

# Can Appalachian Mine Reclamation Be Called Sustainable Using Current Practices?

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OSM Technical Interactive Forum

Geomorphic Reclamation and Natural Stream Design at Coal Mines  
Bristol, Virginia

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GeoFluv

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Carlson Software

# Who has *Natural Regrade* worldwide?



# **Economic competition demands most efficient use of resources**

- **Coordinating mine development, operational, and closure plans adds efficiency**
- **Leads to *land use sustainability***

# 'Land Use Sustainability'

definitions share recognition of the need to maintain:

environmental functions related to landforms when conducting

economic development activities for the benefit of

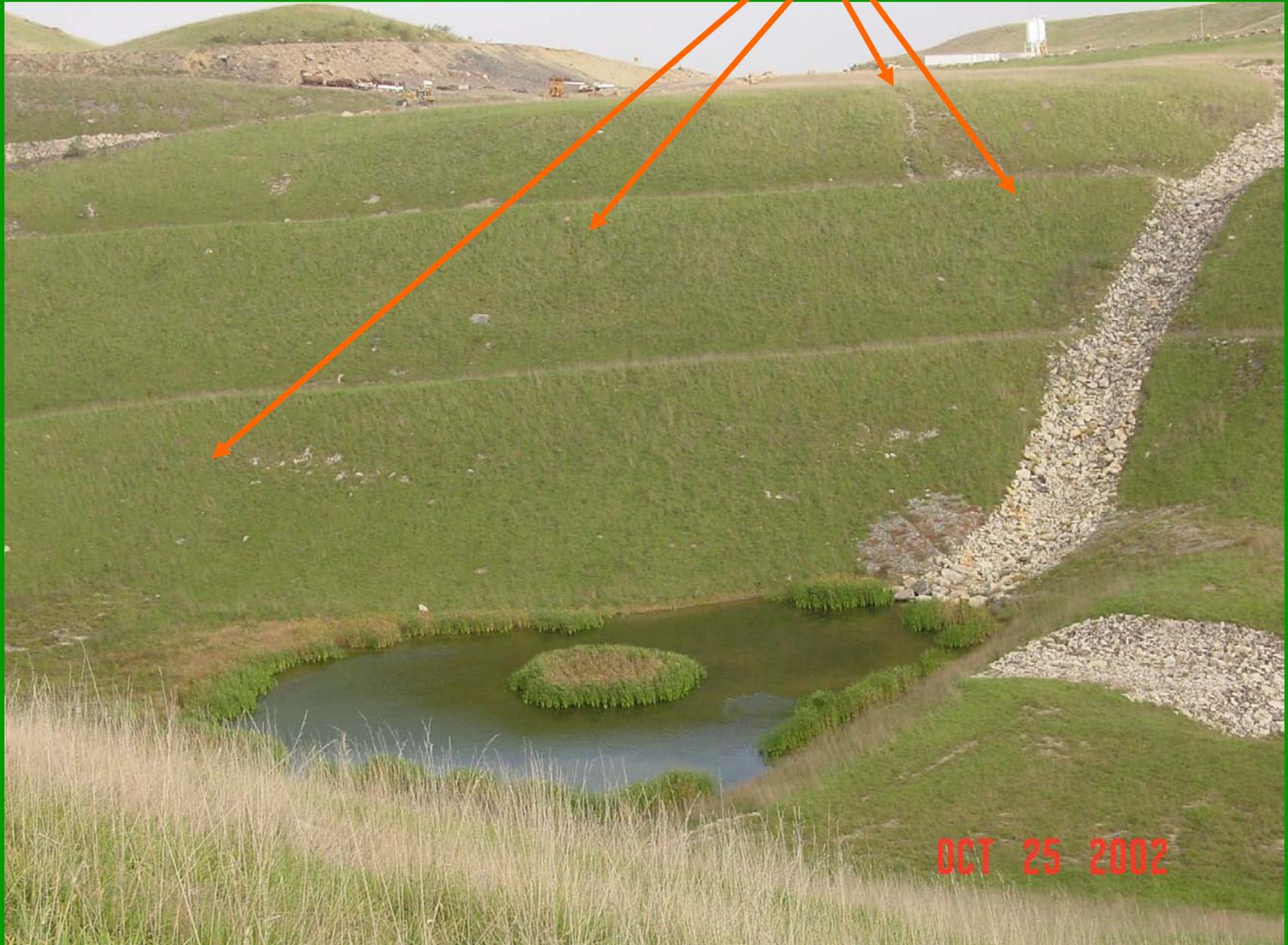
future users of the land.

## “The triple bottom line”

# What are traditional design criteria?

- **Smooth surfaces**
- **Route water away**
- **Minimize footprint**

If you don't add *drainage density*, nature will !!



OCT 25 2002

**constant gradient  
no drainage density**



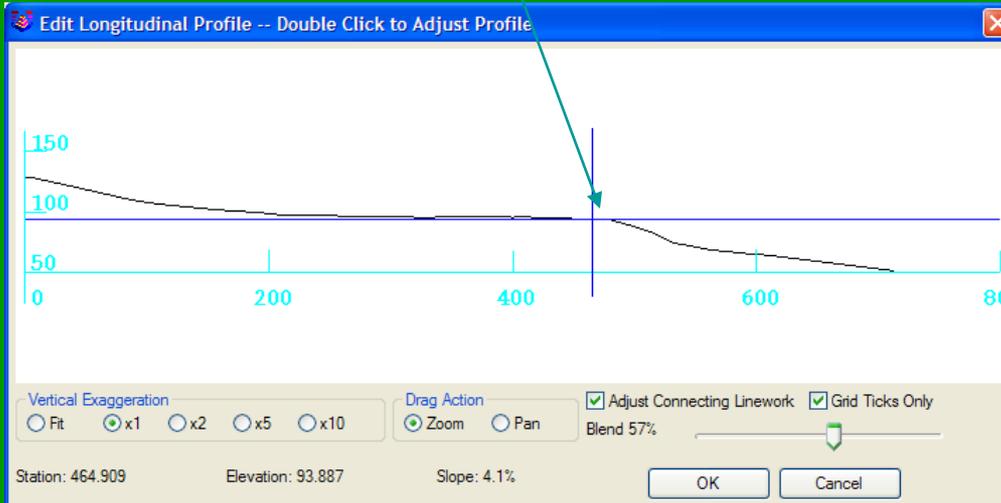
**Slope is creeping, landslide beginning**



**Will these houses be buried?**



# Knickpoints can be BIG problems



(AK)

**One storm corrects longitudinal profile !**



**Terraces can be expensive to build and maintain  
(if you don't see it in nature, don't do it!)**



***Something just tells you it isn't right . . .***



# Coal mine reclamation in the region

*“ . . . has not been accompanied by widespread replacement of forests disturbed by mining.”*

*- Appalachian Regional Reforestation Initiative (ARRI)*

# Traditional Reclamation Landforms:

- fewer ecological niches = *monoculture*
- or worse, are *unsuitable* for the desired species while inviting *invasive* species

# ***Natural Regrade module with GeoFluv™ (Patent Pending)***

**The *GeoFluv™* approach asks,**

***What would be a stable, natural landform?***

**and designs and builds that**

# **GeoFluv landform has diversity similar to the native, undisturbed land**

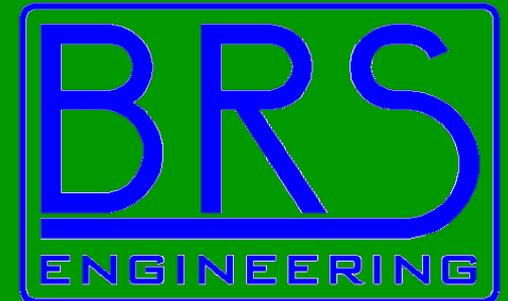
- **provides the optimal niches for native species productivity**
- **simultaneously provides natural invasive species control**
- **promotes suitable water quality**

# What other requirements are related to *sustainable* landform design?

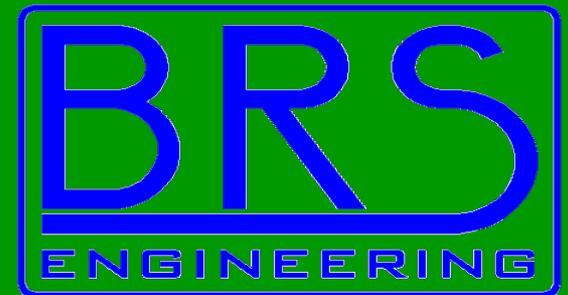
- Free from maintenance, ‘forever’
- NPDES storm water discharge (sediment)
- Vegetation composition & diversity
- COE 404 permit
- Stream ‘mitigation’
- Prove stability against erosion, ‘forever’
- Post-mining land use
- Low cost to achieve these criteria
- Bond release

***View of “A” channels and ridges designed using Natural Regrade,***

***to replace constant 3:1 slope.***



# *GeoFluv design and natural*



# Rip-rap downdrains blow out repeatedly



Water & Earth Technologies, Inc.  
Water Resources and Environmental Consulting

# GeoFluv™ landform and existing quarry



**three days of rain; no problems**  
***a mountaintop removal?***



Water & Earth Technologies, Inc.  
Water Resources and Environmental Consulting

# Dept. of Interior “National” and “Best of the Best” 2004 reclamation awards



*There is something new happening in landform design.  
It's the future. It's natural.*

*Be a part of it.*

# Before *Natural Regrade* GeoFluv design

– Dan Hause, Indiana AML





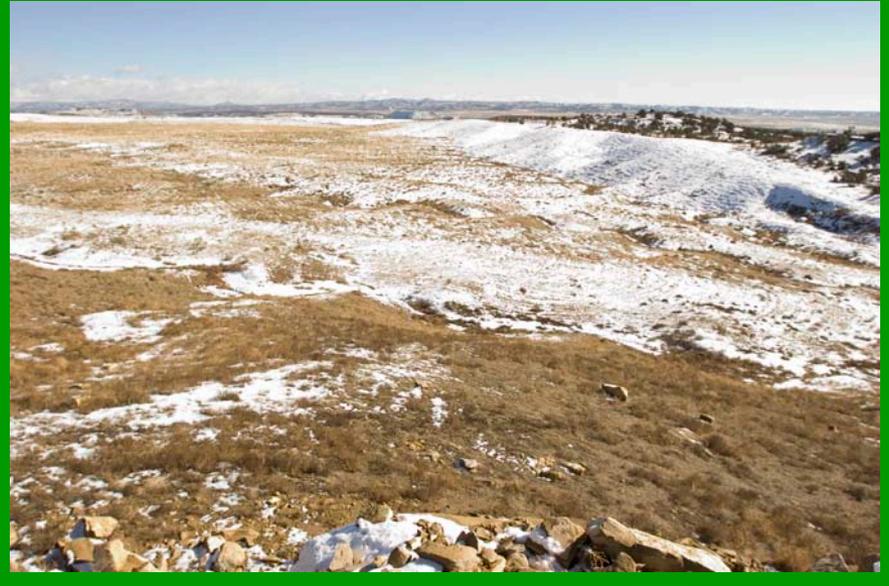
***After Natural Regrade GeoFluv design***

# Mid Continent Regional Award

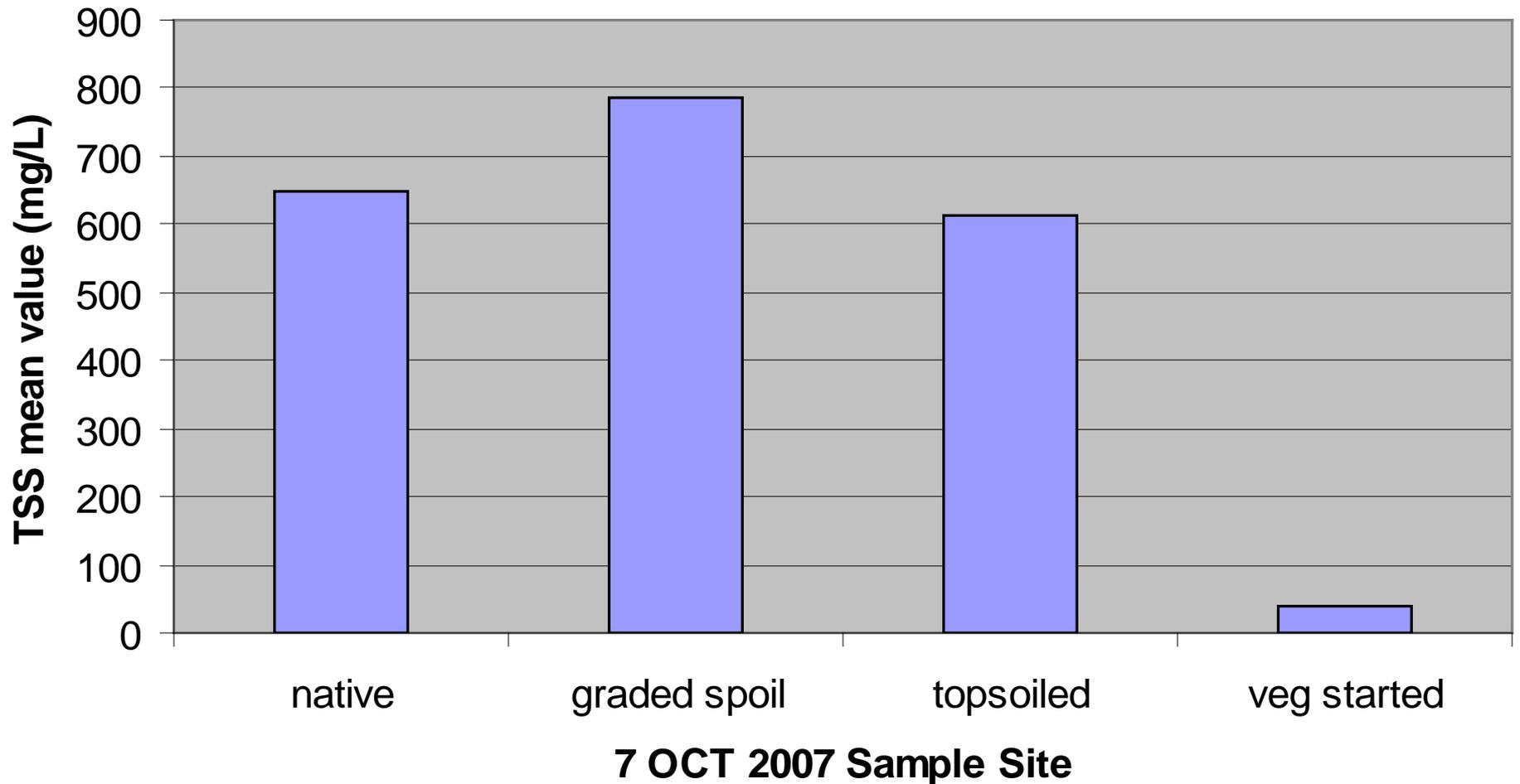
- Log Creek Church AML, *Indiana DNR*

- sequestered >70 acres of acid producing waste
- established forested wetlands
- *sustainable* geomorphic stream channels and upland areas
- natural slopes replaced 4,000 feet of highwall

# highwall to 'wildlife enhancement feature' (~370,000 cubic yards not moved)

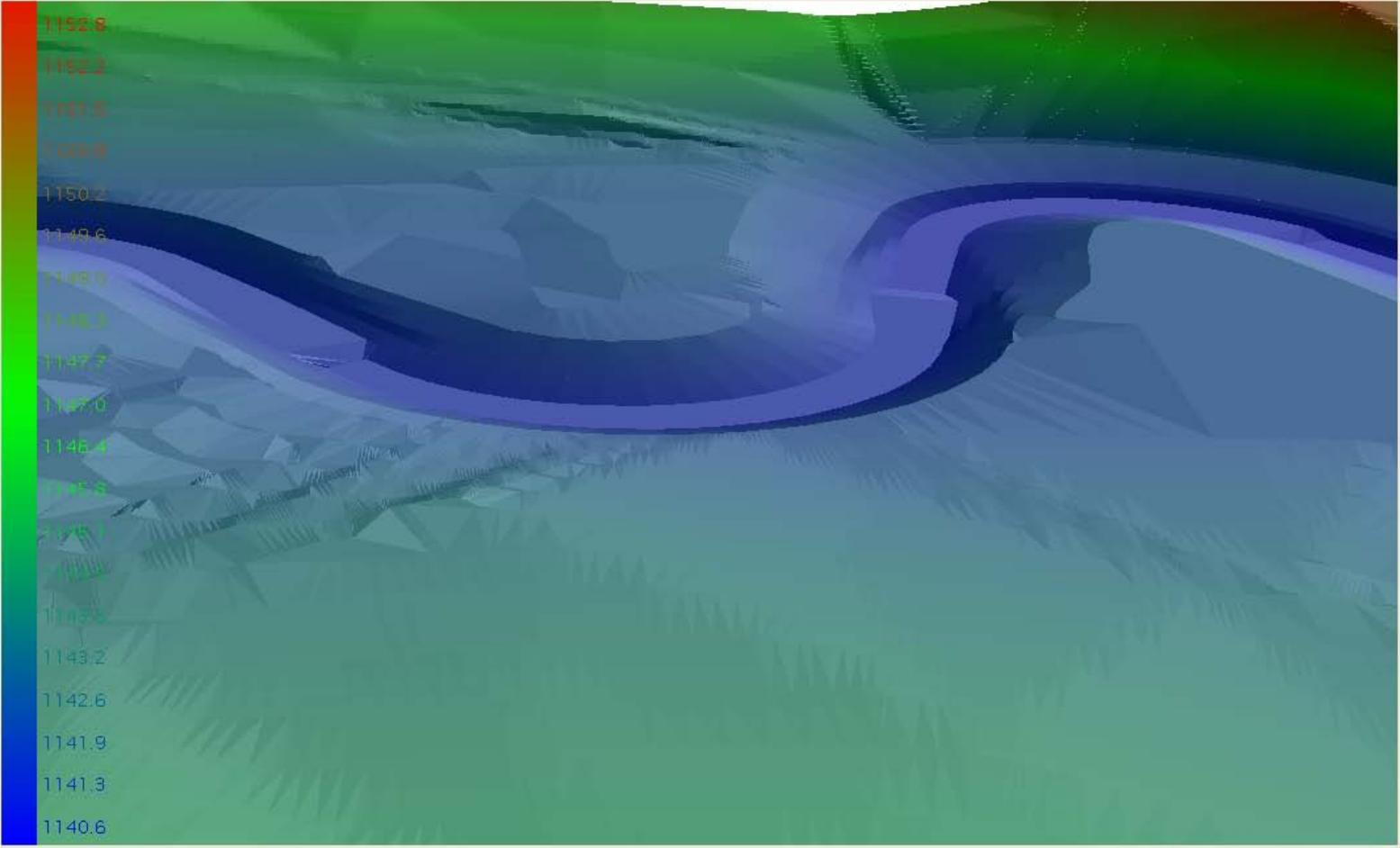


# Storm Water Total Suspended Sediment at Native and GeoFluv-designed sites



# Contoured at 0.2 foot contour interval, vertices densified to enhance 3D view detail of RIVERMorph riffles and pools

Carlson Software 3D Viewer



View Control Advanced

- Ignore Zero Elv
- Color By Elevation
- Vert. scale 1.0

Rotation Axis

- X
- Y
- Z

Clip plane

Hint: To see entity info here: select pick mode and hover above. Double click for more features.

start ZoneAlarm AutoCAD with Carso... AUG07 Level 4 exam... Ford Base Map image... 9:54 PM



Carlson GeoFluv, ver 2.2.2  
C:\Sme example.geo

File... Settings...

Setup Channels Output DWG

Preview

Draw Design Surface

Data for GeoFluv work area:  
Valleys (ft.) 3518.35  
Area (ac.): 26.87  
**Drainage Density(ft/ac): 131**

Comparison Surface

C:\...egrade 1\_1 15 oct 08.tin  
No inclusion polylines were used.  
No exclusion polylines were used.

Update Cut / Fill

Cut (c.y.): 66513  
Fill (c.y.): 195210  
**Cut / Fill (%): 54.07**

Summary Report...

Reread Valley Bottoms

Exit Help



Carlson GeoFluv, ver.2.2.2  
C:\Sme example.geo

File... Settings...

Setup Channels Output DWG

Preview

Draw Design Surface...

Data for GeoFluv work area:  
Valleys (ft.) 3048.88  
Area (ac.): 26.87  
Drainage Density(ft/ac): 113

Comparison Surface

C:\...egrade\_1\_1\_15\_oct\_08.tin

No inclusion polylines were used.  
No exclusion polylines were used.

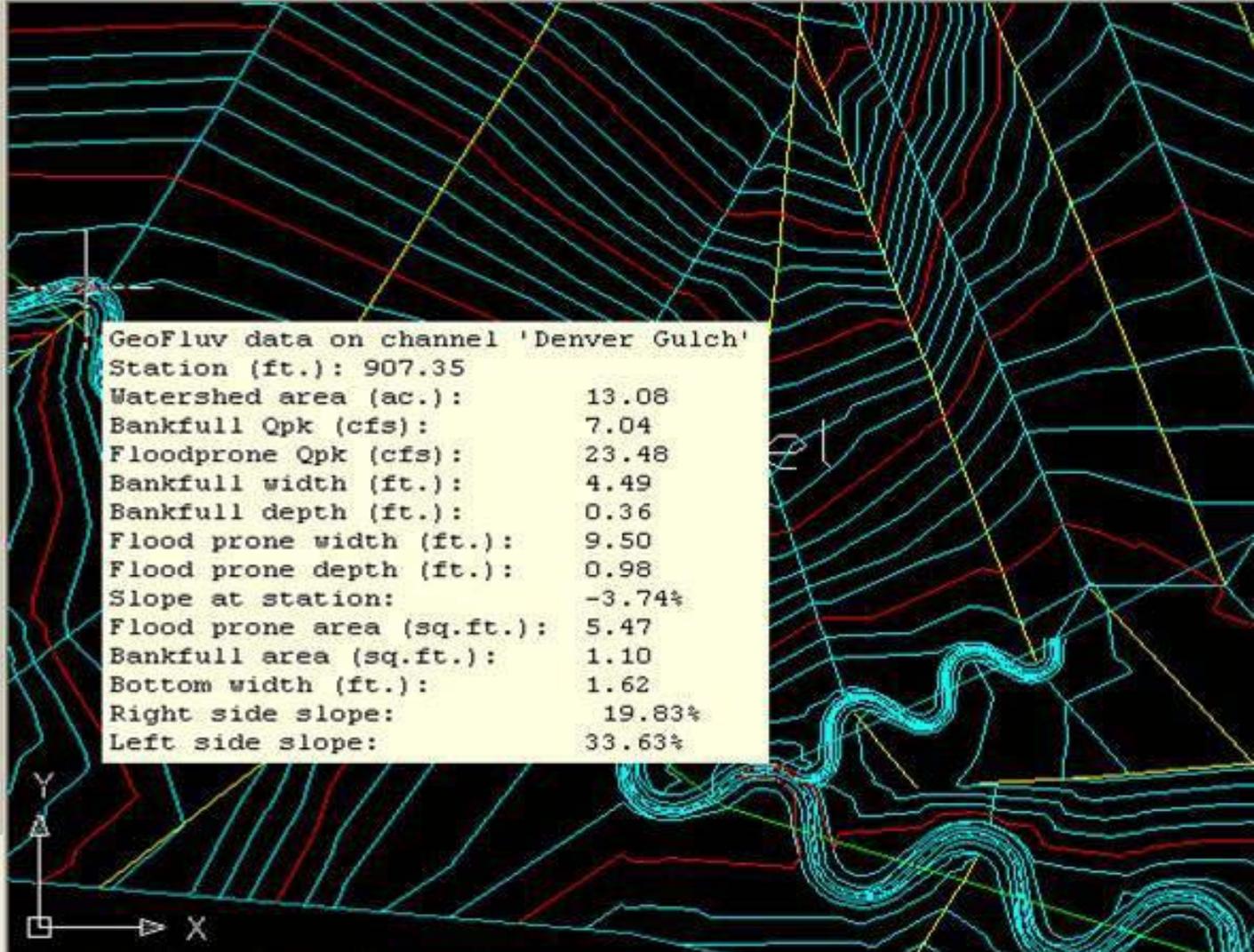
Update Cut / Fill

Cut (c.y.): 125671  
Fill (c.y.): 120519  
Cut / Fill (%): 104.28

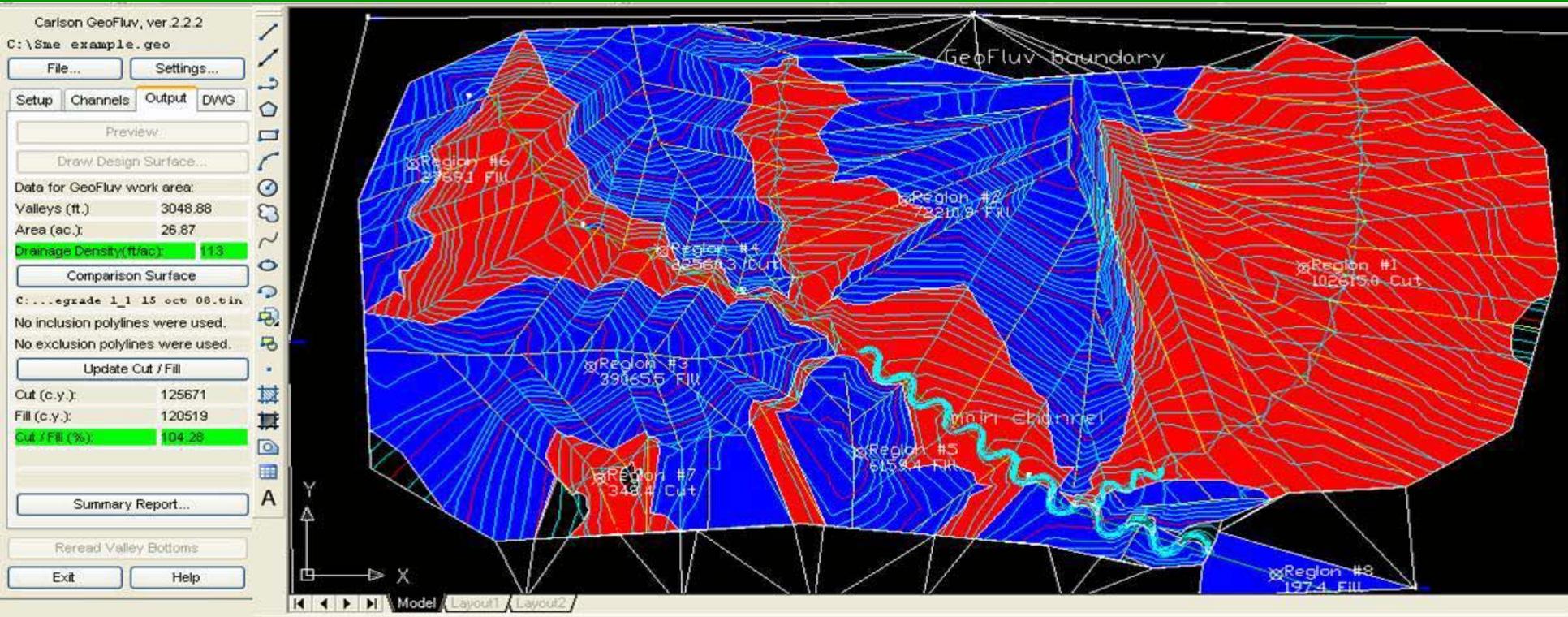
Summary Report...

Reread Valley Bottoms

Exit Help



# Material Cut / Fill Centroids



# Material Quantities & Haul Distances

## Cut & Fill Centroid Report

Original Ground: C:\Documents and Settings\Nicholas

Design Surface: C:\Documents and Settings\Nicholas

Cut/Swell factor: 1.0000

Fill/Shrink factor: 1.0000

Region	Volume(C.Y.)		Northing	Easting
1	102615.0	Cut	704.33	1529.54
2	72210.9	Fill	808.78	972.20
3	39065.5	Fill	552.21	535.43
4	22560.3	Cut	729.57	635.31
5	6159.4	Fill	419.29	911.36
6	2769.1	Fill	864.02	286.55
7	348.4	Cut	379.93	547.71
8	197.4	Fill	231.31	1491.28

## Earth Movement Report:

From Region	To Region	Volume(C.Y.)	Distance
1	2	72210.9	567.04
1	3	16156.8	1005.68
1	5	6159.4	680.73
1	6	2769.1	1253.20
1	8	197.4	474.57
4	3	22560.3	203.55
7	3	348.4	172.71

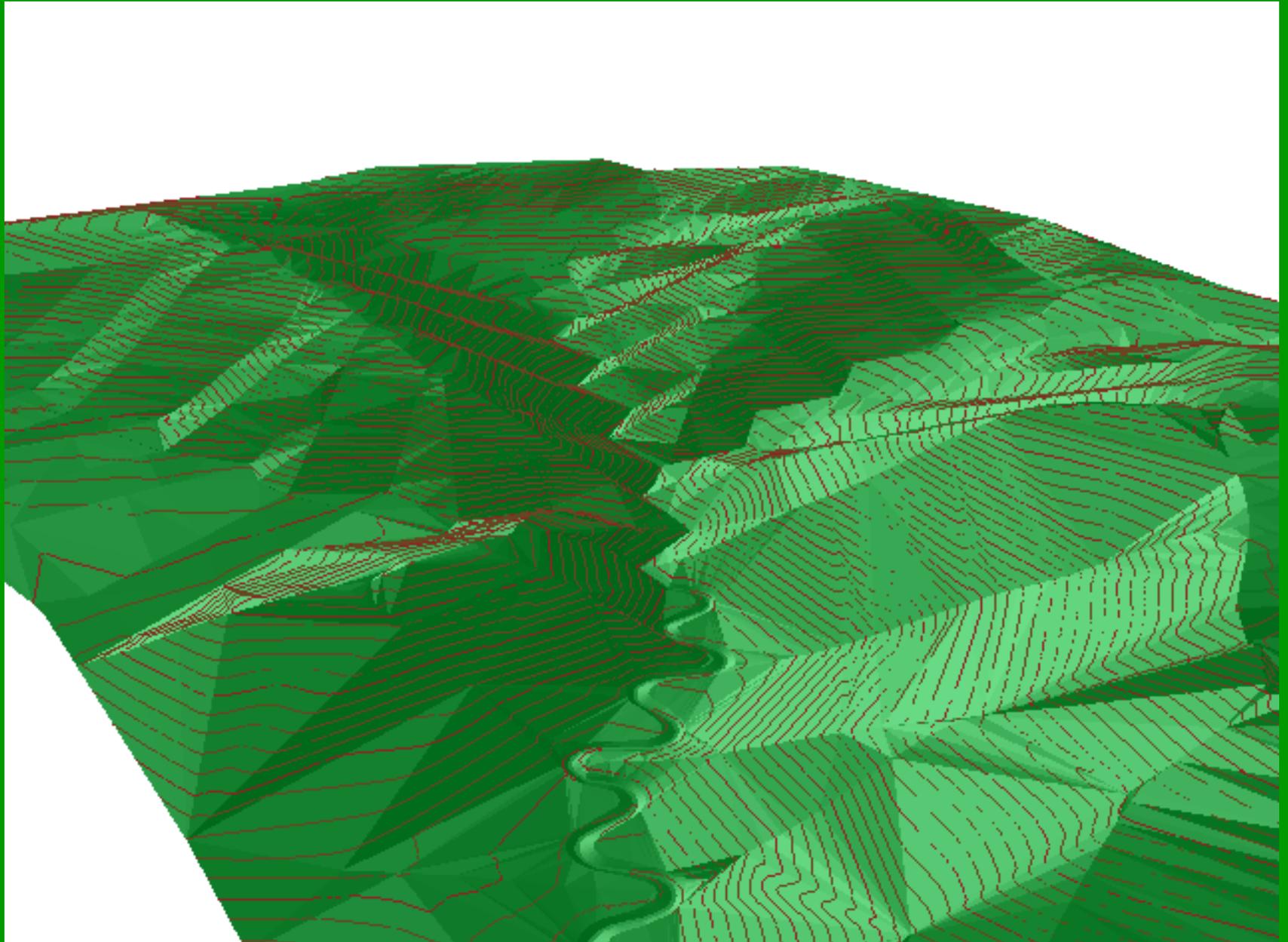
# Grade Operator Screen with three views

The screenshot displays the Carlson Grade software interface, which is divided into several functional areas:

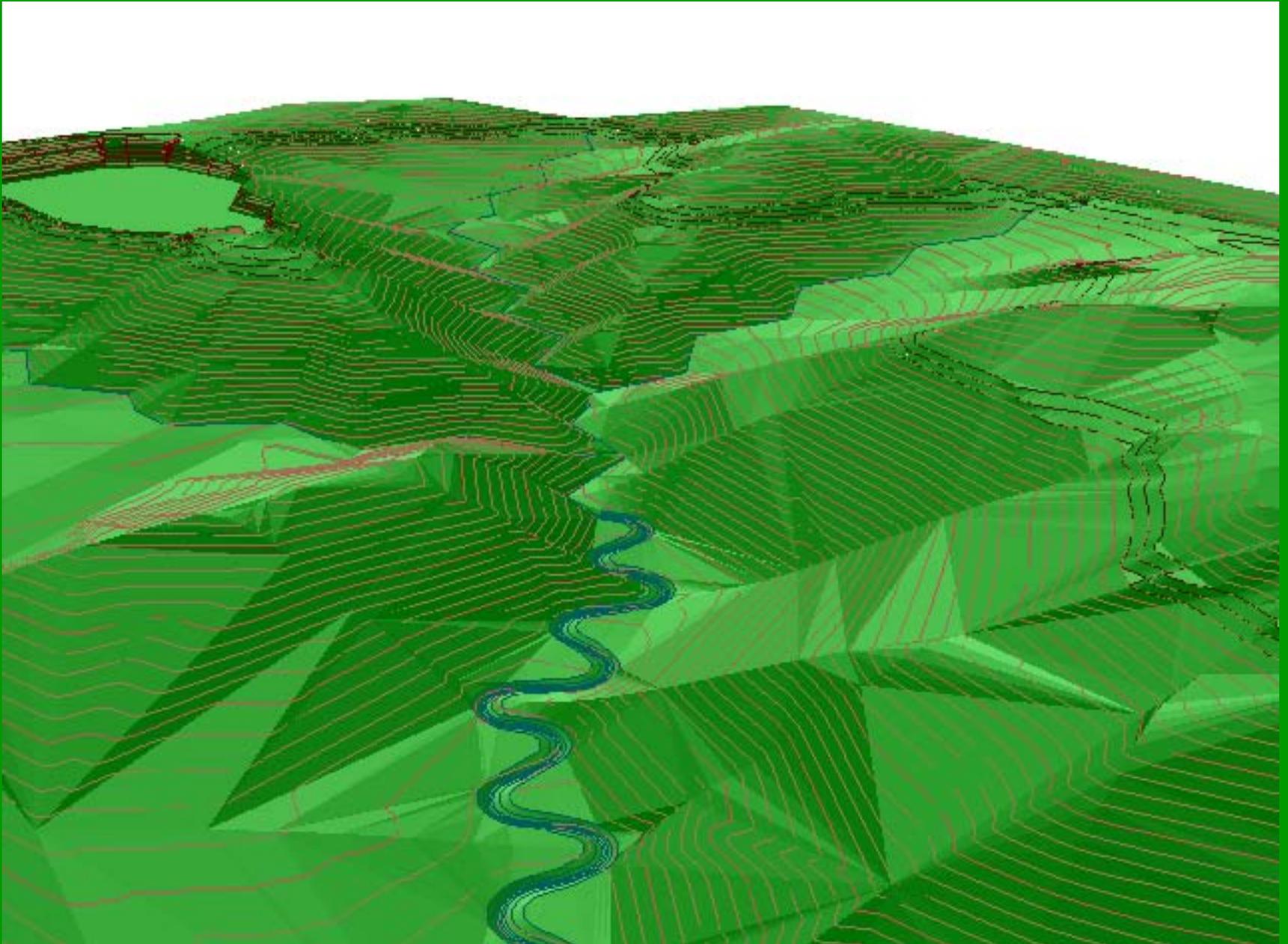
- Top Left:** A 3D perspective view of a construction site. A yellow bulldozer is positioned on a dirt surface. A red dashed line indicates a planned road or path. The elevation is shown as **Z: 1008.95'**.
- Top Right:** A cross-section view of the ground and planned road. It shows a yellow bulldozer on a dirt surface. Below the surface, there are layers of soil and a roadbed. A vertical dashed line indicates a specific point on the road. The slope is labeled as **-0.7%**.
- Bottom Right:** Another cross-section view, showing a different part of the road. It features a yellow bulldozer on a dirt surface. Below the surface, there are layers of soil and a roadbed. The fill depth is labeled as **FILL 3.38'**.
- Bottom Center:** A control panel with a red circular button and the text **1+42.7 5.8'**. A blue arrow points to the right from this text.
- Bottom Right:** The text **Voff: 1.00'**.
- Bottom:** A navigation bar with several icons and labels: **Tools** (wrench and screwdriver), **Project** (globe), **Tasks** (clipboard), **Monitor** (camera), **Reverse** (circular arrow), **Views** (two screens), and two directional arrows (up and down).

**What about steep mountain terrain  
and valley fills?**

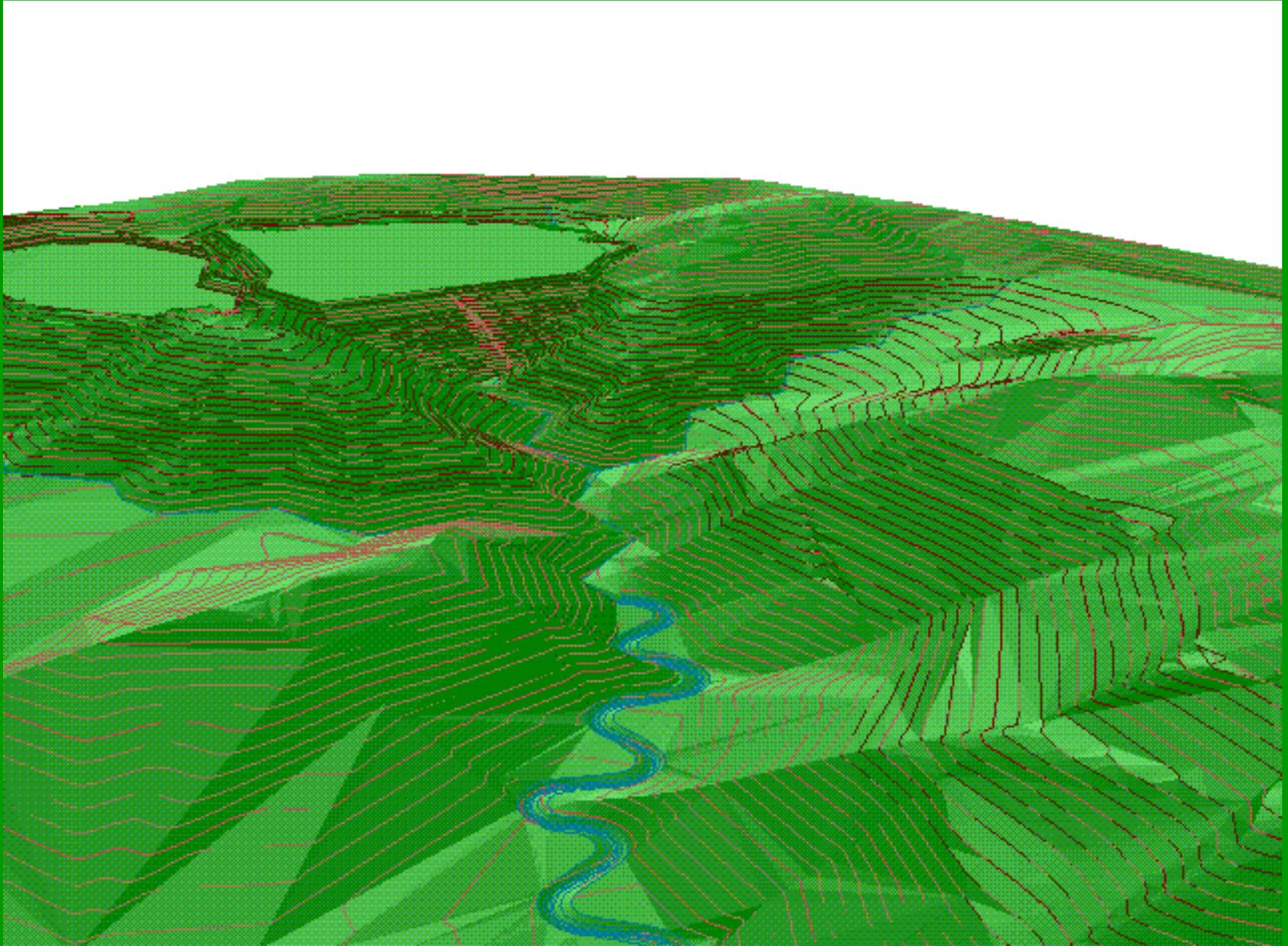
# Undisturbed mountain landform



# Mountain top removal



# Mountain top removal with traditional valley fill



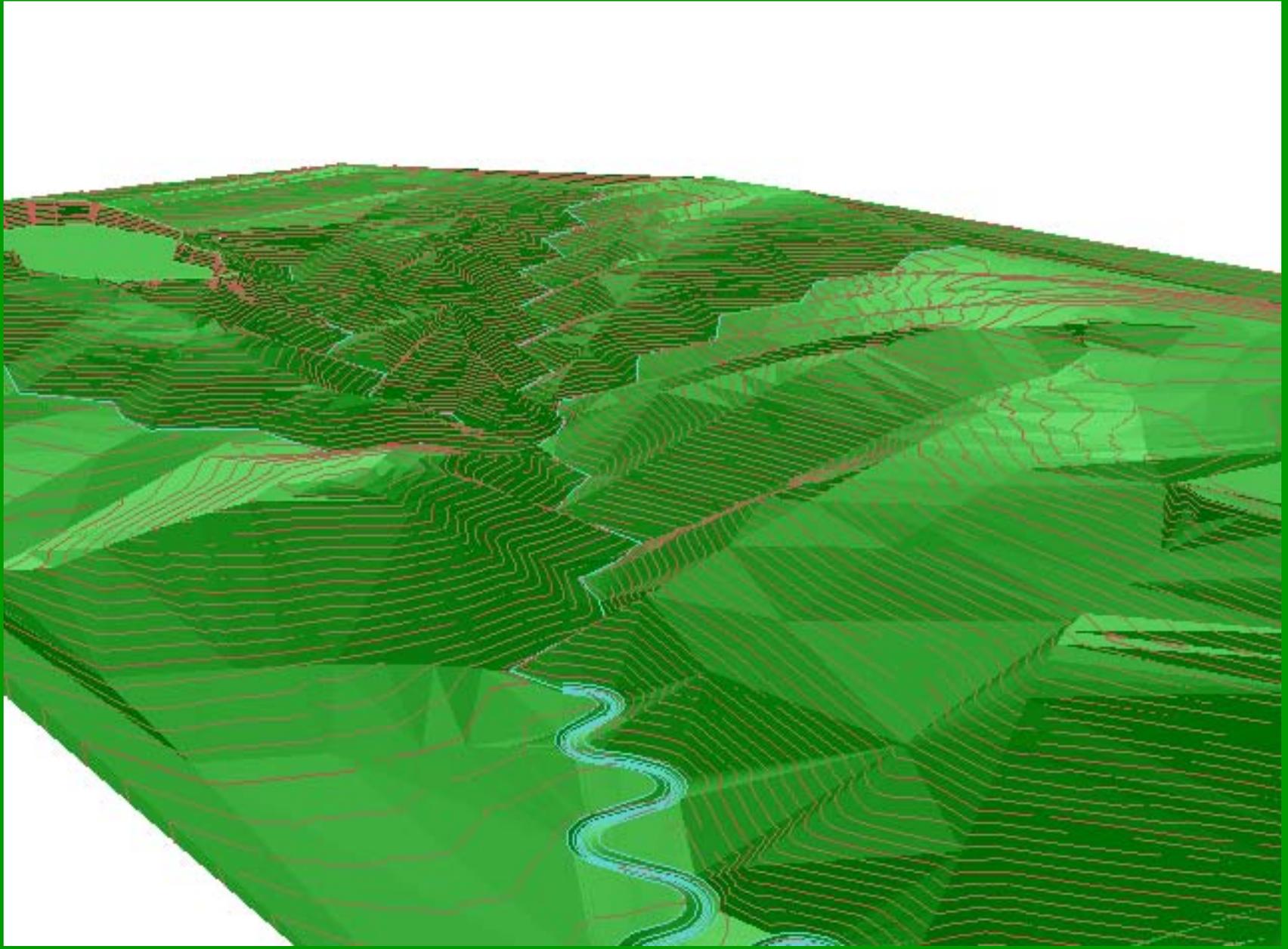
# What is a natural analogy?



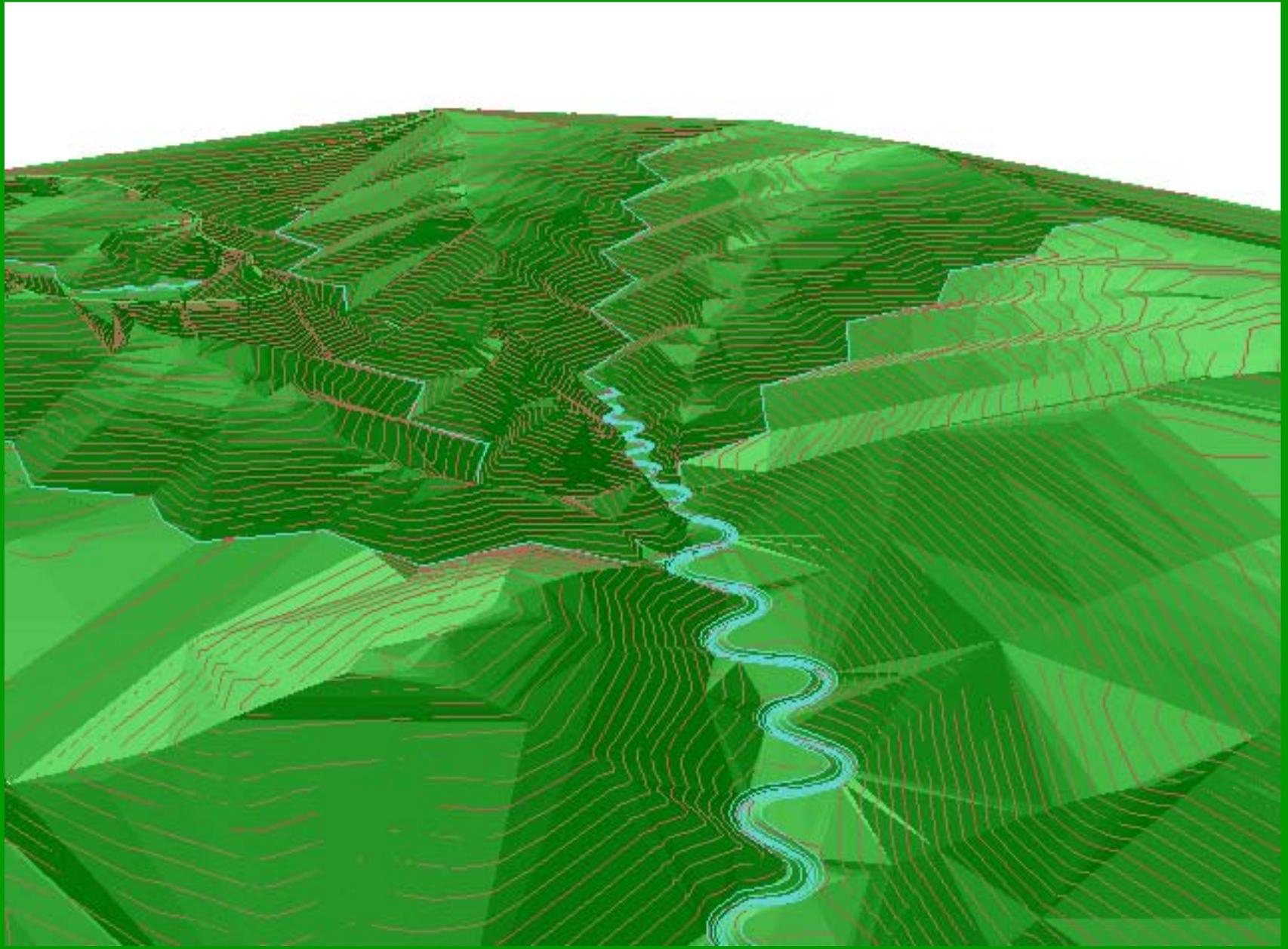
# Stream re-routed to side of valley



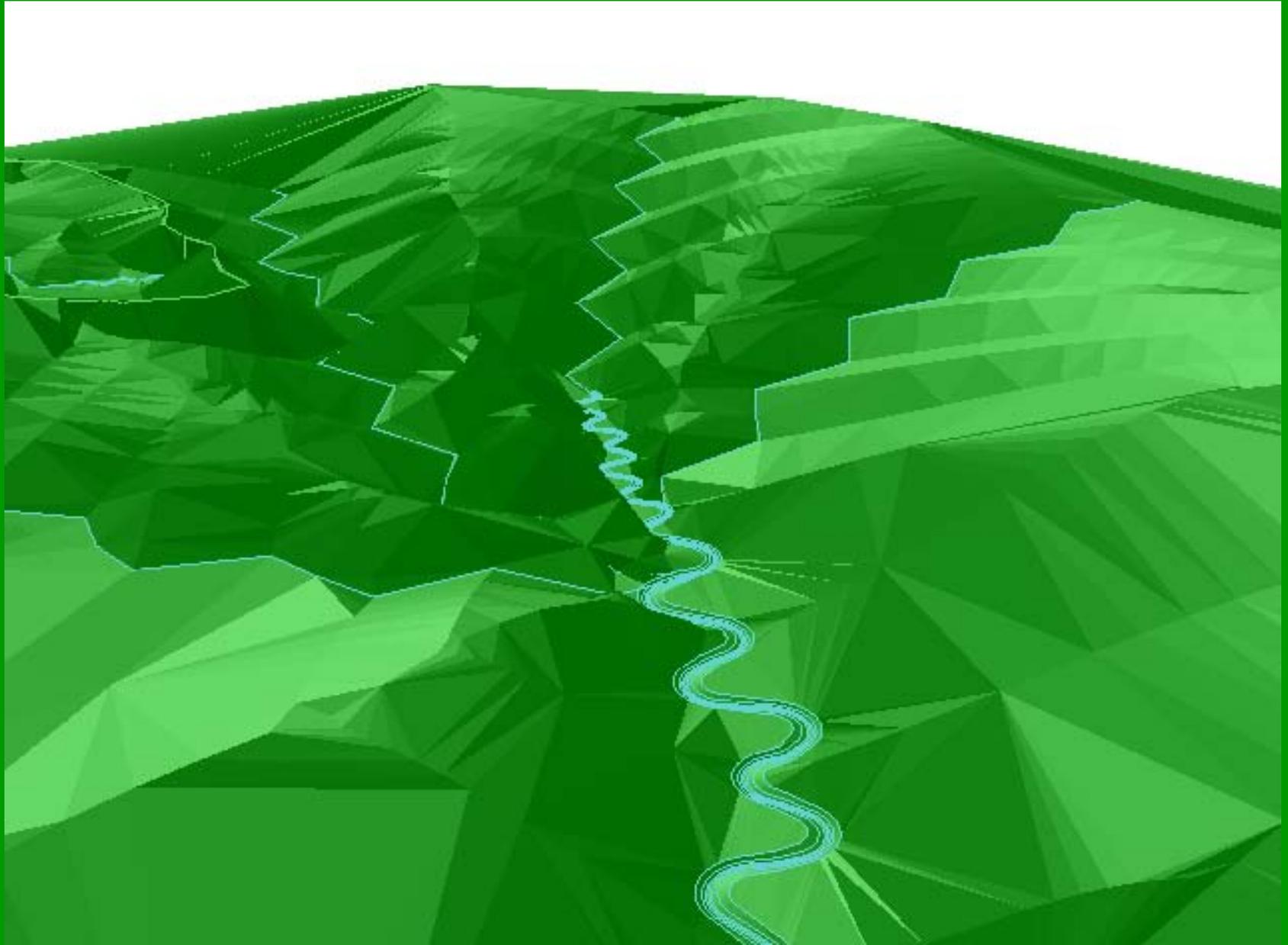
# One possible GeoFluv valley fill



# GeoFluv -designed mountain top and valley fill



# GeoFluv - designed mountain top and valley fill Can this provide sustainability?



# Highwall and contour mining alternatives?

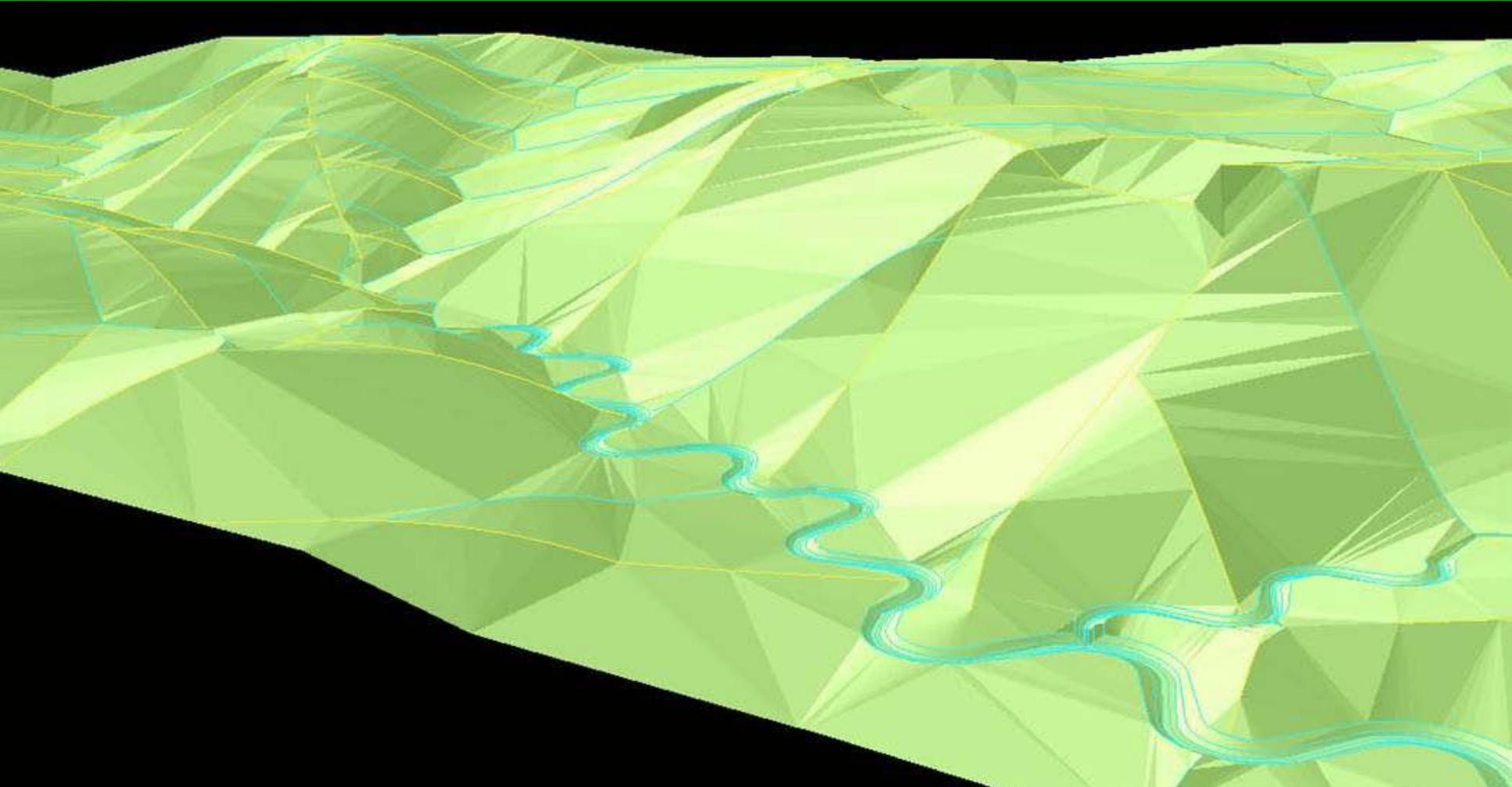


# A stable GeoFluv alternative for highwalls and contour mining



July 2006 received ~ 200-yr, 3-hr event

# 3D GeoFluv design in *Natural Regrade*



**3D GeoFluv design in *Natural Regrade*  
provides**

**environmental functions related to  
landforms when conducting**

**economic development activities for the  
benefit of**

**future users of the land**

**“The triple bottom line”**

**GeoFluv-designed waste dump  
reclamation  
*Natural Regrade***



# GeoFluv channel and uplands



# Thank you

*There is something new happening in landform design.*

*It's the future. It's natural.*

*Be a part of it.*