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CREATIVE APPROACHES TO OLD RECLAMATION CHALLENGES

Bentonite strip mining requires the disturbance of large acreages of native land, …

…all of which requires bonding. This bond is not released until revegetation performance is equal to, or greater than, native conditions.

The Big Horn Basin can be an unforgiving landscape (sodic soils with an average precipitation of 5”, and all with lots of invasive weeds).

What we've learned:

#1: A minimum of 2' of suitable cover over unsuitable overburden is essential

#2: Experiment to identify the best vegetation species for the conditions

#3: Monitor, monitor, monitor… Use your data to develop new directions.

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PART 1

INVASIVE WEED MANAGEMENT

Invasive weeds are transforming the landscape

- Note cheatgrass seed source on BLM lands upwind of our reclamation projects

Weeds can produce incredible volumes of seed

It’s not just cheatgrass:

- ❑ Annual Wheatgrass, Koshia, Halogeton, Russian Thistle, etc, etc, etc.

Ground spraying cheatgrass with Plateau (pre-emergent treatment)

Aerial spraying cheatgrass with Plateau

Chemical treatment does work, but it's costly and is not a permanent solution

- ❑ Note line of T-posts (treatment in front, not behind, the posts)

Alternative solutions: Is “live” topsoiling all it’s cracked-up to be??

- ❑ Note strip of live topsoil within an area topsoiled from a stockpile)

The competitive advantage: Note absence of cheatgrass in this sage plot

Assisted succession with aggressive perennials:

- ❑ Crested wheatgrass vs. cheatgrass

❑ Greasewood vs. cheatgrass (maybe GW's not the demon it was once thought to be?)

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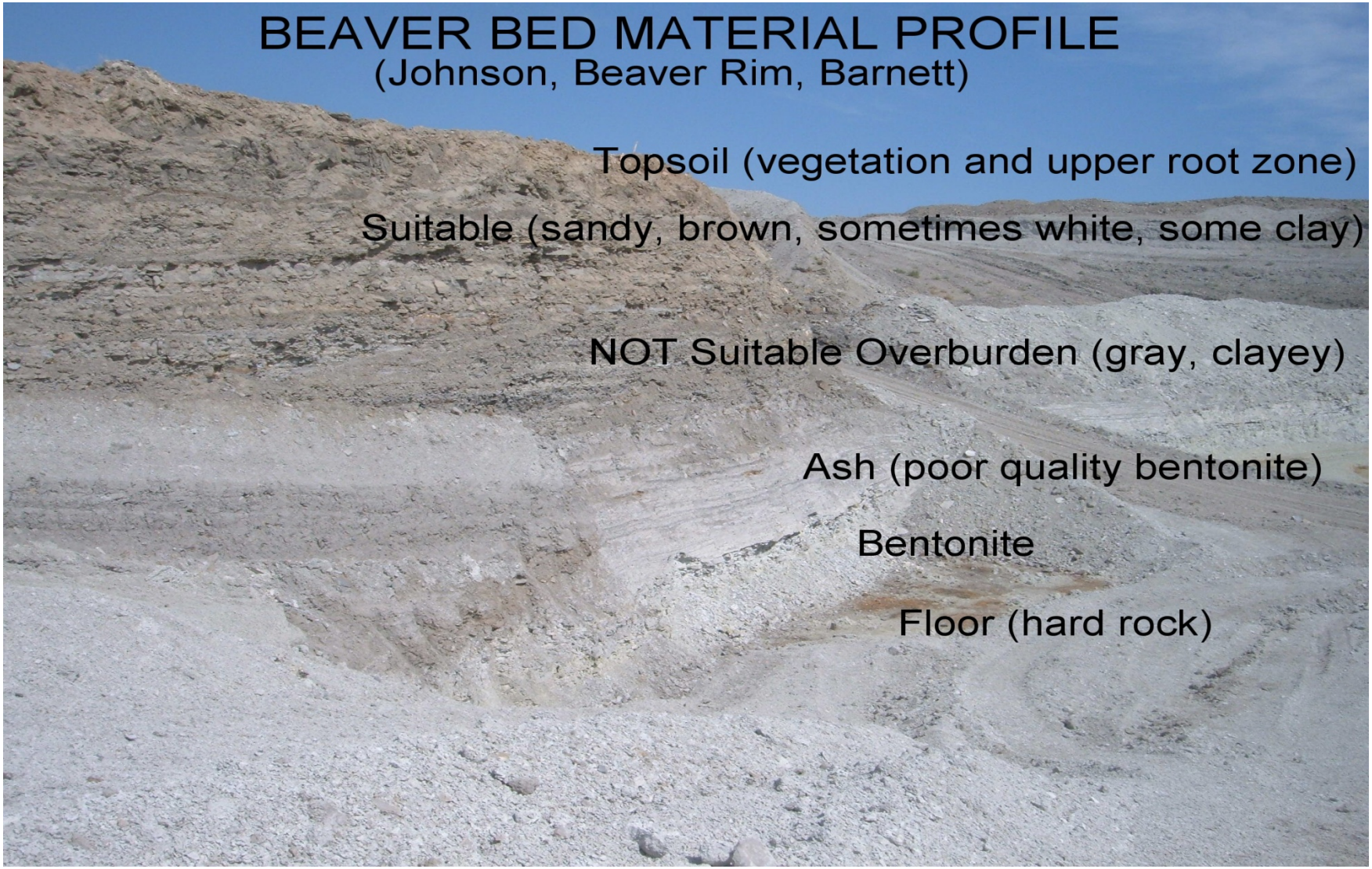
PART 2

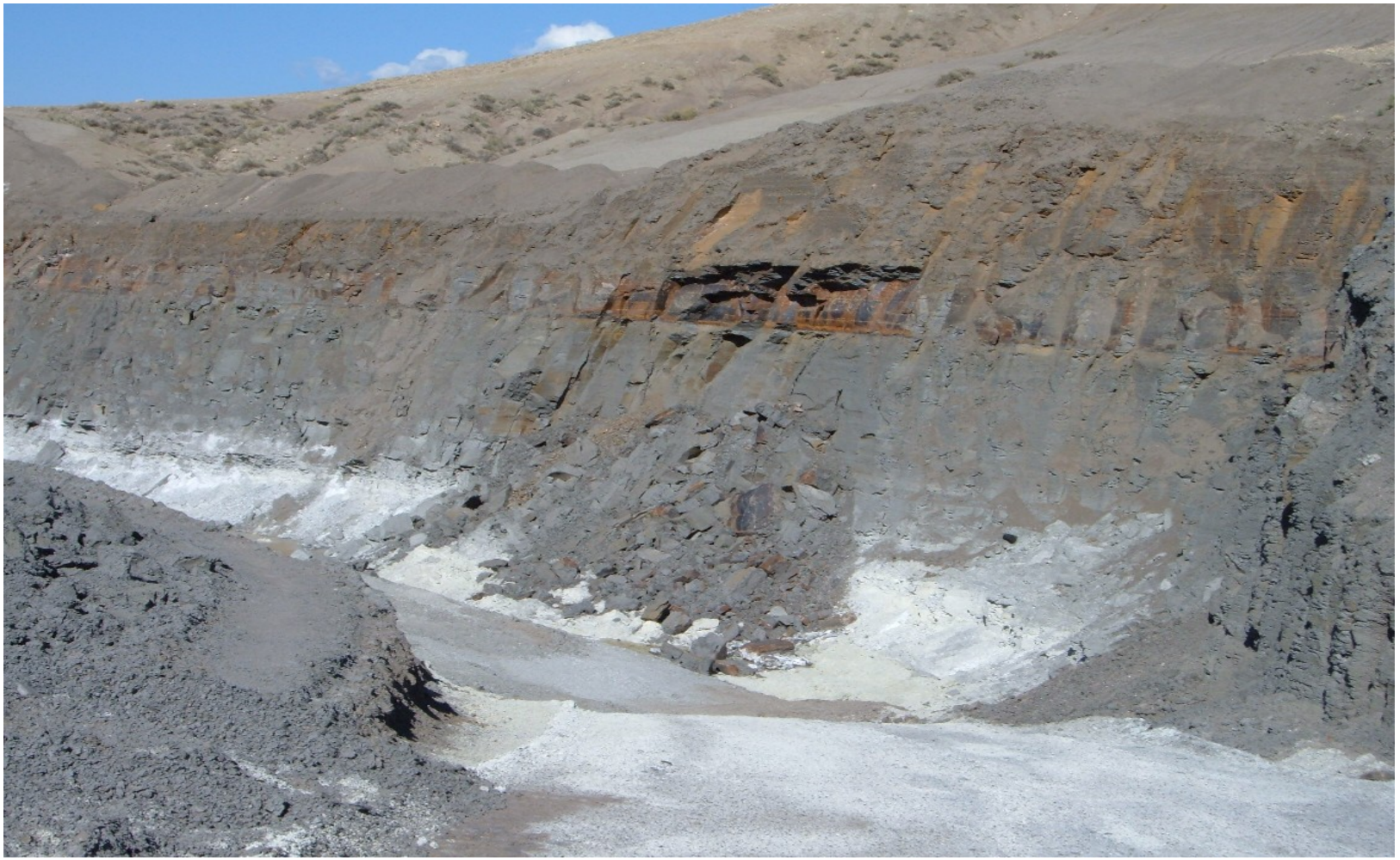
OVERBURDEN EVALUATION AND MANAGEMENT

Some sites offer great reclamation materials (chiefly sand/sandstone)



And some don’t:

- ❑ Flat Bed material profile (poor reclamation materials, chiefly shale)



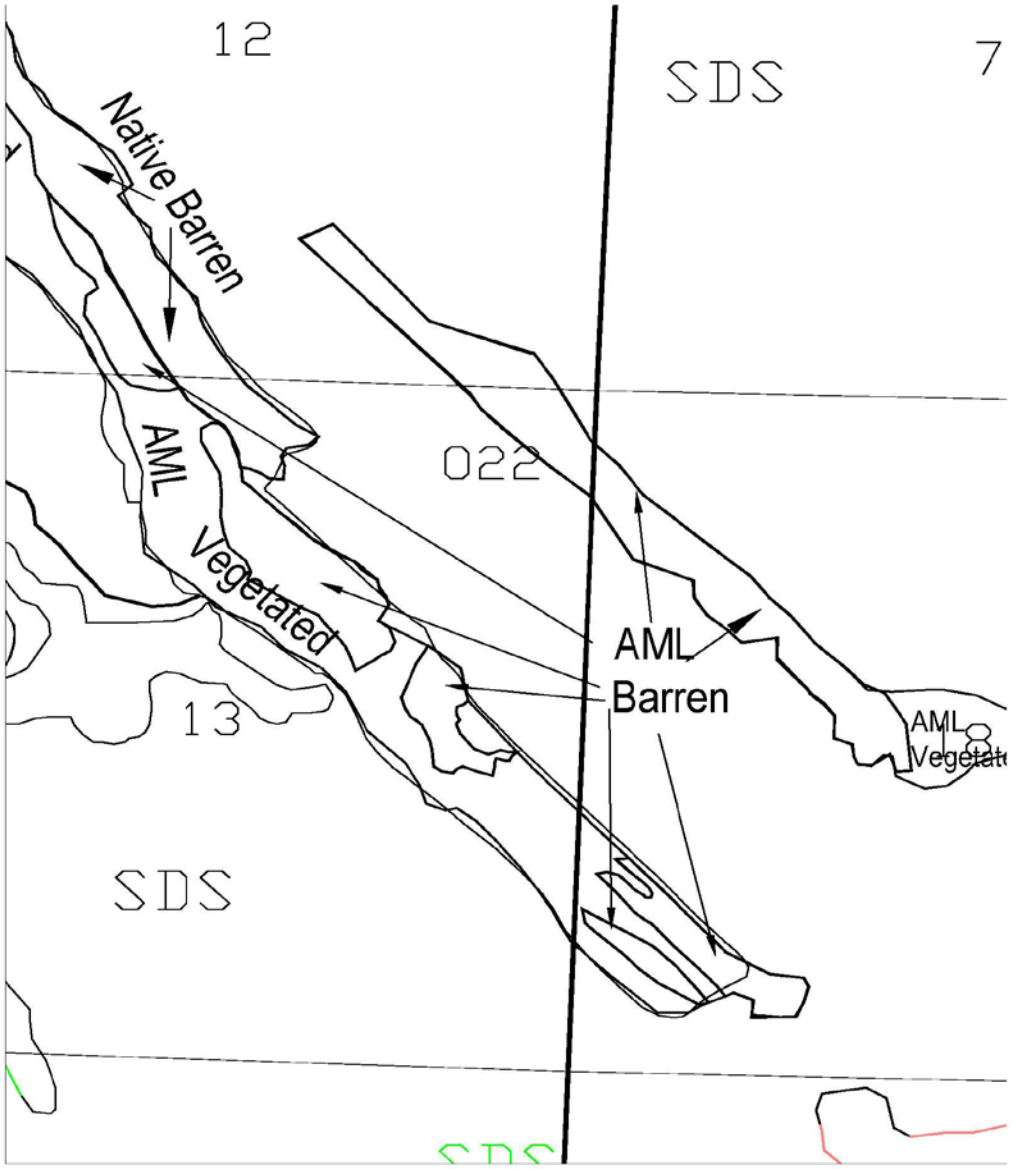
The ideal situation: Again, a 2’ cap, to include both suitable sub-material and topsoil, over unsuitable overburden is essential

When the "ideal" is not possible: (Example Mining Flat Bed at Bear Creek)

- Note AML (Abandoned Mine Lands) lands in the foreground, and mixed vegetated and barren lands in the background

EXAMPLE: BEAR CREEK MINE

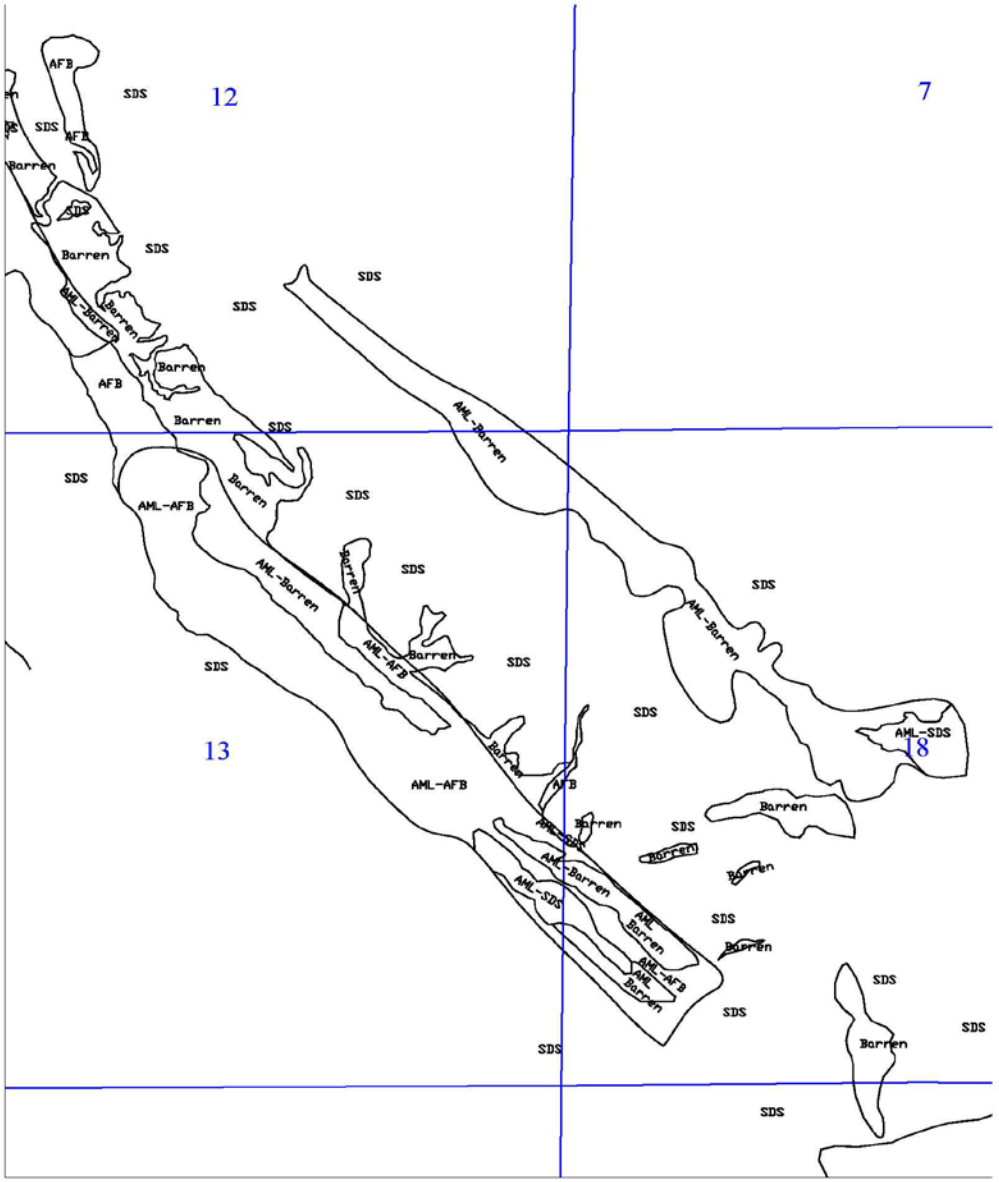
In this example, <u>past vegetation mapping</u> did not necessarily reflect current restoration objectives



This area was re-mapped to:

- Better reflect current objectives,
- Better meet conditions required for revegetation success,
- Create procedures that would be more easily understood by equipment operators

(re-mapping 2012)



Soil samples were collected from each vegetation map unit, with the chemistry analyzed for soil suitability

Bear Creek/Lone Tree Soils Chemistry

NOTES: Underline = Unsuitable Condition **Bold** = Positive Soil Indicator

Sample ID	Date	Vegetation Type/Other	Depth (in.)	pH	Saturation	Electrical Conductivity dS/m	Calcium meq/L	Magnesium meq/L	Sodium meq/L	SAR	Sand %	Silt %	Clay %	Texture	Total Sulfur %	T.S. AB t/1000t	Neutral Potential t/1000t	T.S. ABP t/1000t	Pyr+Org Sulfur %	Pyr+Org AB %	Pyr+Org ABP t/1000t
Range of Suitability				**5 to 9**	**25 to 80**	**<12**			**<15**	**<15**											**<-5.0**
TS.1	3/16/12	**Salt Desert Shrub**	0-12	8.4	58.4	6.51	17.6	3.63	103	31.7	**43.0**	26.0	31.0	Clay Loam	1.08	33.7	9.41	-24.3	0.51	15.8	-6.37
TS.2	3/29/12		0-6	8.2	64.1	6.93	21.2	3.39	87.2	24.9	22.0	26.0	52.0	Clay	0.93	28.9	30.2	1.28			
SU.1	3/16/12	**Sub-material beneath SDS alluvial soils**	12-26	8.0	55.7	6.79	17.5	8.23	92.3	25.7	**57.0**	21.0	22.0	Sandy Clay Loam	0.28	8.89	14.5	5.65			
SU.2	3/29/12		12-24	8.0	48.0	3.29	25.1	8.65	19.4	4.72	**54.0**	14.0	32.0	Sandy Clay Loam	0.12	3.81	8.17	4.36			
SU.5	7/10/08	**gravelly sub-material beneath SDS**	comp	7.6	42.9	6.72	17.6	6.56	61.2	17.6	**47.5**	27.5	25.0	**Gravelly Loam**	0.17	5.40	104	98.7			
TS.3	3/16/12	**Annual Forbs Barren**	0-12	6.7	75.6	11.0	18.3	59.4	185	29.7	20.0	38.0	42.0	Clay	0.60	18.8	6.37	-12.4	0.03	1.08	5.29
TS.4	3/29/12		0-6	5.0	69.9	13.5	16.0	115	185	22.9	3.0	45.0	52.0	Silty Clay	0.58	18.1	7.87	-10.3	0.09	2.84	5.03
SU.3	3/17/12	**Sub-material beneath AFB soils**	12-18	5.1	59.8	21.0	21.5	231	363	32.3	28.0	44.0	28.0	Clay Loam	0.85	26.7	5.88	-20.8	0.04	1.31	4.57
SU.4	3/29/12		12-24	4.3	62.3	16.8	18.3	94.2	251	33.4	4.0	53.0	43.0	Silty Clay	0.43	13.4	12.1	-1.26			
TS.5	3/16/12	**Barren**	0-12	4.6	58.7	15.5	17.3	99.7	222	29.0	19.0	47.0	34.0	Silty Clay Loam	0.50	15.7	0.73	-15.0	0.12	3.87	-3.14
TS.6	3/29/12		0-6	4.6	60.9	15.1	15.5	188	265	26.3	7.0	41.0	52.0	Silty Clay	0.71	22.1	10.6	-11.6	0.07	2.33	8.22

Based on the chemistry, salvage and replacement **instructions were developed in "operator-speak"**

Soil Salvage Priority Order (Refer to Appendix D8 Vegetation: Addendum A Photo Record for an illustration of the vegetation/soils types listed in this section, and Maps D8.1 and D8.2 for location reference)	
1)	**SDS and BSBB topsoil**
	Salvage the top 6".
	Spread as topsoil to a depth of 6" on suitable capping material (if no suitable capping material is available, then spread on clean overburden).
2)	**SDS and BSBB alluvial sub-material** (gravel, sand, and silt)
	Salvage all available alluvial materials from beneath SDS topsoil.
	Spread as suitable capping material (minimum of 1' depth).
	Where there are insufficient volumes of SDS topsoil, spread this material as topsoil (minimum 6" depth on clean overburden).
3)	**AML vegetated topsoil** (SDS, AFB, or Greasewood/Barren)
	Salvage 4" of only those surface materials that are vegetated.
	Spread as topsoil to a depth of 6" on suitable capping material (if no suitable capping material is available, then spread on clean overburden).
4)	**Native AFB topsoil**
	Use as top dressing to blend reclaimed lands with the adjacent native.
	Spread only on lands intended to be postmine barren.
5)	**Native Barren top material**
	Use as top dressing to blend reclaimed lands with the adjacent native.
	Spread only on lands intended to be postmine barren.
6)	**Bedrock** (non-soils)/Clean Overburden
	These are any non-soil materials that do not contain bentonitic materials.
	Use only as cover material to bury bentonitic spoil.
	Not to be used as surface dressing.
7)	**Bentonitic spoil** (low grade bentonite or bentonitic ash/waste)
	This material will be buried at the bottom of the backfill profile.

What the BEAR CREEK MINE re-mapping showed us:

- ❑ The surface and subsurface materials were a mosaic of suitable and unsuitable reclamation materials

❑ A pattern became evident where some topsoils and subsoils, **based on vegetation type**, were found to be chemically suitable for topsoil replacement

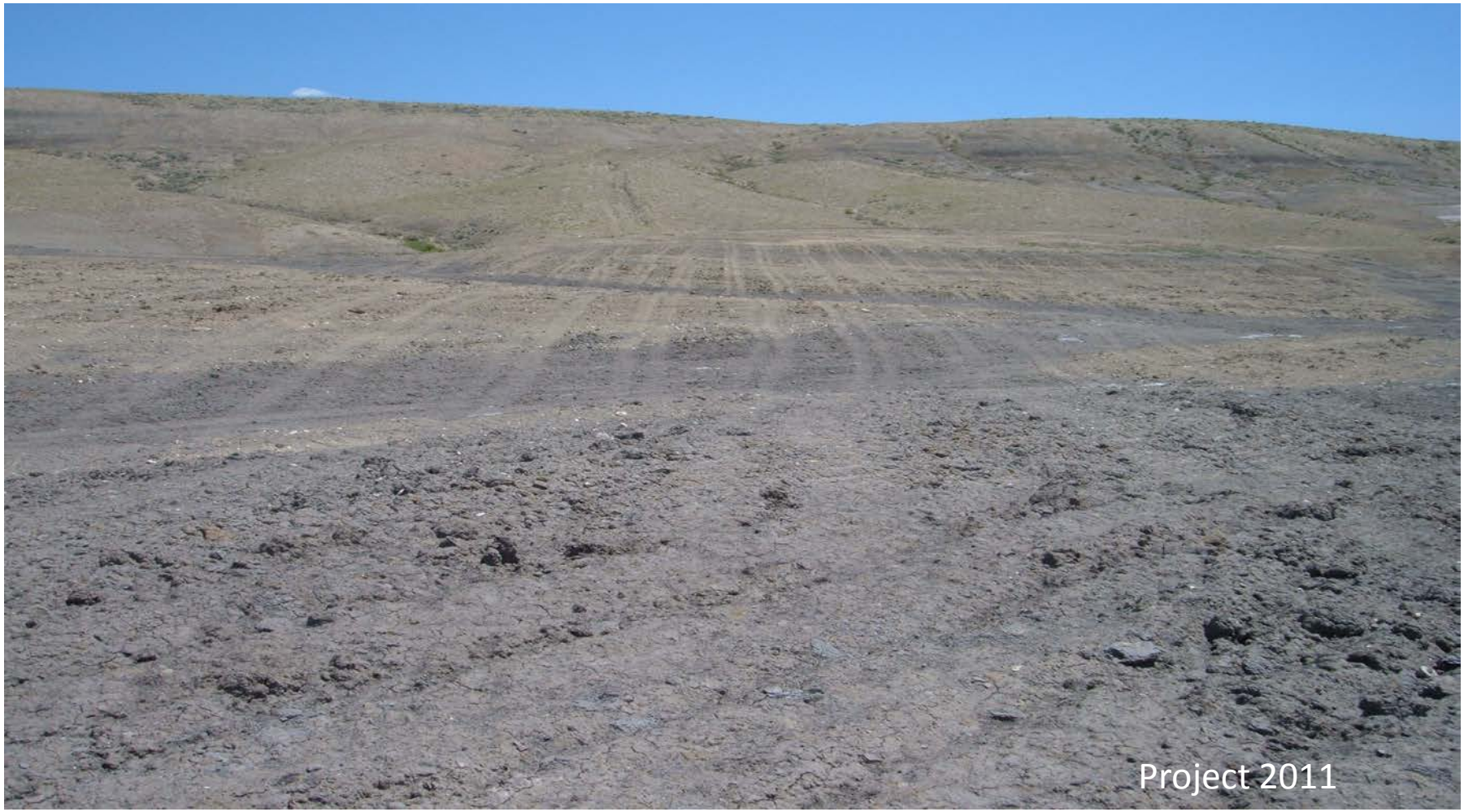
- …and others were found to NOT be suitable for topsoil or subsoil replacement.

❑ …and pockets of sub-surface alluvial material were located and found to be more suitable than many of the topsoils.

<u>Example</u>: Successful reclamation using suitable sub-material as soil

This is a 5-year old reclamation project at Bear Creek that was covered and topsoiled with sub-surface alluvial sands and gravels

When there's not enough soil: Take what you have, and "splash" it on clean backfill to create a mosaic of growing medium – make sure that, where it is spread, the soil is at least 6" in depth and use your best "bomb-proof" seed mix)



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PART 3

MITIGATING FAILED SITES

The Problem: The lands targeted for M-I's 2012 interventions were mined and reclaimed at a time when the variables of cover depth and suitability were not fully understood.

Gary Good and North Hinckley Mines
Pre-Mitigation Photo 2012

<u>PART 1:</u> 2012 Mitigation of failed reclamation sites (total 143.1 acres)

Identified portions of the North Hinckley, Gary Good, East Tanner, and Coyote mines were re-mined, in 2012, for the purpose of:

- recovering remnant bentonite to offset mitigation costs;
- recovering additional suitable reclamation cover materials.

In addition, other topsoil resources were identified outside of the area, and were long-hauled to these mitigation projects.

Re-Mining at East Tanner
Photo 2012

A mine pit was opened in an adjacent area for the purpose of providing additional suitable materials to the mitigation projects.

Seed mixes were customized for successful vegetation establishment specific to the soils types.

Drill Seeding Photo Example
2008 Smith Pilot Project

And, if necessary, we will consider using soil amendments…
(no, we don't use antelope to fertilize)

Project 2010

Where soil quality was in question, surface mulch was applied to the soil surface.

Results from an earlier pilot project, on the Gary Good Mine, where successful techniques were transferred to M-I's 2012 mitigation projects.

Results from another pilot project, on the adjacent Smith Mine, where successful techniques were transferred to M-I's 2012 mitigation projects.

Wahoo!!

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PART 4

PARTNERING WITH COUNTY, STATE AND FEDERAL AGENCIES

Partnering not only can result in additional resources, ….

…but more importantly it can also:

- ❑ Encourage your company's "buy-in" on a project
- ❑ Lead to more-flexible working relationships with regulatory entities

Examples:

Cooperative cheatgrass treatments with the BLM

- Cost share on chemical (2004) – 44 acres affected
- Treatment of upwind seed source (2012) – 411 acres affected

Project 2004

Sage brush research projects – a cooperative effort with Michigan Tech University with assistance from the WWNRT (Wyoming Wildlife and Natural Resource Trust Fund)

Sage brush revegetation projects – A cooperative effort supported, in part, by the Big Horn Basin Sage Grouse Lower Working Group

Livestock grazing control fencing supported with resources from the Bureau of Land Management

Habitat restoration project supported by the Wyoming Game and Fish Department

Tamarisk and Russian Olive removal supported by the Shell Valley CRM (Coordinated Resource Management)

Chemical cost share with Big Horn Basin Weed & Pest

Photo 2012

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PART 5

DEVELOPMENT OF A MINE-WIDE MASTER PERMIT

(revisions 2010, 2012)


MI SWACO
M-I, L.L.C.
MASTER PERMIT
PERMIT 278C
Revised:
May, 2010

Rationale behind a Master Mine Permit:

- ❑ Consolidates all individual permits into one mine and reclamation plan
- ❑ Removes the guess work from procedures and processes
- ❑ Makes procedures more easily understood by equipment operators

- **Serves as a reference manual for non-proprietary aspects of the company**

MASTER PERMIT 278 C
TABLE OF CONTENTS

❑ Expedites permitting with the WYDEQ and BLM. Used as a reference resource, it eliminates the size of permit applications by reducing repetitive language and discourages the “rehashing” of previously-approved concepts

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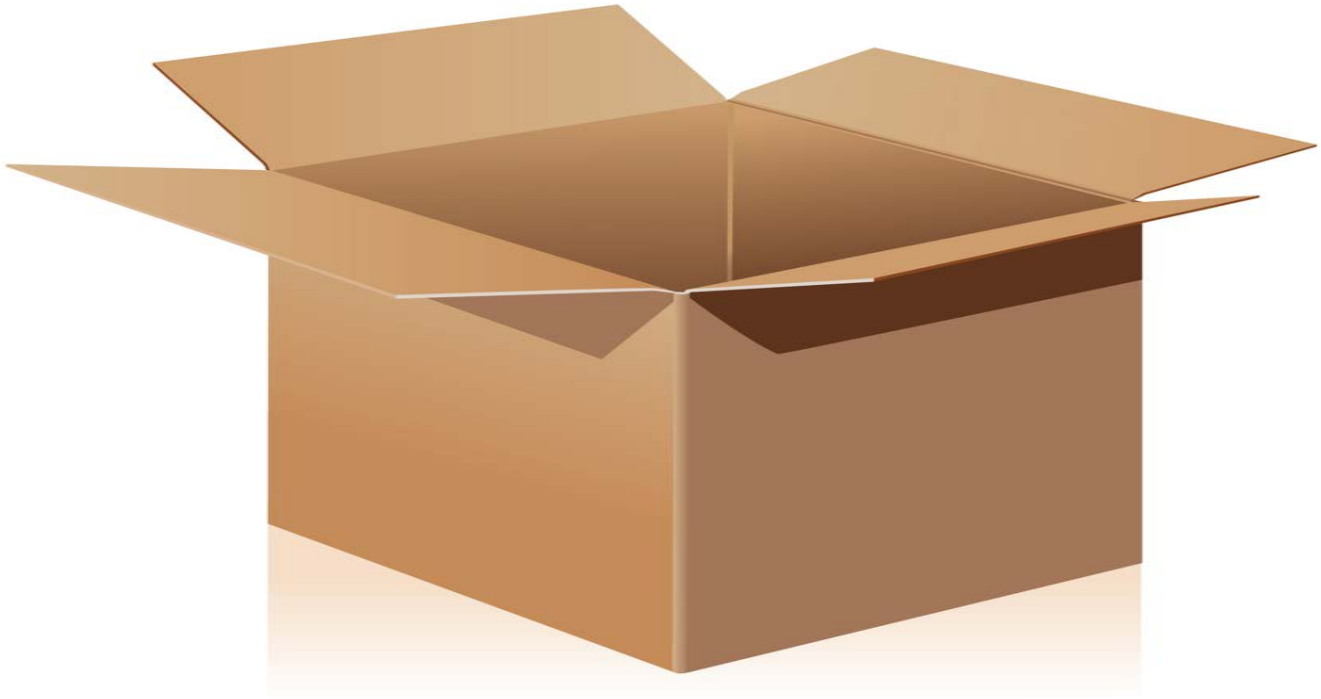
CONCLUSION

Success measured by our #1 critics

GOOD reclamation is GOOD business for everyone

What’s outside YOUR box??



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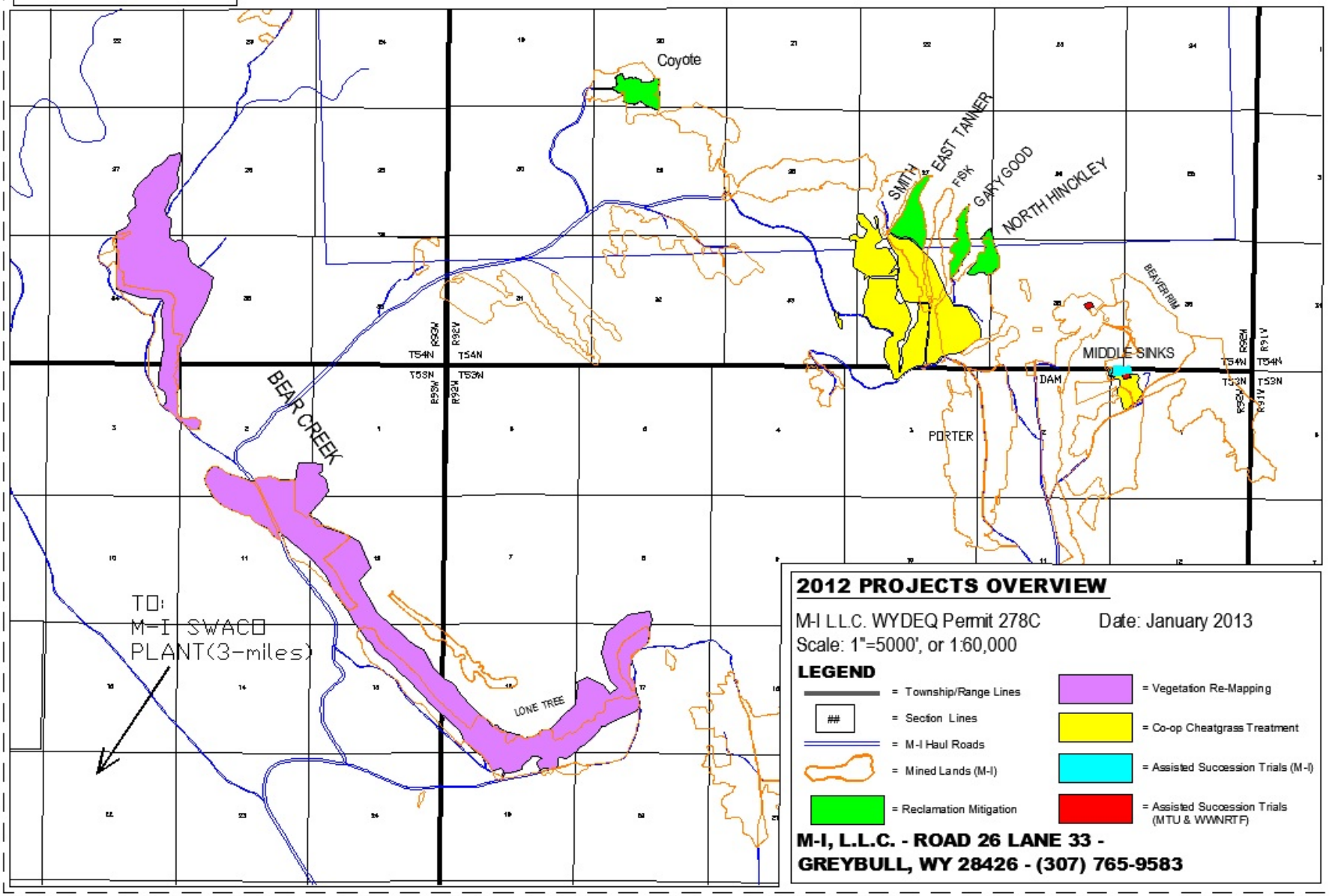
REFERENCE DATA

OVERVIEW MAP
M-I SWACO's 2012 INNOVATIVE RECLAMATION PROJECTS



2012 PROJECTS OVERVIEW

M-I L.L.C. WYDEQ Permit 278C Date: January 2013

Scale: 1"=5000', or 1:60,000

LEGEND

- = Township/Range Lines
- ## = Section Lines
- = M-I Haul Roads
- = Mined Lands (M-I)
- = Reclamation Mitigation
- = Vegetation Re-Mapping
- = Co-op Cheatgrass Treatment
- = Assisted Succession Trials (M-I)
- = Assisted Succession Trials (MTU & WWNRTF)

M-I, L.L.C. - ROAD 26 LANE 33 - GREYBULL, WY 28426 - (307) 765-9583

M-I SWACO INNOVATIVE RECLAMATION PROJECTS - 2012

				Ownership Acres					
Project	**Total Acres**	**Legal Description**	**Project Type**	**Private**	**State**	**Federal**	**Year First Affected**	**Year Reclaimed**	**Project Year**
Coyote	40.2	20-54/92	Reclamation mitigation	40.2			1998		2012
East Tanner	44.9	27,34-54/92	Reclamation mitigation	1.9		43	1996	8.3 ac 2008	2008, 2012
Gary Good	29.4	27,34-54/92	Reclamation mitigation	11.3		18.1	2003	8.7 ac 2008	2008, 2012
Hinckley	28.6	27,34,35-54/92	Reclamation mitigation	3.1		25.5	2002		2012
Asst. Succession (Middle Sinks)	6.4	27,34,35-54/92	Assisted succession techniques to combat cheatgrass	5.6	0.8		2011		2012
Bear Creek Re-Mapping	1248.2	3,4-54/93 - 2,3,11,12,13-53/93 - 17,18,19,20-52/93	Re-mapping of the vegetation and related soils for the purpose of revising reclamation procedures based on suitable materials	789.9		458.3	Pre-1969	1980-Present (approx. 15% of proposed mining acres)	2012
BLM - Co-op Cheat Treatment 2012	411	27,34,35-54/92 1-53/92	Cheatgrass treatment of federal land seed source	207		204			2012
MTU - Assisted Succession	1	1-53/92 26-51/91	Cheatgrass control with aggressive perenials to be followed by assisted succession to diverse vegetation community	1					2012
Total Acres	**1809.7**			**1060**	**0.8**	**748.9**			