INTEGRATING GEOMORPHIC RECLAMATION WITH UNDISTURBED AND PREVIOUSLY RECLAIMED AREAS USING A MULTI-PROGRAM COMPUTERIZED DESIGN APPROACH AT McKINLEY MINE

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McKINLEY MINE

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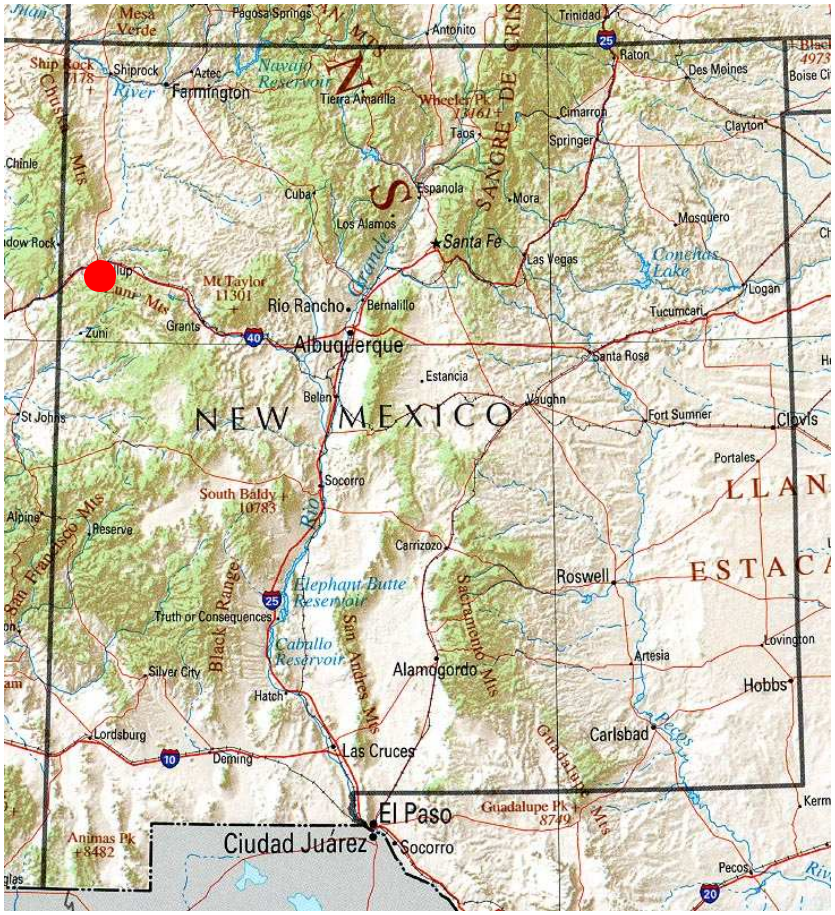
HISTORY:

- McKinley Mine Opened In 1962
- 1st Large Scale Surface Coal Mine in New Mexico
- Employed 600 people in its peak
- 175,000,000 tons over 50 years



The project area is located due North of Gallup NM

Overview of the McKinley Coal Mine

- PROJECT STATS:

- FINAL PIT HIGHWALLS - 11,850 LF
- UNGRADED SPOIL – 793 AC
- CONVENTIONAL RECLAMATION AREA – 211 AC
- CONTRIBUTING UNDISTURBED WATERSHED – 891 AC

SPECIFIC PROJECT CHALLENGES:

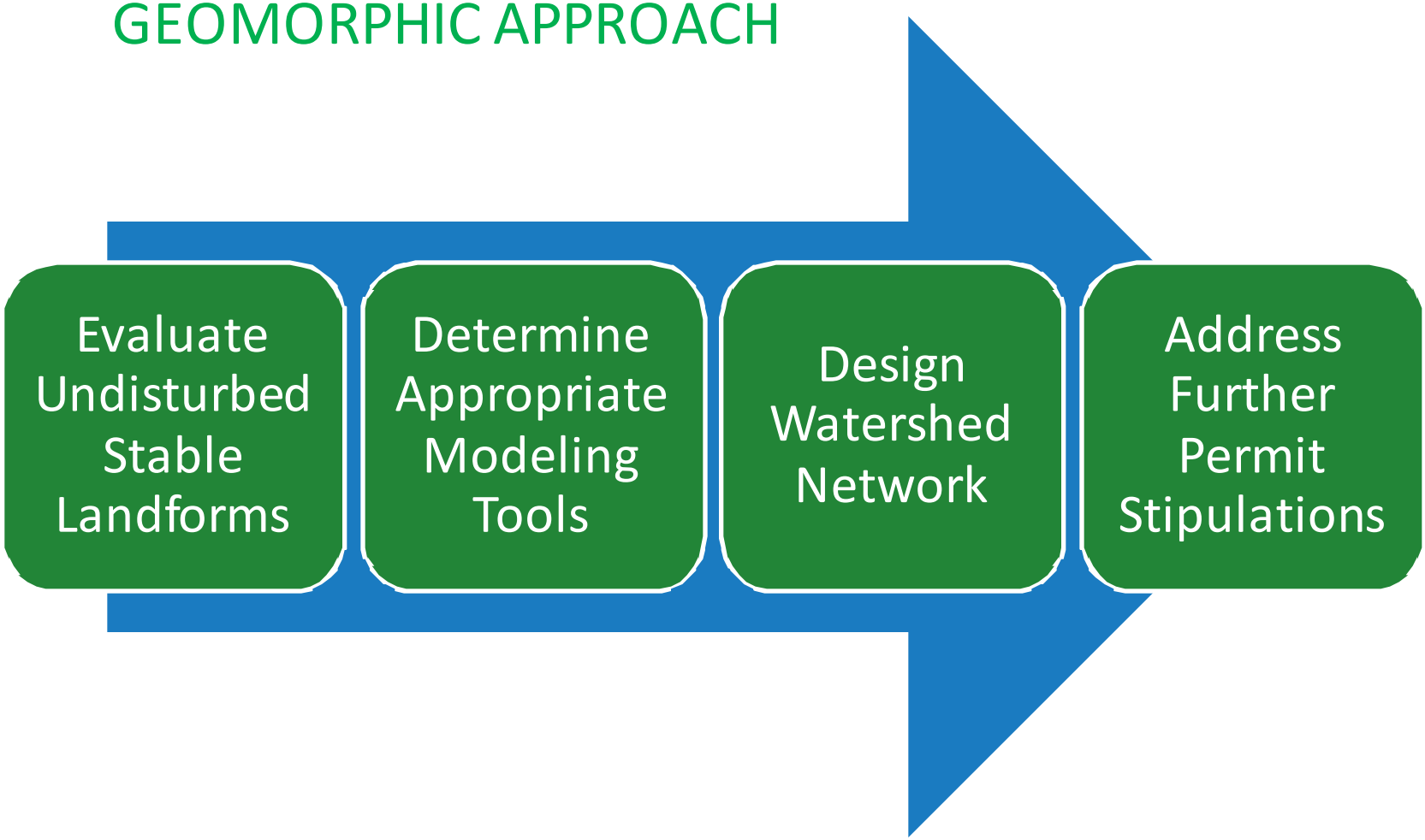
- Handle the interface between existing conventional reclamation & proposed geomorphic reclamation
- Incorporate run on from large upgradient watersheds
- Achieve an earth balance
- Evaluate constructability


Conventionally
Reclaimed Areas

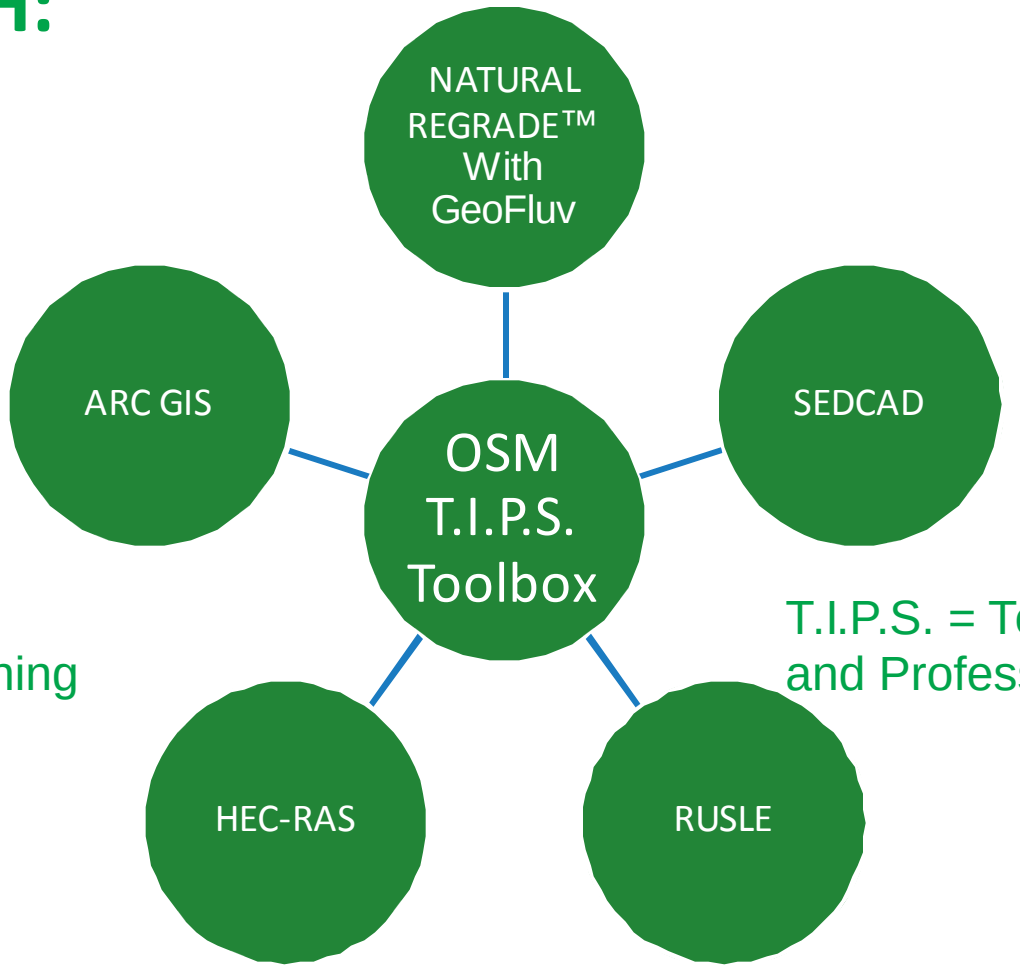
INTEGRATED GEOMORPHIC APPROACH

Hydrology	Geomorphic Characteristics	Hydraulics
• Rainfall Parameters • Runoff Characteristics	• Drainage Density • Ridge to Head Of Channel • Concave Slopes • Slope Lengths • Channel Sinuosity	• Channel Capacity • Velocities • Shear Stress • Channel Protection

GEOMORPHIC APPROACH



MULTI-TOOL APPROACH:



OSM = Office of Surface Mining

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

Rainfall/Runoff Parameters

New NOAA Atlas 14 for New Mexico

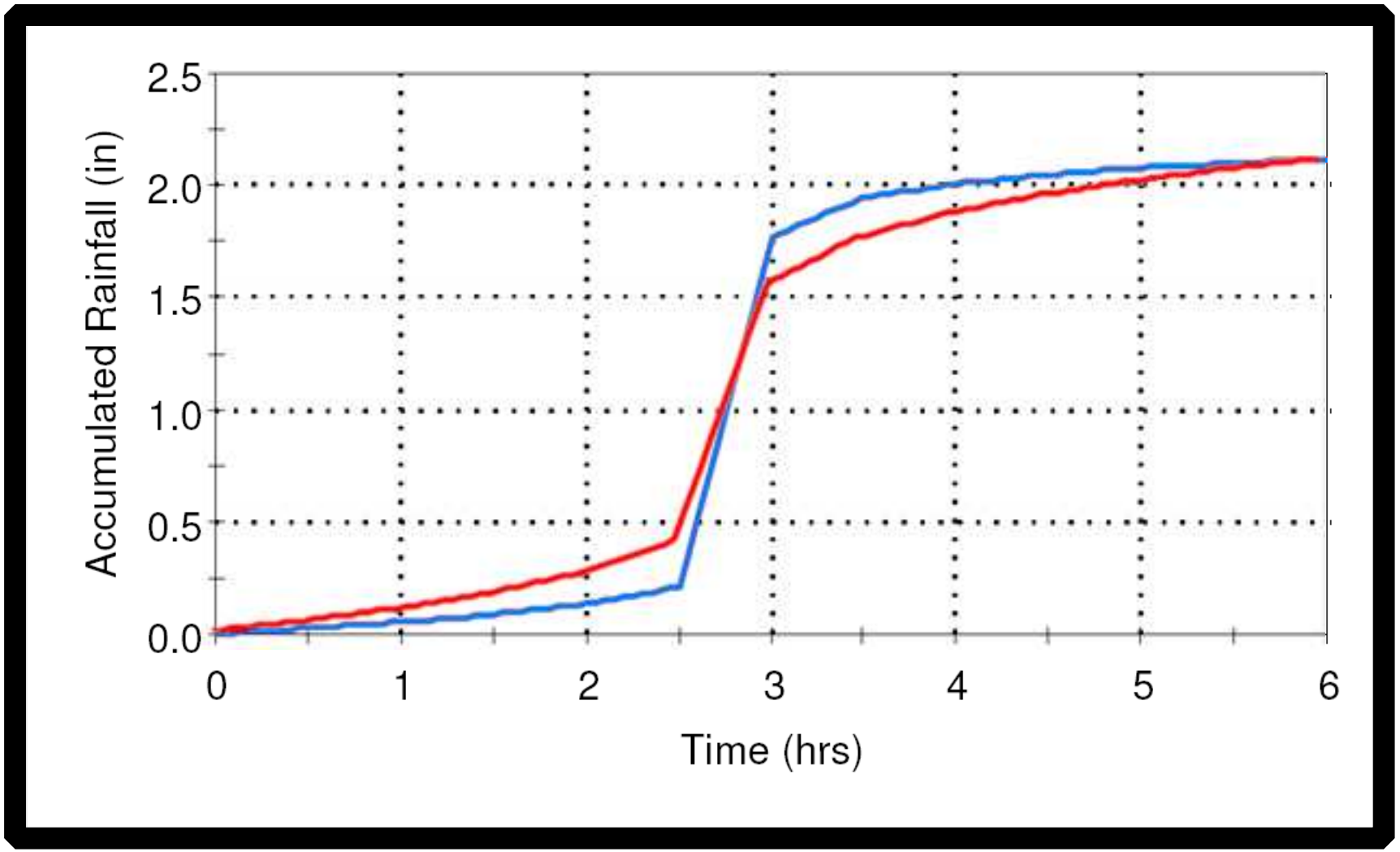
- 2-yr, 1-hr (bankfull)
- 50-yr, 6-hr (floodprone)
- 100-yr, 24-hr (if required by permit)

Rainfall Distribution Curves

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

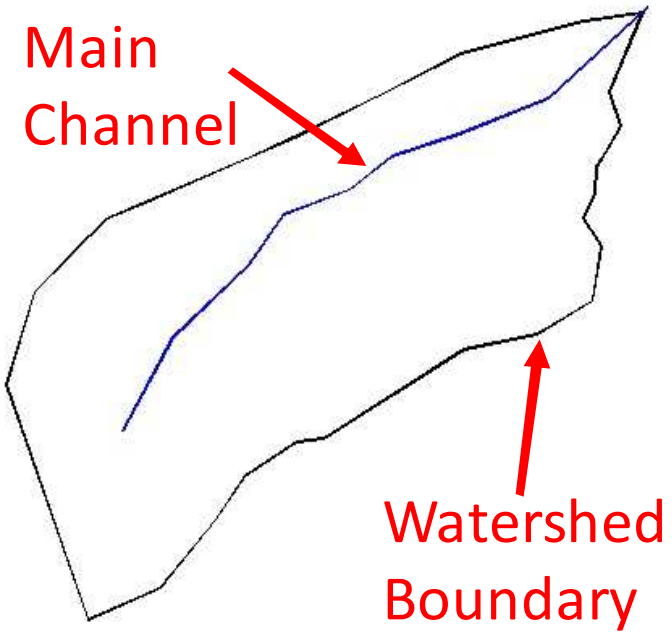
Runoff Characteristics

- NRCS Curve Numbers (Disturbed/Undisturbed)


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

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

Target Drainage Density = 154 ft/acre



Length = 420 ft

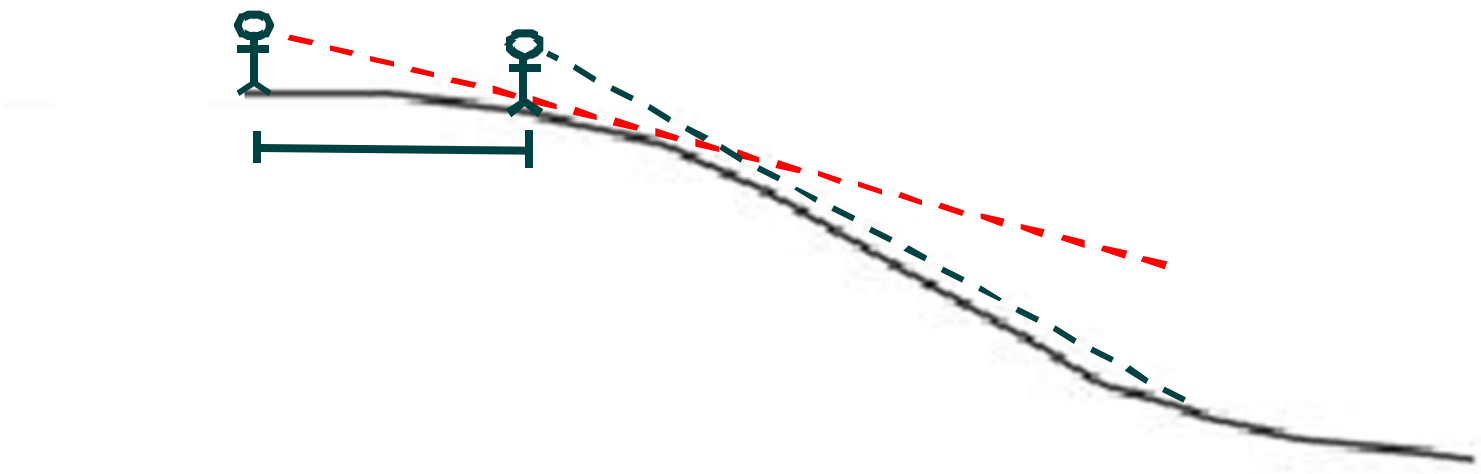
Watershed Area = 2.9 ac

Drainage Density = 145 ft/ac

Ridge to Head of Channel Distance

Ridge

Head of Channel

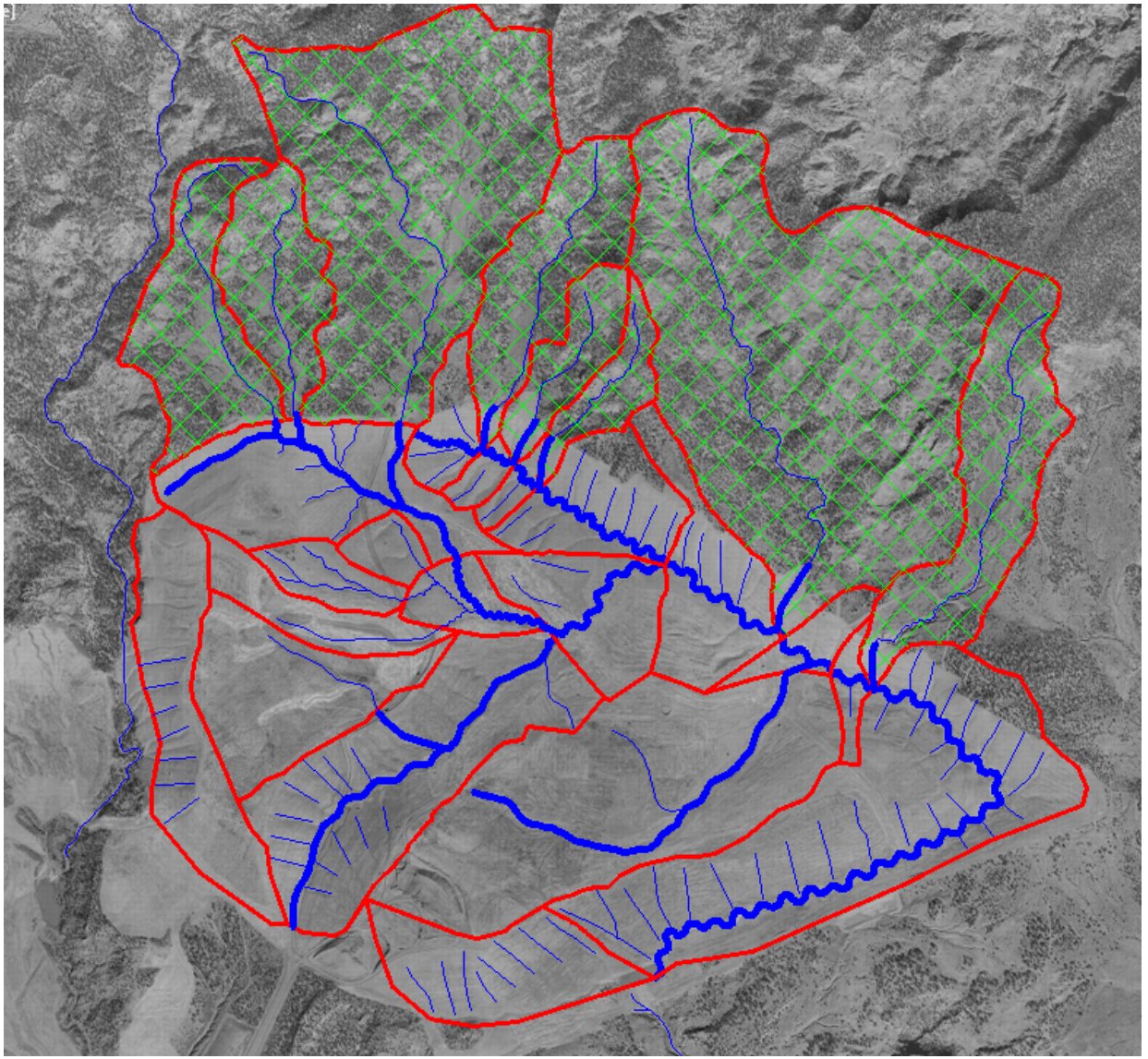


Determine Watershed Configuration

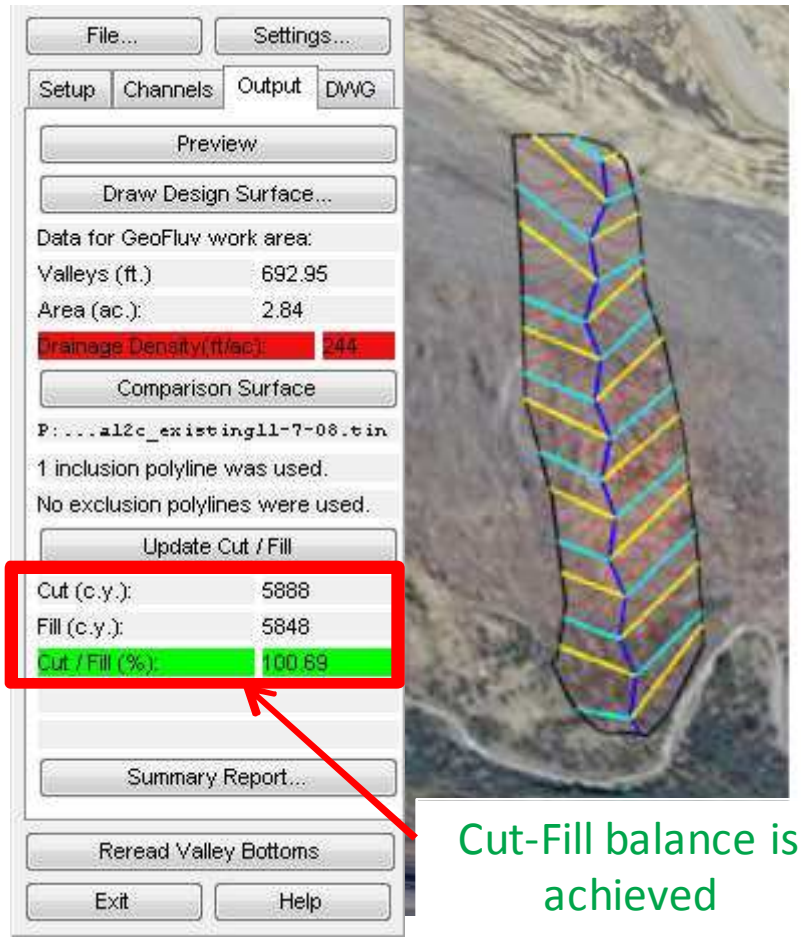
Sub-Watershed Boundary

Drainage

Undisturbed Area



Complete a Geomorphic Design for Stable Landforms using Natural Regrade™



Cut-Fill balance is achieved

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

Importance of Sub-Ridges and Sub-Valleys

As part of the comprehensive approach, additional analysis on the geomorphic design surface was completed to show that erosion rates and specified design flows would meet permit criteria

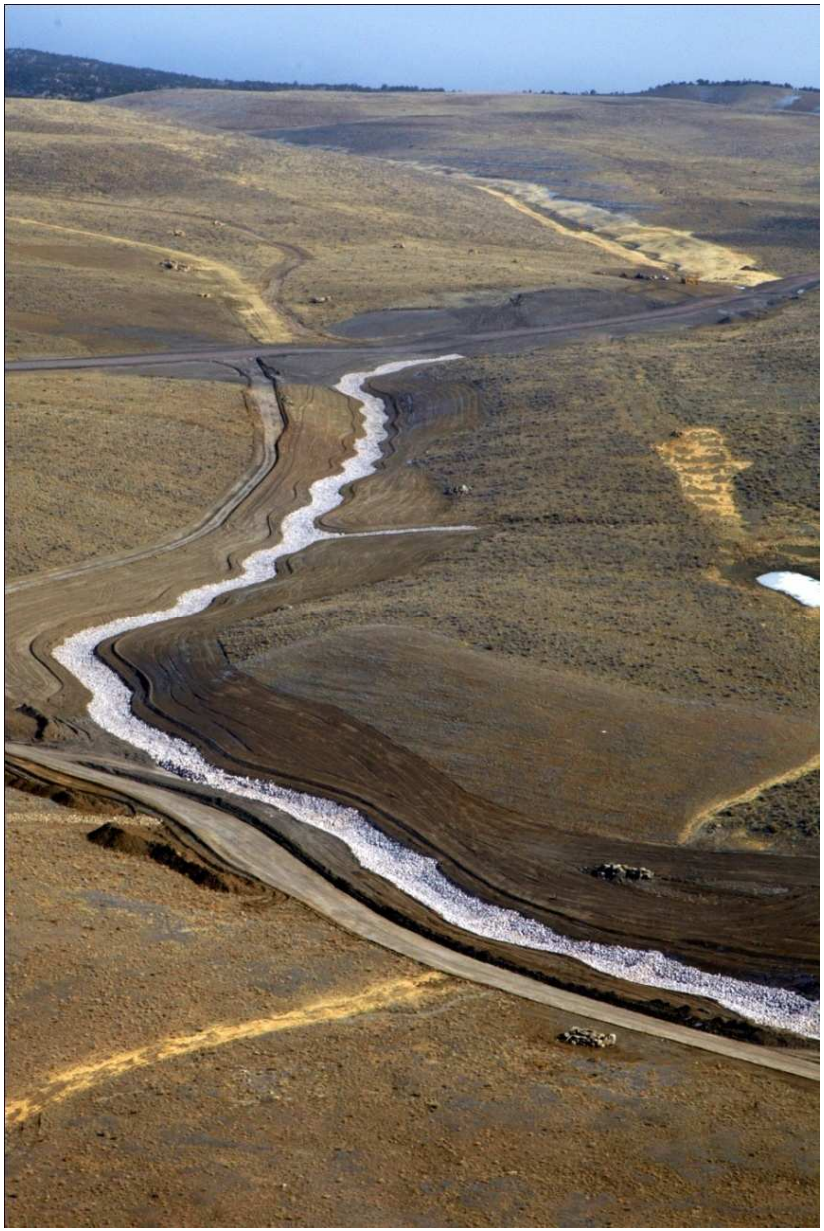
Additional Analysis Completed

- A 100-yr, 6-hr peak flow analysis was completed for designed watersheds with contributing area greater than 1 mile.
- 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.

Channel Protection

-Riprap Lining

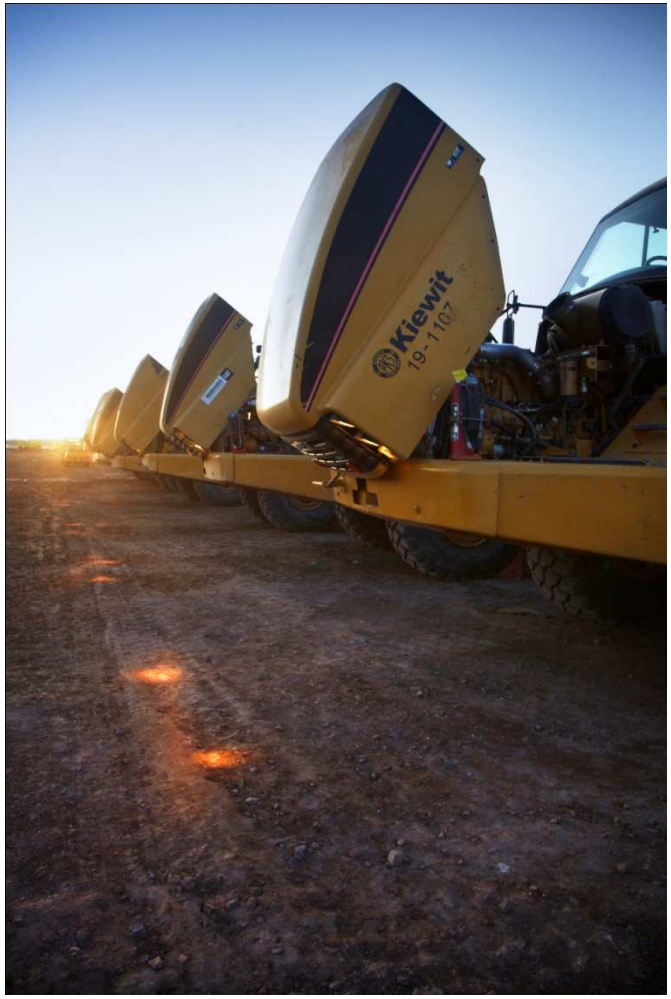
-Loose Rock Check Dams



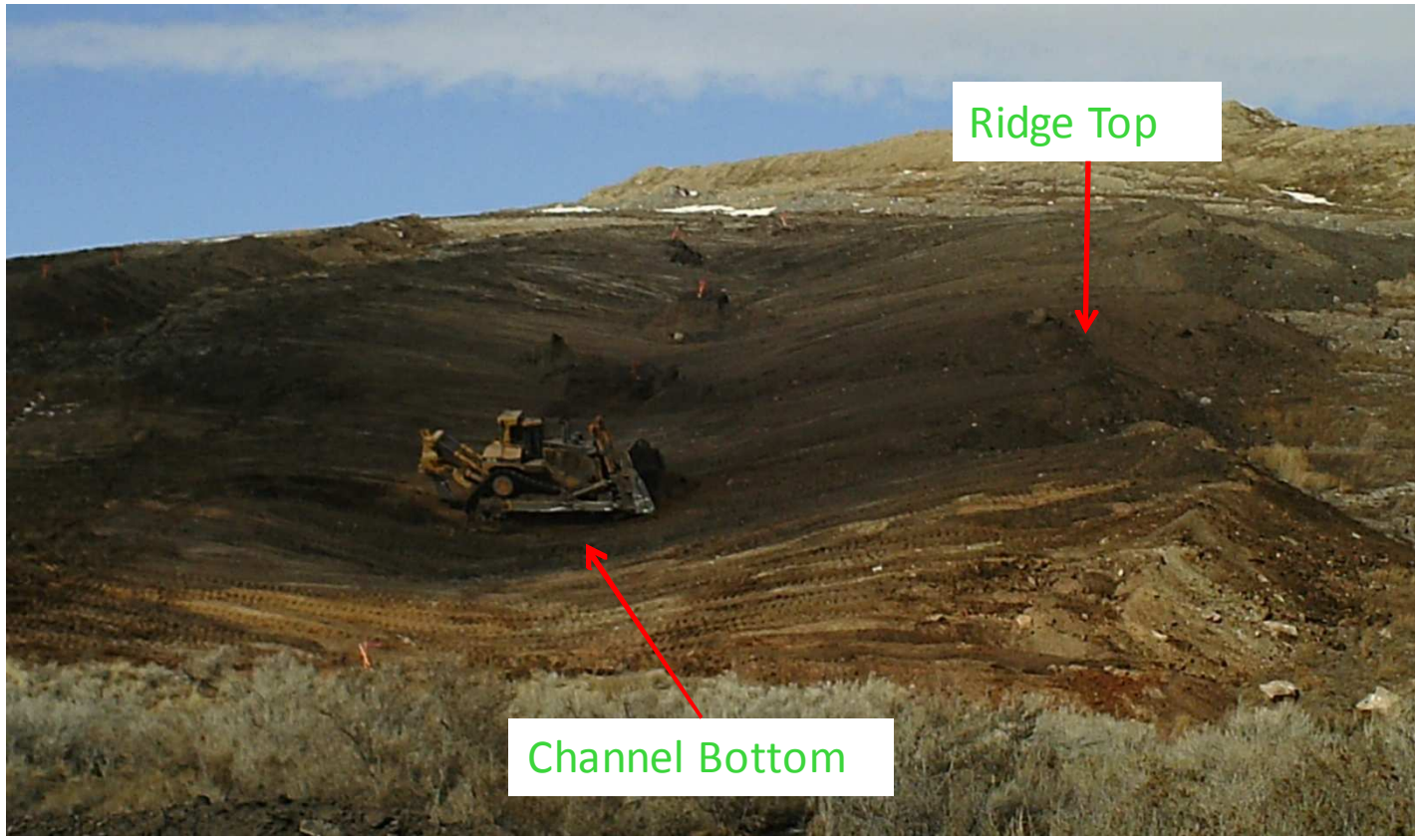

CAT

Time Lapse – 2005 - 2011

Construction



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



Final Product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Benefits of Integrated Geomorphic Reclamation

- Stable Landform
- Flexibility for integrating with existing reclamation
- Ability to handle large flows
- Topographic Diversity
- Low Maintenance
- Aesthetically pleasing

Questions