Geomorphic Reclamation in the Midwest

Industry Perspective:
Past and Current Practices, Benefits and Challenges

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Geomorphic Reclamation and Natural Stream Design at Coal Mines:
A Technical Interactive Forum

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Introduction

The goal of this overview is to better understand the challenges and benefits of geomorphic reclamation at Midwest surface coal mining operations.

What is Geomorphic Reclamation?

- The concept has been developed over the last decade by well known geomorphologists and engineers such as Horst J. Schor and Donald H. Gray (Landforming, John Wiley and Sons, 2007).
- In terms of mining reclamation, the technique was originally developed at active mining sites in New Mexico in 2006 (Carlson Software ‘Natural Regrade’).
- Geomorphic Reclamation can be explained as the process of restoring the earth’s shape or surface to a suitable condition or use.
- In the context of surface coal mining, Geomorphic Reclamation can be narrowed to mean the process of restoring disrupted ground conditions and landscape to a suitable post-mining configuration and use.
What are the Benefits and Challenges?

- The importance of geomorphic reclamation is creating topography and slope configurations that remain stable.

- Stable slopes follow natural hillside geometry more so than conventional grading designs and recreate natural drainage patterns rather than straight convex terraced slopes.

- Natural landform grading techniques and natural drainage development, if designed properly, yield a post-mining landscape that resists surficial erosion and mass wasting and increases the opportunity for more diverse vegetation.

- If geomorphic land grading is preferred for successful surface mine reclamation, why haven’t more operators and regulators considered the long-term environmental and aesthetic benefits of artificial reshaping and restoration of natural topography?
What are the issues?

- Regulations promulgated under the Surface Mining Control and Reclamation Act (SMCRA) and Sections 401, 402 and 404 of the Clean Water Act (CWA)
- Conventional mining and reclamation practices
- Methods of restoring jurisdictional waters, i.e. wetlands and streams
The Laws, Regulations and Permits

➢ Surface Mining Control and Reclamation Act (SMCRA)
  ▪ Each mining and support area will require a SMCRA permit covering both surface affected areas and underground shadow area. Permitted surface areas require reclamation bond. A SMCRA permit may take more than 12 months from submittal to issuance.

➢ The Clean Water Act (CWA)
  ▪ Section 401 (Water Quality Certification)
    • Required when permitted activities may affect the water quality of a receiving stream or when fill material is placed in a jurisdictional water of the United States. A Section 401 WQC is required in conjunction with a Clean Water Act Section 404 permit. A 401 WQC typically takes 9-12 months from submittal to issuance.

  ▪ Section 402 (NPDES Permit)
    • Required for any sedimentation basin and any other point source discharge. An NPDES permit typically takes 9-12 months from submittal to issuance.

  ▪ Section 404 (Permit to Discharge Dredged or Fill Material)
    • Required to place fill material in jurisdictional waters of the United States when disturbing certain existing surface water drainages or wetlands. A Section 404 permit is issued by the U.S. Army Corps of Engineers and can take from 12 to more than 18 months from submittal to issuance.
Regulatory Issues (conflict and duplicity of programs)

- Prime Farmland Requirements
  - No net loss of acreage and no net loss to property owners vs. establishment of riparian buffers and ephemeral streams
  - Proof of Productivity requirements = high target yields (requires conventional tillage practices which increase erosion)
  - Erosion control of cropland

- Balance with other land uses

- NPDES requirements
  - All drainage must pass through sedimentation basins
  - Increased sediment load without erosion control systems

- Erosion Control
  - Pre-mine illustration of ephemeral streams in crop fields; why rebuild the existing problem by putting ephemeral streams back in crop fields?
Ephemeral Streams in Crop Fields

Why replace eroded ephemeral drainages in crop fields?
Property Ownership Issues and In-stream Impoundments

- Landowners prefer other desirable land uses over increased riparian buffers
- Landowners prefer lakes and farmable ground
- Regulators do not allow streams to be routed through bodies of water
  - In-stream impoundments are beneficial in agricultural environments
  - Reservoirs established in streams for flood control require periodic clean-out of sediment … evidence of high sedimentation loading to streams from agricultural areas
    - Sediment to be removed from northern portion of Sullivan Lake, IN = 483,400 cubic yards (accumulated over 40 years)
No Net Loss of Cropland
Landowners Prefer to Maximize Farmable Ground
Properly Constructed Terraces
Property Ownership Issues and In-stream Impoundments

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Agricultural Pre-mine Land Use
Balance and Reconfiguration of Post Mine Land Uses
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Stream Bypassing Open Water and Sediment Control
Stream Connected to Open Water with Above Bank Inflow
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Sedimentation of Reservoirs

Lake Sullivan, IN
Operating Difficulties

- Contemporaneous reclamation
- Significantly longer dozer pushes result in less soil thickness (approximately 1 foot instead of 4 or more feet now typically placed) and increased compaction due to repeat tracking
- Rock grade must enable mobile soil haulage (i.e. maximum grades of 5-6% are typically used for trucks dumping soil)
- Complications of operating rubber tired equipment on uneven grades
- Advantage of trucks over scrapers for soil replacement with minimal compaction
- Safety issues
- Mechanical failure and low tire life
- Swell (different at each location)
Opportunities

- Advance grade plan with appropriate floodplains for primary streams to be replaced.
- Plan for appropriate grades entering into floodplain area (dependent on pre-mine topography, swell, etc.).
- Truck dump single lift of soil in planned forest/wildlife areas.
- Minimal or no grading of replaced soils to reduce compaction and increase tree growth (OSM Midwest Forestry Reclamation Approach).
- Reconstruct tributaries in minimally graded soils.
- Establish enhanced riparian buffers where opportunities allow.
- Develop effective erosion control systems utilizing terraces, water and sediment control basins (WASCOBs), etc. in place of existing erosional features and ephemeral streams.
- Keep topsoil, fertilizer and pesticides in the field and out of the streams (sedimentation basins and vegetative buffers).
- Develop the reclamation plan and implement the plan for SUCCESS!
Spoil Truck Hauling and Dozer Grading
Final Grading

Spoil grade slope is determined by equipment capability.
Soil Replacement

Spoil and soil are direct hauled by trucks and spread by dozers to establish finished grade.
Shovel Loading End Dump Truck with Soil
Soil Quality and Depth

Thick (often > 4 feet) soil lift establishes final grade and growth medium.
Land Uses

Flat grades are required for prime farmland (<5%) and steeper slopes and undulating topography compliment land uses like wildlife and forest.
Replacement of Water Resources

Reclaimed mining areas with lakes, wetlands and streams
Stream Restoration

- The stream restoration methodology recently preferred by regulatory agencies is natural channel design.
- The natural stream channel design concept is based on physical channel criteria best characterized by Luna Leopold and Dave Rosgen.
- The primary criteria include:
  - Valley slope
  - Channel type
  - Meander patterns
  - Flood plain and bankfull channel dimensions
  - Bed stability
Typical Stream Design
Reconstructed Streams

Reclaimed streams using ‘Natural Stream Channel Design’ fundamentals

Peabody
Wetland Restoration

- The wetland restoration methodology preferred by regulatory agencies is bottomland hardwood plantations.
- These wetlands are created by establishing ground elevations and topography that will allow soil substrates to remain saturated and become hydric.
- The hydric soils and saturated hydrology support the growth of hydrophytic vegetation which is primarily selected hard mast tree species such as oak and hickory.
Typical Wetland Design

**TYPICAL WETLAND MITIGATION DETAILS**

**LEGEND**
- STREAM MITIGATION EVALUATION POINT
- WETLAND MITIGATION HYDROLOGY EVALUATION POINT
- WETLAND MITIGATION VEGETATION EVALUATION POINT
- WETLAND MITIGATION PHOTO EVALUATION POINT
- WETLAND TYPICAL CROSS-SECTION LOCATION

**TYPICAL PLAN VIEW**
- FORESTED WETLAND (seedling planting shown)
- WOODY SPECIES SEEDLING PLANTING PLAN
- 6' X 9' SPACING (INITIAL -600/AC. AND FINAL SUCCESS RATE = 400/AC.

**TYPICAL PROFILE VIEW**
- FINAL GRADING WILL BE COMPLETED TO PRODUCE A SURFACE TOPOGRAPHY VARIATION OF (+/-) 1'.
Establishing Lakes and Impoundments

- Post-mining open water bodies are planned prior to and during mining.
- Private land owners recognize the value added to real estate and the added recreational opportunities lakes and impoundments provide.
- Open water bodies may be completely formed in graded spoil or as an end- or final-pit impoundment with graded highwall and spoil slopes.
- Lakes and impoundments often have wetland features incorporated around the perimeter in shallow water fringe areas or adjacent bottomland areas.
Typical Open Water Design
Productivity

Proper landforming and soil replacement yield productive reclaimed ground.
Reclamation Success = Productive Land

Productive reclaimed ground, wildlife habitat and water resources are valuable real estate.