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Using the Land Health Standards to Assess Reclaimed Mine Sites

By Jony Cockman

In the 1980s, BLM embarked on what was called the "Vegetation Management Initiative, or "VMI." At the core of VMI was establishing clearly stated and ecologically attainable objectives for the vegetation on public land. While VMI began as a grazing management program concept, it quickly became apparent that this concept offered "an improved, more effective way to deal with vegetation management across a wide spectrum of renewable resource programs, facilitating improved objective setting and interdisciplinary coordination" (BLM 2008).

In 2001, BLM issued standards and guidelines to improve the health of public rangelands (BLM, 2001). The objective of the Healthy Rangelands Initiative was to promote healthy, sustainable rangelands. Under the Healthy Rangelands Initiative, State Directors, in consultation with Resource Advisory Councils, developed State or regional rangeland health standards that addressed the four fundamentals of rangeland health: 1) watershed function, 2) nutrient cycling and energy flow, 3) water quality, and 4) habitat quality for native plant and animal populations and communities (BLM IVM 2008).

Policies and concepts contained within (the IVM) handbook are intended to build upon previous initiatives, recognizing that healthy native plant communities alone do not define healthy watersheds and landscapes. But without them, there is little hope of achieving broader land health objectives and providing for sustainable use that the public has come to expect from the public lands (BLM IVM 2008).

These standards make sense for a landscape that is "natural," that is, it has not been drastically disturbed by various activities such as mining. However, in the broadest terms, the BLM land health standards are to be upheld by all programs including those programs that create drastically disturbed land. For mined lands this creates an interesting situation.

Coal mining is governed by the Surface Mining Control and Reclamation Act of 1977 (SMCRA). There are two programs within SMCRA: one governs active mines and the second governs abandoned coal mined land. The SMCRA Act also created the Office of Surface Mining within the Department of Interior. This program has developed best management practices to promote environmental compliance and land restoration as well as standards for success.

Hard rock mining is governed by the Mining Law of 1872. This law emerged as a product of the California Gold Rush and the other western mining booms of the mid-19th century. Hard rock mineral deposits in the West were found predominantly on federal lands, but there was no law governing the transfer of rights to these minerals from public ownership to miners. So miners implemented their own customs, codes and laws, which Congress codified and amended as the Mining Law of 1872. This legislation gave broad discretion over the use of public land resources to the private sector, requiring little in the way of public administration. The central provisions of this legislation remain intact today. The Mining Law, in fact, contains no environmental provisions, but mineral exploration and development are subject to state and federal environmental regulations, including those established by the Forest Service and the Bureau of Land Management (BLM) (Gerard 1997).

It should be noted that there is a practical difference between coal mining and hard rock mining when it comes to surface reclamation. Coal mining takes place in country that has soil that is first stripped from the land (in case of open-pit mining) and stock piled. After the coal is removed, overburden waste rock is placed in the mined out pit and then capped with the stock-piled soil and revegetated using best management practices and techniques developed in the SMCRA program. Hard rock mining occurs in country that is "hard rock." There is little if any soil to strip and preserve for later use. The process of mining and milling hard rock for copper or other ore requires the construction of tailing and waste rock dumps for the residue left over after mining and milling. Capping material is "borrowed" from other sites to cover the tailing and dumps. The resulting formation is supposed to resemble something natural and produce vegetation. Needless to say, coal mining has the lesser challenge.

In response to the lack of environmental provisions in the 1872 Mining Law for hard rock mining, states developed their own laws. New Mexico has the New Mexico Mining Act of 1993. Arizona has the Arizona Mine Reclamation Act of 1994. In both states a mine reclamation plan is

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required. In New Mexico a post-mine-land-use must be declared in advance. In Arizona there may be an experimental phase before a post-mine-land-use is declared. For hard rock mining there is no policy or guidance within state, federal or tribal law to measure success.

This latter issue became problematic in administrative litigation for mine reclamation on the San Xavier Mission Mine during litigation between Tohono O'odham allottees and ASARCO Mining Company. Tribal lands had been in litigation with ASARCO for twenty-five years. Recently ASARCO went through nation-wide bankruptcy which ironically allowed for litigation to be reviewed with the U. S. Department of Justice and opportunities were opened up.

The Bureau of Indian Affairs (BIA) is a sister agency to BLM within the Department of Interior. The BIA does not have a mining and minerals section. When the tribal parties need assistance with mining issues it is delegated to BLM to act on behalf of the BIA and the tribal group. BLM along with tribal partners, consultants and the Department of Justice were able to work out a Mining and Reclamation Plan (MARP) as part of the bankruptcy settlement agreement. The revegetation component of this plan required success standards. There was no prototype to follow.

The post-mine-land-use declared by the Tohono O'odham Nation and tribal allottees was to return the mine property to native Sonoran Desert Habitat, or a plant community resembling a close approximation. Could BLM's land health standards (Pellant et al. 2005) be used to assess a reconstructed plant community on mine tailing and dumps?

In review, the four fundamentals of rangeland health are: 1) watershed function, 2) nutrient cycling and energy flow, 3) water quality, and 4) habitat quality for native plant and animal populations and communities. One assessment technique the BLM (and other agencies) uses to examine these attributes is the Range Health Assessment (TR 1734-6). This technique is built on the foundation that certain soil types are capable of producing certain plant communities. There is a very close correlation between soil type and plant community. A plant community in good condition can be used as a reference area to compare and contrast the fundamentals of land health at work. This technique is embodied in three categories: 1) soil and site potential 2) hydrologic function 3) biotic integrity. The performance of each of these three categories is measured by indicators such as flow patterns on the soil surface, rills, gullies, pedestals on rocks and plants, vigor and reproductive capability of plants. There are seventeen indicators in all.

Version 4 of TR 1734-6 recognizes that intact reference areas may not be available. Some soils and ecological sites are lost due to urban sprawl, or degraded due to over use of many activities. If good condition ecological sites are not available for reference, it may be necessary to construct a surrogate reference work sheet composed of composite knowledge. With this concept, the technical team decided to push the envelope even farther. Could reference work sheets be constructed for reconstructed soil on mine tailing and dumps?

In a mined land situation, the original soil profile is no longer intact. It has been turned upside down with elements extracted, and put back together in an order that is no longer natural and frequently not able to produce vegetation without an added layer of capping material. Could the land health standards and assessment process be applied to a mined land situation? At the San Xavier Mission Mine, could it be applied to both tailing and mine dumps?

Mine tailing has the texture of clay but has different chemical properties from clay.

The first task was to examine the hydrologic function of the mine dumps and tailing, their general chemistry and physical features. We also examined the cap material in combination with the tailing and dump, assuming a cap thickness of at least one foot. The San Xavier Mission Mine has relatively benign tailing and dumps. The pH ranges from 5.0-6.0 on most sites which is benign for a copper environment. Depending on milling processes, copper mine tailing pH can be as low as 2.0 which presents a harsher environment to work with. The native soils in the area have

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Tailing subsidence created a depression that filled with water and has been used as a stock pond by local cattle and wildlife.

pH as low as 6.5. If the San Xavier Mission Mine tailing and dumps were more acidic, then a much thicker cap material would be required.

The tailing sorts out into coarse sandy material on the perimeter and finer textured material in the center. This textural difference between perimeter and center is significant to separate the two for vegetation treatment and correlation to native sites. The dumps are very coarse material (cobbles, rocks, gravel, small boulders and finer matrix). All three types will be capped with similar borrowed soil from the Tucson area. But the underlying coarse tailing, fine tailing, and coarse waste rock in the dumps require comparison to three different native sites.

Cap material was examined for chemical and physical properties, pH, water holding capacity, texture, coarse fragments, and volunteer vegetation. Information from previous mine studies was also reviewed. We then looked for native soil that could be used for comparison. The technical team that conducted this exercise had a wealth of local knowledge and expertise:

Expertise in local soils and ecological site descriptions
Expertise in understanding chemical, physical and hydrological properties of mine dumps and tailing
Expertise in local native flora
Expertise in monitoring and assessment protocol
Understanding of the desired post mine land use
Knowledge of Tohono O'odham culture and ethnobotany

The Sandy Loam Upland ecological site was selected for comparison to the tailing perimeter. Disturbed farmland north of Tucson was examined. This farmland had been left abandoned and undisturbed for thirty years. Although some shrubby vegetation had established, the site still had large patches of bareground with sparse patches of native grass and intermittent annual grasses, forbs and weeds. This site had been developing for thirty years and still was not returned to the highly productive original condition.

The tailing center was compared to the Clayey Swale ecological site. The mine dumps and dry sites were compared to the Limy Upland ecological site. Reference condition sites for both of these ecological sites were located at Pima County Fair Grounds.

Locating reference sites provides guidance for a number of parameters. First, it sets realistic expectations for how much plant material the reconstructed site might be able to produce. It also provides guidance on what plant species should be seeded or expected to volunteer on the site. And it provides a realistic time frame. For example, the abandoned farm land indicates that it will probably take at least thirty years for the tailing perimeter to make significant progress toward the objectives, and may still not have reached the final goal of a mature Sonoran Desert Habitat.

The seventeen indicators examined in TR 1734-6 assess the condition of soil and site stability (S), hydrologic function (H) and biotic integrity (B). One indicator may serve more than one of the three attributes as shown in the table below.

1 – Rills	S	H		
2 – Water flow patterns	S	H		
3 – Pedestals	S	H		
4 - Bare ground	S	H		
5 – Gullies		S	H	
6 - Wind scour	S			
7 - Litter movement	S			
8 – Soil surface resistance	S	H	B	
9 – Soil Surface loss	S	H	B	
10 – Plant composition / infiltration		H		
11 – Compaction layer		S	H	B
12 – Functional groups				B
13 – Plant mortality			B	
14 – Plant litter		H	B	
15 – Annual production			B	
16 – Invasive plants			B	
17 – Reproduction of plants				B

What we would expect for each of the seventeen

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indicators is described by compiling information from reference sites. For example, the Clayey Swale ecological site in good condition should have soil and site stability parameters that resemble those in the description below.

. Number and extent of rills – none
2. Water flow patterns – Water flow patterns are limited to man-made obstructions (the artifact of soil capping operations). Nearly all water flow is sheet flow coming as runoff from adjacent areas of the tailings perimeter.
3. Pedestals and terracettes – Since the revegetation effort begins with a groomed surface, there will be no pedestals or terracettes at the time of seeding and planting. Terracettes may develop over time and are a natural part of this reference condition.
4. Bare ground – Is expected but should not exceed 30% of the surface.
5. Number of gullies – none.
6. Extent of wind scour and blowouts – none.

If the indicator does not resemble the description of the reference condition, the next step is to determine the level of departure from the reference condition. Levels of departure are none to slight, slight to moderate, moderate, moderate to extreme, and extreme.

Old tailing at the San Xavier Mission Mine known as Pima Tailing Pond #6 was reclaimed with a combination of seeding trials and volunteer vegetation in the 1970s. The center of the tailing resembles the Clayey Swale ecological site. The modified land health assessment was carried out on it. The results are shown below.

Several inches of dark colored cap material cover lighter colored tailing at Pima 6 Tailing. A subsidence feature is examined by Dan Robinett (contractor) and Al Richins (ASARCO).

Pima 6 Tailing Center - Clayey Swale Soil and Site Stability	
None to slight departure from reference conditions.	All indicators except number 4.
Slight to moderate departure from reference conditions.	4) bare ground. The site was assessed as having 15% bare ground which is somewhat high for a Clayey Swale ecological site. Ground cover classes were estimated at gravel 10%, litter 50%, live plant bases 10-20% and soil cryptograms 5%.
Indicators not applicable.	8) soil surface resistance to erosion.9) soil surface loss or degradation. **Indicators 8 and 9 are not assessed in the traditional sense that they would be addressed for a native soil. In a natural setting indicators 8 and 9 examine soil erosion and departure from a stable environment. On the mine tailing, indicators 8 and 9 will track evolution of the site toward a stable setting. Depth of cap material will be monitored.**

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Pima 6 Tailing Center - Clayey Swale Hydrologic Function	
None to slight departure from reference condition.	All indicators except 4, 10, 14
Slight to moderate departure from reference condition.	4) bare ground 10) plant community composition and distribution relative to infiltration and runoff. **Fresh tailing deposition impedes establishment of perennial grasses.** **14)** litter amount (percent coverage and depth). **Without the establishment of perennial grasses, litter amount remains sparse.**

Pima 6 Tailing Center - Clayey Swale Biotic Integrity	
Slight to moderate departure from reference condition.	14) litter amount. 15) annual production. **There is reasonable cover of litter in the grassed areas but much less where fresh tailing spills occur. Annual production is good on woody species but is reduced on perennial grasses.**
Moderate departure from reference condition.	13) plant mortality and decadence. **Where fresh tailing is applied there is significant mortality of perennial grasses. Seedlings of desert broom are coming in.**
Moderate to extreme departure from reference condition.	16) invasive plants. **The Pima No. 6 Tailing has demonstrated the ability to produce substantial grass coverage. Much of this is Lehman lovegrass which is an exotic invasive species and lowers the biotic integrity rating. Other invasive species include salt cedar, bermuda grass and yellow bluestem. Seeding with native species on new projects is expected to accelerate the establishment of a desirable plant community that meet the post mine land use objectives.**

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Indicators 8) soil surface resistance to erosion and 9) soil surface loss and degradation could not be examined in the traditional sense. The ca material on Pima 6 Tailing averaged four to six inches deep and supported a variety of vegetation. When fresh cap material is put in place on new projects it will have a larger percentage of rock and gravel which will provide protection from wind and water erosion.

Another peculiarity that had to be considered for Pima Tailing 6 is the fresh tailing precipitate that is still deposited from an overflow pipe. The precipitate forms a crust but it does not appear to be impeding the recruitment of new vegetation.

The cap material on Pima Tailing 6 ranges from 4 to 6 inches deep. New projects will have thicker cap material (at last one foot thick). The tailing material has the texture and similar water holding capacity of heavy clay, but is not chemically similar.

One peculiarity that had to be assessed for Pima 6 Tailing hydrology was tailing subsidence. This is a natural feature on the tailing as the tailing continues to dry out. Tailing subsidence is a unique feature not discussed in the land health assessment matrix. The tailing dam is a contained unit with no outlet. If there were an outlet for hydrologic flow then the subsidence features could develop into pipes, rills and gullies with massive erosion associated. However, within the enclosed system the subsidence is seen as a natural feature.

The assessment of biotic integrity on Pima 6 Tailing reflected the current and necessary activity of applying fresh tailing from an over flow pipe. Over time this activity will subside and perennial grasses will encroach. This tailing dam also has a history of being used for experimentation of exotic grasses in the 1970s. The presence of Lehman lovegrass dominates the site. Because the post-mine-land use is the establishment of a Sonoran Desert Habitat, exotic species are given a lower score. New projects will be seeded with native plants and this should help to impede the volunteer establishment of exotic grasses. However, Lehman lovegrass is bound to occur in the plant community.

Summary

Assessment of the seventeen indicators (TR 1734-6 version 4) worked well on the tailing and dam features at San Xavier Mission mine. Some peculiarities such as tailing subsidence must be taken into account. Also, the assessors must remember that while the ratings are assigned for departure from a reference condition, the reclaimed sites are actually working toward a reference condition. This may affect interpretations and is acceptable as long as rationale is provided for each assessment. Rationale is also required in the traditional implementation of TR 1734-6.

As with the traditional implementation of TR 1734-6 the assessors must be familiar with local soils and ecological sites. Application of this process to mined sites should be limited to persons who are considered expert in this field. The process also requires an understanding of the hydrologic function of the mine tailing and dump features.

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I have always been a big advocate of tap water—not because I think it harmless but because the idea of purchasing water extracted from some remote watershed and then hauled halfway round the world bothers me. Drinking bottled water relieves people of their concern about ecological threats to the river they live by or to the basins of groundwater they live over. It's the same kind of thinking that leads some to the complacent conclusion that if things on earth get bad enough, well, we'll just blast off to a space station somewhere else.

-Sandra Steingraber, *Having Faith*, 2001

Can You Recycle Pizza Boxes?

Many people assume that pizza boxes are recyclable. In fact, most boxes have recycling symbols on them and are traditionally made from corrugated cardboard. However, what make parts of them non-recyclable are the hot, tasty treat that comes inside them, specifically, the grease and cheese from pizza that soil the cardboard.

So there you have it, pizza boxes that are tarnished with food, or any paper product that is stained with grease or food, are not recyclable - unless you remove the tainted portions.

Food is one of the worst contaminants in the paper recycling process. Grease and oil are not as big of a problem for plastic, metal and glass, as those materials are recycled using a heat process. But when paper products, like cardboard, are recycled, they are mixed with water and turned into slurry.

Grease from pizza boxes causes oil to form at the top of the slurry, and paper fibers cannot separate from oils during the pulping process. Essentially, this contaminant causes the entire batch to be ruined. This is the reason that other food related items are non-recyclable (used paper plates, used napkins, used paper towels, etc).

"The oil gets in when you're doing your process of making paper," said Terry Gellenbeck, a solid waste administrative analyst for the City of Phoenix, Ariz. "The oil causes great problems for the quality of the paper, especially the binding of the fibers. It puts in contaminants, so when they do squeeze the water out, it has spots and holes." But what about other things regularly found on paper products, like ink? "Most inks are not petroleum-based so they break down fast. Food is a big problem," he said.

Also, be mindful of adhesives that may be on the pizza box (coupons, stickers, etc.) as those are contaminants. Known as "pressure sensitive adhesives (PSAs)" these can ruin the recycling process just as much as oil or food remains.

Calendar of Events

Wednesday, March 11, 2009, 7 p.m.
March's meeting will be held at the Graham County General Services Building, 921 Thatcher Blvd., Safford, Arizona

Wednesday, April 8, 2009, 7 p.m.
March's meeting will be held at the Graham County General Services Building, 921 Thatcher Blvd., Safford, Arizona

Our partners include:

Arizona Department of Agriculture
Arizona Department of Environmental Quality
Arizona Department of Transportation
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U.S. Fish and Wildlife Service
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For more information, contact Jan Holder at the Gila Watershed Partnership, 711 S. 14th Avenue, 85546, 520-395-2499, email-watershedholder@yahoo.com