

McKinley Mine

A Commitment to Stable Land Forms

Utilizing Geomorphic Principles

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Project Team



Chevron Mining Inc.

McKINLEY MINE





McKinley Mine History

- McKinley Mine opened in 1962
- 1st large surface coal mine in New Mexico
- Employed 600 people in its peak
- Sold 175,000,000 tons over lifespan
- Entered final reclamation in 2010



Location

- McKinley Mine is located NW of Gallup, New Mexico
- Overview of active reclamation area





Geomorphic Design Methodology



- Create a long term stable product that requires little to no maintenance
- Accomplished by grading concave to convex slopes, inclusion of swales and sub ridges to break up watersheds and channel sinuosity to increase drainage length



Construction



- Drainage construction duration was approximately 2 years
- Detailed construction required small, specialized equipment; mining equipment was too large
- Required highly skilled operators used to detailed work



Construction (cont'd)



- A professional team of engineers and supervisors worked continuously to develop designs during construction
- Success factor was a collaborative team effort between operations and engineering



Project Challenges

- Handle the interface between existing conventional reclamation and geomorphic reclamation
- Incorporate runoff from large up-gradient watersheds onto disturbed areas
- Highly erosive environment
 - Average annual precipitation of 11.5 inches
 - Rainfall typically occurs over a one-month period in July / August
 - 70% of design rainfall event falls in 30-minute period



Geomorphic vs. Conventional Grading

Geomorphic Graded Slope



- Small watersheds are created by incorporating designed ridges and slopes to produce stable landform
- Creates topographic diversity

Conventional Graded Slope



- Utilizes low gradient terraces to divert water to a drop structure
- Terrace clean out is necessary
- Slope stabilizes over time



Multi-Software Design

- Carlson Natural Regrade
 - Utilized to develop final post mining topography incorporating conventional reclamation work, native drainage density, soil characteristics and any other unique site specifics
- RUSLE 1.06c
 - Used to calculate and model soil erosion / detachment rates
- SEDCAD 4
 - Used to determine and evaluate channel stability and riprap lining requirements
- AutoCAD Civil 3D
 - Used to develop detailed drawings for permit submittals and for construction



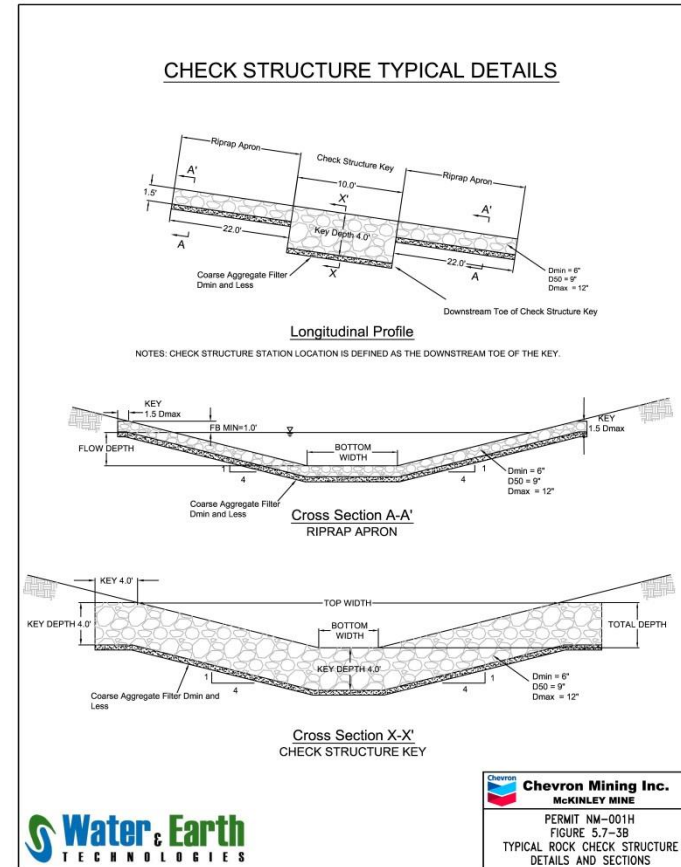
Design Parameters

- Design Storm Event
 - 50-year, 6-hour Storm Event for watersheds less than 640 acres
 - 100-year, 6-hour Storm Event for watersheds greater than 640 acres
- New Mexico Type II Storm Distribution
- Limiting soil stability velocity of 5 fps for unlined channels

Channel Stabilizing

Check Structure

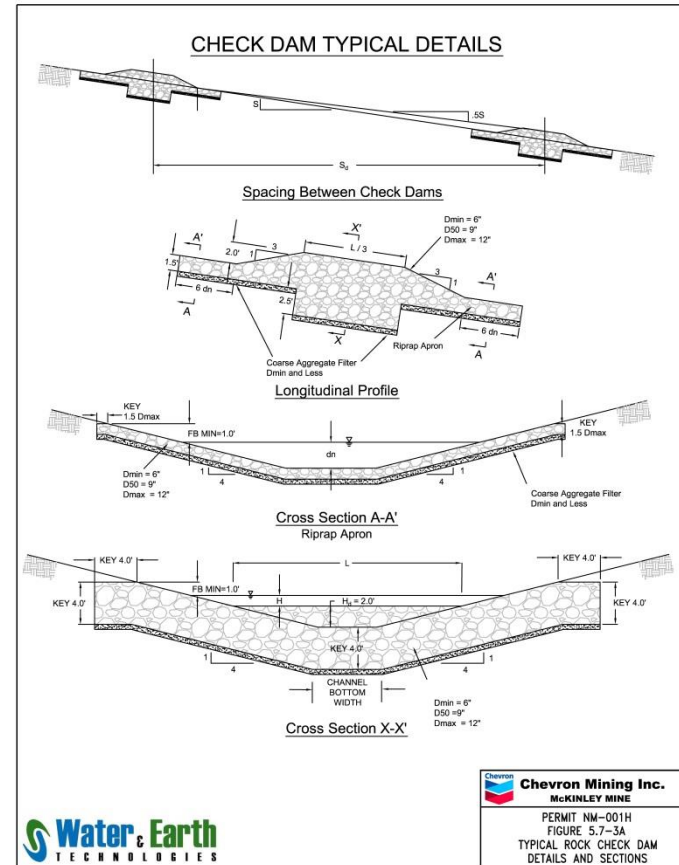
- Used as grade control
- Composed of a large center key to prevent channel head cutting
- Apron at either side to transition into channel



Channel Stabilizing (cont'd)

Check Dam

- Used to reduce channel gradient
- Composed of center dam designed to reduce channel gradient through channel silting in
- Effective way to reduce gradient of large watersheds when slope is less than 3%



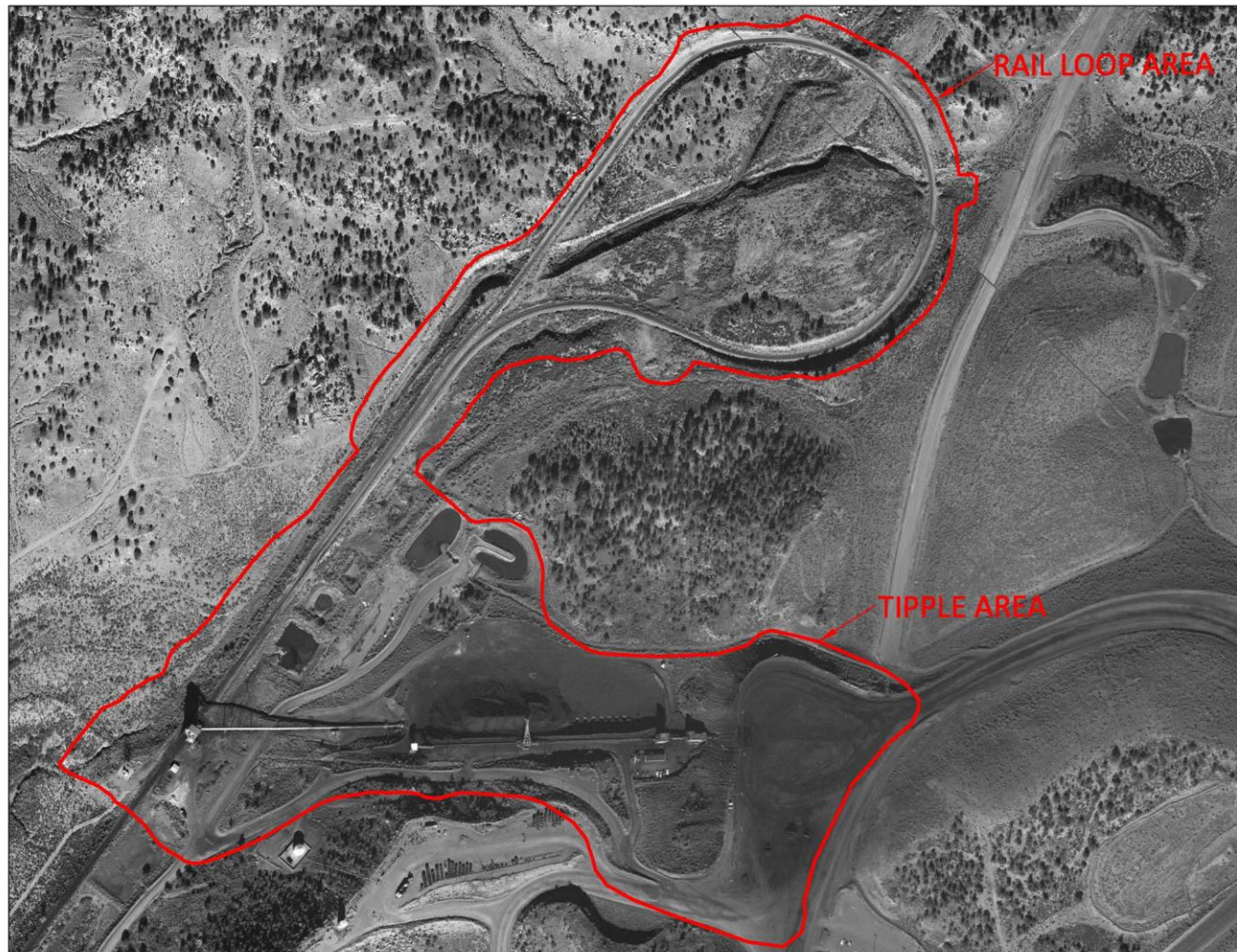


Tipple Area

- Composed of two different areas presenting differing challenges
 - Hopper and load out facilities
 - Structure removal
 - Minimum cover requirements on unsuitable material
 - Steep slopes
 - Large cut / fill balance
 - Rail loop corridor
 - Large earthwork mass balance
 - Blending of geomorphic reclamation with surrounding undisturbed areas
 - Reconstruction of natural wash with watershed > 5,000 acres

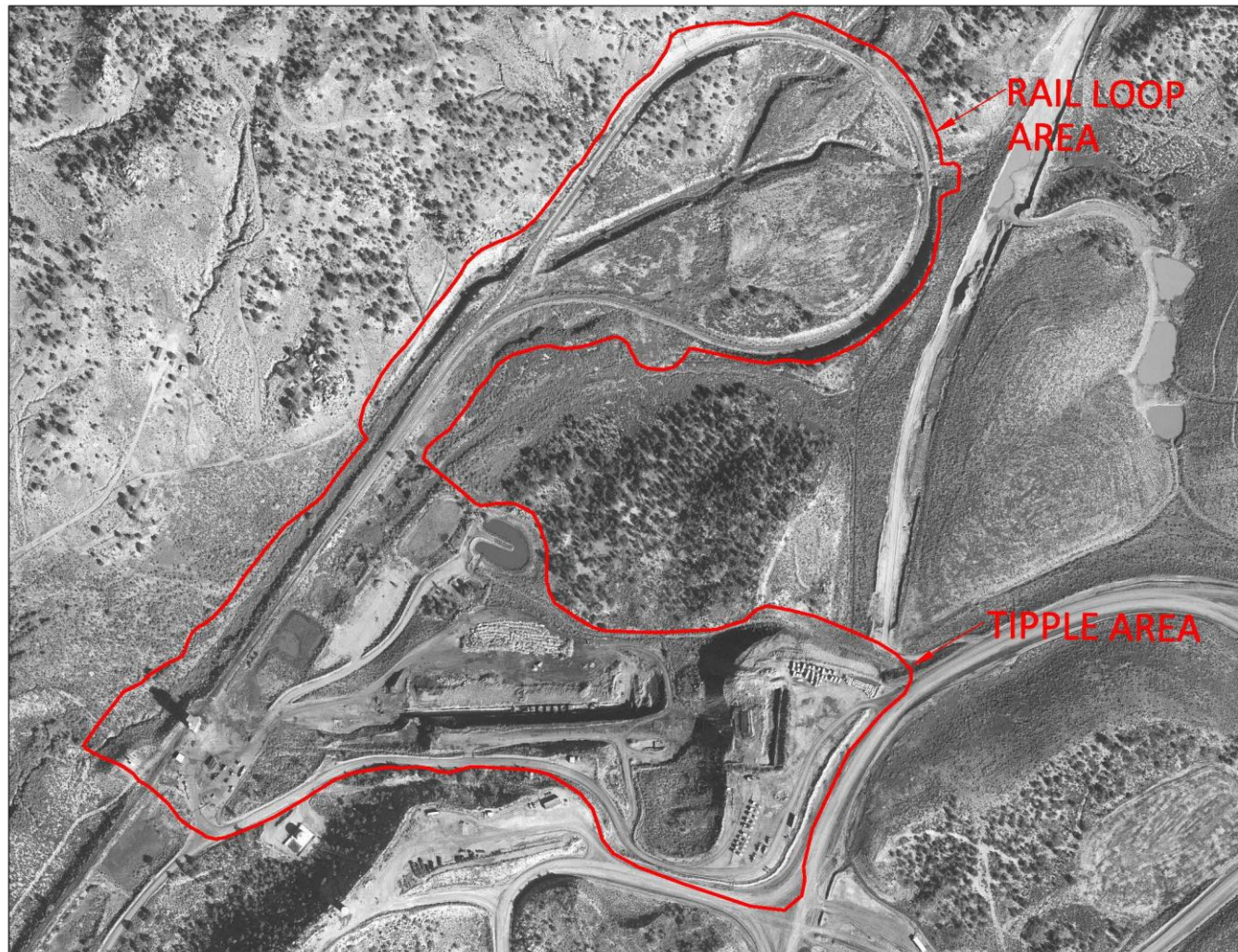


Tipple Area (Cont'd)



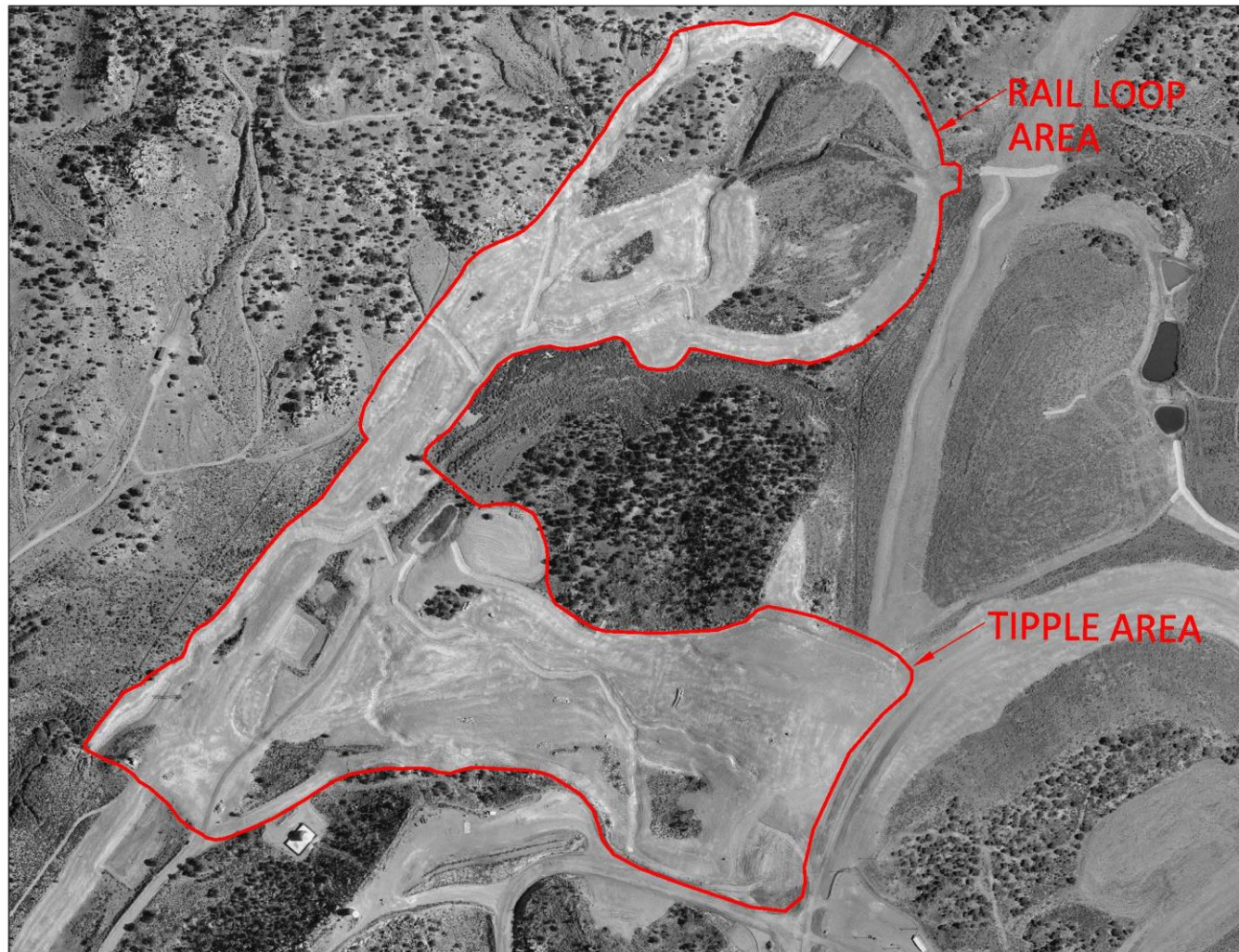


Tipple Area (Cont'd)





Tipple Area (Cont'd)





Tipple Area (Cont'd)





Tipple Area (Cont'd)





Tipple Area (Cont'd)





Tipple Area (Cont'd)



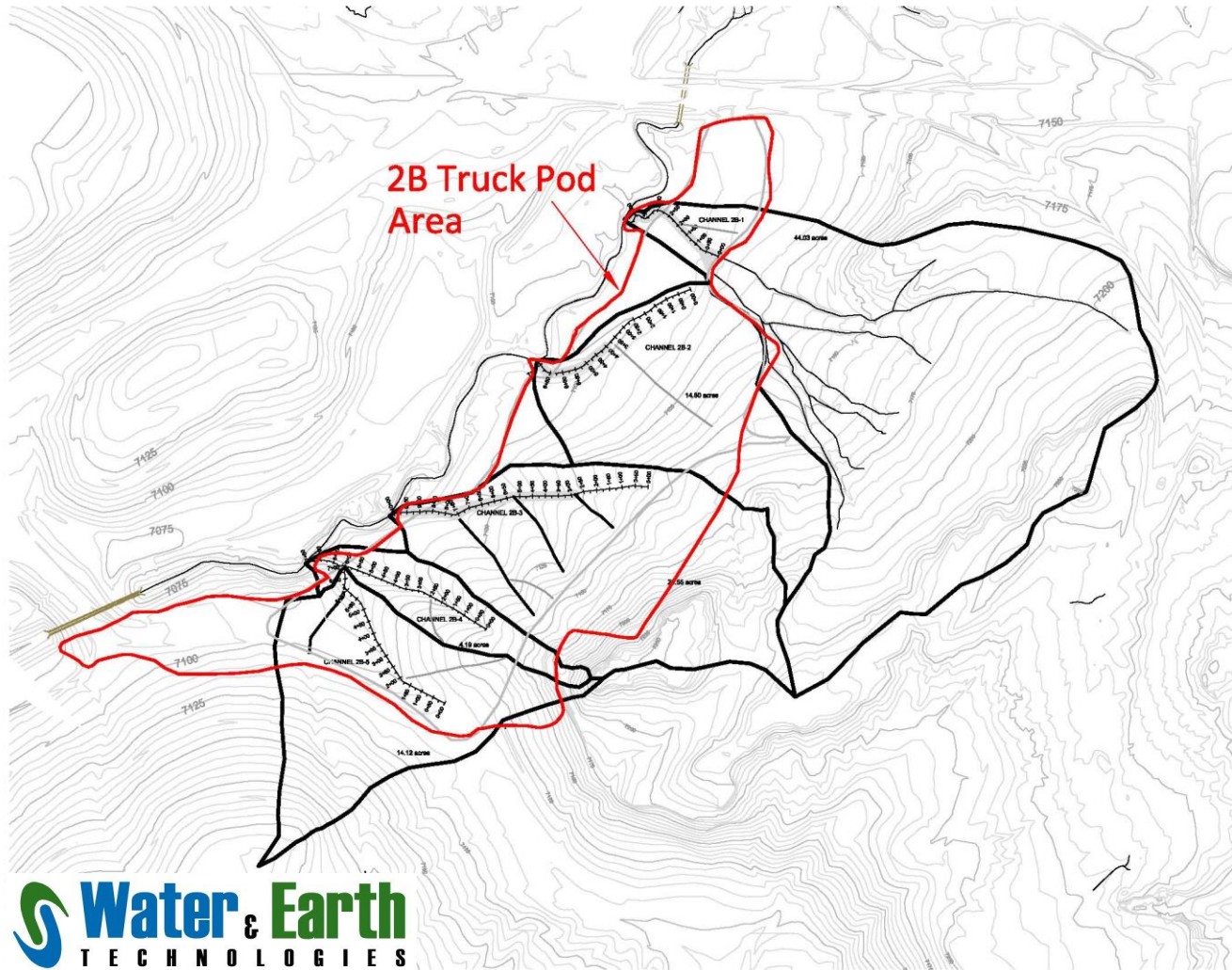


2B Truck Pod

- Small parcel in the overall mine mined using truck and shovel that is limited on one side by a significant wash and a ridge on the other side that limited coal recovery
- Mining was completed in 2009 and the reclamation completed in 2012
- Reclamation created a unique situation due to the gradient transition from the ridge to the natural wash within a small area
- Geomorphic principals were used to grade the slopes into a convex configuration with ridges and swales to break up the area and create a stable landform.
- Blending of large hill at edge of disturbance to overall grading plan

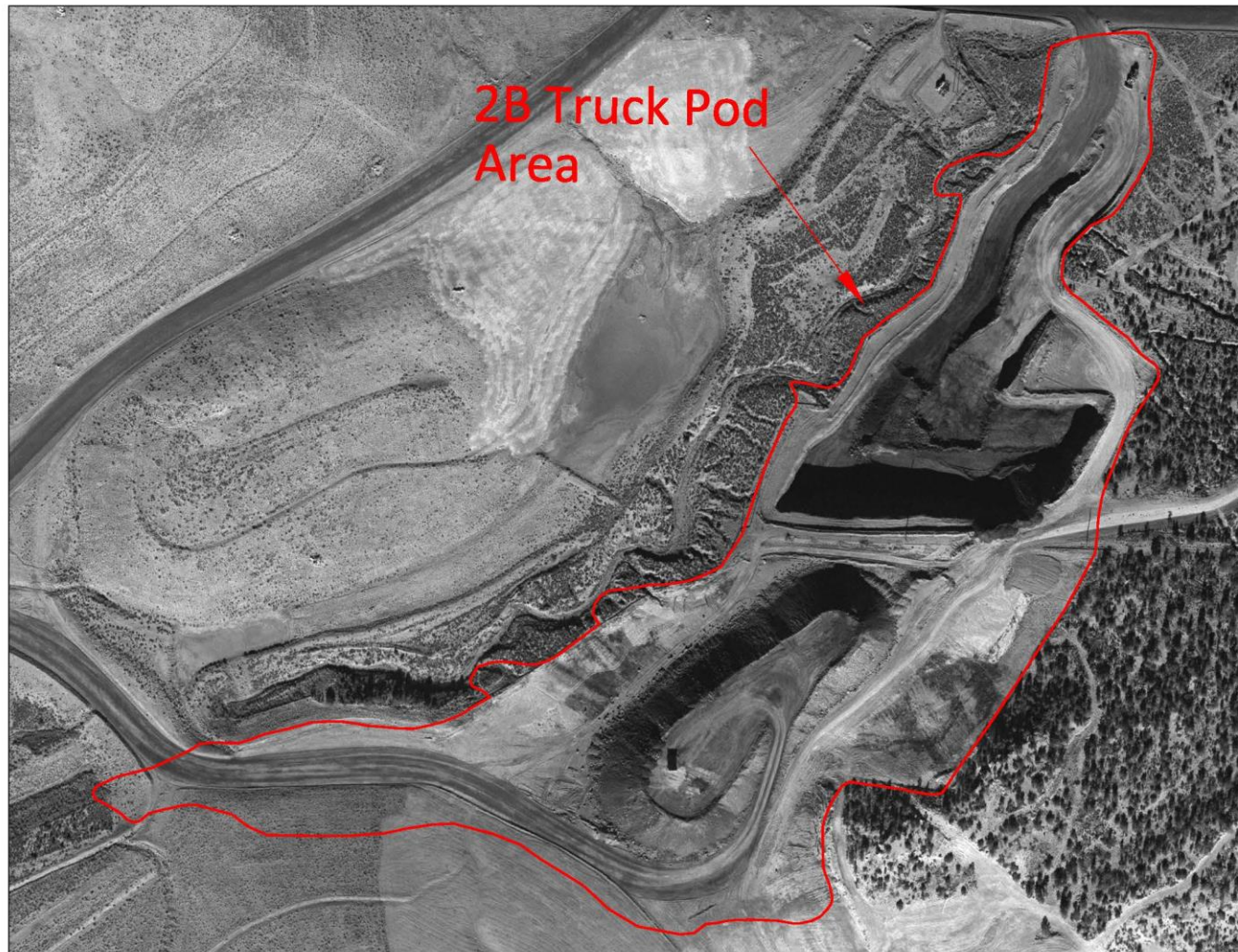


2B Truck Pod (Cont'd)



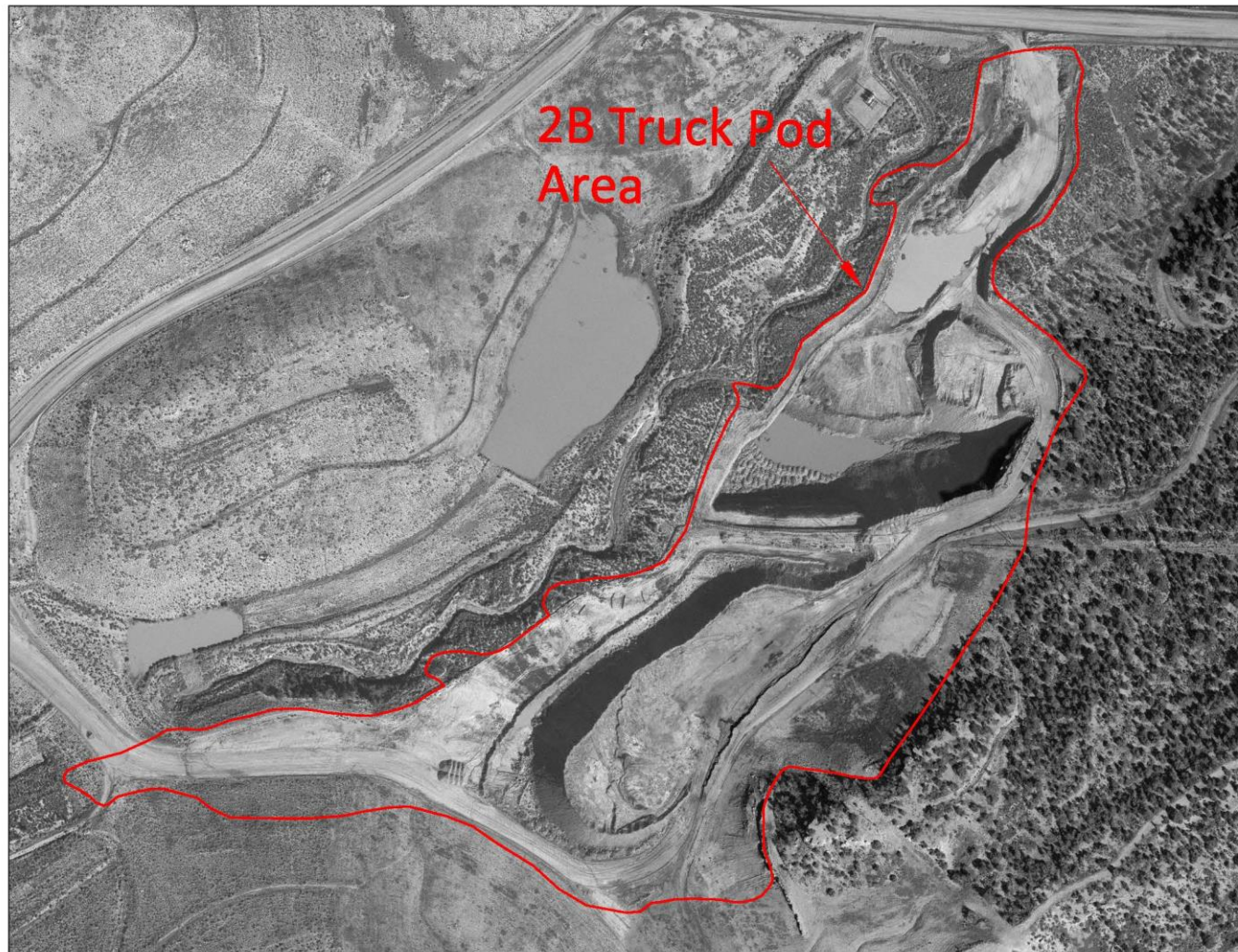


2B Truck Pod (Cont'd)



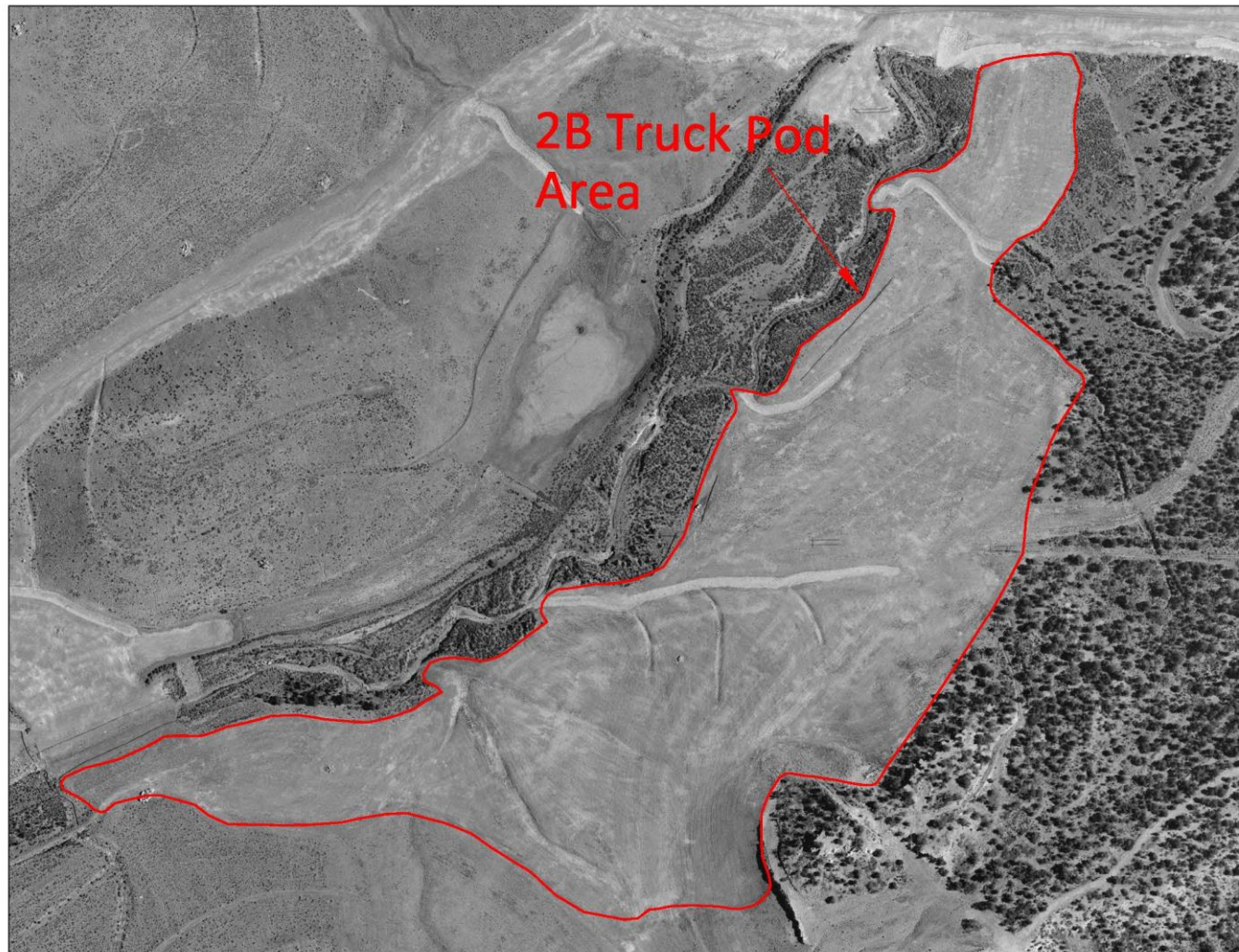


2B Truck Pod (Cont'd)





2B Truck Pod (Cont'd)





2B Truck Pod (Cont'd)



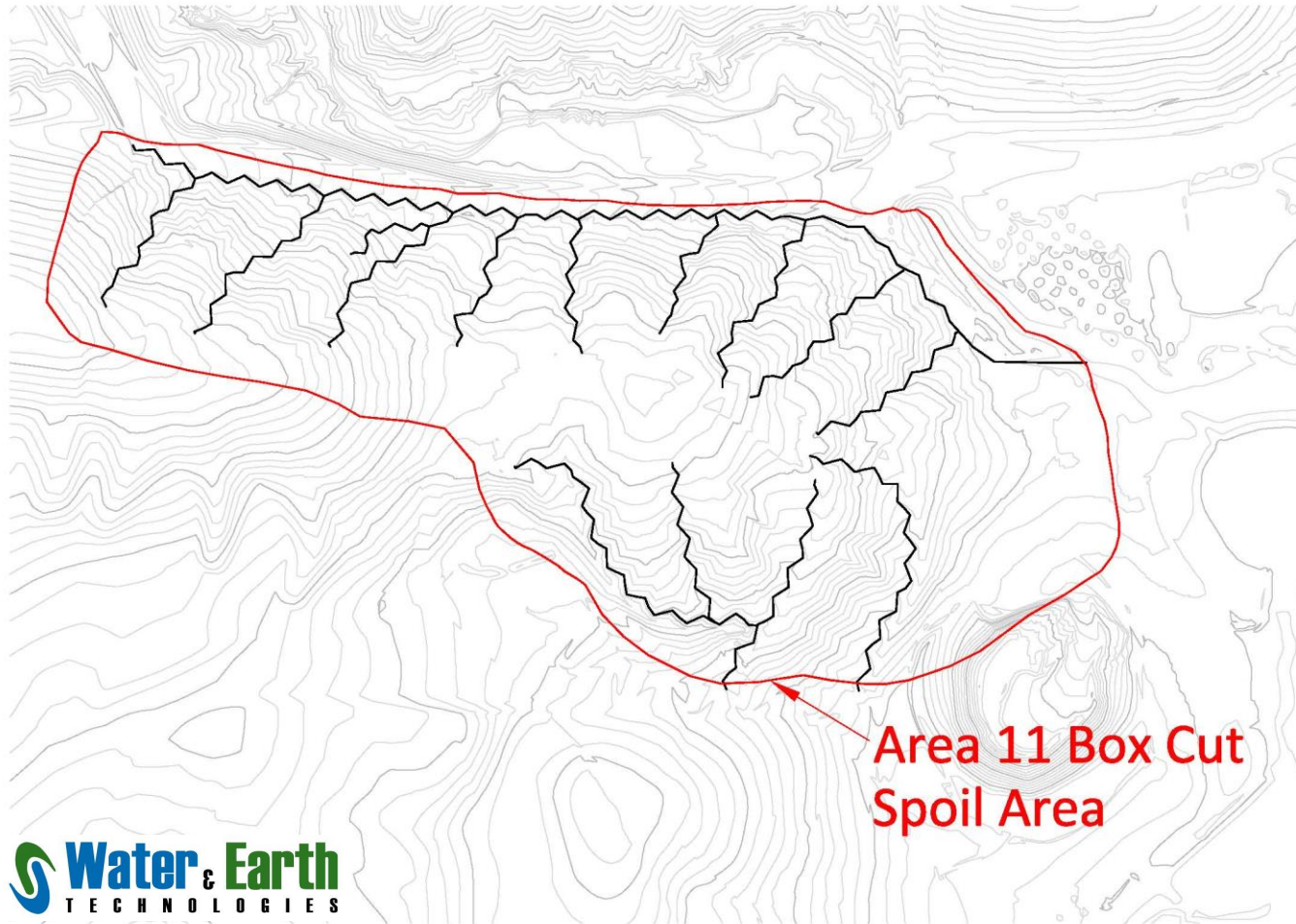


Area 11 Box Cut Spoil

- A material cut / fill balance was created to ensure optimum cost effectiveness of grading plan while created stable landform
- Long convex slopes were created with ridges, sub ridges and swales to break up the watersheds
- The flow was concentrated at the toe of the slope and armored with rip rap to prevent future erosion
- Final configuration is stable and will require minimal maintenance during the Extended Responsibility Period (ERP)



Area 11 Box Cut Spoil (Cont'd)



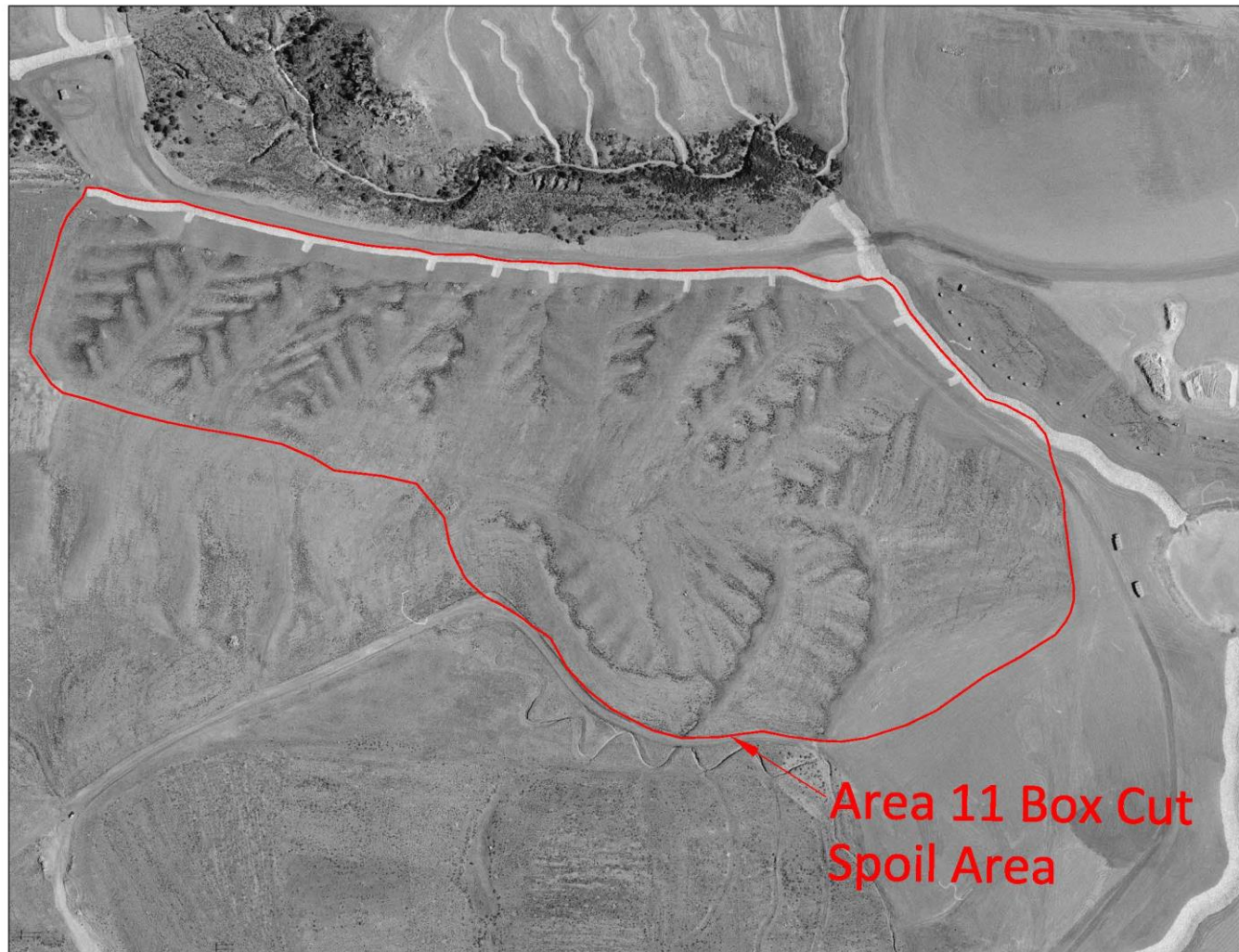


Area 11 Box Cut Spoil (Cont'd)





Area 11 Box Cut Spoil (Cont'd)





Area 11 Box Cut Spoil (Cont'd)





Area 11 Box Cut Spoil (Cont'd)





Area 14/15 Final Pit Channel





Questions

Questions???