Disturbed Land Reclamation Design and Construction Using Fluvial Geomorphic Techniques

Presented by: Melissa Robson, E.I.
Water and Earth Team
1225 Red Cedar Circle, Suite A
Fort Collins, CO, 80524

970-225-6080

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The Water and Earth Team (WET)

This project was completed by:

Chevron Mining Inc.

McKINLEY MINE

WET Qualifications

- Professional expertise and experience in:
  - Sediment and erosion control
  - Surface water conveyance and runoff control systems
  - Regulatory permitting services
- Trained in disturbed-land reclamation models including SEDCAD, RUSLE and Natural Regrade

Project Location

The project area is located due North of Gallup NM

Overview of the McKinley Coal Mine

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Reclamation challenges that are presented for a surface coal mine include:

- Areas of disturbance are very large (>100 ac.),
- An earth balance is desired to minimize haul away or import materials, and

Disturbance is composed of overburden material cast into piles by draglines.

- Haul and push distances should be minimized for economic purposes.

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Area 12C

Project Area at the McKinley Mine Site

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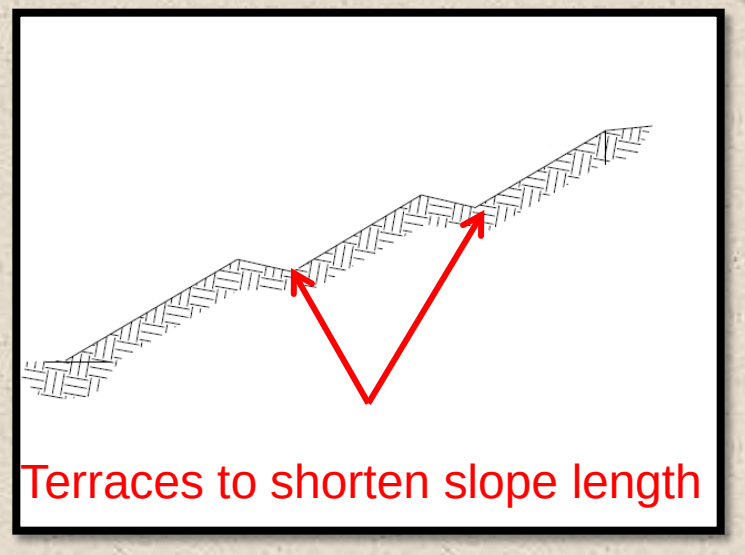
Site Specific Challenges

1. Long steep slopes (18%-35%)
2. Southwest facing aspect
3. Undisturbed rock outcropping
4. Operational need to limit bulldozer pushes
5. Balance cuts and fills

Image courtesy of Google Earth

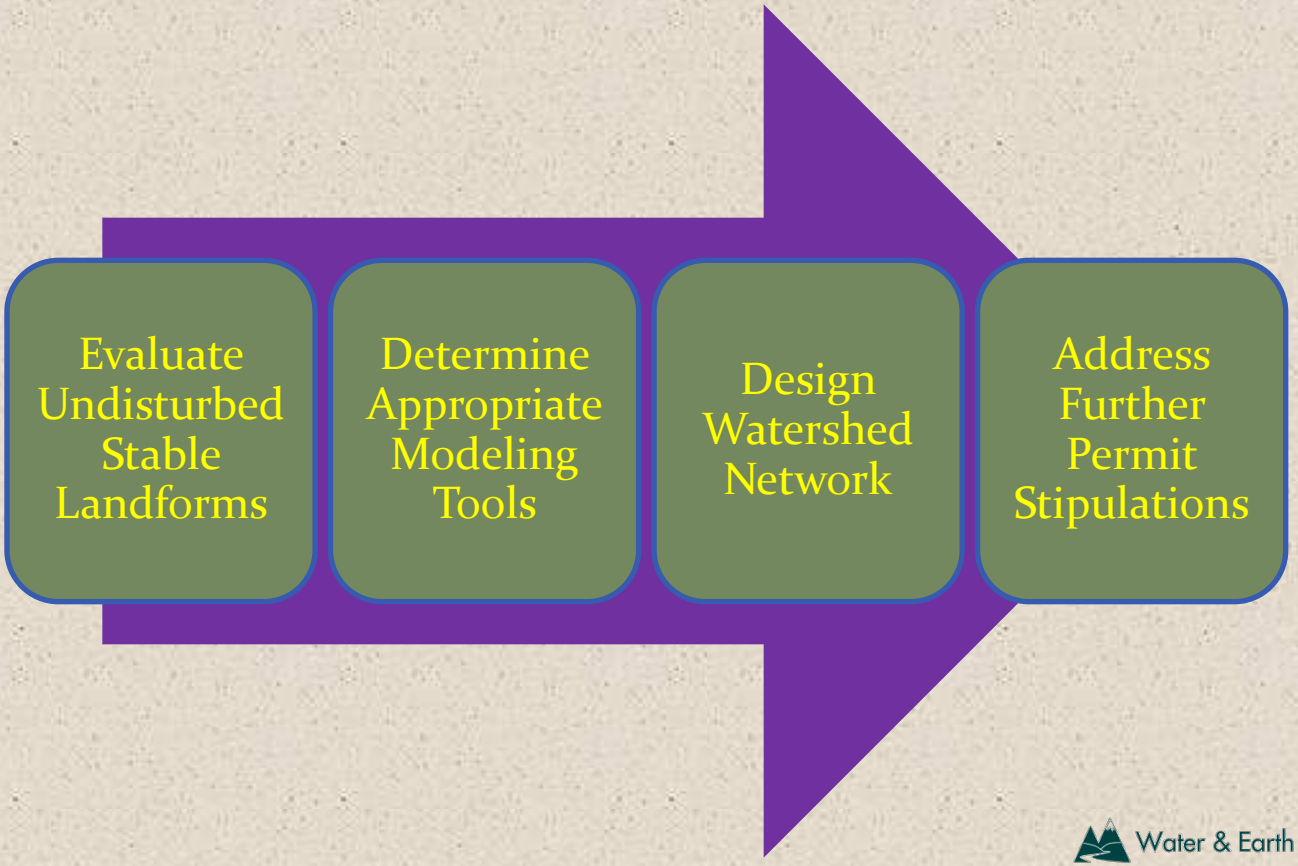
Traditional Solutions:

Draining terraces



Riprap downdrains

Geomorphic Approach



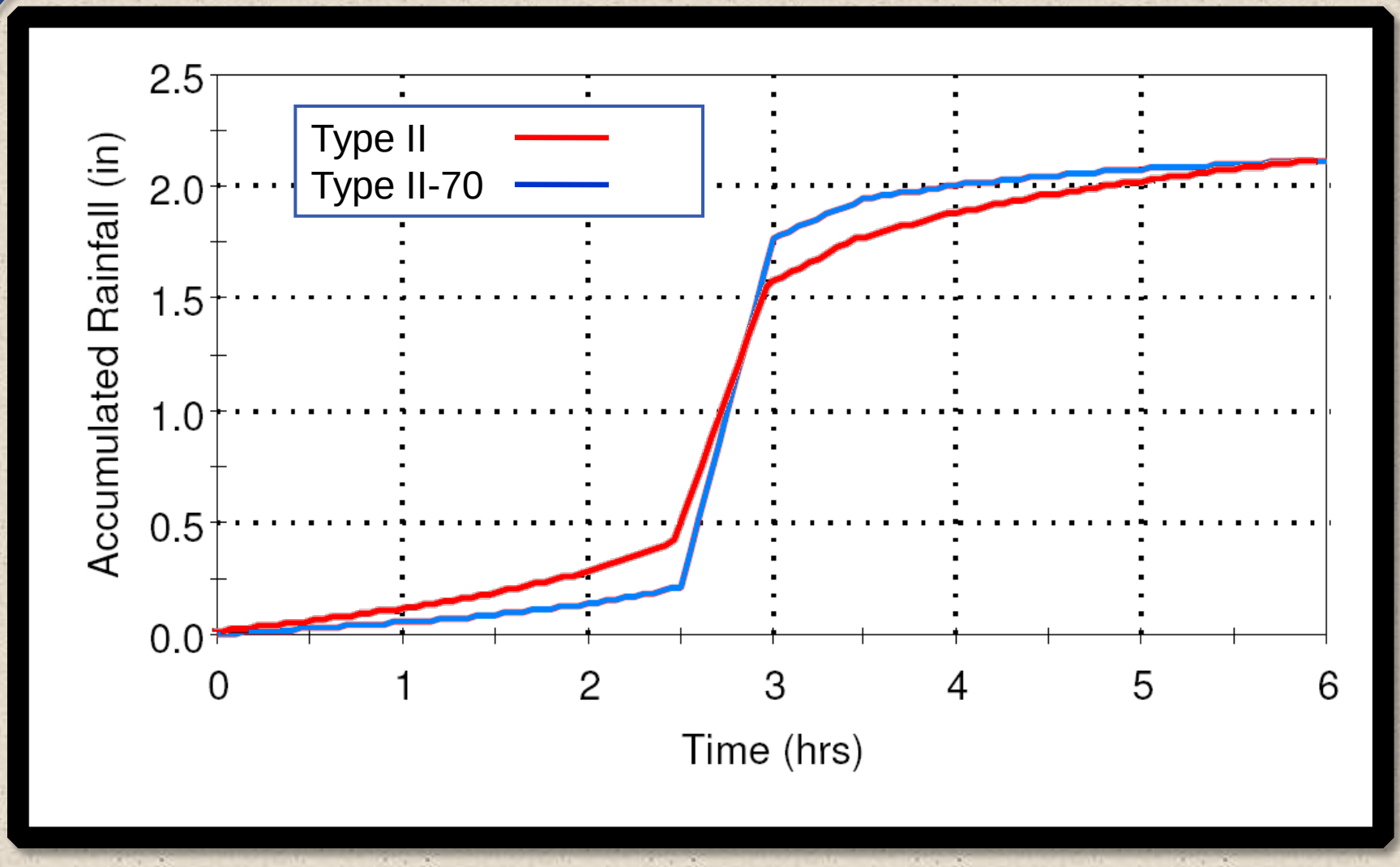
Rainfall Parameters

New NOAA Atlas 14 for New Mexico

- 2-yr, 1-hr (bankfull)
- 50-yr, 6-hr (floodprone)
- 100-yr, 24-hr (if required by permit)

Rainfall Distribution Curves

- Type II 70 distribution
- United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS)


Type II
Type II-70
Accumulated Rainfall (in)
2.5
2.0
1.5
1.0
0.5
0.0
0
1
2
3
4
5
6
Time (hrs)

Complete Field Survey to Determine Input Parameters

A Geomorphic approach using Natural Regrade™ with GeoFluv requires input parameters including:

-Drainage density
-Ridge to head of channel

-Sinuosity
-Width to depth ratio
- A-channel reach length

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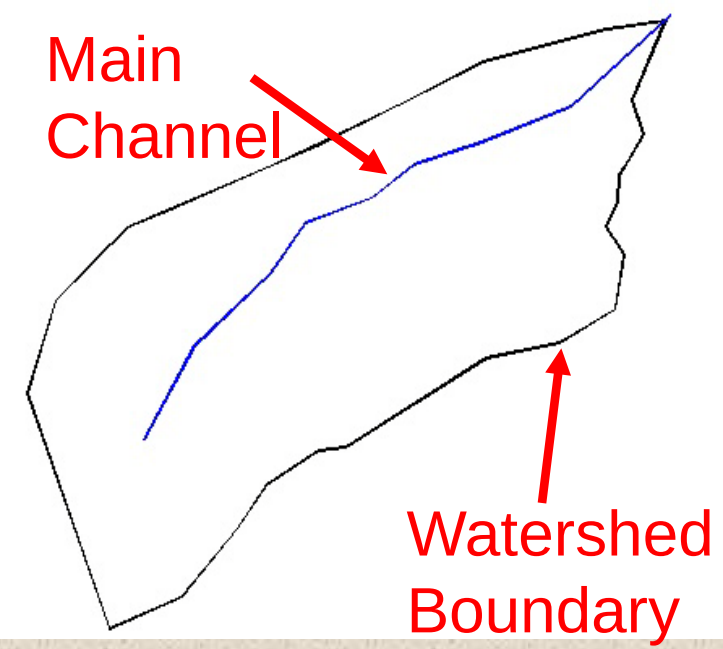
$$\text{Drainage Density} = \frac{Length\_Of\_Channel}{Watershed\_Area}$$

Target Drainage Density = 154 ft/acre



Length = 420 ft

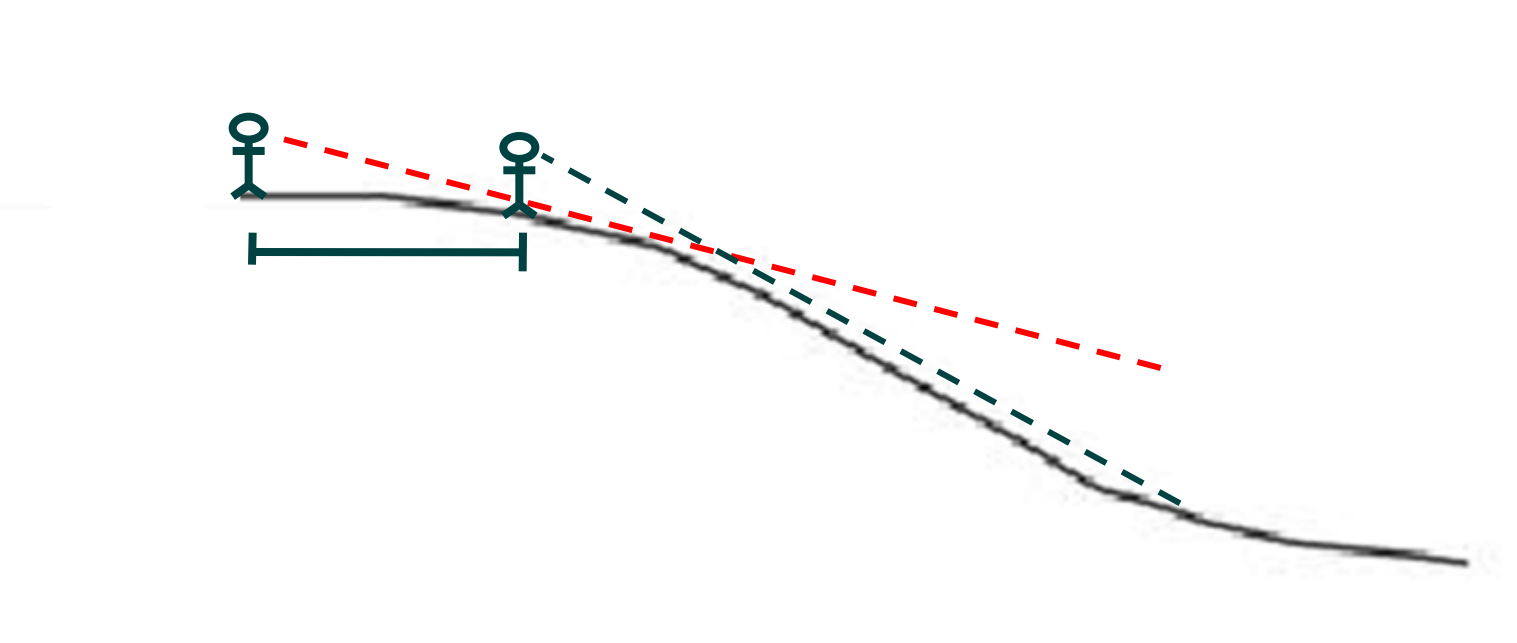
Watershed Area = 2.9 ac

Drainage Density = 145 ft/ac

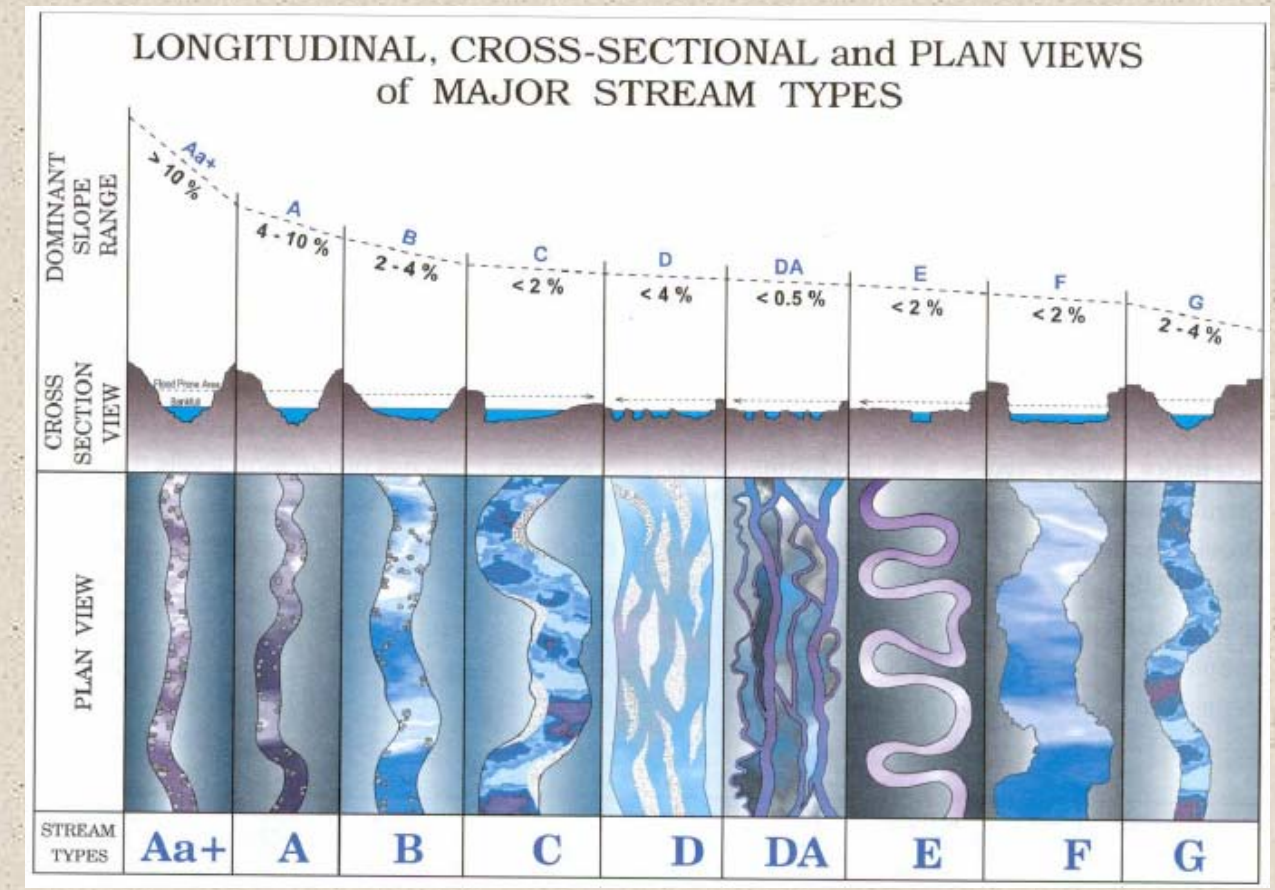
Ridge to Head of Channel Distance

Ridge

Head of Channel



What is an “A-Channel”?



Rosgen Stream Classification System

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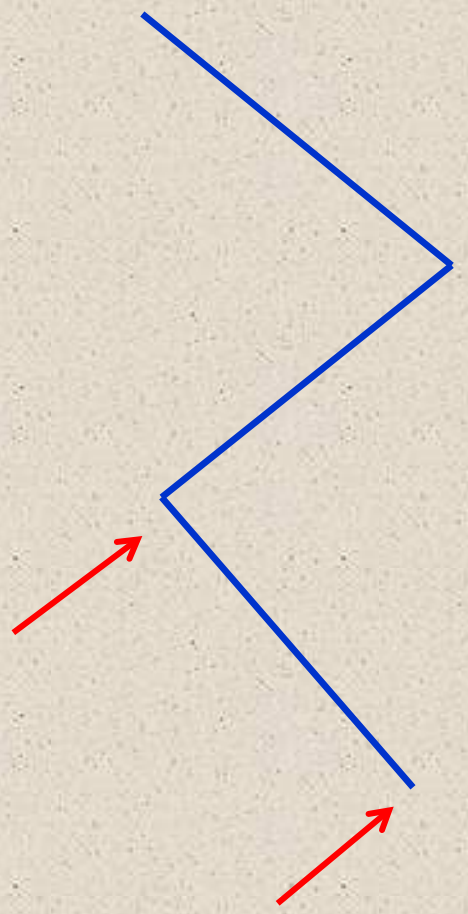
A-Channel Reach Length



Determine the Geofluv Configuration for a Functioning Watershed System

Watershed configuration for Area 12C

Seven subwatersheds to drain to existing arroyo

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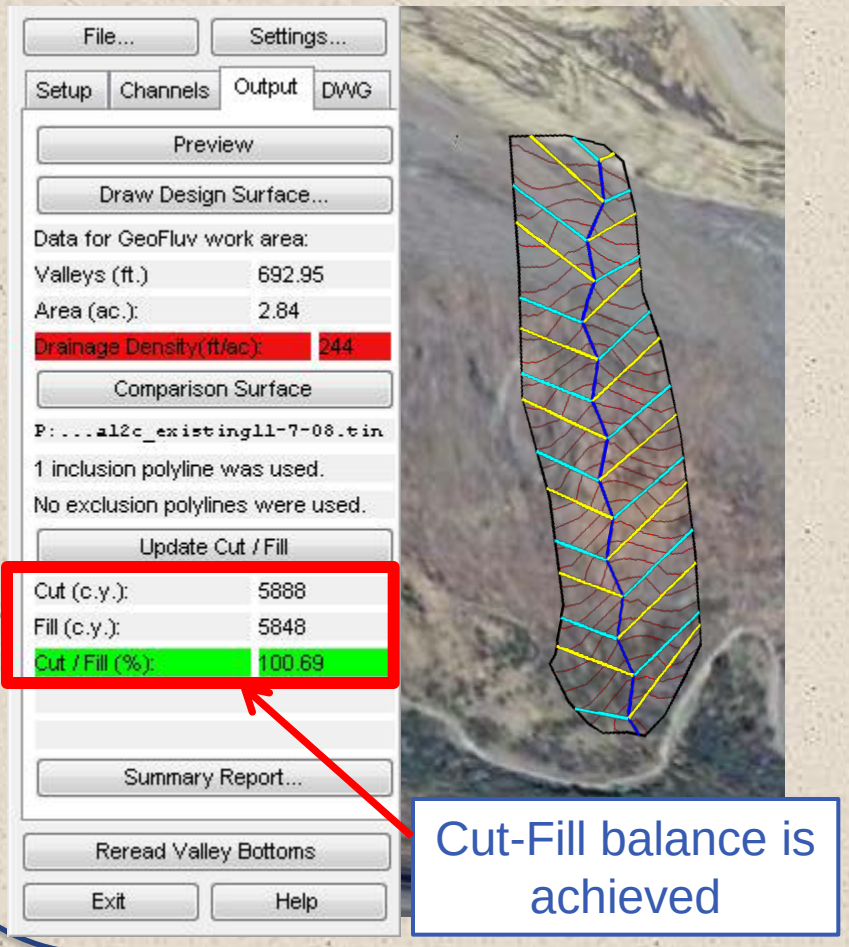
Complete a Geomorphic Design for Stable Landforms using Natural Regrade™



Cut-Fill balance is achieved

- Subwatershed Boundary
- Channel
- Ridge
- Valley
- 5’ Contour

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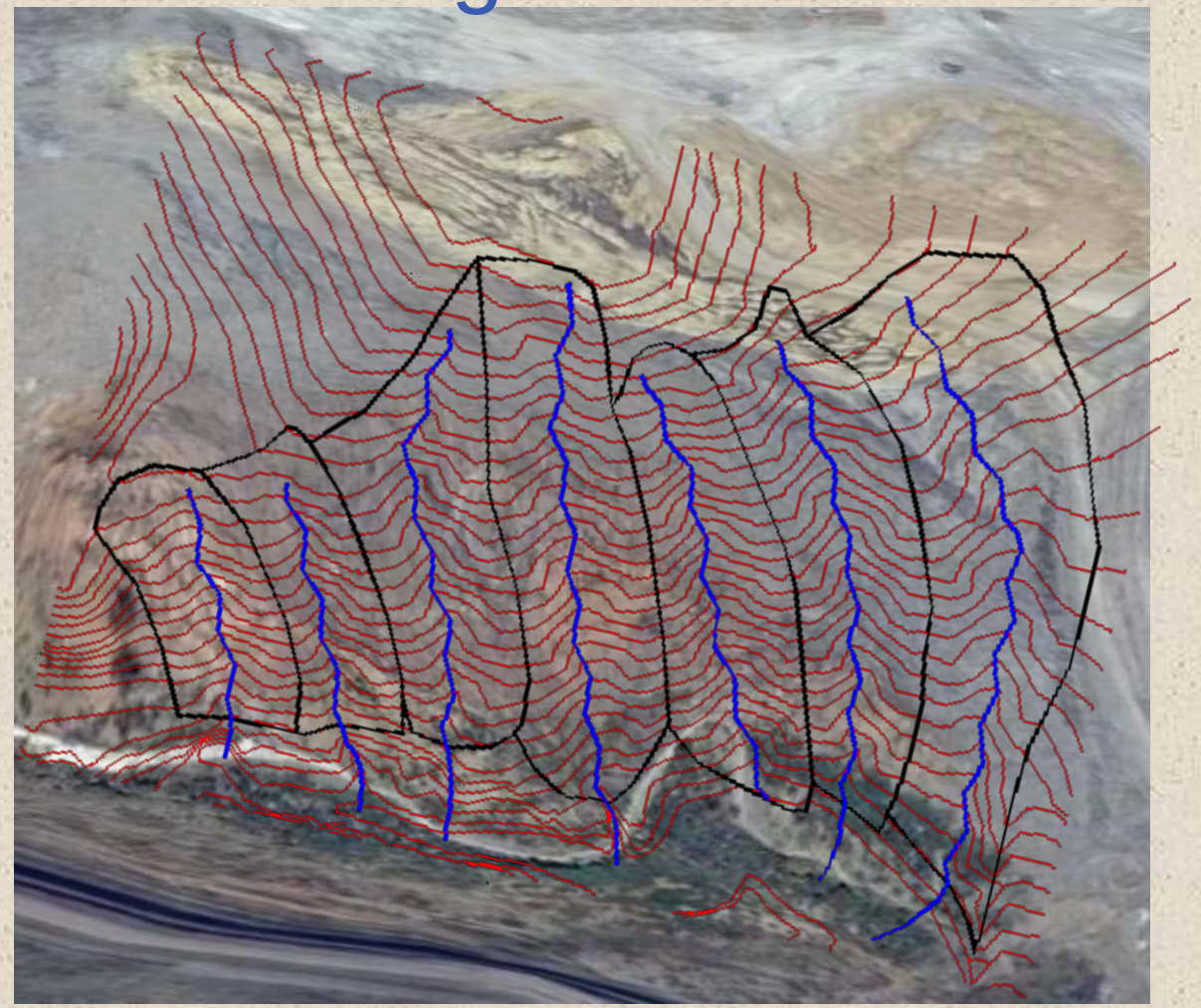
Final Design for Area 12C



Erosion Considerations

Additional analysis on the geomorphic design surface was completed to show that erosion rates and specified design flows would meet the correct criteria.

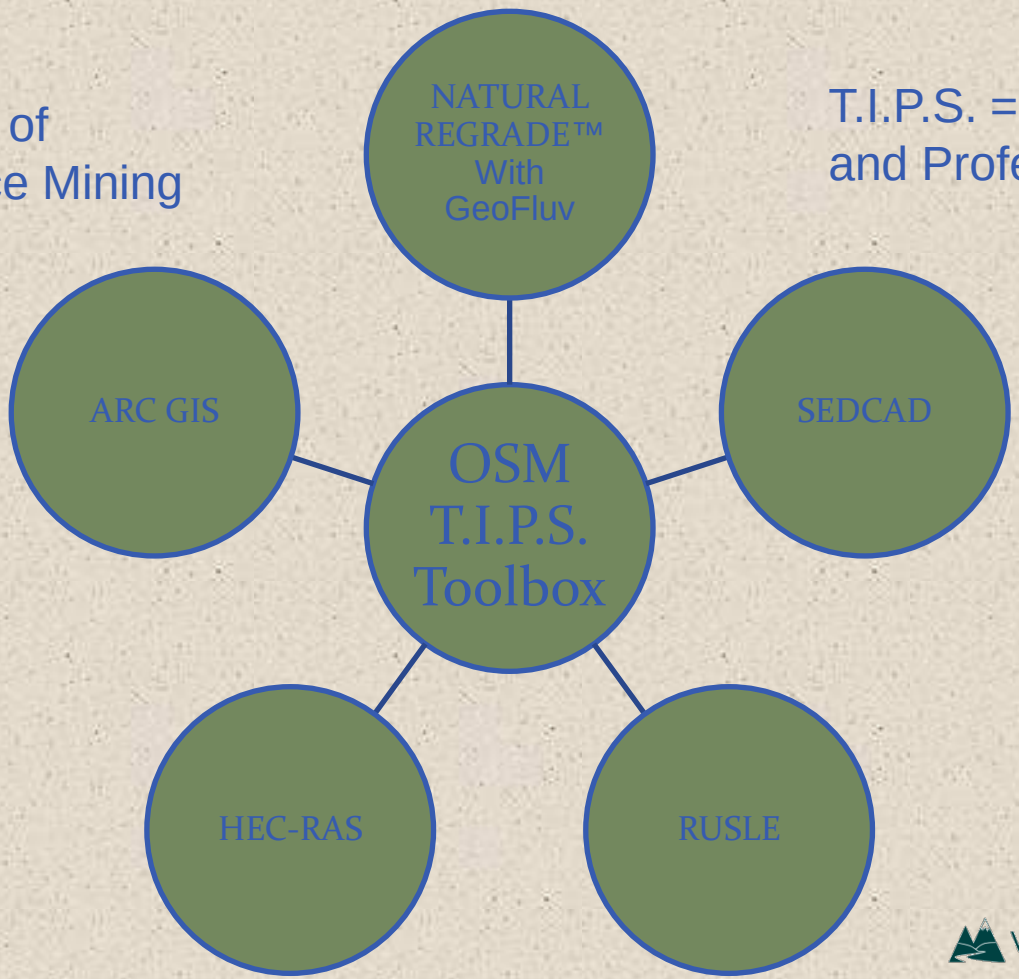
Additional Analysis Completed

- A 50-yr,6-hr peak flow analysis was completed for designed watersheds with contributing area less than 1 square mile.
- A soil loss analysis was completed on the worst case slope in each watershed. The condition needed to be better than or equal to soil loss for pre-mining conditions.
- A channel stability analysis was completed to determine if additional channel protection would be necessary.

Available Tools to Support Geomorphic Analysis

OSM = Office of Surface Mining

T.I.P.S. = Technical Innovation and Professional Services



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Tools Used for Analysis

The geomorphic design was analyzed using:

SEDCAD = Sediment, Erosion, Discharge by Computer Aided Design

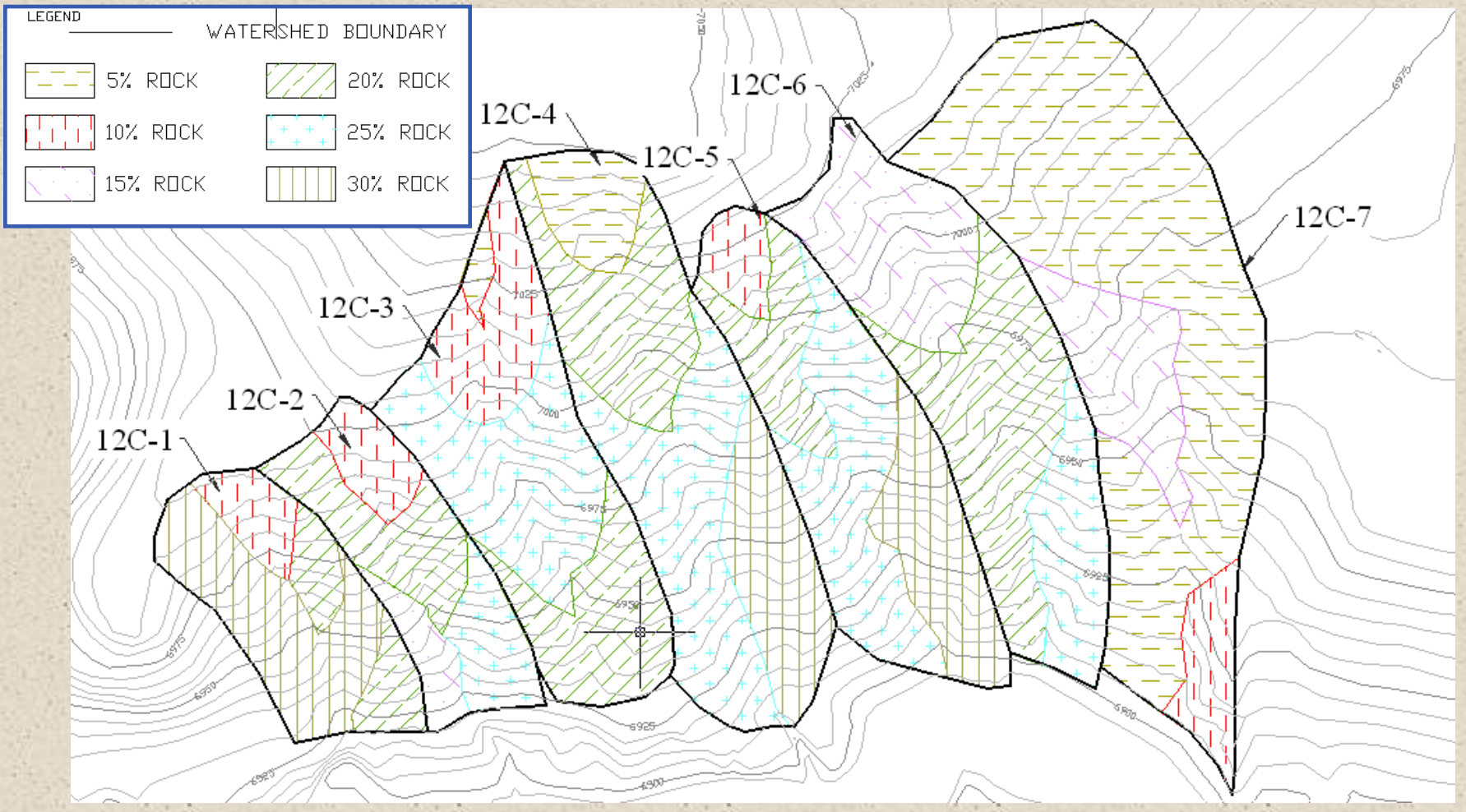
RUSLE = Revised Universal Soil Loss Equation

Sensitivity Analysis

Peak flow comparison between models:

Subwatershed	Peak Flow (cubic feet per second) Natural Regrade (50-yr, 6-hr = 2.12")	Peak Flow (cubic feet per second) SEDCAD (50-yr, 6-hr = 2.12")
12C-1	2.52	2.46
12C-2	2.33	2.28
12C-3	4.95	4.87
12C-4	6.1	5.99
12C-5	5.02	4.95
12C-6	6.11	6.03
12C-7	9.32	9.16

RUSLE Analysis



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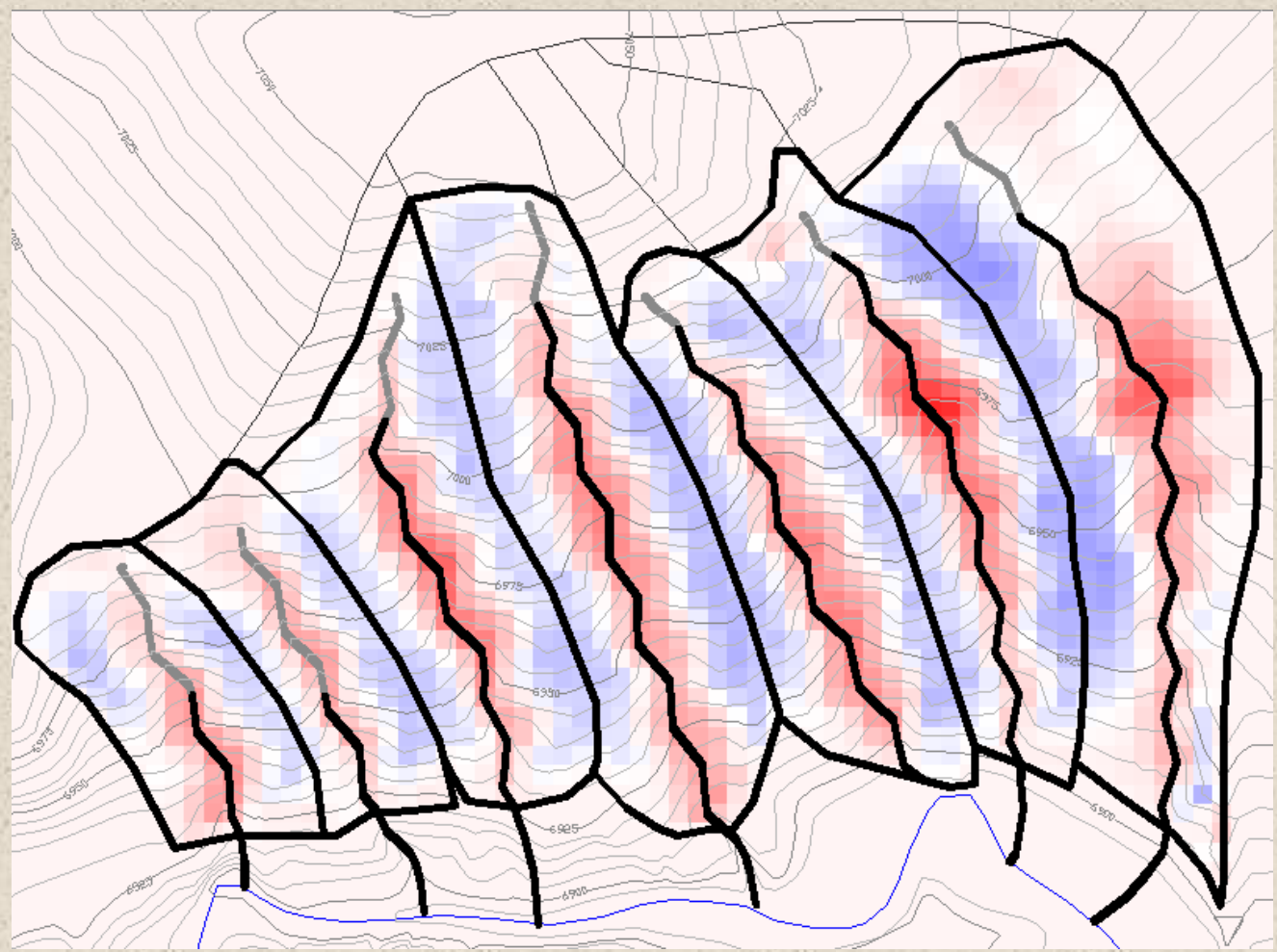
From Design to Construction



Area in Cut

Area in Fill

Cut-Fill Color Mapping

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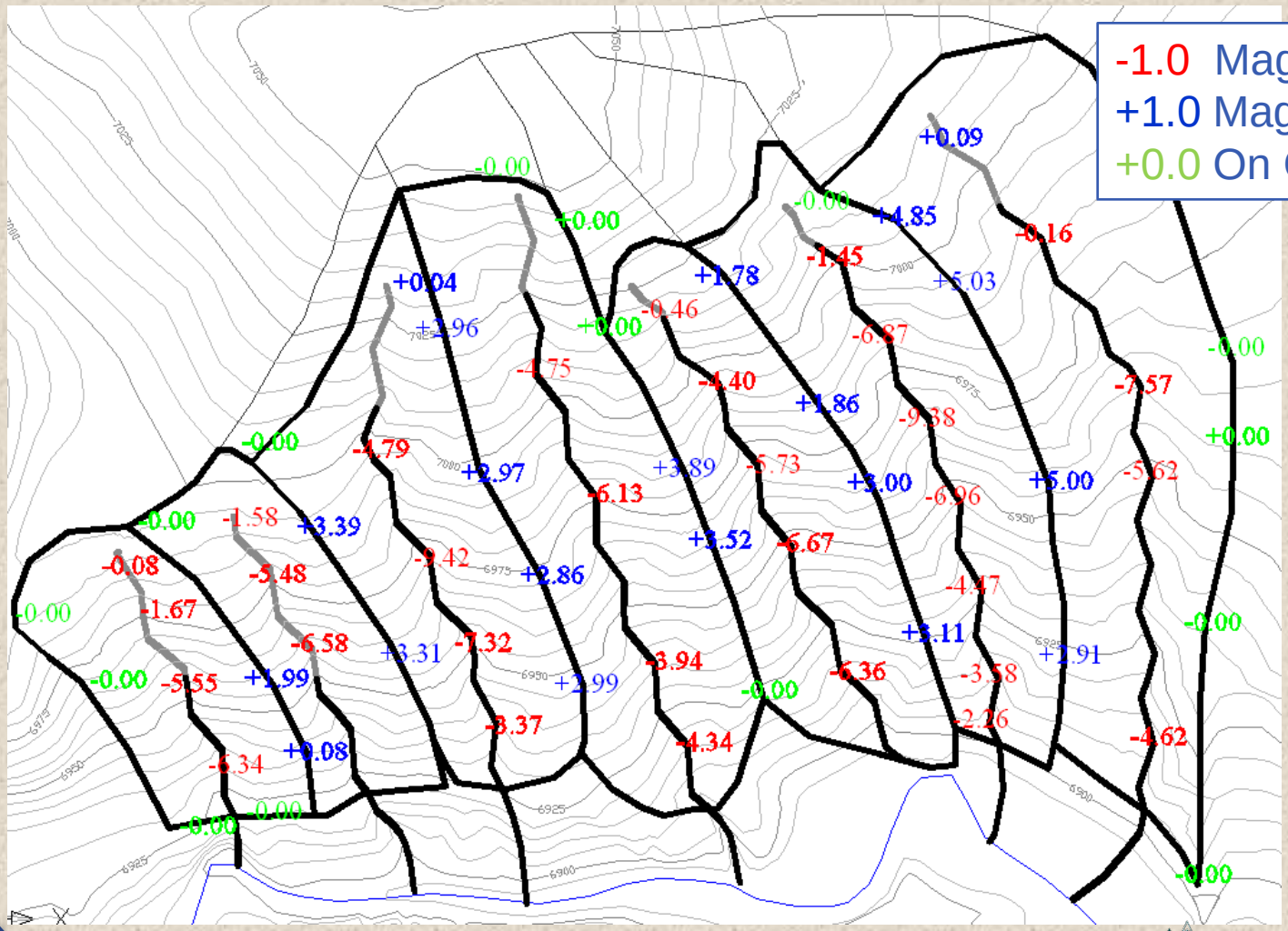
Construction Staking



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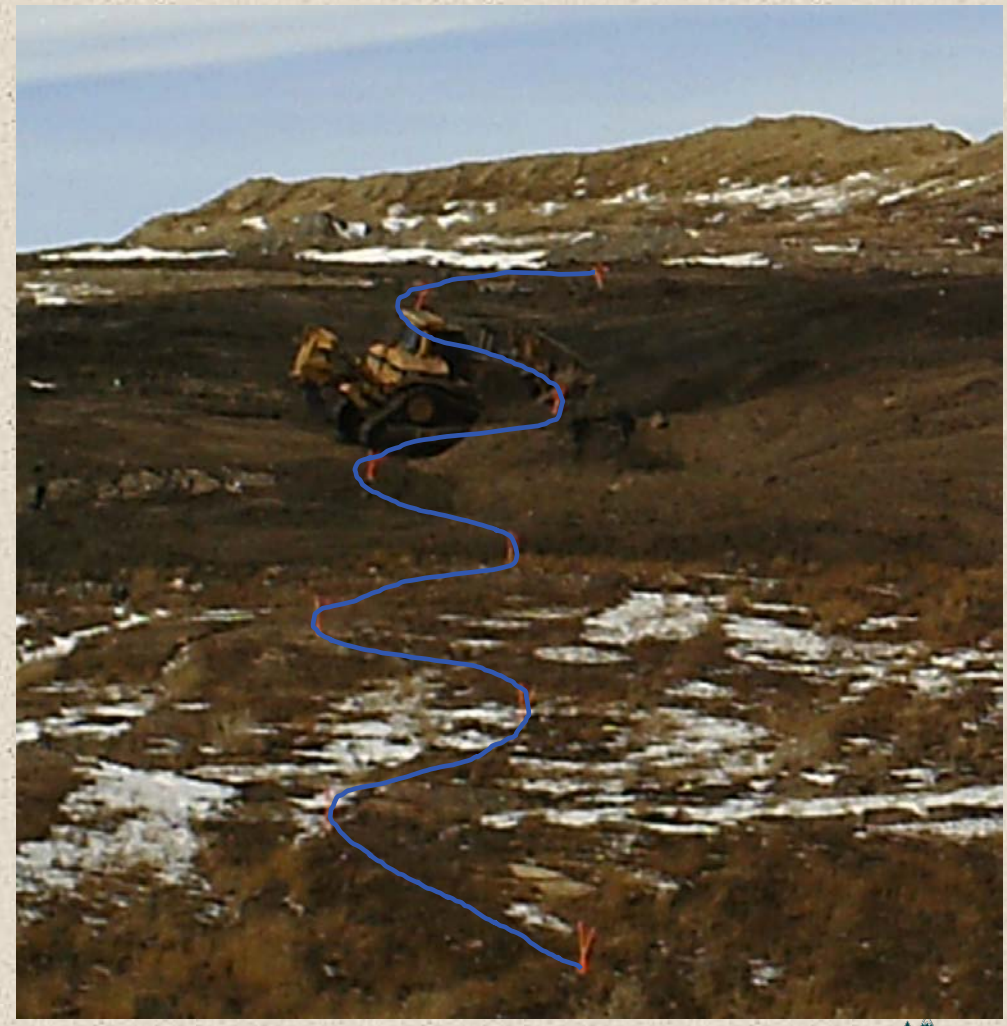
Construction

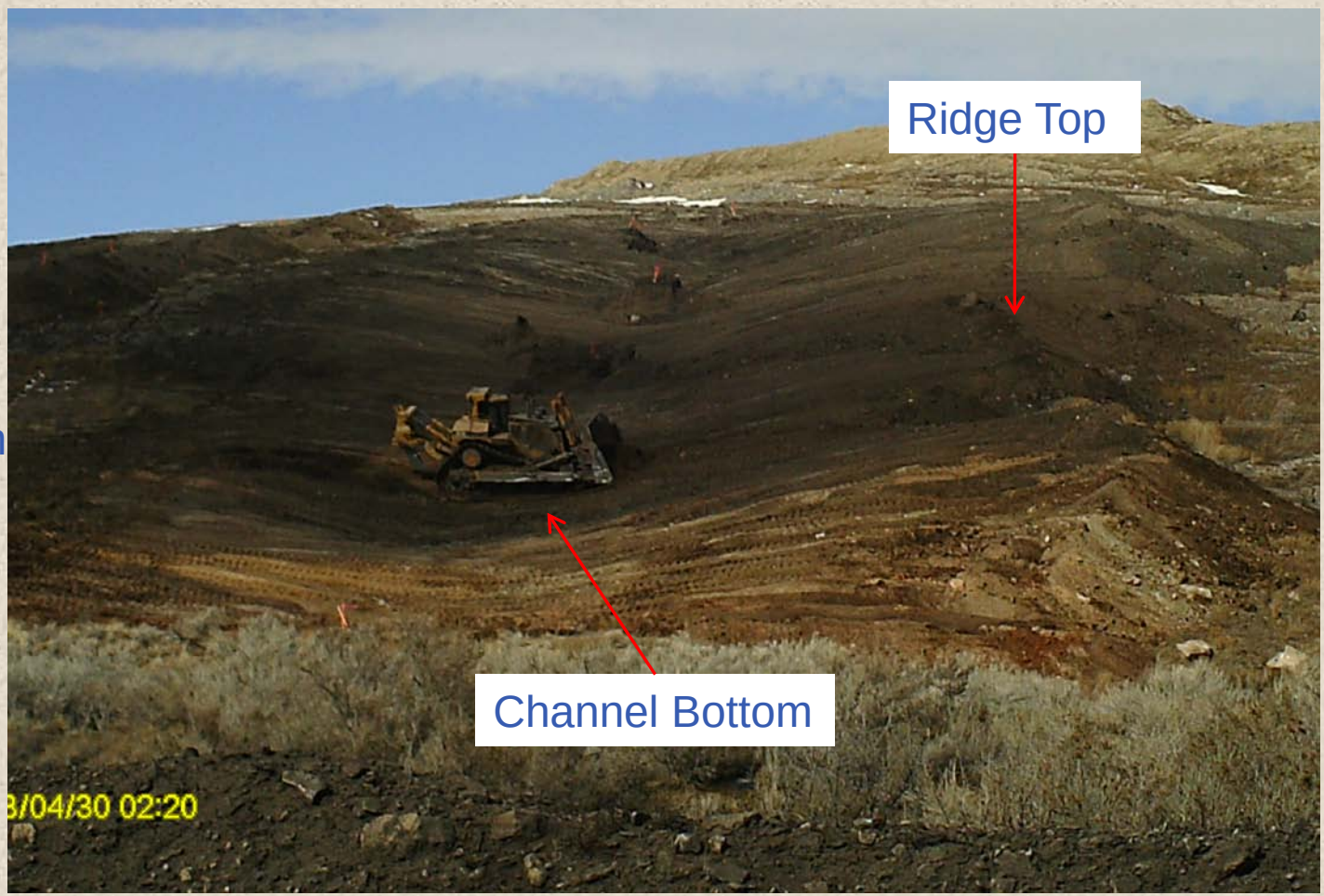
Red flagging in the field indicates the location and magnitude of channel cuts.

Channel sinuosity defined by stake locations.



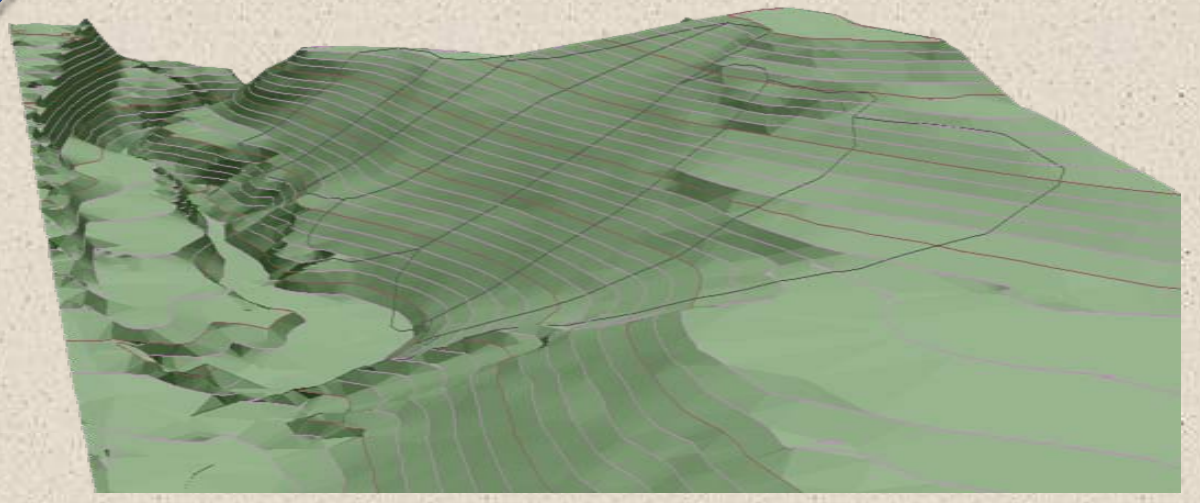
Construction

Bulldozer rough grades watershed geometry by pushing horizontally from the channel bottom to the ridge tops

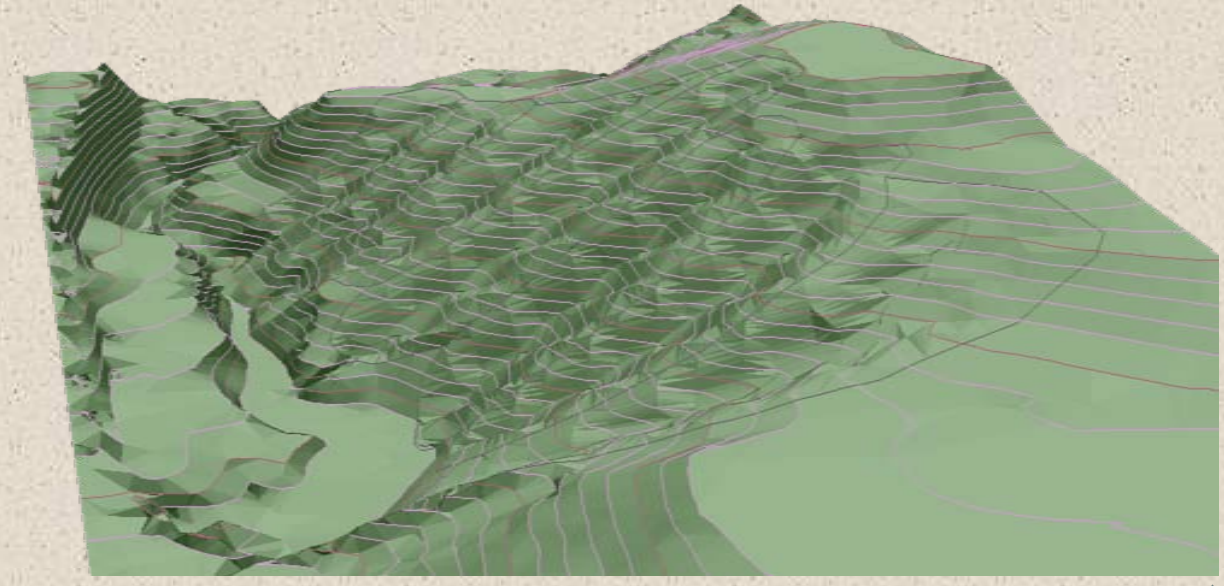


Construction

Regraded hill slope draining toward existing channel



Pre-Regraded Surface



Proposed Final Reclamation Surface

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Compliance

Provisions agreed to by the Office of Surface Mining:

1. Final Post Mining Topography can deviate +/- 10 vertical feet.

2. Constructed watershed boundaries must be within 10% of designed area.

3. Drainage Density must be maintained.

4. Constructed channels designed with freeboard to meet or exceed minimum requirements.

Questions