

# Challenges of Applying Geomorphic and Stream Reclamation Methodologies to Mountaintop Mining and Excess Spoil Fill Construction in Steep Slope Topography (e.g. Central Appalachia)



**PETER MICHAEL<sup>1</sup>**  
**MICHAEL SUPERFESKY<sup>2</sup>**  
**LOIS URANOWSKI<sup>1</sup>**

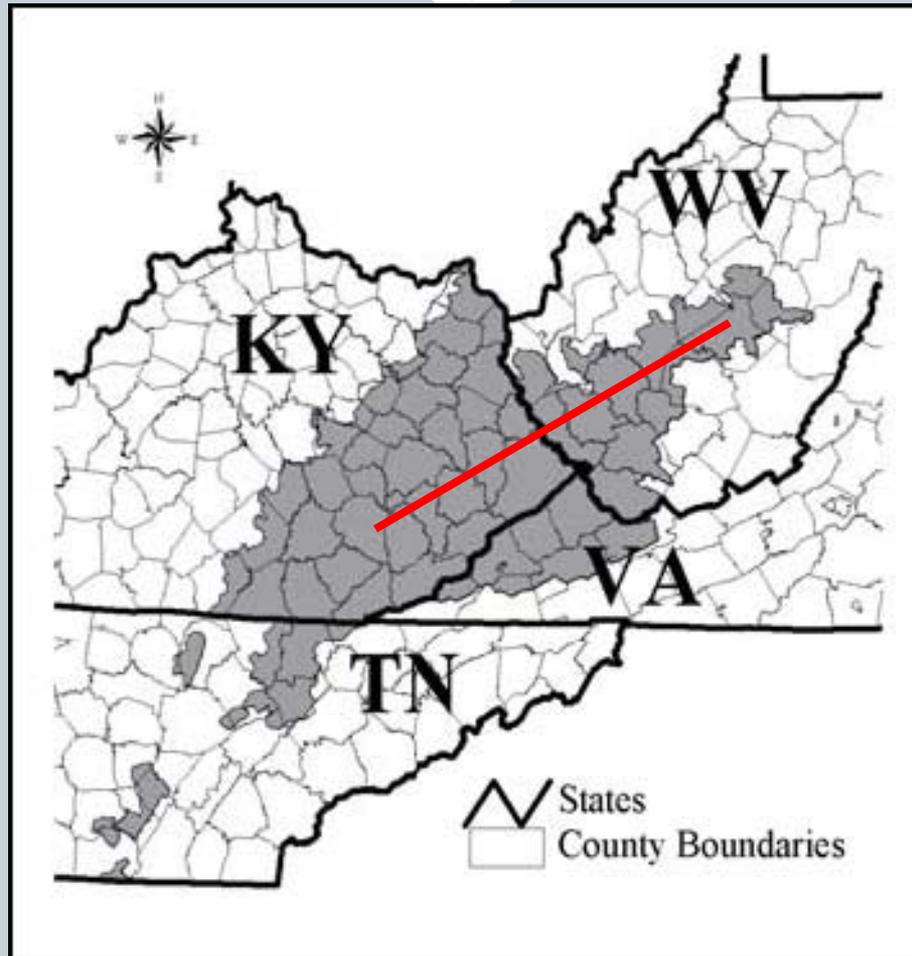
**<sup>1</sup>U.S. OFFICE OF SURFACE MINING,  
PITTSBURGH, PA**

**<sup>2</sup>U.S. OFFICE OF SURFACE MINING,  
MORGANTOWN, WV**



Counties in the Appalachian Coalfield Region with watersheds affected by valley fills.

From:  
Mountaintop Mining/Valley Fill (MTM/VF) EIS (2005).



Example of reclaimed mountaintop mining and excess spoil fill construction in Central Appalachia, as currently practiced.



# Current Federal Requirement Closest to Geomorphic Reclamation



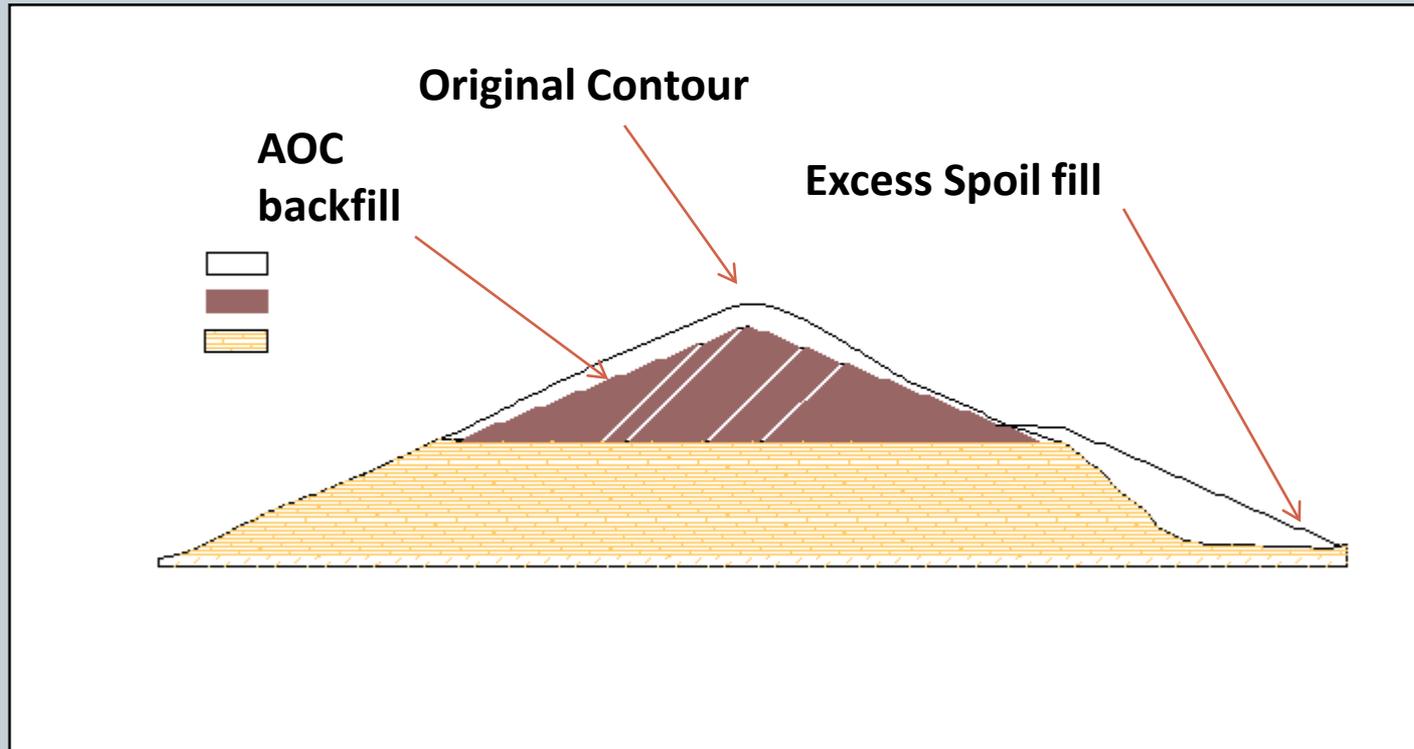
**Approximate Original Contour (AOC),  
defined as:**

“That surface configuration achieved by backfilling and grading of the mined areas so that the reclaimed **area...closely resembles the general surface configuration of the land prior to mining** and blends into and complements the drainage pattern of the surrounding terrain....”

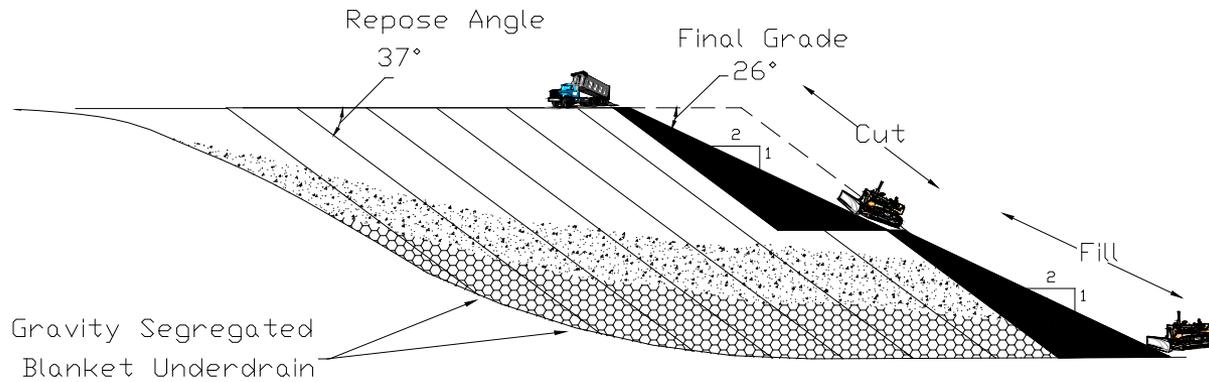
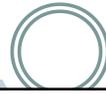
# Challenging Site. Fills and ridges.



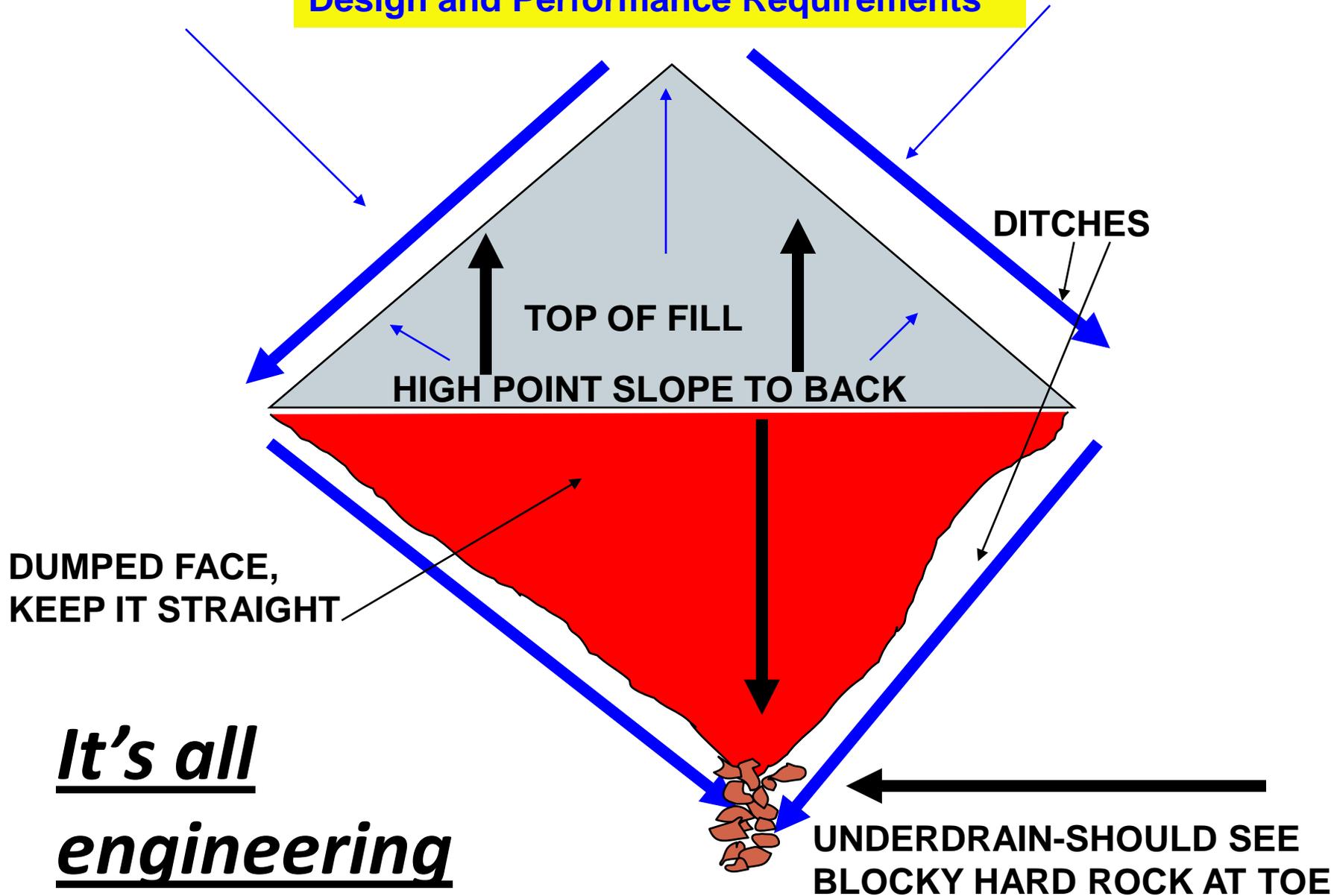
# Generation of Excess Spoil Fills



# Durable Rock Fills



**Design and Performance Requirements**



**It's all**  
**engineering**  
**in the regs.**

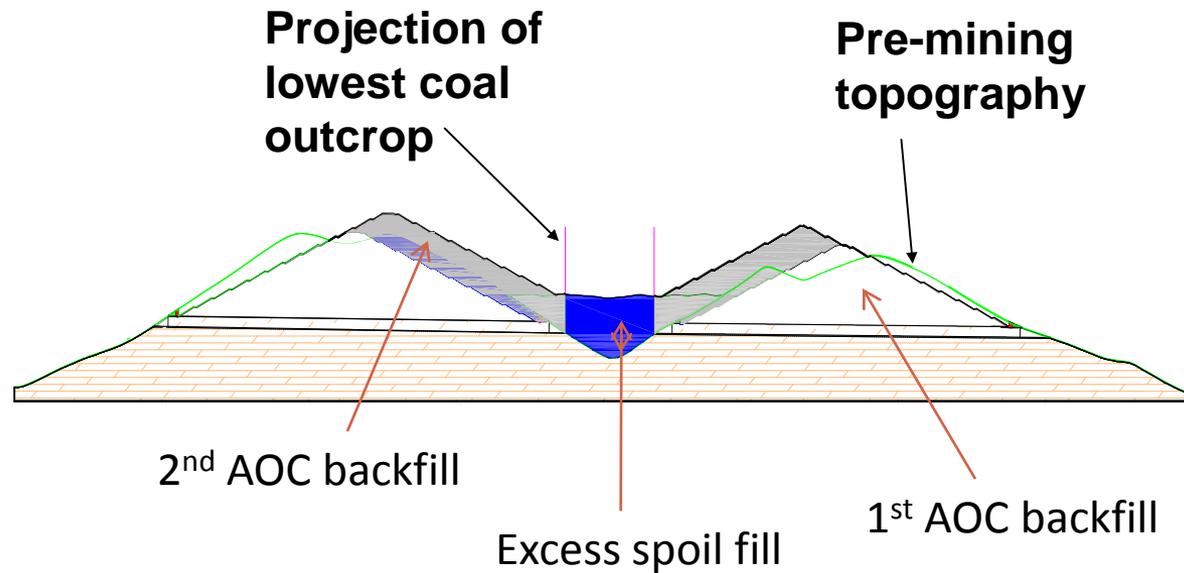
# Recent Regulation Changes to Limit the Adverse Effects of Excess Spoil Fill Construction



**Changes to SMCRA regulations require:**

- **Limit the amount of excess spoil generated at a mine site;**
- **Limit the size of fills constructed;**
- **Consideration of alternative configurations for excess spoil disposal; and**
- **Development of a disposal plan that would minimize adverse impacts to the environment.**

# Spoil Placement Optimization to Limit Excess-Spoil Fill Disturbance of Land and Water





**PAST AND CURRENT  
ENGINEERING AND  
ENVIRONMENTAL  
ISSUES REGARDING  
VALLEY FILLS**

Effective Gravity  
Segregated  
Underdrains for  
Durable Rock  
Fills.

(Related Issue:  
Sampling and  
Testing for Rock  
Durability)



# Stream Disturbance and Burial



# ...but also Long-Term Stability of Elevated Excess Spoil Fills on Steep Foundation Slopes.



# Contemporaneous Reclamation



# Erosion and Flooding





# Enter Geomorphology!!

# Goals



- **Back to Basics- what nature builds will stay put?**
- **What about reclamation and engineering?**
- **How can it work in mountain top mining with steep areas?**

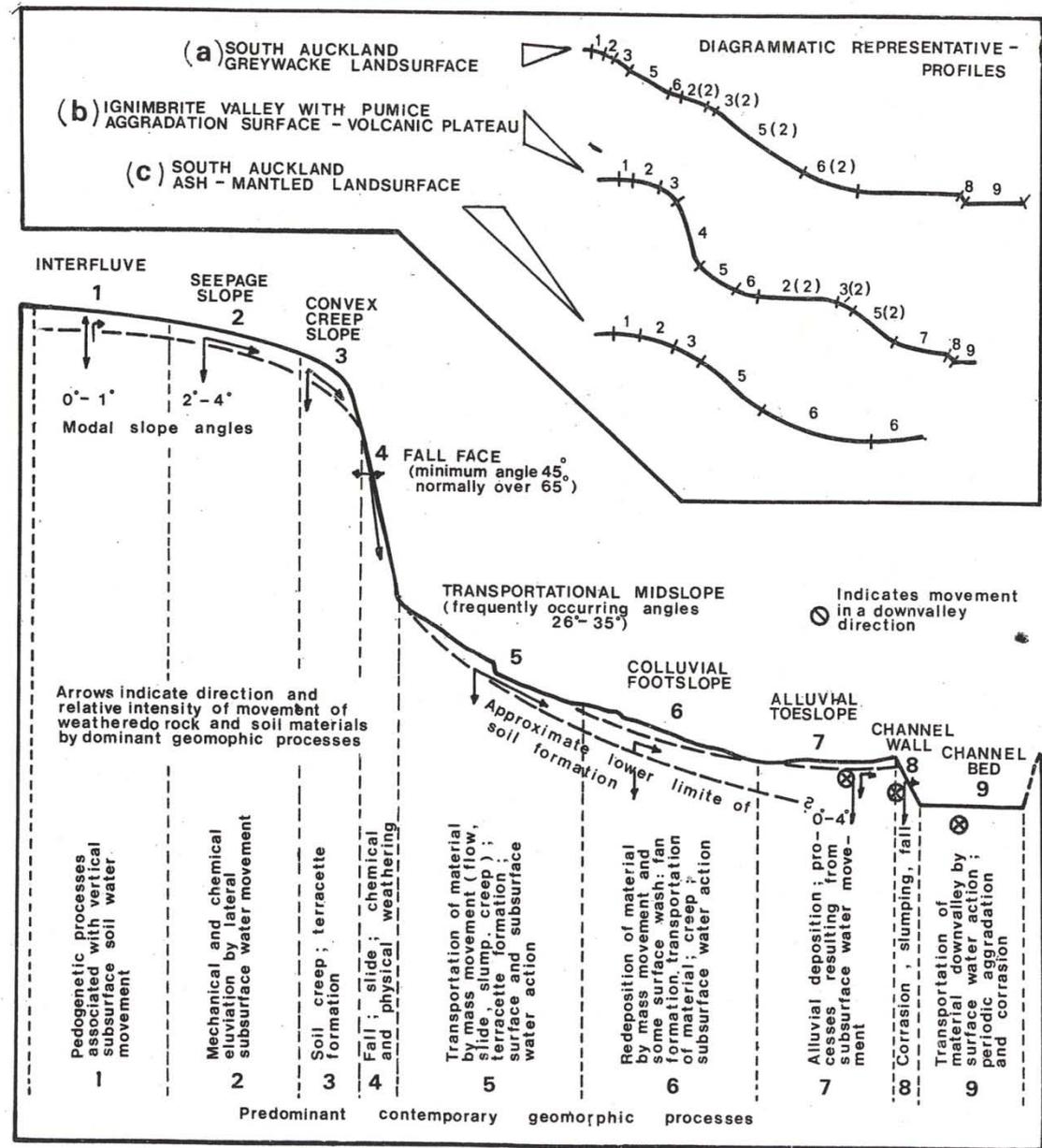
# Geomorphology Defined



Simply put: *the study of landforms*

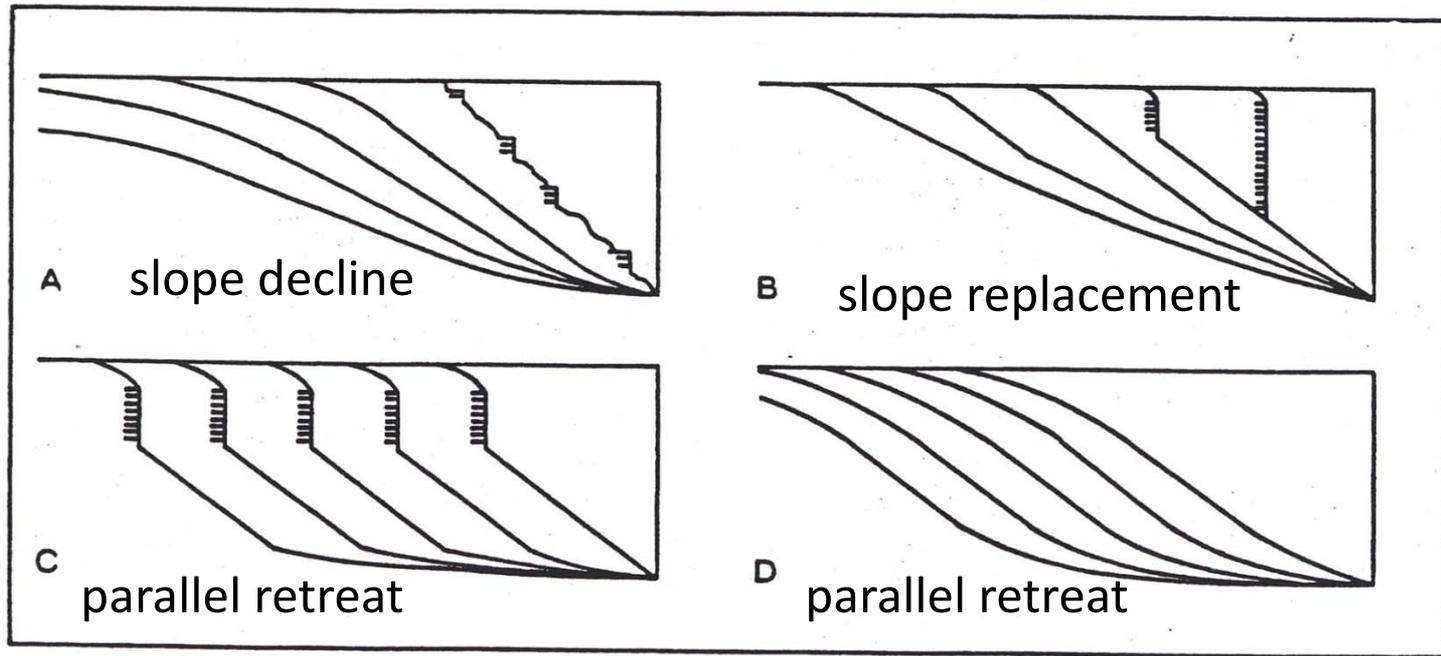
- Classification of landforms, based on:
  - Shape (“morphology”).
  - Materials they are made out of (“constituent materials”).
  - How they formed (“origin”).
- Study of landforming processes. 
- Study of stages of landform development. 

# Study of landforming processes.



“Nine-Unit Land Surface Model” (after Dalrymple *et al.*, 1968)

# Study of landform development. (after Young, 1972)

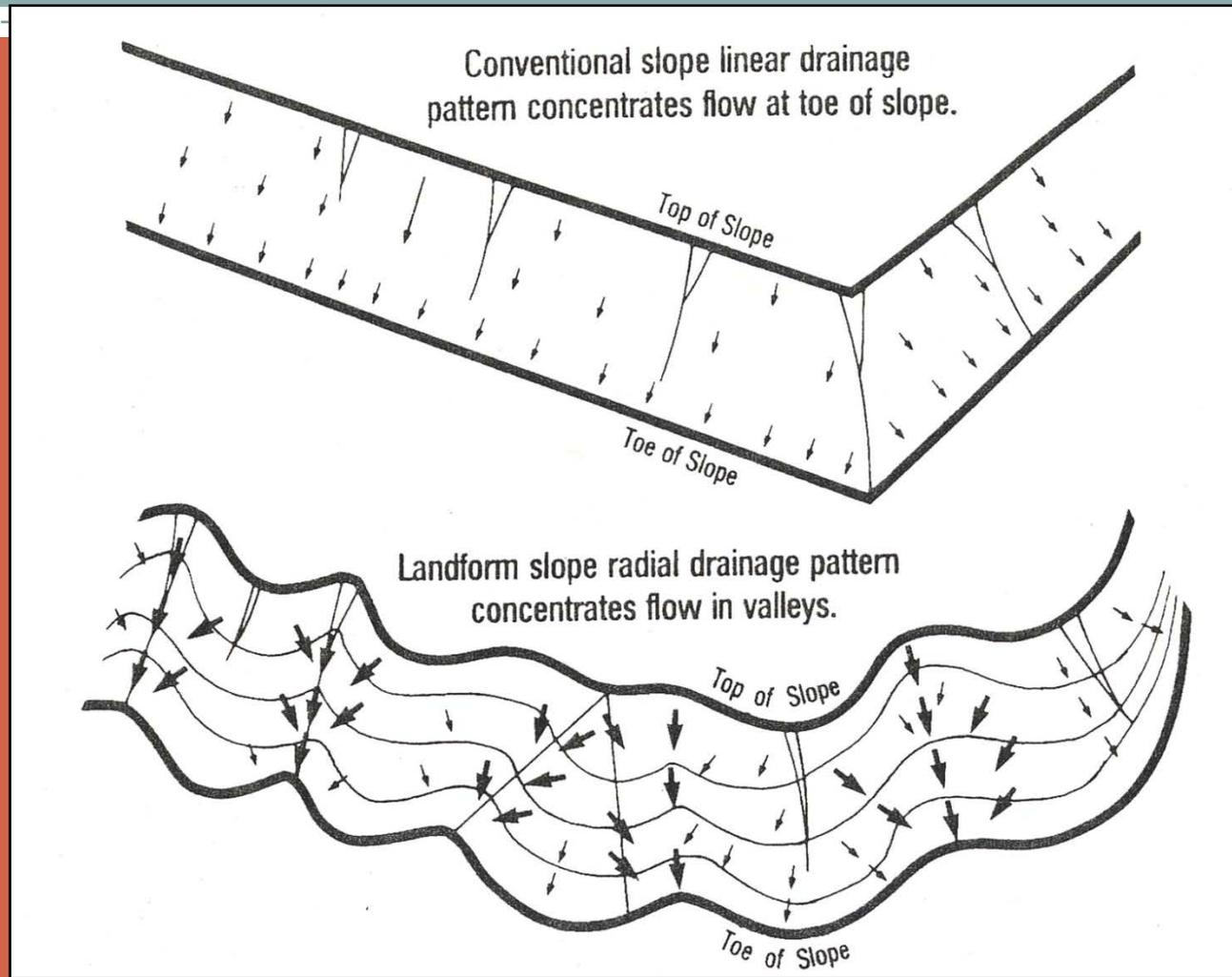


# Geomorphic Reclamation, or “Landforming.”



- **Definition:**
  - Application of principles and insights gained from the study of geomorphology to land modification and reclamation.
- **The benefits:**
  - Aesthetically more pleasing.
  - **Greater stability (less erosion and less chance of mass instability).**
- **The objectives:**
  - Constructing artificial landforms that blend in with the surrounding natural landscape.
  - Constructing artificial landforms that are naturally stable (i.e. stable landforms that nature would form).
  - **Rephrasing: constructing artificial landforms that are stable in the long-term and maintenance free. And look they they belong.**

Comparison of surface water-flow regime in a landform graded slope as opposed to a conventionally graded slope.

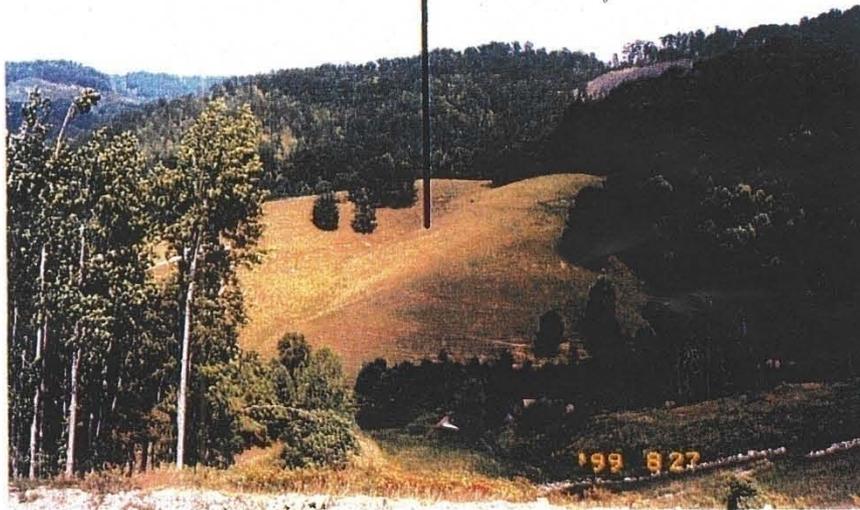


(from Schor and Gray, ©2007 John Wiley and Sons, Inc., reprinted with permission of John Wiley and Sons, Inc.)

NATURAL LANDFORM IMMEDIATELY ADJACENT TO OUTSLOPE ON RIGHT.

THIS WOULD HAVE MADE AN IDEAL NATURAL ANALOGUE FOR THE DESIGN OF THE MAN-MADE SLOPE

(b)



CONSTRUCTED OUTSLOPE AT VALLEY FILL

CONVENTIONAL "DAM" TYPE DESIGN, LINEAR WITH UNIFORM SLOPE RATIOS, NO ATTEMPT HERE TO MIMIC NATURE

(a)



Tailings-disposal fill configurations: (a) "outward"-facing slope of valley fill once constructed and graded and (b) adjacent natural slope, whose topographical form would have made an ideal natural analog for the "outward" slope. (from Schor and Gray, ©2007 John Wiley and Sons, Inc., reprinted with permission of John Wiley and Sons, Inc.)

**Example of landforming on  
mountain top in WV**



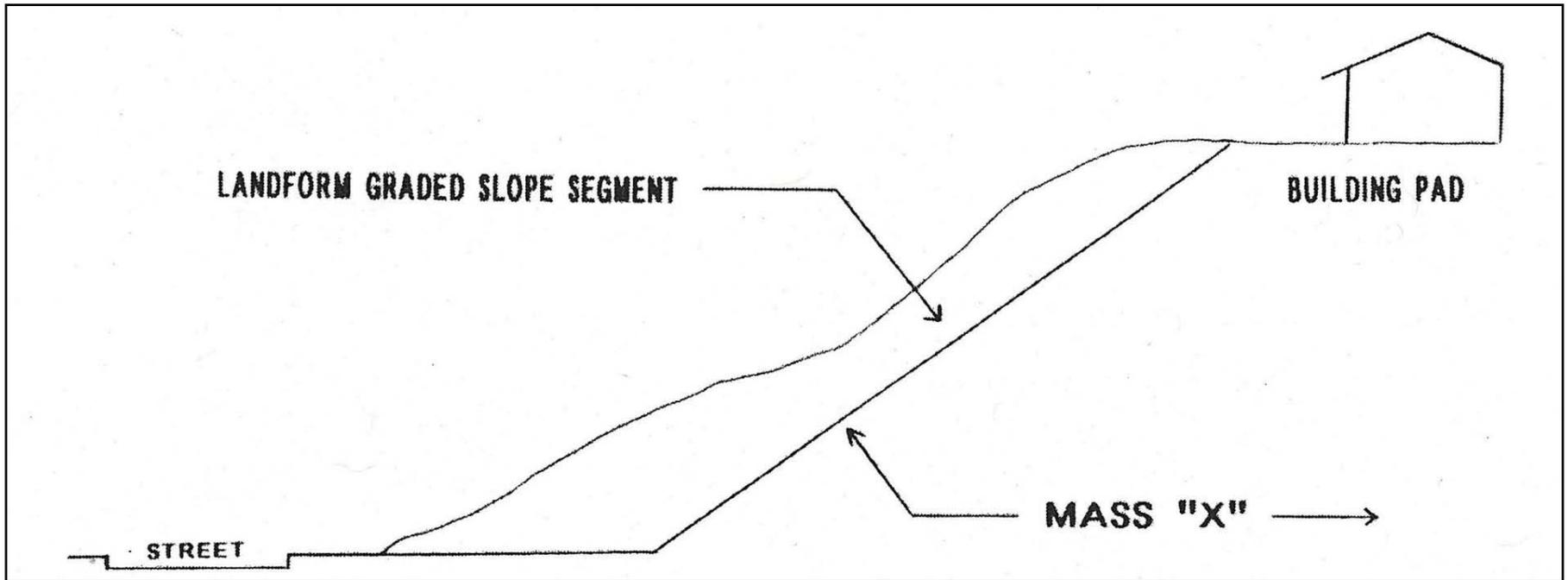


# Challenges to Landforming in Steep- Sloped Central Appalachia



How can we incorporate natural landform design to these site conditions? Would nature form a valley fill like this?

## Relative amounts and location of earth movement by conventional as opposed to landform grading.

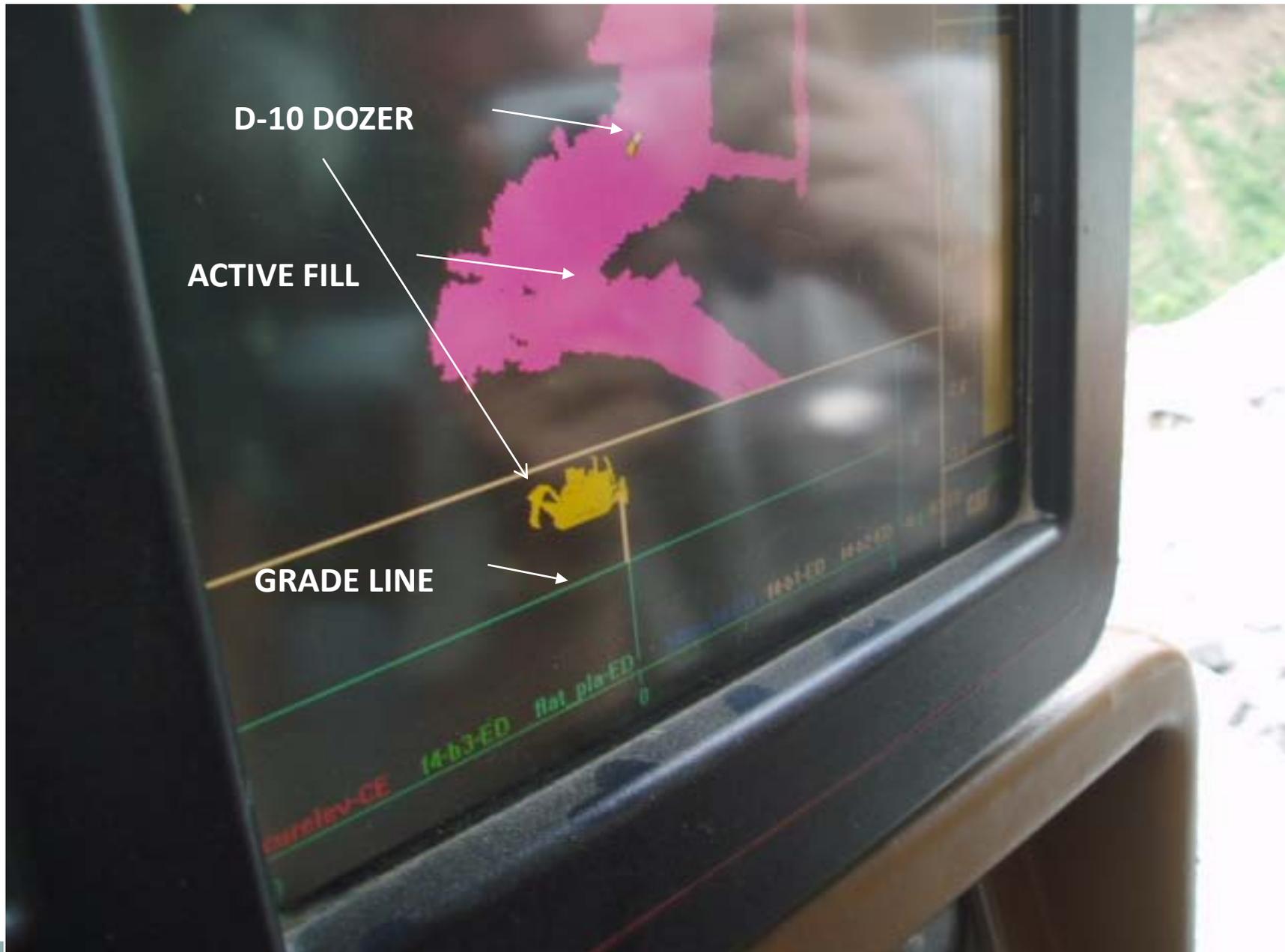


*The point of this diagram:* Landform grading is applied only to the surficial veneer of earth material, minimizing increases in labor costs. Will the cost increase still prohibit landforming in steep-slope topography?

(from Schor and Gray, ©2007 John Wiley and Sons, Inc., reprinted with permission of John Wiley and Sons, Inc.)

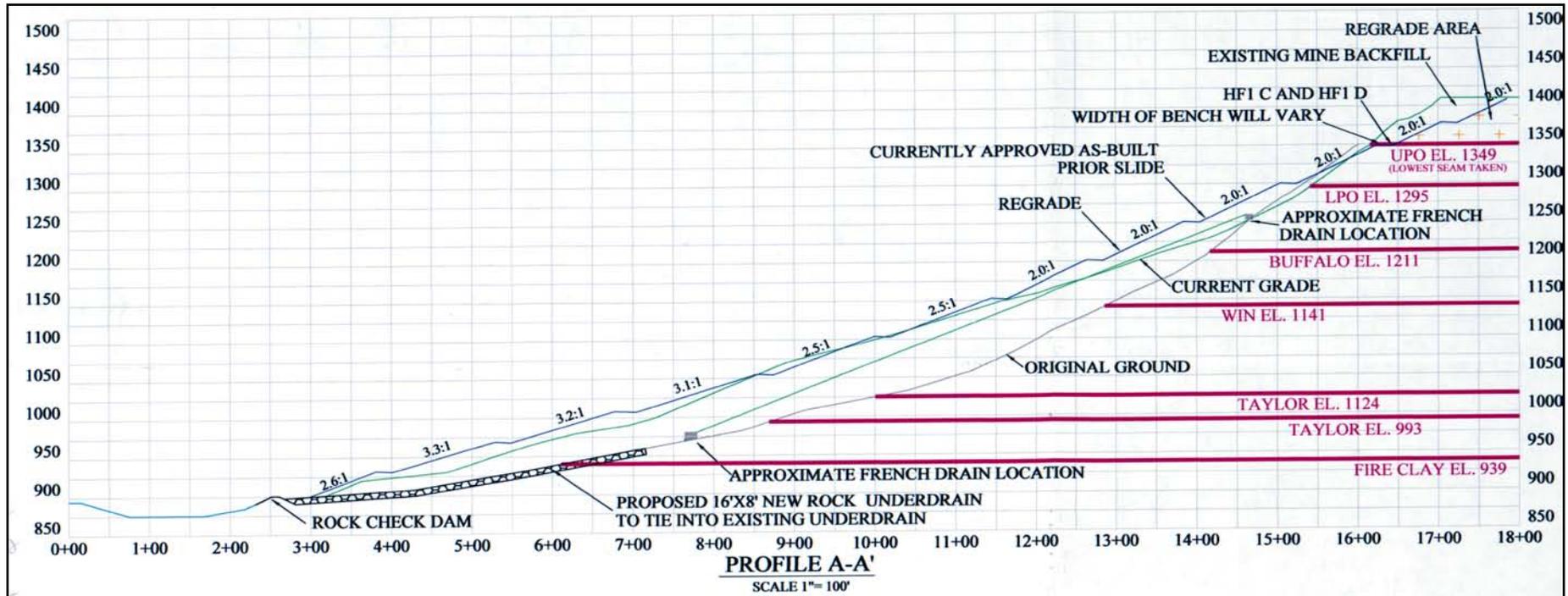


# COMPUTER-GPS ON D-10 DOZER





Geomorphic reclamation should not deter contemporaneous reclamation.



Elevated valley fills in steep-slope topography can be pretty thin to begin with.

Constructing fills that simply blend in with an erosional landscape is not enough....





.....They also must be stable.

# Conclusions



- The authors support the concept of geomorphic mine land reclamation in Central Appalachia and elsewhere.
- We particularly like its implications for long-term, post-bond-release stability of reclaimed surfaces, especially excess spoil fills.
- Challenges to the application of landforming and stream restoration on surface mines in steep-slope topography include:
  - Absence of explicit references in the Federal regulations to geomorphic reclamation.
  - A potential conflict with recently promulgated rules for excess spoil (fill) limitation.
  - Potential increased time and cost relative to current practices.
  - Designing and constructing stable landforms within an otherwise youthful, erosional landscape.