, which include the physical, chemical, and biological processes that occur in aquatic ecosystems. Researchers have also found that despite the incorporation of reclamation stipulations via state and federal mining permits, problems with placer mine stream reclamation persist and the techniques being used are largely ineffective at stabilizing stream channels, which is a critical first step in the rehabilitation of stream habitats.

Traditional reclamation techniques, which focus on recontouring the valley and letting natural processes dictate recovery, can be effective in upland areas but using this approach to stabilize streams has had limited success. When it comes to reclaiming streams, several researchers have noted that traditional reclamation approaches generally result in channelized streams that are disconnected from the floodplain and have limited ecological function beyond water conveyance. A review of 13 reclaimed streams in Interior Alaska by the Department of Civil and Environmental Engineering at the University of Alaska Fairbanks concluded that the majority of reclaimed streams have low rates of revegetation, straight over-widened channels and steep slopes resulting in an increase of erosion and bank instability. These conclusions are not surprising given Alaska's short growing season, the impacts of annual

Figure 1. Aerial image of a placer mined stream 15-years after reclamation showing very limited recovery of riparian vegetation resulting in an unstable multi-thread channel.

ice scour and spring break up, and the general vulnerability of sites to erosion after mining. Nonetheless these findings and the climate of Alaska highlight the need to improve stream reclamation practices.

To better understand the recovery rates of reclaimed placer mined streams, BLM has been monitoring sites throughout Interior Alaska for several years. Results for the Eastern Interior Field Office area illustrate that reclaimed streams exhibit a moderate to major departure from reference condition or loss of stream function, which often persist well after reclamation has been completed. Stream functions include the physical, chemical, and biological processes that occur in aquatic ecosystems. Like previous studies, the BLM assessment concluded that reclamation techniques that are reliant on natural processes often fail to stabilize the stream and are inadequate at rehabilitating fisheries habitat, which is a required performance standard (43 CFR 3809.420). Conversely, the assessment showed that stream reclamation projects that used a more deliberate approach resulted in conditions that were within the range of natural variability for most metrics and trending toward fully functioning conditions within a single season.

Because of the challenges and complexities associated with stream reconstruction, the USDA Natural Resources Conservation Service (NRCS) developed and published the Stream Restoration Design Handbook (NEH-654) to provide stream restoration practitioners with a comprehensive document of the most current and best guidelines and tools for designing stream restoration projects (https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=21433). The NEH-654 provides a variety of design-based approaches for reconstructing streams to meet reclamation, as well as restoration goals. In Alaska, the most commonly used approach for designing stream reclamation projects is based on Chapter 11, titled "Rosgen Geomorphic Channel Design." This approach is based on the form and characteristics of unaltered streams and today is most commonly referred to as the Natural Channel Design (NCD) method. In Alaska, stream reclamation projects that were designed using NCD approaches result in conditions that are comparable to those found in non-impacted streams and satisfy BLM's requirements for rehabilitating fish habitat within a single season. Many miners may be reluctant to embrace NCD methodologies due to the complexity, cost, and perceived fear of failure. However, given BLM's refinement of stream reclamation design and construction methods over the last decade, miners that embrace deliberate design approaches and concurrent reclamation are expected to have shorter bonding periods, reduced maintenance requirements, and a higher likelihood of rehabilitating fish habitat.

Figure 2. (Left) Recontoured mine site on Wade Creek prior to stream reclamation. (Right). Same section of Wade Creek two seasons after stream reclamation was completed. Post stream reclamation conditions show improved riparian vegetation conditions and a mix of pools and riffle habitats.

Four Key Components of Stream Reclamation

Over the last ten years, BLM has been working to improve consistency and communication with the mining community regarding stream reclamation. Policy guidance and training has minimized inconsistencies regarding reclamation evaluations and provided opportunities for technical assistance to miners conducting stream reclamation. BLM-provided technical assistance includes stream reclamation planning support, as well as implementation oversight during layout and construction of stream reclamation projects. BLM relies upon established principles of stream stability rooted in science and from past experience in Alaska to evaluate stream reclamation and in the application of technical assistance. While the rehabilitation of fisheries habitats is one of BLM's regulatory requirements for reclamation, BLM acknowledges that miners must first achieve stream stability. By focusing on stream stability, miners can create the foundation for fish habitat rehabilitation and ensure that costs are minimized.

BLM stream reclamation guidance focuses on four key components of stream stability: Bed Form Diversity (mix of pools and riffles), Floodplain Connectivity, Riparian Vegetation, and Lateral Stability. These four elements of stream stability and habitat rehabilitation are highlighted in the image below and are described in detail in the following pages.

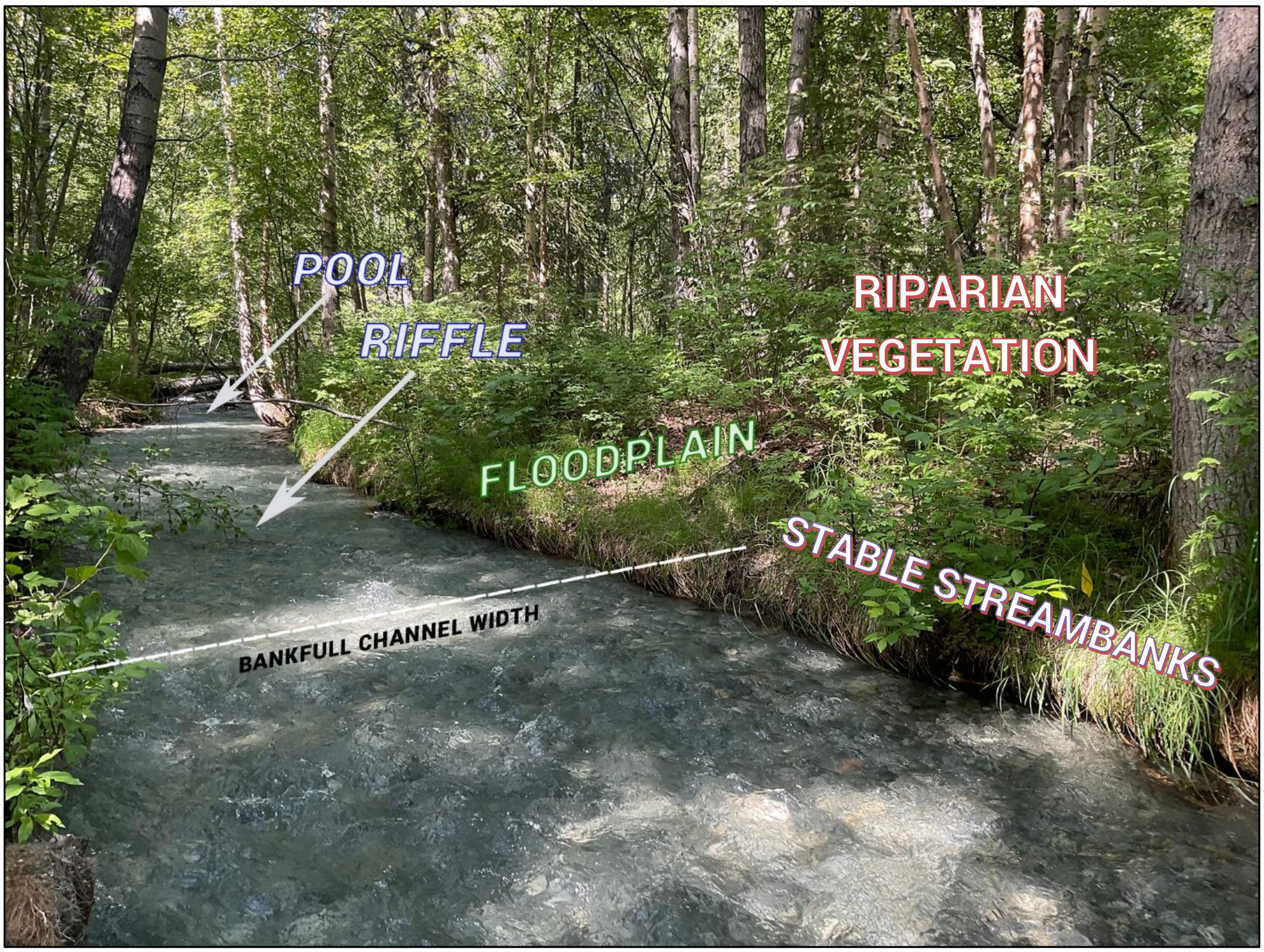

Figure 3. Image of a stream illustrating key components of stream stability.

Bed Form Diversity—The transport of water and sediment creates a mix of bed forms (i.e., pools and riffles) based on the slope, bed material, and streambank conditions. These features dissipate stream energy, contribute to channel stability, and provide a suite of habitats needed by many fish species here in Alaska. The arrangement and integration of varying slopes, grade control features, and structures into the stream reclamation project creates a mix of pools and riffles. One simple technique that can be used to create bed forms are “constructed riffles”. Figure 4 provides images of a constructed riffle-pool sequence.

Figure 4. Images of a riffle-step-pool sequences constructed by miners with BLM assistance on Davis Creek (left) and White Creek (right).

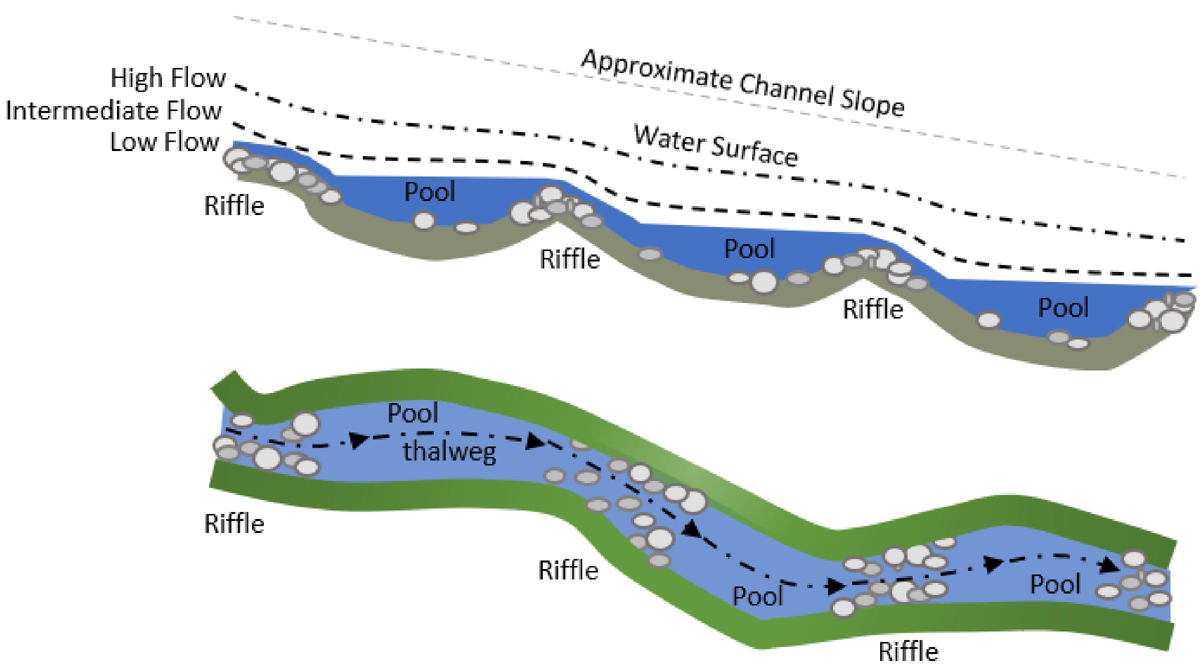

Figure 5. Diagram of a riffle-pool sequence (adapted from Dunne & Leopold, 1978)

Floodplain Connectivity—Many streams have well developed and vegetated floodplains, which are essential for dissipating flood energy, providing organic matter to the stream, and as habitat for wildlife. Reclamation should ensure that the constructed stream has access to its floodplain (or floodprone area in confined valleys). A stream should access its floodplain during relatively frequent high-water events, such as those that typically happen every 1.5 to 2 years. This is accomplished by careful consideration of channel dimensions using local and regional information, such as hydraulic geometry curves, which BLM has prepared for key areas of Alaska. Berming or attempting to contain a stream within a confined ditch in which the stream cannot access its floodplain increases bank and streambed erosion, resulting in unstable conditions and long-term maintenance. Examples of floodplain connectivity are shown in Figure 6.

Miners are encouraged to contact the local BLM office when planning to develop a reclamation plan or preparing to implement stream reclamation. Sometimes the dimensions of the naturally occurring stream at a site may not be ideal for a newly constructed channel. Often, well-vegetated channels are slightly narrower due to the high stability of the streambanks, a benefit that newly constructed channels do not have. BLM staff can provide advice based on past project results and regional datasets which summarize conditions associated with stable streams, and which can be used to properly determine stream dimensions and ensure floodplain connectivity after reclamation.

Figure 6. Images of two sites with dramatically different levels of floodplain connectivity. (Left) This stream cannot access its floodplain and is confined by large material and unstable streambanks. (Right) This stream has easy access to the floodplain as water levels rise and is a good example of a reclaimed stream with a well-connected floodplain.

Riparian Vegetation—Riparian vegetation plays a key role in providing lateral stability and floodplain cover, which contributes to channel stability, stream canopy cover, organic matter, and wildlife habitat. The recovery of riparian vegetation can use natural revegetation processes, which can take several years, or use more accelerated approaches using a combination of light seeding with native species or plantings and floodplain roughness elements, which help hold soils in place while natural recovery occurs (Figure 7 & 8). Another tool used with great success is transplanting vegetation mats stripped from the next mining cut to the floodplain portion of the area undergoing reclamation. This technique will be described further in the next section.

Figure 7. Floodplain roughness elements (spruce logs) and vegetation transplant mats along the stream (left) to minimize erosion until vegetation can fully reestablish.

Figure 8. Images showing floodplain conditions prior to floodplain enhancement (left, 20+ years post mining) and 7 years post treatment (right). The application of floodplain roughness elements (vegetation transplants, woody debris, etc.) and a light application of native seed accelerated the deposition of fine sediment and enhanced the recovery of floodplain vegetation.

Lateral Stability—Bank material and cover (e.g., vegetation, large wood, rocks) provide resistance to hydraulic forces to minimize erosion. To create lateral stability in a newly constructed channel, it is highly recommended that miners use transplanted vegetation, large rock and wood, live staking, and other streambank stabilization techniques (Figure 9 & 10). Bed form diversity dissipates energy, and riparian vegetation holds the bank sediments in place. Lateral stability and riparian vegetation are often integrated.

*Figure 9. Images of stream reclamation construction specific to lateral stability. (Left) Wheel-loader placing vegetation along the stream to create "instant streambanks" and improve floodplain and lateral stability. (Right) Tracked excavator completing the final grading of the stream channel into the transplant mats (*note coarse substrate along the face of the transplant mats).*

Figure 10. Image of a site where boulders and logs were integrated as a foundation for streambank and floodplain vegetation transplants. This technique can be highly effective at promoting lateral stability especially in areas prone to erosion.

What BLM's Stream Reclamation Assessment Policy Means for Miners

To date, policy guidance issued by BLM has focused entirely on how to evaluate stream channel stability. The data supporting these measures can be used to assist miners with stream reclamation planning and implementation. The main focus of stream reclamation should be on the four key components of stream reclamation and what resources are available onsite to reassemble the stream after mining has concluded.

The availability of vegetation mats for rebuilding streambanks and reclaiming floodplains can help reduce costs and enhance success. Another important consideration is the the availability of large rock for stream reconstruction. By focusing on these two key aspects of stream reclamation, miners will be well positioned for success when the reclamation phase of their operation begins.

More details about revegetation and stockpiling materials are outlined below.

<u>Concurrent Reclamation & Transplanting Vegetation</u>

Before the vegetation is cleared from the next mining cut, miners should consider using the vegetation onsite to stabilize the stream channel during reclamation (for lateral stability and riparian vegetation). In doing so, miners will greatly reduce the risks of blow-outs and other failures, which means more time mining and less time repairing problem areas. Stabilizing floodplains and streambanks using riparian vegetation transplants is one of the most important steps for successful stream reclamation.

<u>Stockpiling Materials</u>

Instead of using large rock as fill material, miners must consider separating large cobble (>12" intermediate axis) and boulders (>24" intermediate axis) for stream reclamation. These materials are commonly extracted or encountered during the mining process but are seldom stockpiled for stream reclamation. Large rock is critical for grade control (bed form diversity) in the channel and can be used to stabilize the banks (lateral stability).

Figure 11. Stockpiles of boulders, large cobble, and logs for stream reclamation.

BLM-Provided Technical Assistance

BLM realizes that stream reclamation is complex, and without careful consideration of the local and regional watershed characteristics, the risk of failure is increased. To help minimize risk and reduce reclamation costs, BLM has been assisting miners for several years. If you would like assistance with reclamation planning or implementation, please contact your local BLM office. Early communication is recommended to ensure assistance meets schedule requirements.

Figure 12. Images of upper Wade Creek prior to stream reclamation and 2 years afterward. (Left) Image of the site looking downstream in 2015. (Right) Image of the site in 2019 after implementing a stream reclamation project with BLM Technical Assistance.

Equipment

Having the right tools for the job can save precious time when completing the stream reclamation phase of a mining operation. All situations are different, but these types and sizes of equipment are the most efficient and cost-effective tools for the listed stages of stream reclamation:

- Wheel Loader (Cat 930 or larger) for transplanting vegetation mats.
- Excavator with hydraulic thumb (Cat 318 or larger) for building constructed riffles and shaping the channel.
- Other equipment such as dozers and dump trucks are also helpful during the stream reclamation construction process for moving materials, floodplain and valley shaping, etc.

Summary

The rehabilitation of fisheries habitat after placer mining can be challenging, but with advanced planning and the use of existing materials onsite you can be successful. BLM has completed extensive work to test, simplify, and refine stream reclamation techniques over the last several years with the goal of improving your success on the ground.

To further simplify the stream reclamation process BLM developed a stream design guide (BLM Technical Report #65 - https://www.blm.gov/learn/blm-library/agency-publications/select-state-publications/alaska-tech-reports) and is producing short videos on specific construction techniques. The first video developed by BLM is available at: https://youtu.be/2ZhRnwcCfd8. BLM is also working to improve staff expertise so that the agency has the capacity to better assist the mining industry on stream reclamation planning and implementation.

Commonly Asked Questions

Q: Why is so much attention being focused on stream reclamation?
A: Over the last couple of decades BLM, other agencies, and researchers have documented the poor recovery of placer mined streams and the need to improve stream reclamation techniques to ensure the rehabilitation of fisheries habitats and channel stability. The most recent report can be found at: https://www.blm.gov/sites/default/files/docs/2022-05/Library_Alaska_OpenFileReport169.pdf.

Q: Do I have to restore or make the stream look the same as it did prior to mining?
A: No, restoration is focused on rebuilding a stream to the conditions that existed prior to being impacted, which is more than is required under BLM regulations regarding reclamation. Reclamation is rebuilding the stream so that it is stable and provides for the rehabilitation of habitats. Stable streams exist under a range of conditions on the landscape depending on slope, channel material, and other factors. BLM evaluates your stream reclamation based on similar stream types to determine if it is stable using four key parameters. In most cases, a stable stream has a mix of pools and riffles, vegetated streambanks, and is connected to a vegetated floodplain.

Q: If I use BLM's technical assistance program will my reclamation be signed off (bond released) when it is finished?
A: All reclamation projects require time to revegetate and stabilize after construction. The BLM evaluates reclaimed sites for two years before determining reclamation success. The goal of BLM-provided technical assistance is to achieve reclamation success within 2 years of construction.

Q: Do I need to hire an outside operator or consultant to do stream reclamation work?
A: Not at all. Most miners have the equipment they need already onsite, and with a little stream reclamation training (and a dose of patience), they are successful doing it themselves. The more you do it, the easier it gets.

Q: Do I need large rock and vegetation sources to use for transplanting to successfully meet BLM's reclamation requirements?
A: To reconstruct a stream channel, operators will need access to large quantities of cobble and boulder size rock. This material is critical for reestablishing grade control and creating a mix of pools and riffles. Lateral stability can be achieved using a variety of streambank stabilization measures. The use of vegetation transplants requires the least maintenance and is the most efficient technique for achieving reclamation objectives related to streambank stability. The stream reclamation planning process and information in BLM Technical Report #65 should help determine what quantities of materials are needed based on the scope and scale of the stream reclamation project.

Q: How long does it take for my stream to be signed off (bond released)?
A: Being signed off depends on the level of stream reclamation completed. For example, if the reclamation is done in the early spring and streambanks are transplanted with existing vegetation, it is likely that sign off would occur after the following spring, which would give the floodplains nearly two growing seasons to revegetate. All operators should plan for some level of maintenance in the first couple years following construction.

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