Appalachian Ecosystem Restoration; Stream Restoration Techniques and Case Studies in “Coal Country”

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“Restoration is defined as establishing natural stability and proper function of rivers.” (ROSGEN, 1997)

“Stream Channel Restoration refers to actions to convert an incised, unstable stream channel to a natural stable condition, considering recent and future watershed conditions.” (USACE, 2004)

“Stream restoration re-establishes the general structure, function, and self-sustaining behavior of a stream system to a better functional condition; stabilizes or reverses stream aggradation or degradation; and enables more diverse aquatic habitats. “ (FHWA, 2004)
Stream power is the rate of energy dissipation against the bed and banks of a river or stream per unit downstream length.

\[ \Omega = \tau V \]

The transport of bed particles in a stream is a function of the fluid forces per unit area...the tractive force or shear stress \( \tau \), acting on the streambed.

\[ \tau = \gamma DS \]
Natural Channel Design

Plan and Profile Diagrams of a Longitudinal Profile

Plan View
- Water Surface
- Thalweg
- Low Bank Height
- Bankfull Stage

Profile View
- Average Bankfull Slope
- Average Water Surface Slope
- Degree of Incision “Wedge”

Field Determined Bankfull Stage
- Max Riffle Depth
- Max Run Depth
- Max Pool Depth
Longwall Mining

- Longwall mining is a form of underground coal mining where a long wall of coal is mined in a single slice (typically 0.6–1.0 m thick). The longwall panel (the block of coal that is being mined) is typically 3–4 km long and 250–400 m wide.

http://en.wikipedia.org/wiki/Longwall_mining
Longwall Mining
Longwall Mining Subsidence

Schematic illustration, not to scale

Donnelly 2007

$S_{\text{max}} = \text{Maximum subsidence}$

$s = \text{Vertical subsidence}$

$v = \text{Displacement}$

$\theta = \text{Tilt}$

Collapsed longwall workings (goaf)  Unworked coal seam
Longwall Mining Stream Impacts
Longwall Mining Stream Impacts
Longwall Mining Stream Impacts

Stream Subsidence Profile

- Subsidence pool
- Gate dam
- Top of bank
- Water level
- Stream bed

Distance along stream (ft)

Elevation (ft)
Longwall Mining Stream Impacts

- Pre and Post mining surfaces using LIDAR

- Need to capture the pre-mining hydraulic slope to calculate bankfull discharge.
Longwall Mining Stream Restoration

- Designers should take advantage of the subsidence with a Priority I restoration to minimize earthwork quantities.
Longwall Mining Stream Restoration

- Completed Subsidence Mitigation
- Pooling remediated
- Facet slopes and habitat restored
- Stream banks stabilized
Surface Mining

"Strip mining" is the practice of mining a seam of mineral, by first removing a long strip of overlying soil and rock (the overburden). It is most commonly used to mine coal and lignite (brown coal). Strip mining is only practical when the ore body to be excavated is relatively near the surface. This type of mining uses some of the largest machines on earth, including bucket-wheel which can move as much as 12,000 cubic meters of earth per hour.

Video provided by Roger Wolfe, West Virginia DEP
Surface Mining Stream Impacts

Photo provided by Roger Wolfe, West Virginia DEP
Surface Mining Stream Restoration

- Geo synthetic liner
Surface Mining Stream Restoration

- Creating perched water with the GCL minimizes hydrostatic rebound and creates intermittent flow patterns during low flow seasons.
Surface Mining Stream Restoration

Liner Bulkheads
Surface Mining Stream Restoration
High Wall Mining

Highwall mining is a form of surface mining that evolved from auger mining. In Highwall mining, the coal seam is penetrated by a continuous miner propelled by a hydraulic Pushbeam Transfer Mechanism (PTM). A typical cycle includes sumping (launching and pushing forward) and shearing (raising and lowering the cutterhead boom to cut the entire height of the coal seam).
High Wall Mining
High Wall Mining Stream Impacts
High Wall Mining Stream Restoration

- **UT to Pendleton Run**
  - Primary goal was to convey water away from deep mine workings.
  - Technique to achieve the goal included a geosynthetic liner and natural channel design.

Before

After
High Wall Mining Stream Restoration

► UT to Pendleton Run (1 Year Later)
Thank you!
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