

# RECLAMATION WITH BIOTIC SOIL MEDIA

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American Society of  
Reclamation Sciences

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# Overview

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- Pikeview Quarry Background
- Project Goals and Product Selection
- Biotic Soil Media (BSM)
- Erosion Control Selection
- Q & A

# Quarry History

Beginning in 1903, limestone was excavated from Pikeview Quarry via the drill and blast mining method. Prized for its contribution to concrete's strength and reduction in shrinkage and cracking, limestone was (and still is) a sought-after building material.

In 1940, the quarry was expanded to provide limestone for the concrete used to build the United States Air Force Academy.

**It is estimated that nearly half of the limestone used in the construction of Colorado Springs was mined from the Pikeview Quarry.**

In 1972, the quarry was acquired by Castle Concrete (now Castle Aggregates). Mining operations were permanently halted in 2018, following a series of slope failures, and previously approved reclamation plans were amended and formally approved in 2020.





## PHASE I: RECLAIM

BEGINS 2022

The 100-acre quarry site is filled and regraded, restoring its original topography.



## PHASE II: RESTORE

BEGINS 2023

Plants are installed, creating wildlife habitat and returning the land to its previous state.



## PHASE III: RECREATE

DATE TBD

After successful reclamation and restoration, the site can be developed for ecologically responsible recreation.

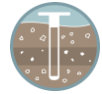
# Pikeview Goals and Objectives

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- Establish vegetation as quickly as possible to transfer ownership from Castle Aggregate to the city
  - Need 2 years of growth
- Existing conditions were not conducive to vegetation attempts
- Initial seeding window of 2.5 months. All products need to be installed as quickly as possible
- Close out the permit

# How to Establish Vegetation

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**Create Optimal Soil Conditions:** Test the soil or substrate to assess first



**Pick the Right Plant Species:** Plant materials compatible with project goals



**Select the Correct Erosion Control Materials:** The most effective control measures for your site and seasonality



**Ensure Proper Installation:** Follow all guidelines and specifications



**Follow-Up Inspection and Maintenance:** Coordinate plan to ensure success

*Fundamentals must be integrated into a process that entails proper planning and execution*

# Soil Health is the Foundation of a Successful Project!



## Healthy Soil

- Alive with microbes
- Storing water
- Cycling nutrients
- Attractive animal habitat

## Sustainable Vegetation

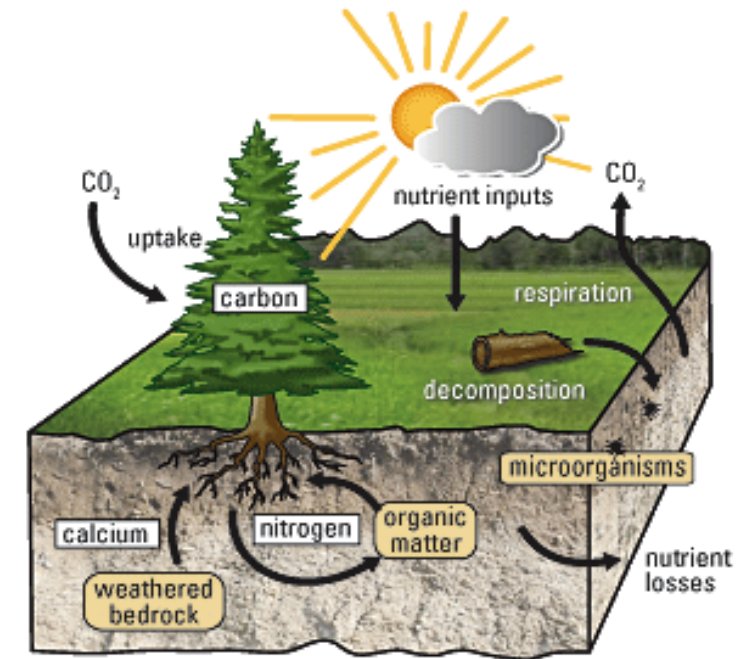
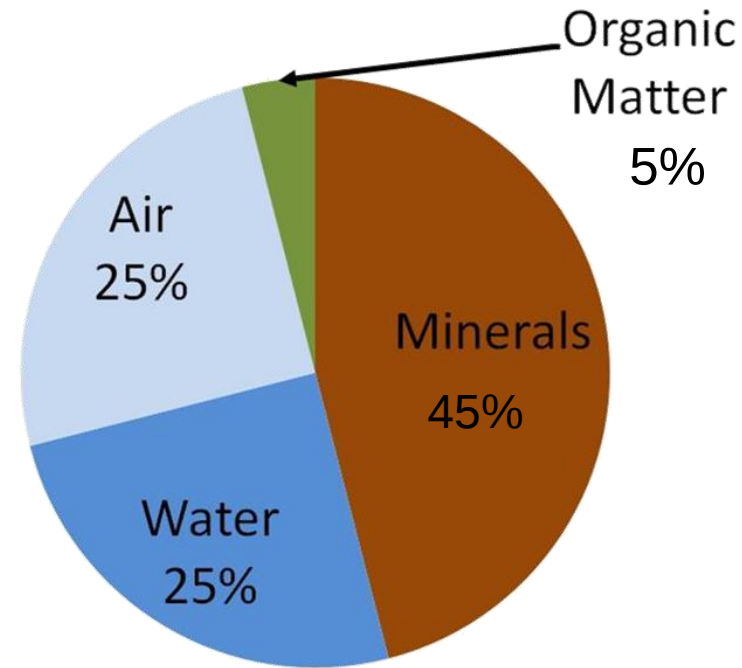
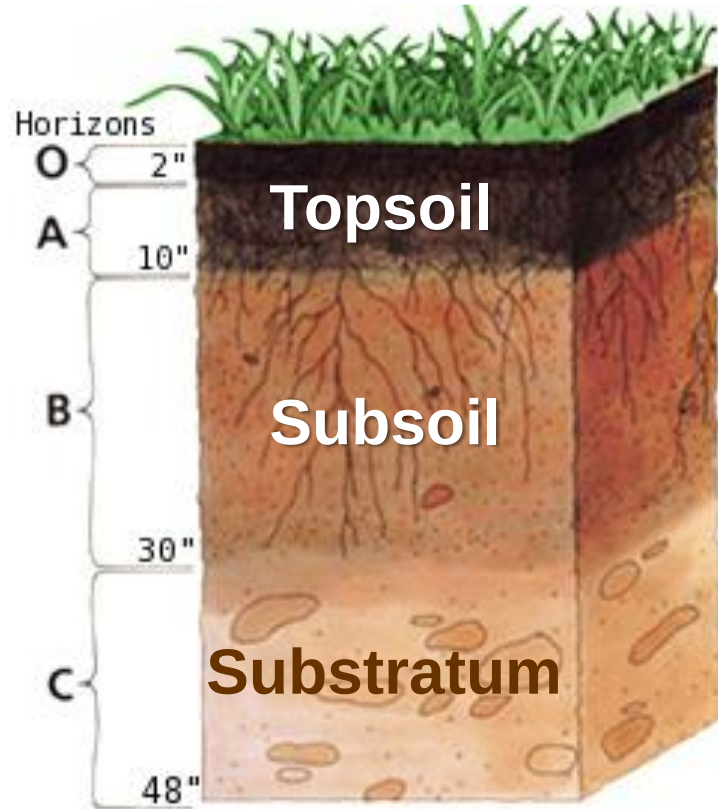
- Dense coverage
- Diverse species
- Prolific roots
- Aesthetically appealing

## Long-Term Erosion Control

- Minimal cost
- Low maintenance
- Habitat enrichment
- Water quality enhancement

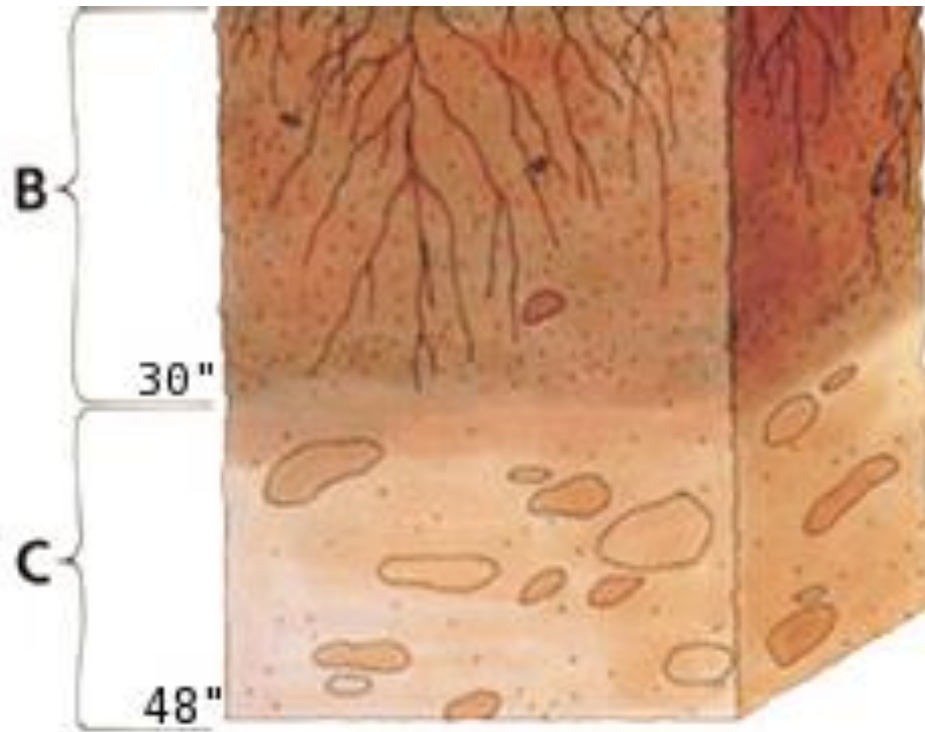
# Ideal Soil Profile

## Ideal Topsoil Composition for the O/A Horizon



# Typical Construction Soil Profile

Organic Matter < 1%



Most projects start with “B” or “C” horizons, maybe even worse:

- Subsoils
- Saline Soils
- Mine Wastes
- Industrial Wastes
- Coal Combustible Residuals (CCR)

# How can you tell if your soil is healthy?

- Can you see if your soil has the right minerals?
- Contains sufficient organic matter?
- Can you see if your soil has a salt imbalance or a pH problem?
- Generally not, therefore...
- Test Your Soil!



# Organic Matter

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- Organic Matter (OM) is the foundation for all biological life in the soil
- Ideally, we want organic matter to be  $> 5\%$  OM
- Regional differences in targets and the ability of soil to reach certain levels
- Typical “construction” (disturbed) soils  $< 1\%$  OM
- This can take truckloads of topsoil, compost, or other sources of organic material hauled to jobsites to get to 5% OM



# How Do I Increase Organic Matter in My Soil?

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- Topsoil
- Compost
- Peat
- Manure or biosolids
- Wood chips, sawdust, etc.





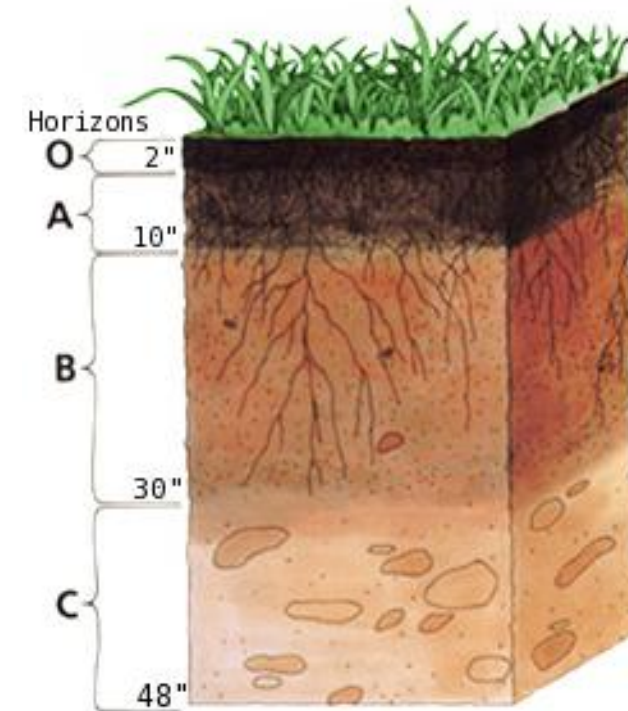
# Biotic Soil Media (BSM)

- Designed as a topsoil and compost alternative
- Manufactured growth media containing recycled biodegradable fibers, biostimulants, a patented biological soil nutrient system and other amendments
- Engineered to promote regeneration of denuded soils and accelerate sustainable vegetative establishment
- Why import topsoil or compost when you can build a topsoil in place?



# How Does BSM Build Healthy Soils?

- BSM improves soil chemistry — which later improves soil structure / texture — with increased organic matter and biological activity combined with plant establishment and subsequent nutrient cycling
- Helps O & A horizons to regenerate faster by creating a “revegetation platform”
- While the soil chemistry is improving, the media provides a more ideal growing environment
- Provides rapid growth establishment and sustains long-term vegetation



# Mixing and Application

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- Pre-packaged bales mixed with water, seed, fertilizer, amendments and other components
- Applied below hydraulically-applied or rolled-erosion control products, blown straw or even sod
- Complements performance of hydraulically-applied erosion control products



## Fundamental #3

# Select Right Erosion Control Material

Establishing vegetation  
requires balancing

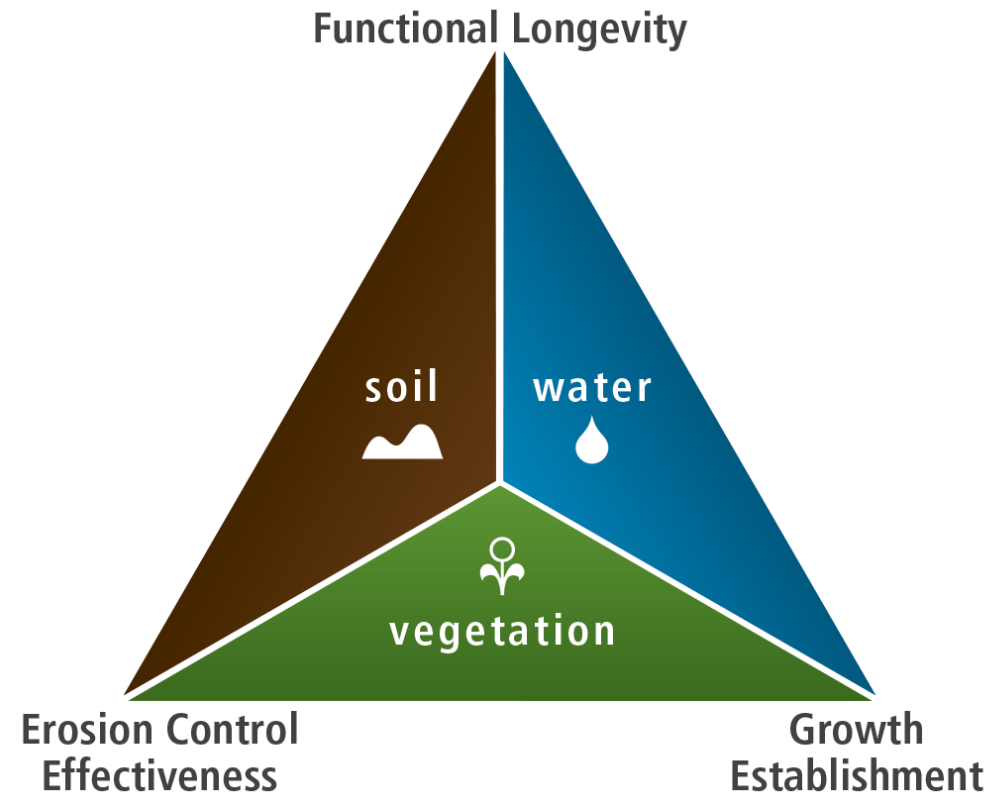
**NATURAL VARIABLES**

and

**PRODUCT ATTRIBUTES**

to create the best  
environment for growth  
and establishment

## Green Design Engineering™ Triangle





# Pikeview Scope of Work

- Approx 565,000 CY of Structural Material
- 4 Miles of Channel Construction and Rip Rap Placement
- 127 acres of Topsoil for Grass/Seeding
- 31,000 Trees to be planted



# Haul in Fill Material and Grade Slopes



## ***Revegetation***

Affected areas will be revegetated in such a way as to encourage a diverse, effective, and long-lasting vegetative cover that is capable of self-regeneration without continued dependence on irrigation, soil amendments, or fertilizer. Revegetation throughout the mine site will differ depending on surface ownership, elevation, and availability of water. The revegetation plan has not changed from the current plan. The western portion of the mine site is on National Forest System (NFS) lands. The 2001 EA sought re-establishment of a Douglas Fir-Ponderosa pine forest on 2:1 slopes on this parcel, and these coniferous species will be planted on slopes above 7450'. Prior reclamation plans included a pinyon juniper revegetation plan between 7450' and 7250' on private surface. As an expansion of their prior plans, the applicant has identified a mixed shrub community of Gambel's Oak and Mountain Mahogany from approximately 7250' to the base of the property. The acreages associated with these vegetation types are summarized in Table E-1.

SOIL

Sa

Sa

Sa

SOIL ANALYSIS RESULTS (Optimal Plant Growth Conditions)

| Sample | Nitrate N ppm | Phosphorus ppm | Potassium ppm | Magnesium ppm | Calcium ppm | Sulfur ppm | Zinc ppm    | Manganese ppm | Copper ppm  | Iron ppm     | Boron ppm |
|--------|---------------|----------------|---------------|---------------|-------------|------------|-------------|---------------|-------------|--------------|-----------|
| 1      | 1             | 20             | 269           | 470           | 5708        | 266        | 1.72        | 18.4          | 1.2         | 49           | 0.6       |
| 2      | 3.2           | 12             | 181           | 396           | 7329        | 123        | 1.18        | 5.4           | 1.4         | 37.1         | 1.6       |
|        | (10 - 30)     | (20-40)        | (150 - 250)   | (60 - 300)    | (≥ 400)     | (5 - 20)   | (1.3 - 3.0) | (4.1 - 12.0)  | (1.0 - 2.0) | (7.1 - 20.0) | (< 2.0)   |

| Sample | % Organic Matter | Soil Respiration<br>mg CO2/kg soil/week <sup>5</sup> | Sand %     | Silt %                 | Clay % | Texture USDA    |
|--------|------------------|------------------------------------------------------|------------|------------------------|--------|-----------------|
| 1      | 1.5              | Not Tested                                           | 64.4       | 18.4                   | 17.2   | Sandy Loam      |
| 2      | 1.4              | Not Tested                                           | 54.4       | 18.4                   | 27.2   | Sandy Clay Loam |
|        | (> 5%)           | (> 1,000)                                            | (20 - 60%) | Silt & Clay (40 - 80%) |        |                 |

Notes: 5. Soil Respiration ppm = mg/kg

| Sample |                      |              |                      |                        |            |                  | Bulk Density      |                    |
|--------|----------------------|--------------|----------------------|------------------------|------------|------------------|-------------------|--------------------|
|        | Soil pH <sup>6</sup> | Buffer Index | TDS <sup>7</sup> ppm | Soluble Salts mmhos/cm | Sodium ppm | SAR <sup>8</sup> | g/cm <sup>3</sup> | oz/in <sup>3</sup> |
| 1      | 7.9                  | 7.5          | 3577.6               | 5.59                   | 367        | 3.8              | 1.37              | 0.79               |
| 2      | 8.4                  | 7.5          | 704                  | 1.1                    | 118        | 1.11             | 1.26              | 0.73               |
|        | (6.3 - 7.3)          |              | (<256)               | (< 0.75)               |            | (<2)             |                   |                    |

**Table E-1 Revegetation Summary**

| Vegetation Type            | Area (ac) |
|----------------------------|-----------|
| Douglas Fir-Ponderosa Pine | 32.18     |
| Pinyon-Juniper             | 37.52     |
| Gambel's Oak-Mt. Mahogany  | 69.40     |
| Total                      | 139.10    |

**Table E-2 Seed Mix Composition for USFS Lands**

| Species                                  | Common Name-Variety              | lbs./acre | Seeds/sq. ft. |
|------------------------------------------|----------------------------------|-----------|---------------|
| <i>Achnathum hymenoides</i> <sup>a</sup> | Indian Ricegrass- Rimrock        | 1.5       | 5             |
| <i>Bouteloua curtipendula</i>            | Sideoats Grama- Vaughn           | 0.7       | 3             |
| <i>Bromopsis ciliatus</i>                | Nodding Brome- Native            | 0.5       | 1             |
| <i>Chondrosum gracile</i> <sup>b</sup>   | Blue grama- Native               | 0.1       | 2             |
| <i>Danthonia parryii</i>                 | Parry Oatgrass- Native           | 2.4       | 5             |
| <i>Elymus lanceolatus</i> <sup>c</sup>   | Thickspike Wheatgrass- Critana   | 2.3       | 8             |
| <i>Elymus trachycaulus</i> <sup>d</sup>  | Slender Wheatgrass - San Luis    | 2.7       | 10            |
| <i>Elymus elymoides</i> <sup>e</sup>     | Bottlebrush Squirreltail -Native | 2.3       | 10            |
| <i>Festuca arizonica</i>                 | Arizona Fescue - Redondo         | 0.8       | 9             |
| <i>Festuca saximontana</i>               | Rocky Mountain Fescue- Native    | 0.2       | 5             |
| <i>Hesperostipa comata</i> <sup>f</sup>  | Needle-and-thread- Native        | 1.9       | 5             |
| <i>Leymus ambiguus</i>                   | Colorado Wildrye- Native         | 3.4       | 10            |
| <i>Muhlenbergia montana</i>              | Mountain Muhly- Native           | 0.2       | 10            |

**Table E-3  
SEED MIX – Permanent Mix for Erosion Control on Private Surface**

| Species <sup>1</sup>         | PLS <sup>2</sup><br>lbs./ac | SEEDS/SF |
|------------------------------|-----------------------------|----------|
| Big Grama                    | 0.5                         | 9.47     |
| Crested Wheatgrass - Ephraim | 1                           | 4.59     |
| Green Needlegrass            | 1                           | 4.16     |
| Intermediate Wheatgrass      | 4                           | 8.08     |
| Little Bluestem              | 1                           | 5.97     |
| Pubescent Wheatgrass         | 4                           | 9.18     |
| Russian Wildrye              | 2                           | 8.03     |
| Sideoats Grama               | 2                           | 8.77     |
| Western Wheatgrass           | 4                           | 10.10    |
| Ranger Alfalfa               | 1                           | 4.82     |
| Mountain Mahogany            | 2                           | 2.7      |
| Rubber Rabbitbrush           | 1                           | 9.18     |
| TOTALS                       | 24                          | 85.05    |

# Seeding

- Seed coated with endo/ecto mycorrhizae
- Drill seeding was the primary method selected to ensure proper seed to soil contact
- Hydroseeding was utilized at peaks where machine access was limited



# Product Selection: Soil Amendments

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- BSM selected to amend topsoil throughout the project mixed with a Multi-nutrient plant-based fertilizer, Humate, and organic fertilizer in slurry
- Two man crew able to efficiently mix and load BSM slurry



# Soil Amendment Application



# Erosion Control Selection

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- Areas with slopes up to 3H:1V were treated with a 2-in-1 HECP which combines components of a BSM and Bonded Fiber Matrix (BFM) erosion control product in one bale for faster installation
- Slopes steeper than 3H:1V were treated with the BSM & Amendment slurry and capped with a biodegradable wood-based ECB
- Vertical areas were hydroseeded and sprayed with BSM and BFM in two-step application



FINN  
Hydro-Seeder

HYDRO TURF  
VEGETATION & EROSION CONTROL  
719.591.8151



## Two-Step Application:

- With 2.5 month reclamation time frame, crews were able to hydraulically-apply amendments and then have a separate crew cap slopes with ECB for protection
- Two-step application provides better erosion control protection for steeper and longer slopes







### One-Step Application of ProGanics DUAL:

- BSM, Amendments and Erosion Control mixed and applied in one slurry
- 2-in-1 product recommended for slopes up to 2H:1V

# August Updates

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- Initial goal of July 1 not met, seeding and reclamation outpaced the speed of hauling and grading fill dirt
- Severe weather in July lead to limited access on-site









# October Updates





# Conclusion

- Weather and grading pushed the seeding window into September
- Even seeding during the heat of the summer, the summer storms helped get quick germination
- While introducing mountain goats was a goal of the reclamation, they came in on their own earlier than anticipated and ate a large majority of planted trees
- A combination of multiple Erosion Control BMPs worked together to help heal “The Scar”



Work to reclaim the century-old Pikeview Quarry northwest of Colorado Springs is nearing completion



The Pikeview Quarry served an essential role in Colorado Springs' history. Its story is still being written



Healing the Scar: As Reclamation Nears Completion, What's Next for Pikeview Quarry?

July 22, 2024

# Thank You!

## Questions?

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