# Assessing Geomorphic Reclamation in Valley Fill Design for West Virginia

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**Project Description and Objectives**: State and Federal regulations have been promulgated to control environmental impacts associated with mountaintop mining and valley fill construction, resulting in geotechnically stable designs of valley fills with runoff management; however, major environmental concerns have resulted, specifically the loss of headwater stream length, increased flooding risk, and degrading water quality to downstream communities. One technique to lessen impacts involves geomorphic landform design (GLD) which uses a reference landform approach. This research created conceptual geomorphic designs for a West Virginia valley fill and identified challenges and benefits.

**Applicability to Mining and Reclamation:** While proven successful in semi-arid regions, this approach has not been utilized in Central Appalachian surface mining design or reclamation. The goal of geomorphic reclamation is to re-design valley fills in a way that reduces the effect of natural geomorphic processes, i.e. that replicates a mature landform that is geotechnically stable and in erosive equilibrium. Potential challenges associated with implementing geomorphic landform design principles to mountaintop mining in Central Appalachia have been recognized but not quantified. This work quantified these issues by evaluating geomorphic landform design as a potential reclamation strategy for Central Appalachia valley fills.

**Methodology:** This work created conceptual geomorphic landform designs for two constructed valley fills in West Virginia. First, we collected field data to serve as our reference data in two watersheds in Twin Falls Resort State Park and Cabwaylingo State Forest to characterize mature, undisturbed landforms in the steep terrain (Figure 1). Critical design parameters included drainage length (the distance from a ridgeline to the initiation of a channel within a valley) and drainage density (channel length per watershed area). We also evaluated channel properties (bed slope, bed material grain size, channel width) and valley side-slope characteristics (gradient and aspect).

Using the reference data, a series of conceptual geomorphic landforms were created for the valley fills. The newly generated geomorphic contours were connected to the conventional reclamation contours surrounding the valley fill boundary. The resulting landforms were then evaluated with respect to landform stability, channel stability, and fill volume.

**Highlights:** Conclusions from this study evaluating geomorphic landform design for valley fills in West Virginia include the following:

- Geomorphic properties of landforms in Central Appalachia are different than the properties in the southwestern U.S. where geomorphic reclamation has been successful. Local reference data need to be developed and utilized in reclamation designs in the steep-sloped Appalachian region.
- Geomorphic reclamation in Central Appalachia can likely mitigate the burial of a pre-existing channel by re-creating a stable channel on spoil at a slightly higher elevation.
- When the area of impact of the conventional reclamation was maintained, a geomorphic design could not meet the requirements of channel stability, landform stability, and fill volume simultaneously for the locations studied.

- Expanding the area of impact of one of the fills resulted in a landform that better satisfied the three criteria for a successful geomorphic design; but, the design still did not completely comply with regulations governing excess spoil placement.
- Creating a geomorphic landform does not recreate the pre-mined topography of Central Appalachia as in the southwestern U.S. due to differences in environmental factors and mining/reclamation techniques.
- Potential benefits of geomorphic designs include: increased variability in slope gradient and aspect; newly generated stream length; decreased erosion; and improved management of surface water, groundwater, and mine spoil contaminants.

**Results/Findings:** Geomorphic landform characteristics were measured for undisturbed landforms in southern West Virginia, resulting in a set of input parameters (Table 1). The designed valley fills had one main channel in the center of the structure. The created landforms had a series of ridges and valleys, with increased physical variability as compared to the standard design (e.g. slope, aspect). The best performing designs in the permitted area and the expanded impact area created a stable channel under both bankfull and flood prone flow conditions. Calculated shear stresses suggest that cobbles could resist motion at all design flows. For the geomorphic design in the permitted area (Fig. 2), side-slope stability and fill volume had to be reduced to reach this desired level of channel stability. The steepest slopes were located towards the middle of the redesigned fill's longitudinal profile (at the transition point from convex to concave slope profiles) and were shown to be unstable. The geomorphic design with an expanded impact area (Fig. 3) met fill volume requirements but hillslope stability remained an issue. Although the steepest slopes were shown to be stable, they did not comply with the regulatory design standards of a maximum 2:1 slope and a factor of safety $\geq 1.5$.

**Table 1. Summary of input design parameters calculated from field measurements**

| Input Parameter | Field measured value |
|---|---|
| Drainage length (ft) | 408 |
| Slope at the mouth of main valley bottom channel (%) | Design dependent |
| Target drainage density (ft/ac) | 61.7 |
| Target drainage density variance (%) | 23 |

**Figure 1. Setting up survey equipment along ridgeline of reference watershed**

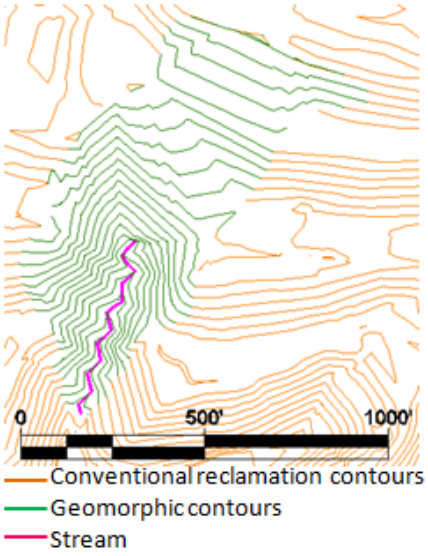


**Figure 2. Example GLD valley fill for the permitted area**

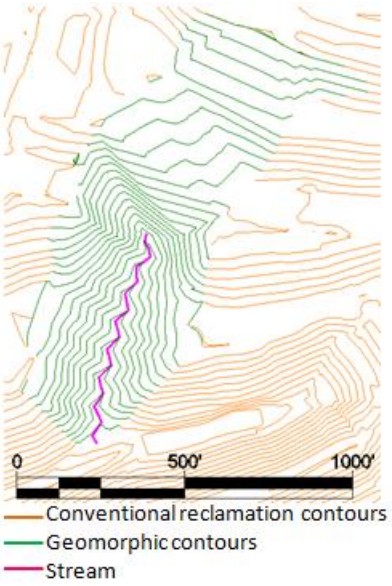


**Figure 3. Example GLD valley fill for the extended area**


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**Website Information**:
The final project report can be found at http://www.osmre.gov/programs/tdt/appliedscience/projects.shtm