A Geomorphologist's Perspective on "Natural Stream" Applications in Mine Reclamation

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Terms like "Natural Stream Design" and "Natural River Restoration" evoke a variety of images ranging form lofty broad ideals to a very specific set of procedures used to characterize, classify, and design streams. For purposes of mine reclamation, the most constructive use of these "buzzwords" is to recognize that stream processes in "natural" settings offer great insights into how reclaimed streams can be engineered and constructed to allow them to exist in long-term equilibrium with the watersheds they drain. Our considerable knowledge in the field of fluvial geomorphology is very relevant to mine reclamation.

The most obvious geomorphological role of any stream is convey water, at least some of the time, and any observer of nature recognizes the role streams play in providing a ecological template for diverse life forms. Just as important is the role that streams play in sediment transport, and if this function is ignored, the hydrologic and ecological functions of streams are likely to fail, sometimes catastrophically. One of the core fluvial geomorphology concepts is the widely confirmed "Wolman-Miller" theory that the lion's share of sediment transport in streams is accomplished not by mundane day-to-day flow or big-headliner floods, but instead by moderate events that recur approximately every 1-3 years on average. These moderate magnitude-moderate frequency floods and "flood wannabees" are the dominant flows most responsible for creating the hydraulic geometry (dimension, pattern, and profile) of stream channels. These flows fill the stream banks just the point of incipient flooding onto the adjacent floodplains, and thus are called "bank-full flows."

Mine reclamation, like most engineering of streams, has long focused on very large floods, such as a 20-, 50-, or 100-year runoff events. This concern is warranted because of the consequences of failure, especially in mountainous terrain. However, more complete stream function and long-term stability are best served when provisions are made for the moderate events that determine whether a reclaimed landscape will remain in equilibrium in the long run. Good engineering practice calls for bank-full channels to be constructed within high-flow floodways. Field study shows that if bank-full channels are not created, the fluvial system may take matters into its own hands, commonly with unfortunate and unintended consequences.

Although a strict "reference reach approach" to stream design is controversial among geomorphologists, it is undeniable that a clearer understanding of fluvial process and hydraulic geometry can come from observations on streams analogous to those being restored. Undisturbed streams may not provide meaningful comparisons to post-mining landscapes, and better reference reaches for reclaimed streams are likely to occur in reaches that have been stable for decades on unreclaimed pre-law sites.

Geomorphological issues are often ignored in many watersheds with water chemistry issues that present severe limits to ecological success over a scale of decades. However, in many streams, bad chemistry may be short lived compared to erosion and deposition problems, which may persist for centuries or millennia if unaddressed.