Reclamation at Badger Mining's Taylor Plant

Sand Mine Life Cycle Seminar

May 12, 2017

Mine Life Cycle Timeline

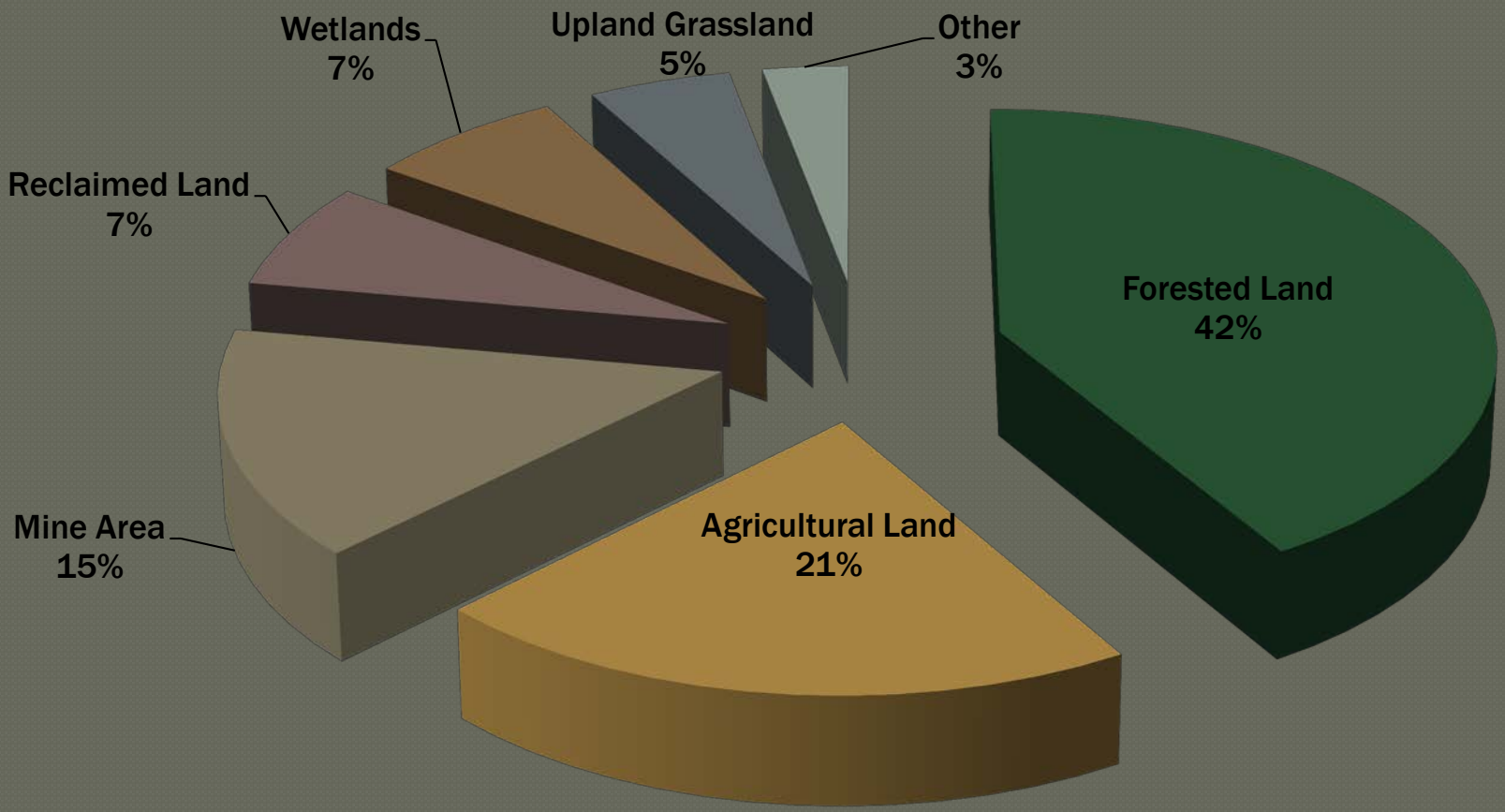
- 500 million years ago

- 30,000 to 10,000 years ago

- Last 200 years - forestry

- 5 – 30 years active mining

- In the future ???

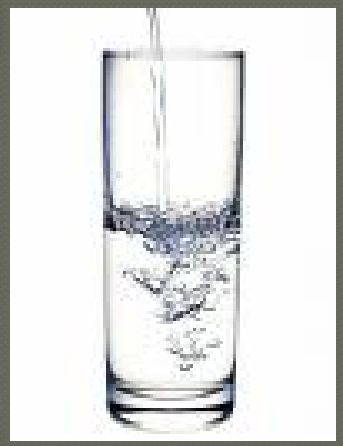


- **BMC Taylor Plant ~ 6,000 acres**







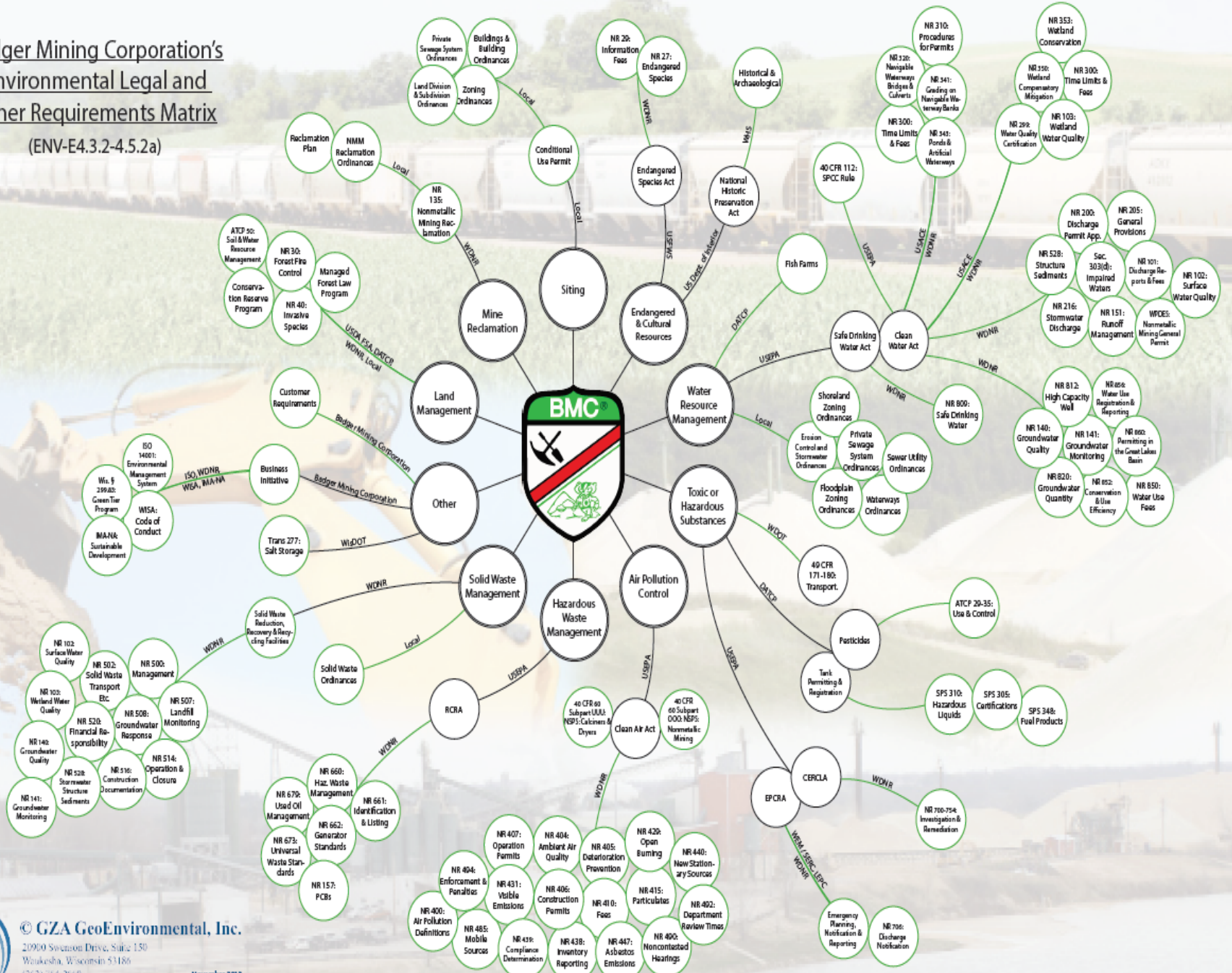
Including:

- 313 plant species
- 155 bird species
- 22 mammal species
- 9 amphibian species
- 7 reptile species

Yes – we counted.

Badger Mining Corporation's Environmental Legal and Other Requirements Matrix

(ENV-E4.3.2-4.5.2a)



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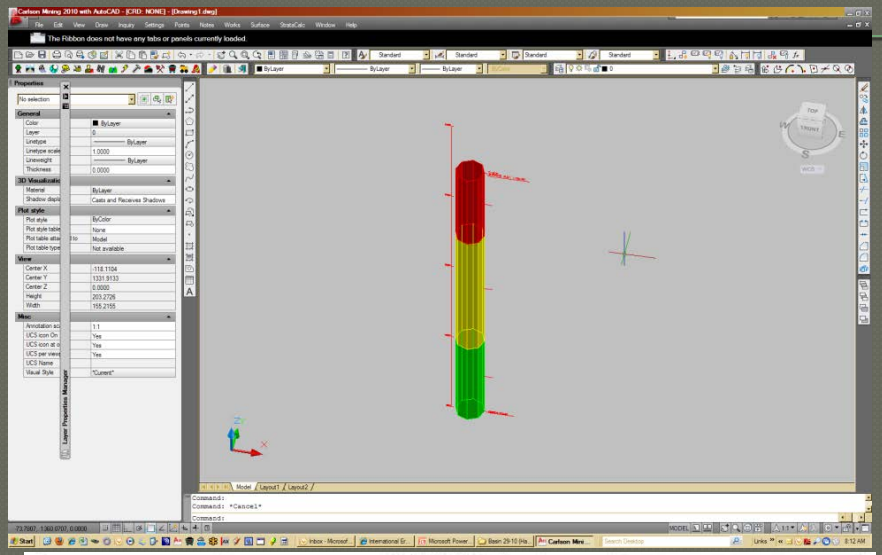
November 2013

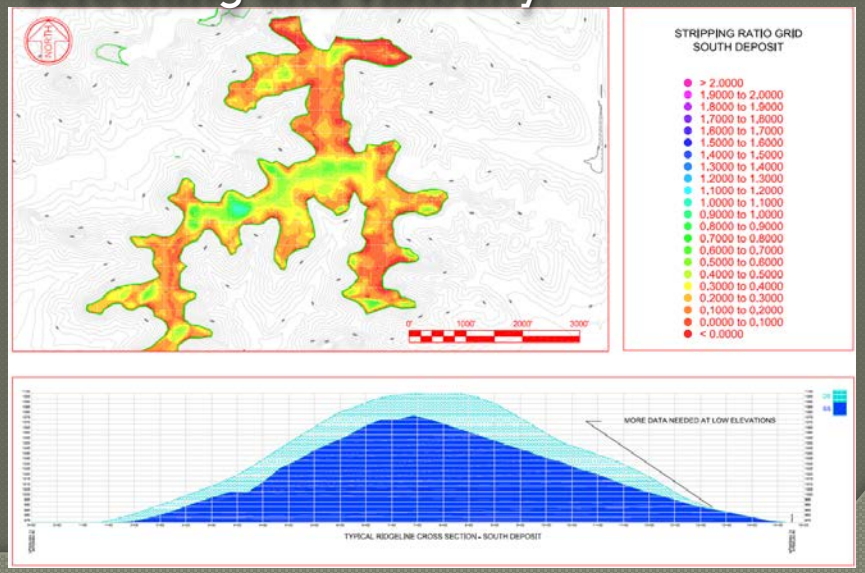
Exploration



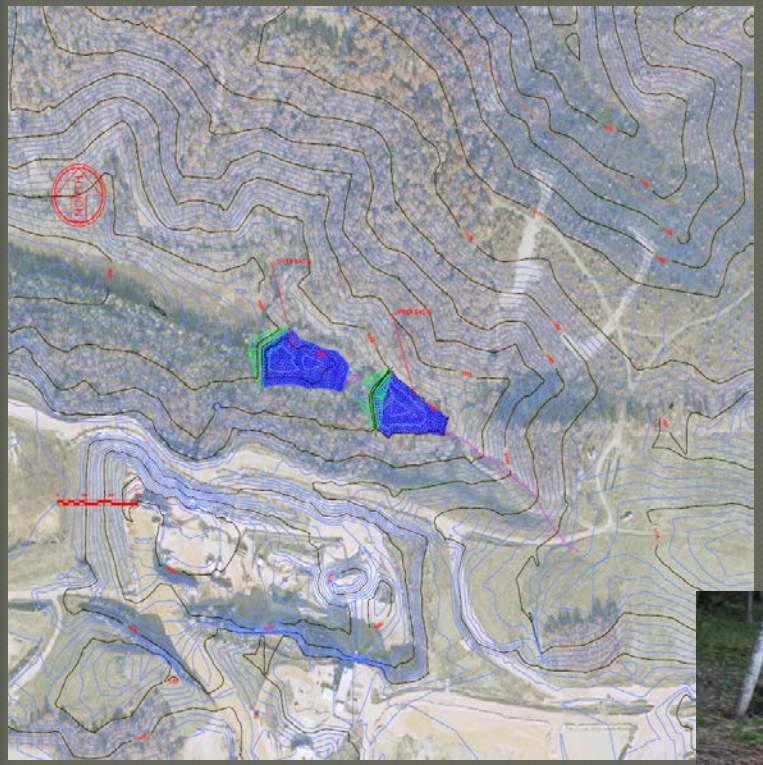
- Identify potential mining areas.
- Understand the quality characteristics of the sand.
- Quantify the costs associated with mining the area – overburden removal, environmental risk, screening and visibility.

Stratigraphic Nomenclature		Initial hydraulic values		Calibrated hydraulic values		Model Structure	Lithology and Generalized Hydrostratigraphy
Group	Formation	Kh (ft/d)	Kv (ft/d)	Kh (ft/d)	Kv (ft/d)		
Quaternary	(undiff.)	0.003-7	0.001-0.1	0.2-100	0.005-1	Layers 1-2	Quaternary and Silurian aquifers: sand & gravel, till, dolomite
Devonian	(undiff.)	30	0.03-0.1	30	0.03-0.1	Layer 4*	
Silurian	(undiff.)	1-4	0.001-0.1	1-4	0.001-0.1	Layers 5-6	
	Maquoketa	0.0003-0.3	0.0001-0.001	0.0003-0.3	0.000005-0.001	Layers 7-8	Maquoketa aquitard: shale and dolomite
Sinnipee**	Galena	0.003-0.3	0.0001-0.01	0.04-0.3	0.0005-0.01	Layers 9-10	
	Platteville						
Ancell	Glenwood	1-5	0.001-0.1	1.2-6	0.0004-0.04	Layer 11	Cambrian-Ordovician aquifer system: sandstone and dolomite, with interbedded shale and siltstone (leaky aquitards)
	St. Peter						
Prairie du Chien	(undiff.)						
Trempealeau	Jordan	0.5-2	0.0001-0.01	0.24-2.4	0.00004-0.004-	Layer 12	
	St. Lawrence						
Tunnel City	(undiff.)					Layer 13	
Elk Mound	Wonewoc	3-7	0.001-0.1	2.4-8.4	0.0004-0.04	Layer 14	
	Eau Claire	0.5-2	0.0001-0.03	0.6-3.6	0.00004-0.004	Layers 15-18	
	Mt. Simon	1-5	0.0003-0.1	1.2-6	0.00012-0.04		
Precambrian		not simulated					Precambrian: igneous and metamorphic

*Layer 3 not shown because it represents Mesozoic rock that is absent in southeastern Wisconsin
**The Sinnipee is an aquitard below the Maquoketa and an aquifer to the west. Where the Maquoketa is present, the upper layer of the Sinnipee Kh=0.04 and Kz=0.0005 ft/day. Where the Maquoketa is absent, the Sinnipee Kh=0.3 and Kz=0.01 ft/day. For the lower layer of the Sinnipee, Kh and Kz values depend on proximity to the unit's western subcrop.



Environmental



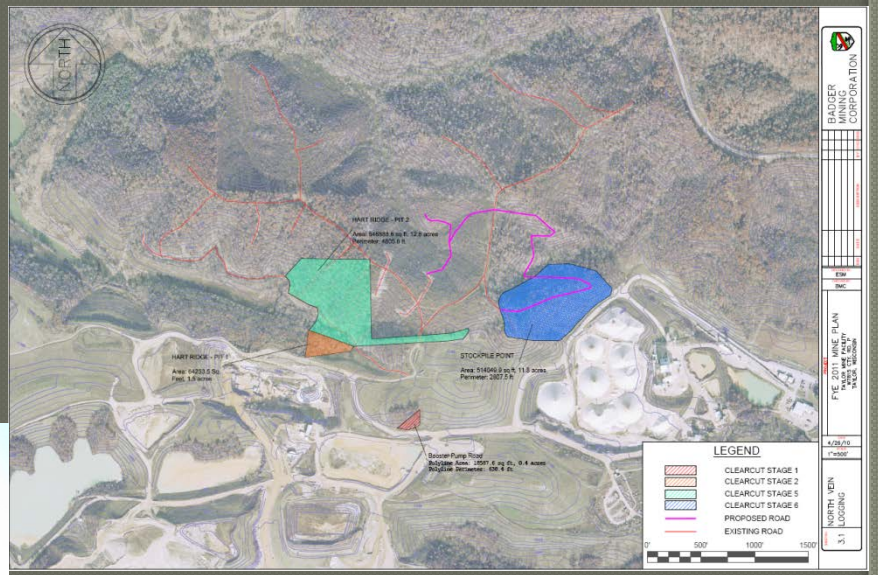
•Identify resources susceptible to impact – historical, archeological, wetlands, wildlife, streams.

•Anticipate potential impacts from mining activities.

•Devise protection plans to prevent impacts - erosion control, storm water management, buffer zones, etc.

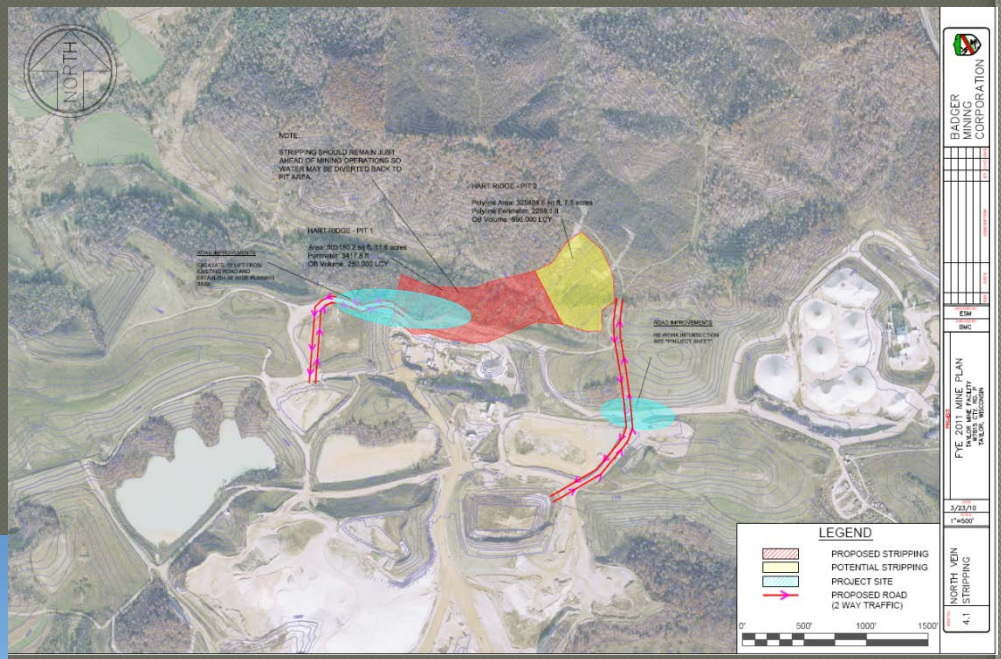
Logging

- Identify areas for timber harvest.
- Plan access routes, staging areas, Trucking activities.



Stripping

- Identify overburden removal areas.
- Plan access roads, optimize haul distances.
- Erosion control & stormwater planning.



Drilling & Blasting

- Shot sequencing.
- Blast design.
- Monitoring & continuous improvement.

NOV-18-2009(WED) 19:35 QUICK SUPPLY MASON CITY (FAX)1 641 422 1252 P.005/006

Instantel

Quick Supply Co, Event Report

Date/Time	Long at 1:01:32 PM November 17, 2009
Trigger Source	Geo: 0.0500 in/s Mic: 110 dB(L)
Range	Geo :5.00 in/s
Record Time	10.0 sec at 1024 sps

Serial Number	4315 V 2.61 MiniMate
Battery Level	6.4 Volts
Calibration	May 20, 2009 by Instantel Inc.
File Name	F315C2GS.6K0

Notes
Location:
Client:
User Name:
Converted: October 13, 2003 9:55:51 PM (V8.12)

Extended Notes

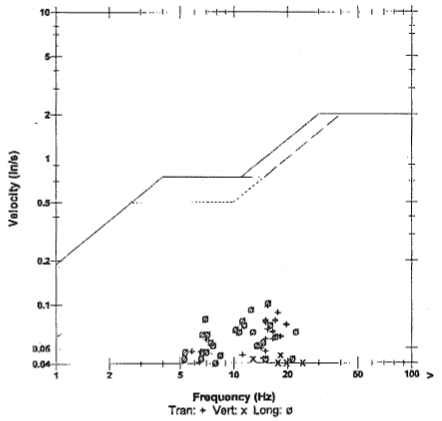
Post Event Notes
Badger Mine, Taylor WI
Kolve Res.
Operator Chuck Holmes

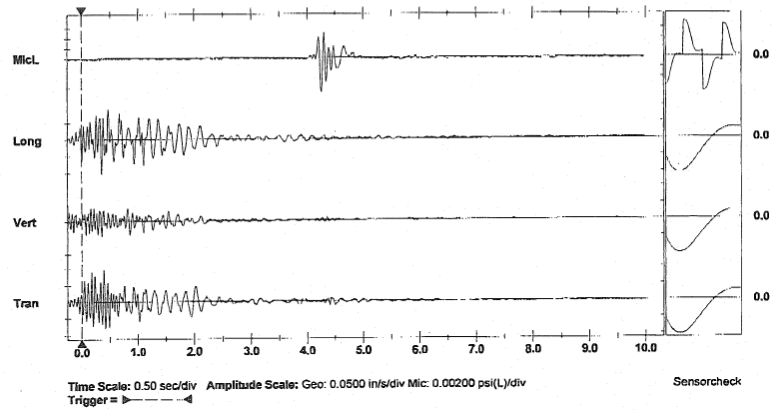
Microphone	Linear Weighting
PSPL	127.6 dB(L) at 4.249 sec
ZC Freq	9.1 Hz
Channel Test	Passed (Freq = 20.0 Hz Amp = 325 mv)

	Tran	Vert	Long	
PPV	0.0975	0.0450	0.103	in/s
PPV	30.8	24.1	31.2	dB
ZC Freq	16	18	16	Hz
Time (Rel. to Trig)	0.388	0.349	0.348	sec
Peak Acceleration	0.0265	0.0199	0.0265	g
Peak Displacement	0.00140	0.00058	0.00159	in
Sensorcheck	Passed	Passed	Passed	
Frequency	7.7	7.6	8.1	Hz
Overswing Ratio	4.2	4.2	4.0	

Peak Vector Sum 0.121 in/s at 0.351 sec

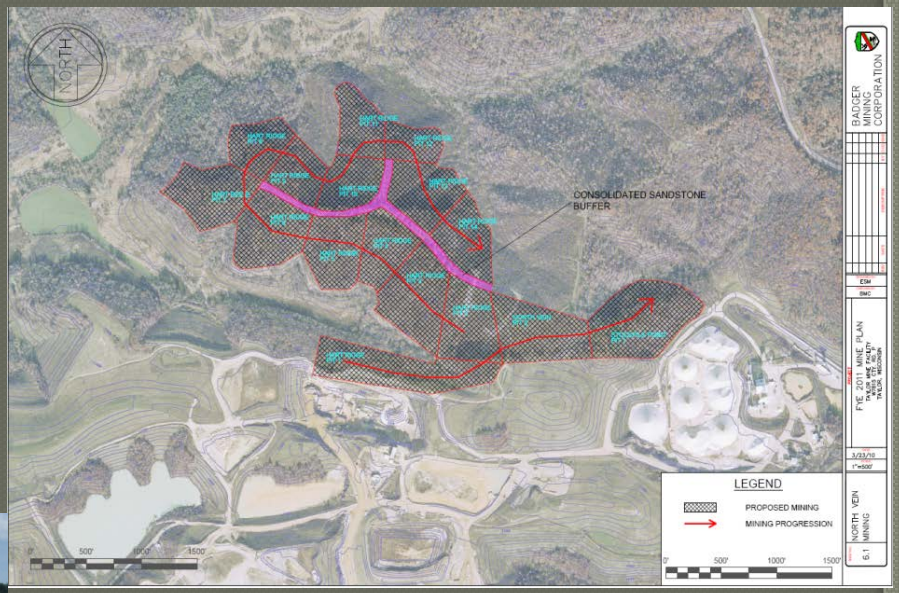
USBM RI8507 And OSMRE





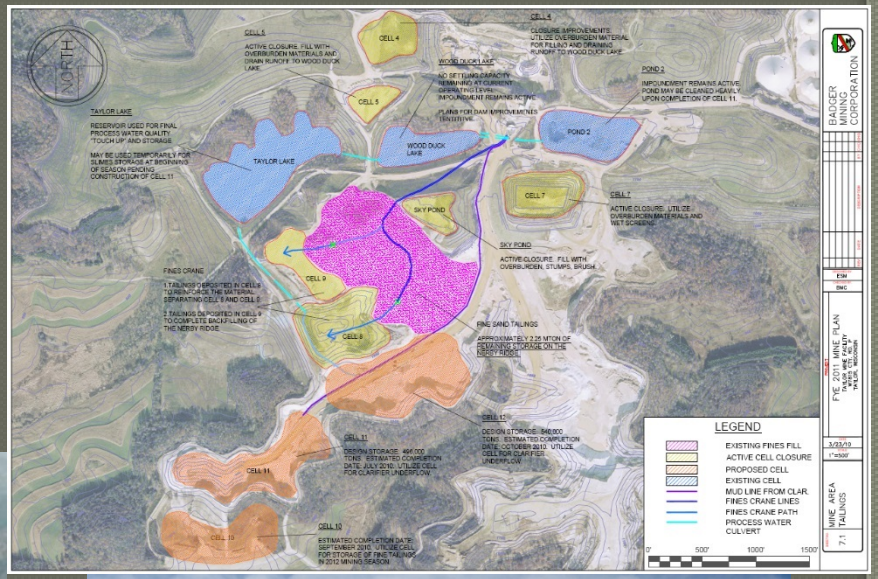
Extraction

- Mining efficiently & cyclically.
- Minimizing haul distances & overall process footprint.
- Managing operational constraints – weather, pit runs, grading & drainage.



Slimes & Tailings

- Material Characteristics
- Planning Storage Areas
- Feed/Return Systems
- Monitoring



Backfilling

- Fill sites for overburden & waste rock placement.
- Stormwater management
- Anticipate highly erosive areas.
- Slope stability

Reclamation (Industrial Landscaping)

1978

1992

2009

Re-establishing terrain to approximate original site qualities or meet other post-mining land use goals.


4/21/1998
1998
2011
N
Nerby Rd
1998
Image U.S. Geological Survey
Google earth
Imagery Date: 4/21/1998 44°21'15.80" N 91°09'12.95" W elev 1084 ft eye alt 8382 ft


9/2/2005
1998
2011
Nerby Rd
2005
Google earth
1998
Imagery Date: 5/31/2005 44°21'15.80" N 91°09'12.95" W elev 1084 ft eye alt 8382 ft


9/13/2006
1998
2011
Nerby Rd
2006
Image USDA Farm Service Agency
Google earth
1998
Imagery Date: 6/3/2006 44°21'15.80" N 91°09'12.95" W elev 1084 ft eye alt 8382 ft


9/8/2008
N
Nerby Rd
2008
Image USDA Farm Service Agency
Google earth
1998
Imagery Date: 6/22/2008 44°21'15.80" N 91°09'12.95" W elev 1084 ft eye alt 8382 ft


11/8/2010
1998
2011
Nerby Rd
2010
Image USDA Farm Service Agency
Google earth
1998
Imagery Date: 6/27/2010 44°21'15.80" N 91°09'12.95" W elev 1084 ft eye alt 8382 ft


7/24/2011
1998
2011
Nerby Rd
2011
1998
Google earth
Imagery Date: 7/24/2011 44°21'15.80" N 91°09'12.95" W elev 1084 ft eye alt 8382 ft


2012


2013

Reclamation Considerations

- Consistency with surrounding topography & land uses
- Efficiency of transporting materials
- Watershed and storm water management
- Erosion control
- Water infiltration rates
- Compaction issues
- Carbon sequestration
- Vegetation layer with the most benefits


O and A Horizon
B Horizon
C Horizon


Not Ground
Ground

Vegetation Establishment

#1 goal is to get the site stabilized as quick as possible

- Mulch and cover crop

#2 goal is to establish a permanent mix of perennial species

- Prairie
- Cool season Mix

Vegetation Establishment - Planting

Planting Methods

- Mechanically Broadcast
- Hand Broadcast
- Drill

- We use all 3 planting methods. The method used is dependant on time of year and slope steepness.

Planting-Mechanical Broadcast

- Specialized broadcast seeder designed for prairie seed (fluff)
- Low volume (7 – 10 lbs/acre)
- 7-8 ft spread
- Planting rate accuracy moderate
- Moderate on steep slopes

- Broadcast seeder designed for cover crop
- High volume (50 – 100 lbs/acre)
- 12-15 ft spread
- Works well on steep slopes
- Seed to soil contact is moderate
- Seed exposed to herbivores

Planting – Hand Broadcast

- Works well on steep areas
- Handheld broadcaster works for cover crop or high volume seed
- Seed to soil contact is moderate
- Seed exposed to herbivores
- Labor intensive but effective

Planting- Hand Broadcast

- Sand and seed mix (low volume mixes)
- Works for steep areas
- Labor intensive but effective
- Light snow cover helps with placement
- Utilizing freeze and thaw for seed to soil contact

Planting - Drill

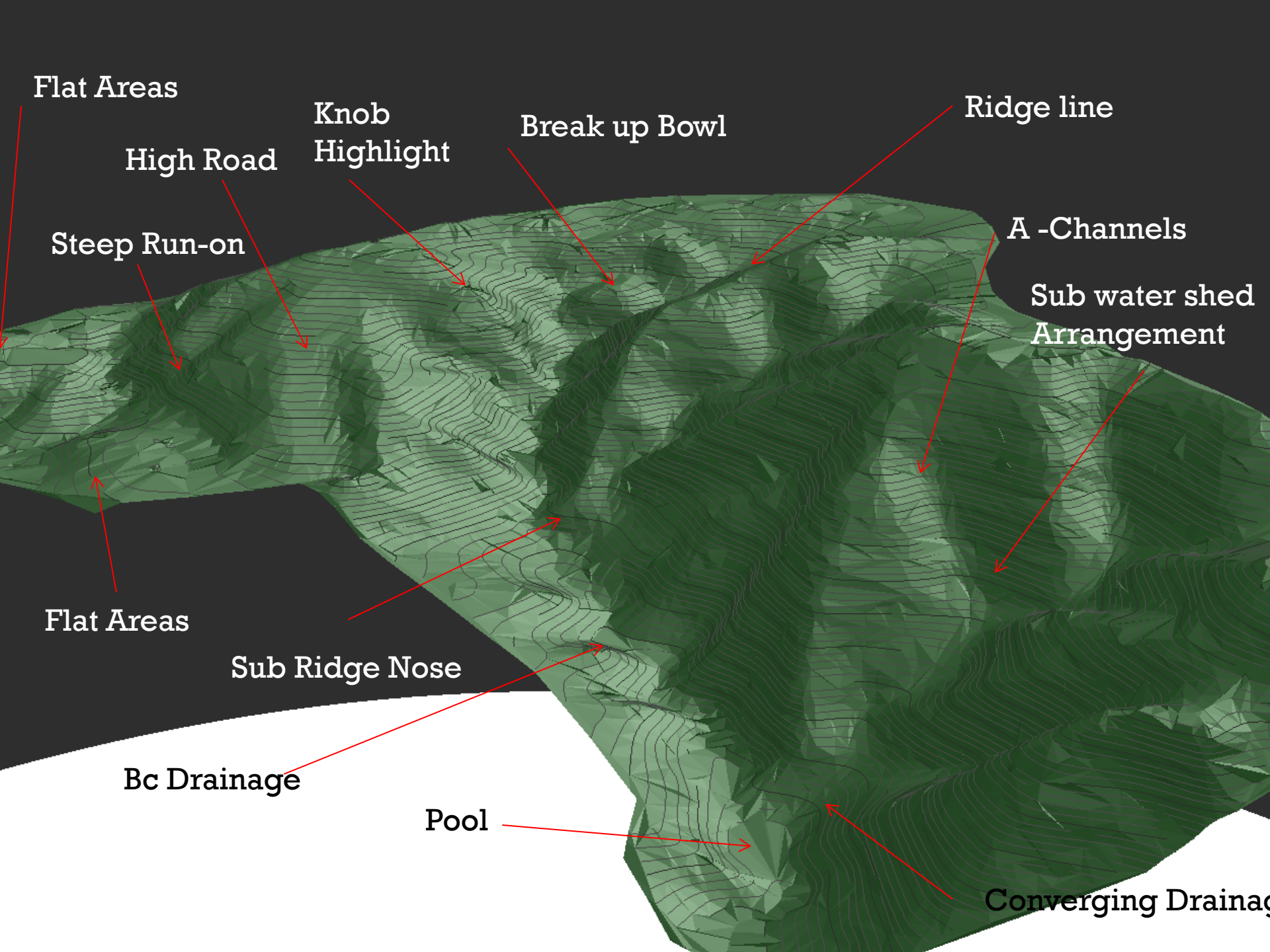
- Can plant all seed mixes in one pass (cover crop and prairie)
- Can be difficult on steep slopes
- Good seed to soil contact
- Good accuracy on seed placement and rate
- 8 ft planting width

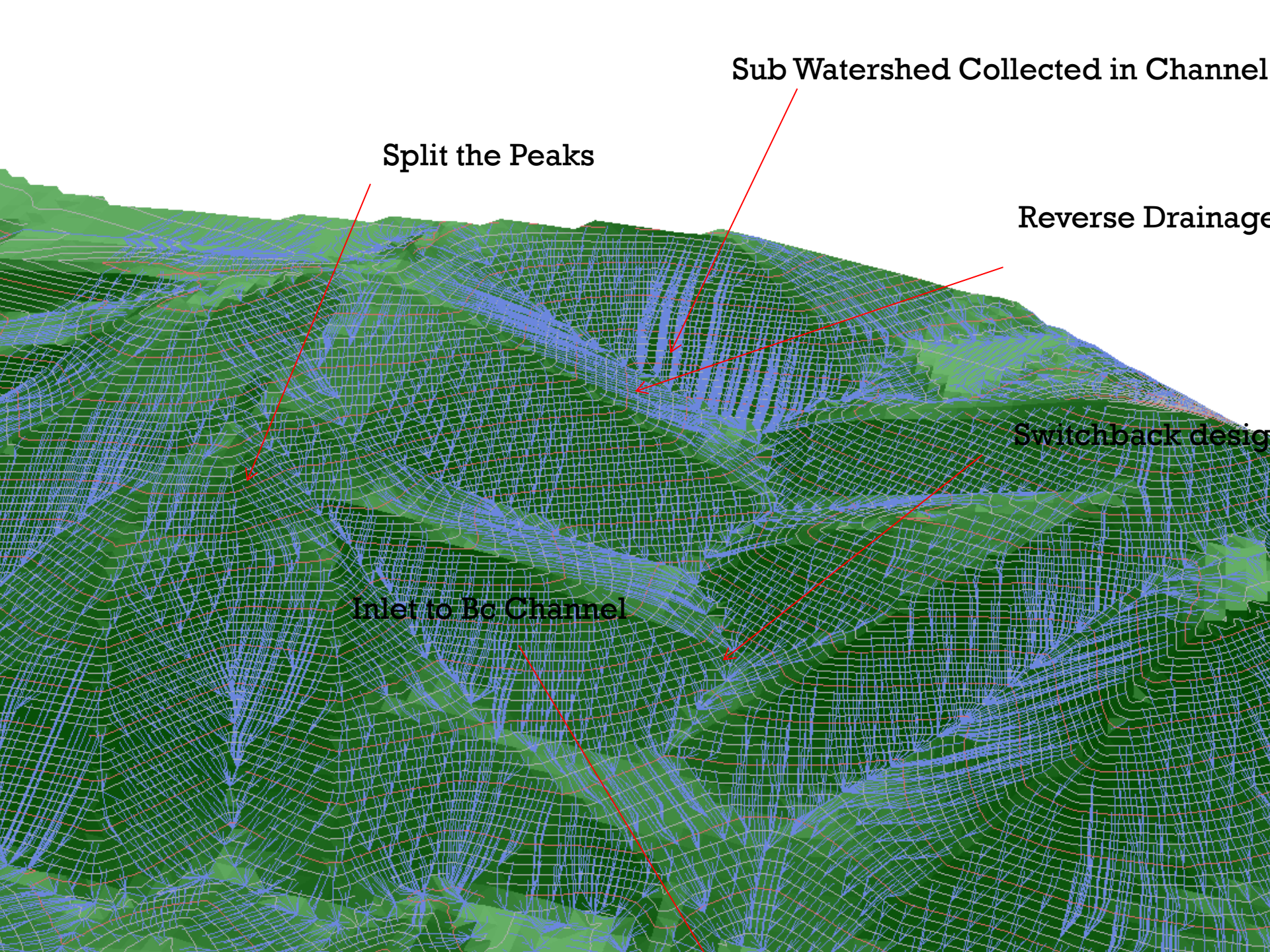
Vegetation Establishment - Mulching

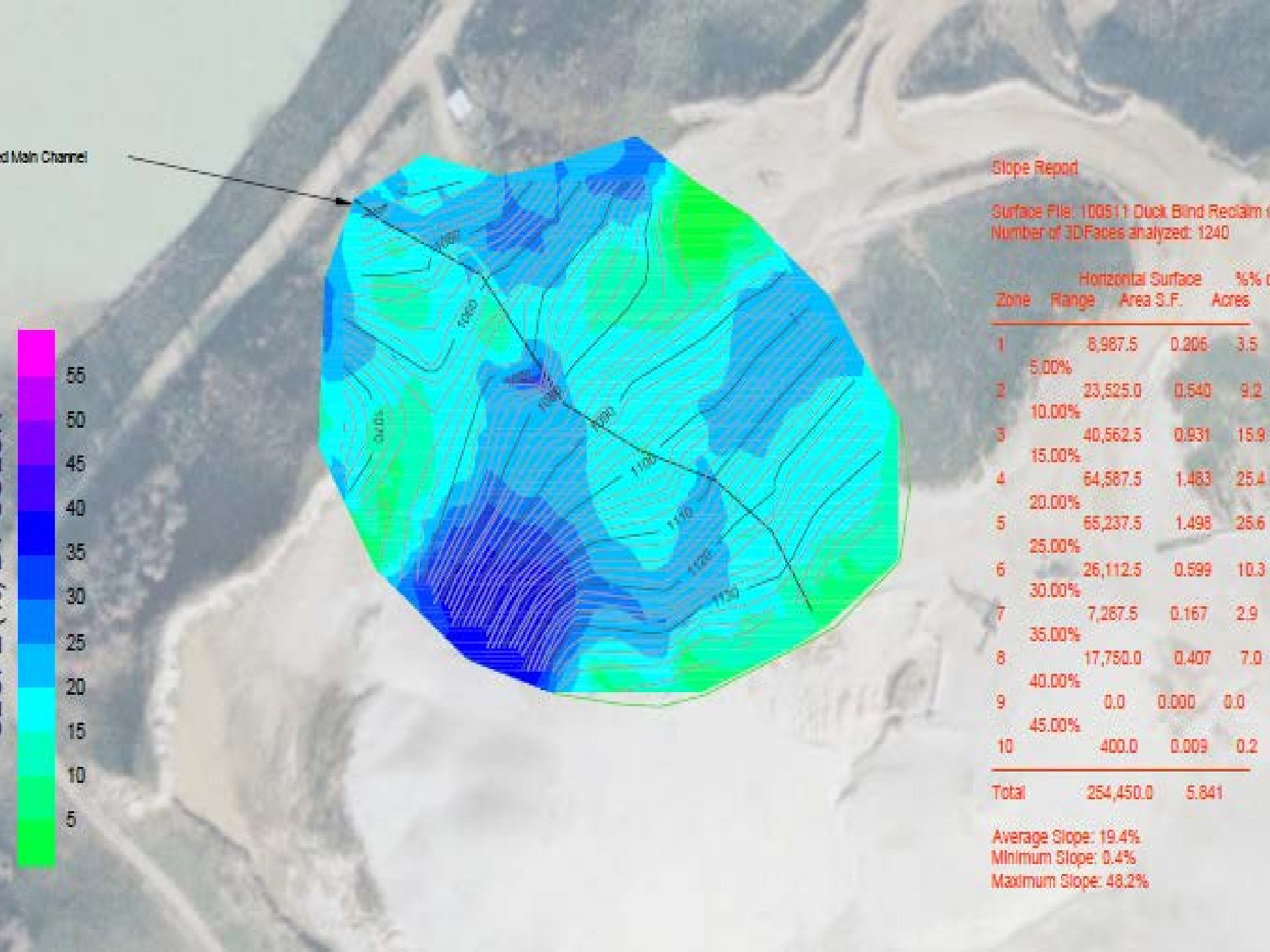
- Use a large scale mulcher or bale chopper
- Applied at 2 to 3 tons/acre (4-5 bales/acre)
- Clean weed free oat straw and hay
- Crimped in by dozer or grain drill
- Can spread up to 35 feet
-

Crimping mulch in by planting over

Pre-construction view of the “Pickle Park” Geomorphic Land Reclamation Project looking South-West


Flat Areas
High Road
Knob
Highlight
Break up Bowl
Ridge line
Steep Run-on
A -Channels
Sub water shed
Arrangement
Flat Areas
Sub Ridge Nose
Bc Drainage
Pool
Converging Drainag


Sub Watershed Collected in Channel
Split the Peaks
Reverse Drainage
Switchback desig
Inlet to Bc Channel



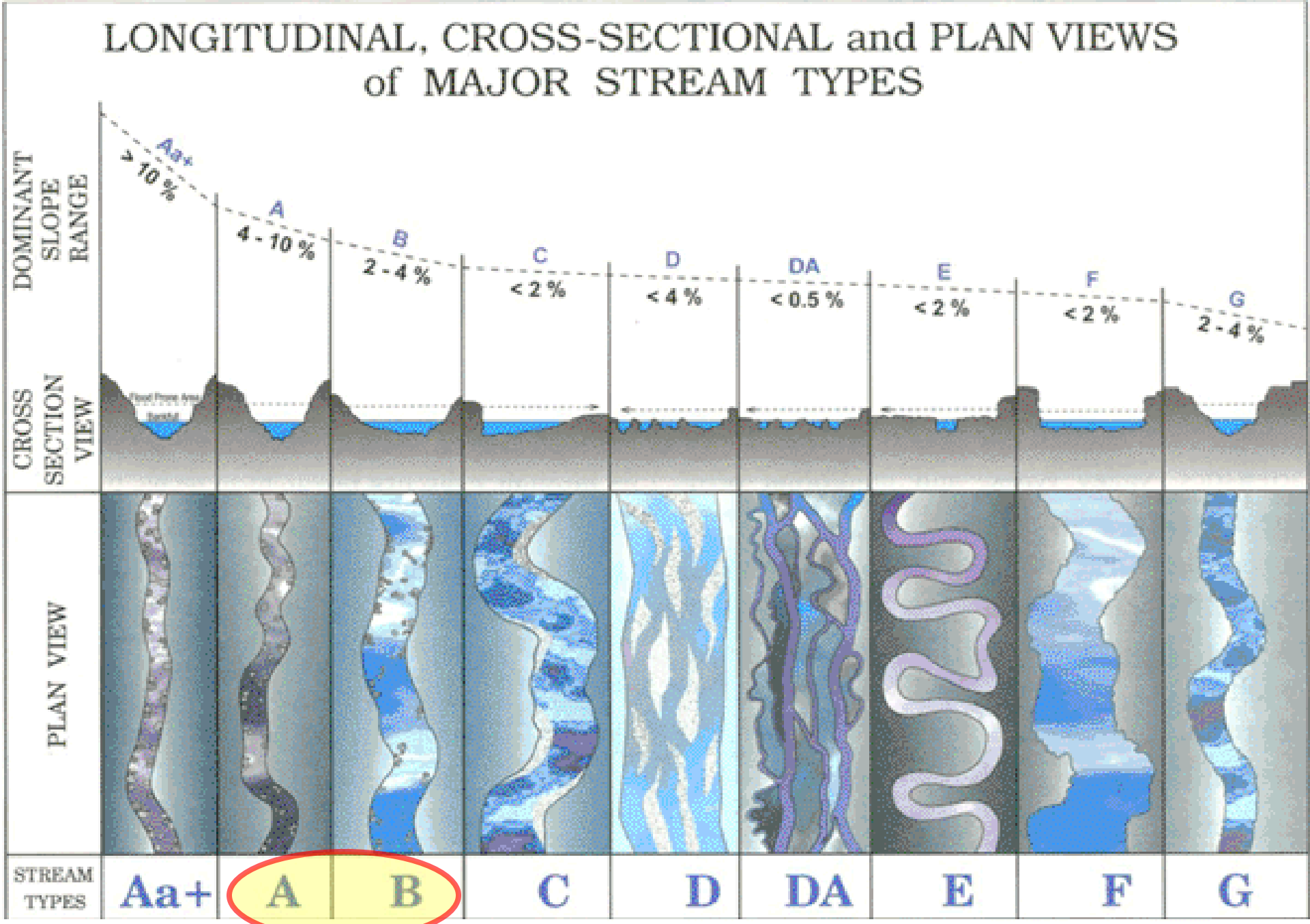
Slope Repod

Surface File: 100511 Duck Blind Reclaim
Number of 3DFaces analyzed: 1240

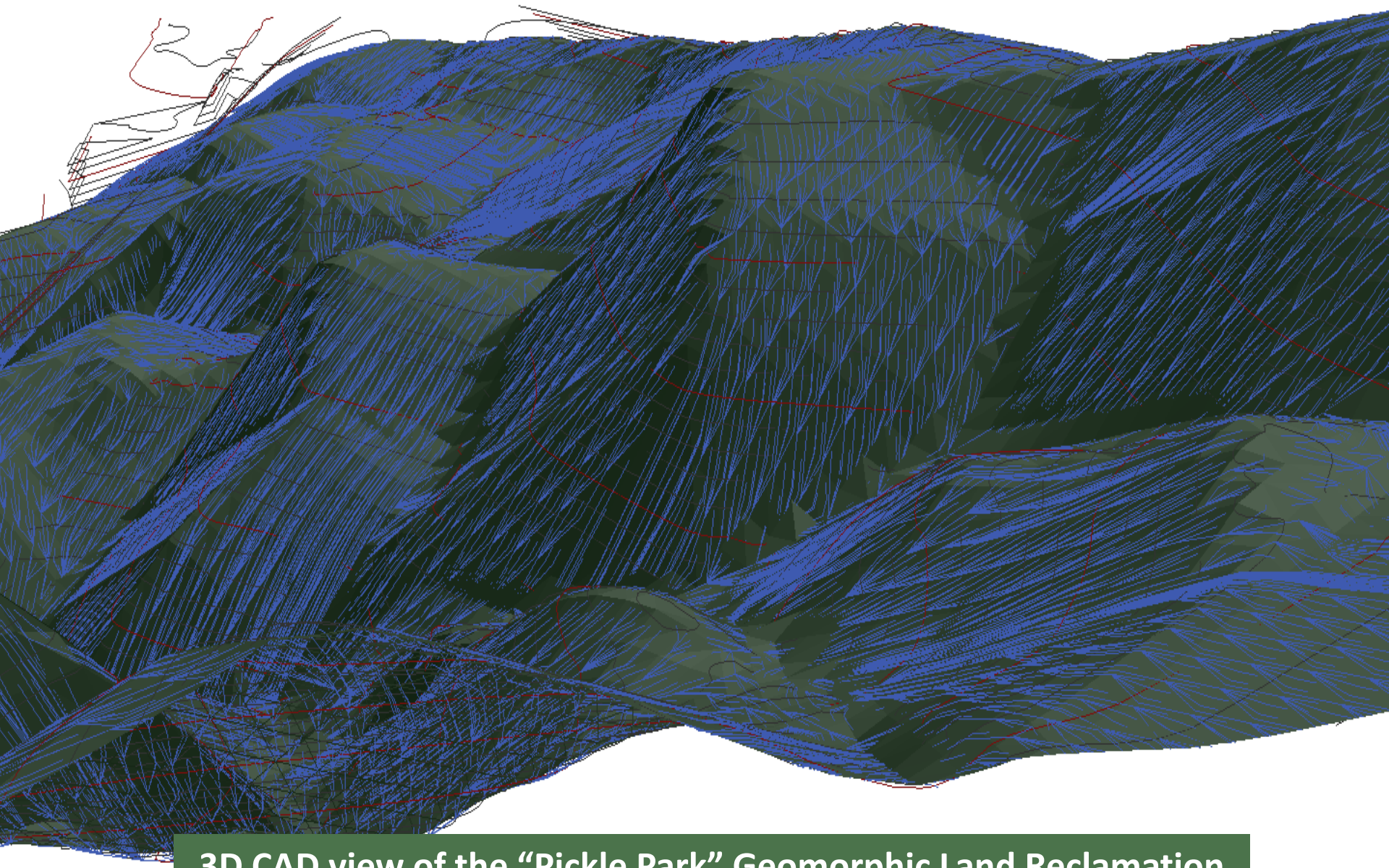
Zone	Range	Horizontal Surface Area S.F.	Acres	%%
1	5.00%	6,987.5	0.206	3.5
2	10.00%	23,525.0	0.540	9.2
3	15.00%	40,562.5	0.931	15.9
4	20.00%	64,587.5	1.483	25.4
5	25.00%	65,237.5	1.498	25.6
6	30.00%	26,112.5	0.599	10.3
7	35.00%	7,267.5	0.167	2.9
8	40.00%	17,750.0	0.407	7.0
9	45.00%	0.0	0.000	0.0
10		400.0	0.009	0.2
Total		254,450.0	5.841	

Average Slope: 19.4%
Minimum Slope: 0.4%
Maximum Slope: 48.2%

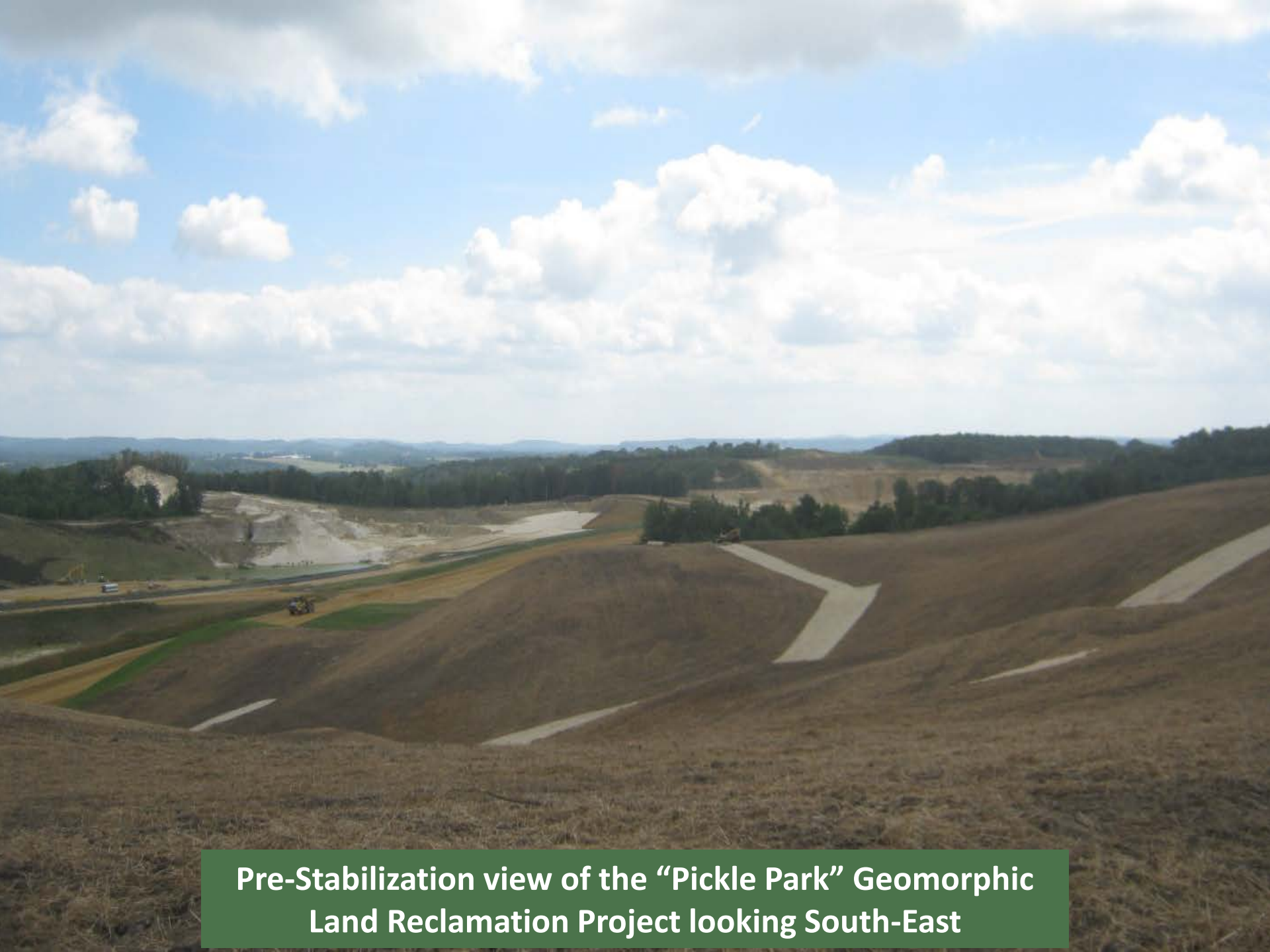
LONGITUDINAL, CROSS-SECTIONAL and PLAN VIEWS of MAJOR STREAM TYPES



Rosgen, David L. "A classification of natural rivers." Catena 22 (1994): 179. www.wildlandhydrology.com

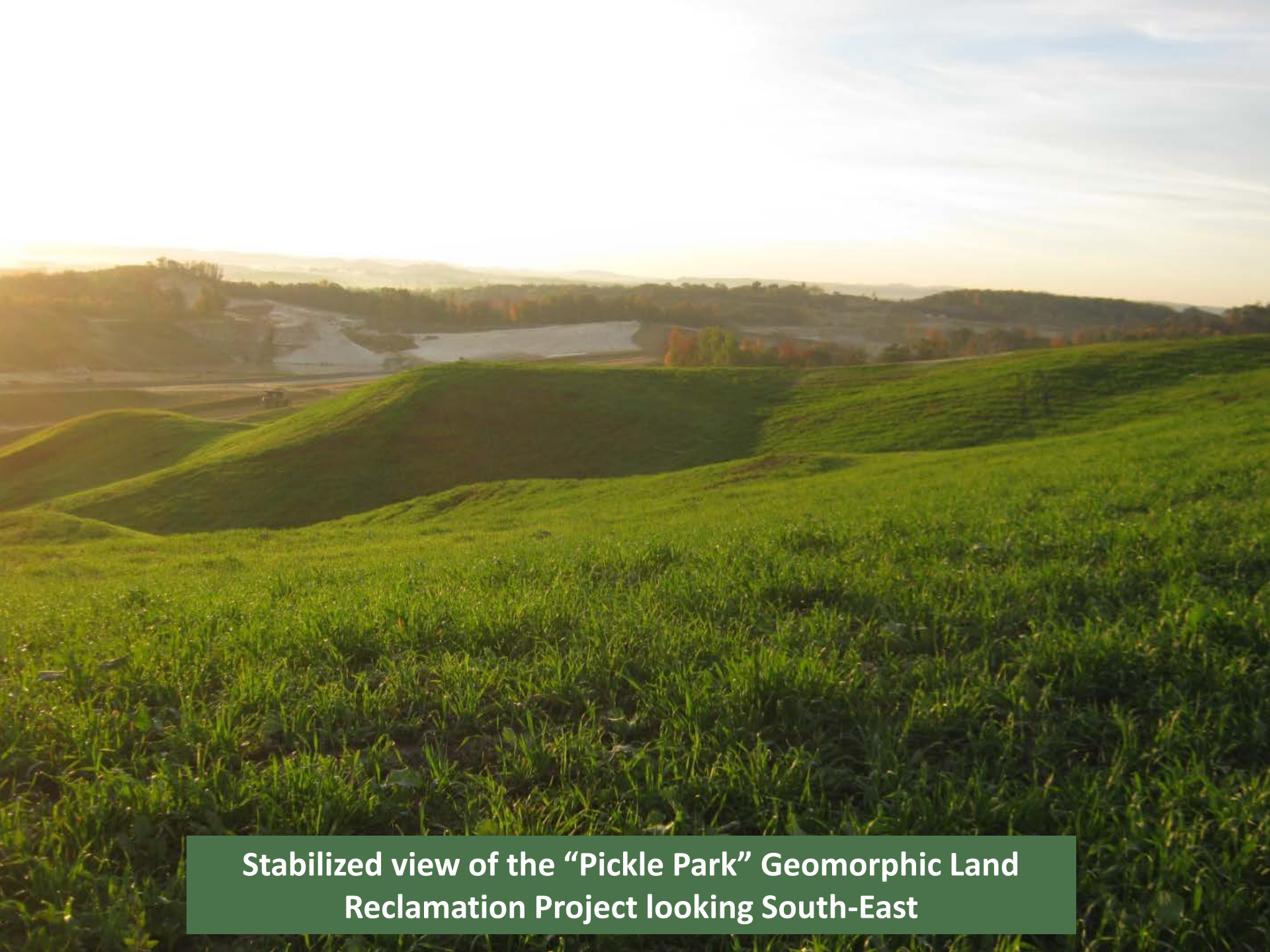


3D CAD view of the “Pickle Park” Geomorphic Land Reclamation Project looking South-East



Pre-Stabilization view of the “Pickle Park” Geomorphic Land Reclamation Project looking South-East

Post Construction View of the “Pickle Park” Geomorphic Land Reclamation Project Looking South-West



Stabilized view of the “Pickle Park” Geomorphic Land Reclamation Project looking South-East


1/31/12 4:00 PM
Cuddleback

Vegetation Establishment – Cover Crop

Cover or nurse crop

- Initial plant that helps stabilize the soil
- We use a certified oat seed or winter wheat
- Certified seed is much cleaner (weed free)
- Grows quickly (1 – 2 weeks)
- 1 year deal

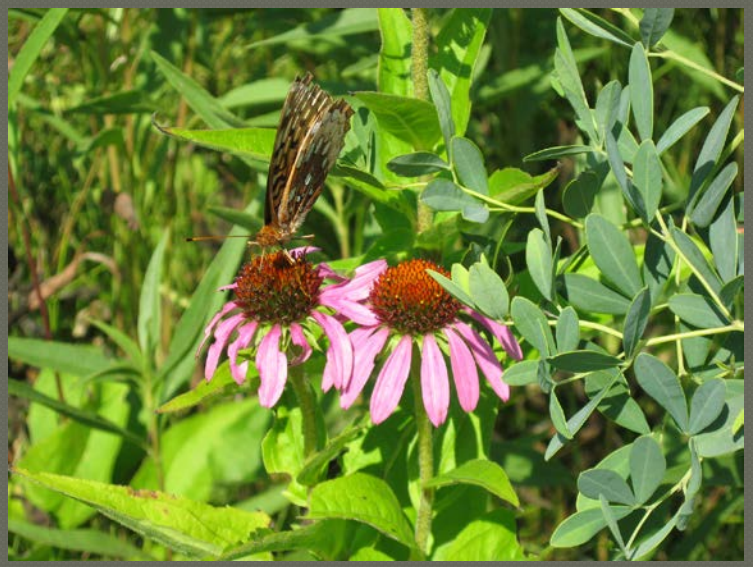
Vegetation Establishment - Prairie

Prairie

- We plant prairie with a cover crop
- Mix is made up of 30 species; 6 grasses and 24 forbs
- Plant at 8 – 10 lbs/acre
- Seed cost is about $300.00/acre
- Permanent cover but it takes time to mature

Conclusion

- Reclamation is one part of the mine life cycle.
- Utilizing geofluvial principles in combination of establishing a native plant community with land reclamation will help mimic a natural landscape that provides more benefits for soil, water quality, wildlife, and overall aesthetics.



QUESTIONS / COMMENTS

THANK YOU & HAVE A GREAT DAY!