Remedial Action, Remedy Performance, and Long-Term Land Management

Anaconda Smelter NPL Site

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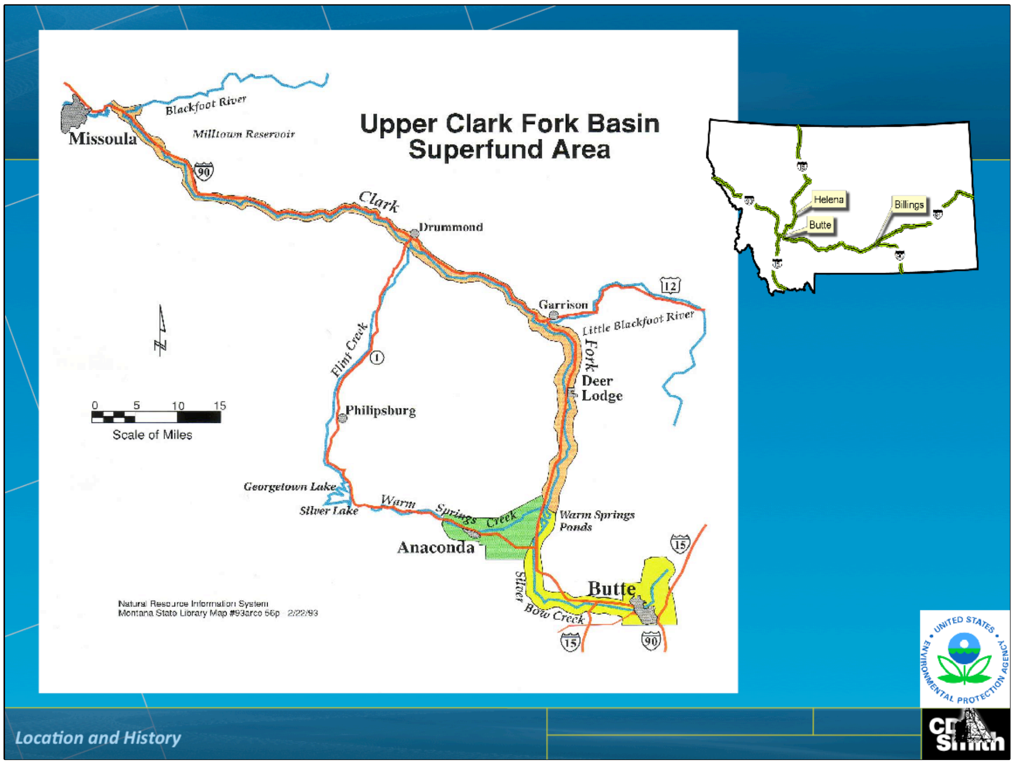

These sites are in and near the upper Clark Fork River valley and include the Butte site where ore was mined for more than 120 years and the Anaconda site where the ore was smelted up until 1983.

Placer mining began in the Clark Fork River Basin in the 1860s

Location and History

1 Butte overlies a massive metallic ore body
2 Over 10,000 miles underground workings, 4 open pit mines, and an estimated 12.4 mcy of mining waste.

Open pit mining began in 1955 and continues today

The Berkeley Pit - mined until 1982

Location and History

Smelting began in Anaconda, MT in the 1880’s

Butte mines and Anaconda smelters, owned by Marcus Daly, produced more than $300 billion worth of metal over its lifetime.

- High wages - raised national standard of living
- Raw material for many products
- Contributed to war efforts

Location and History

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Smelting Legacy at the Anaconda Site

- **Wastes**
  - **230 million yd^3 of tailings**
  - **30 million yd^3 of furnace slag**
  - **500 yd^3 of flue dust**

- **Impacted soils, plant communities, and habitats over a 300 square mile area***

*EPA Website 2012

Location and History

Brief Regulatory History

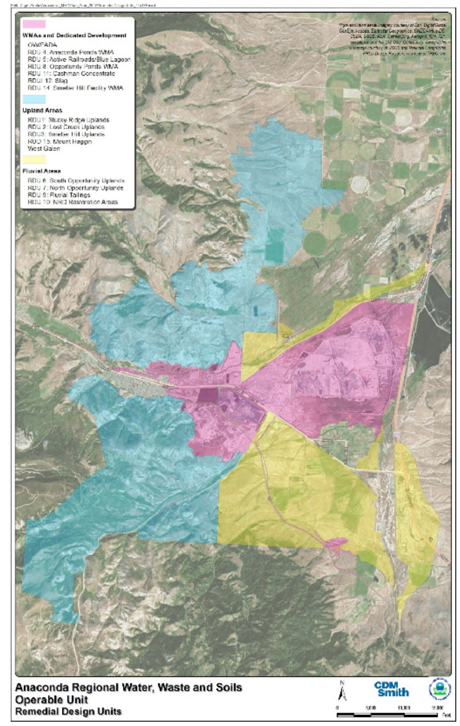
- Smelter closed in 1980
- Site listed 1983
- Demolition of the smelting facilities 1983 - 1986
- First Administrative Order with Atlantic Richfield 1986
- Early studies/development of Operable Units (OUs) 1986-1988
- Mill Creek Relocation Record of Decision (ROD) 1988
- Removal Action 1989 – 1992
- Flue Dust OU ROD 1991
- Old Works/East Anaconda Development Area OU ROD 1994
- Community Soils OU ROD 1996
- Anaconda Regional Water, Waste &Soils OU ROD 1998

Anaconda Regional Water, Waste & Soils

Red Areas – Waste Management Areas (Tailings, Slag, other smelting wastes) and Dedicated Development (railroad built out of mine waste materials). Anaconda Ponds tailings impoundment nearly 100 feet thick

Yellow Areas – Lowland areas impacted by deposition of fluvially-deposited wastes (sulfidic mine tailings) from historic flood events and subsequent irrigation practices. Thickness ranges from less than an inch to several feet in historic stream channels. Despite metals, subirrigated areas are typically well-vegetated.

Blue Areas – Upland areas impacted solely by aerial deposition of smelter emissions. Contaminants most concentrated in upper 2 inches, but low pH and limited soil buffering capacity may leach copper and zinc to 18 inches in some areas.



Location and History

Contaminant Releases from Smelter Complex

- 1907: 37 tons/day of As, Cu, Pb, and Zn from main chimney
- 1914-1918: Arsenic release averaged 40-62 tons/day
- October 1976: 578 tons/day of As, Cu, Pb, Zn, and Sulfur

Smelter Complex, Anaconda, MT 1903

Smelting Impacts Near Anaconda

Immediate, severe impacts to natural environments near the smelters

Long-term impairment to plant/soil systems

Location and History

Smelting Impacts Near Anaconda

1910-1911 Forest Survey*

"All trees dead or dying within eight miles of smelter"

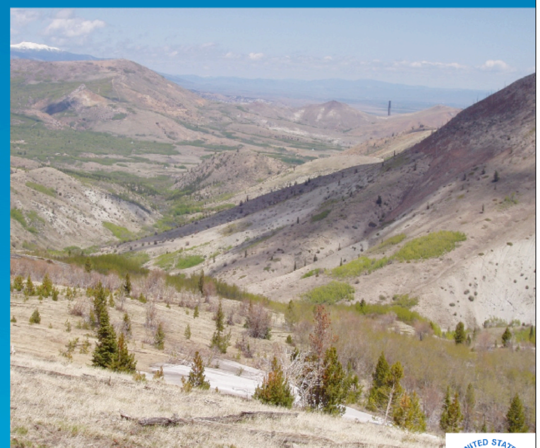
Affected Trees

-Engelmann spruce up to 15 miles

-Lodgepole pine up to 18 mile

-Douglas fir up to 20 miles

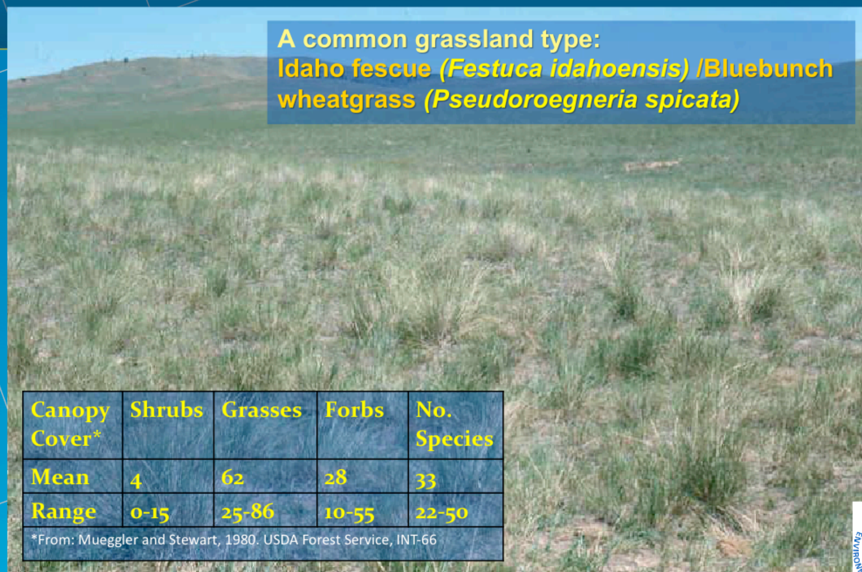
-Subalpine fir up to 22 miles



*USDA Technical Bulletin 1117

Location and History

Perspective: Uncontaminated Rangeland in SW Montana



Canopy Cover*	Shrubs	Grasses	Forbs	No. Species
Mean	4	62	28	33
Range	0-15	25-86	10-55	22-50

*From: Mueggler and Stewart, 1980. USDA Forest Service, INT-66

Location and History

EPA's Remedial Action Objectives for the ARWW&S OU*

- *Establish a self-sustaining assemblage of plant species capable of:*

  1) stabilizing the soils against erosion and minimizing transport of contaminants to surface and ground water to meet water quality standards

  2) preventing human contact with contaminants

  3) maximizing water usage;

  3) re-establishing wildlife habitat; and

  4) accelerating successional processes.

- *Successfully reclaim contaminated land, defined as:*

  1) establishing self-perpetuating plant communities capable of stabilizing contaminated soils;

  2) reducing risks to human health and the environment; and

  3) compliance with ARARs, in perpetuity.

Anaconda Regional Water, Waste & Soils Operable Unit ROD, 1998

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Part 2 – Basis of Remedial Design (1998-2006)

- Quantifying the impact of smelting on native plant communities and the soil resource
- Selecting remediation techniques

Basis of Remedial Design for the ARWW&S OU

Goal: Select the type and intensity of reclamation to meet the RAOs for each discrete land parcel within the operable unit

Challenge: Develop a method to determine the level of ecological dysfunction and the remedial approaches for 30,000+ impacted acres

Remedial Design

Basis of Remedial Design for the ARWW&S OU

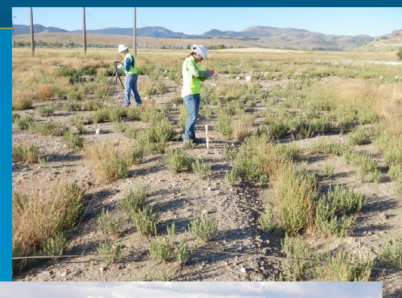
The evaluation method must:

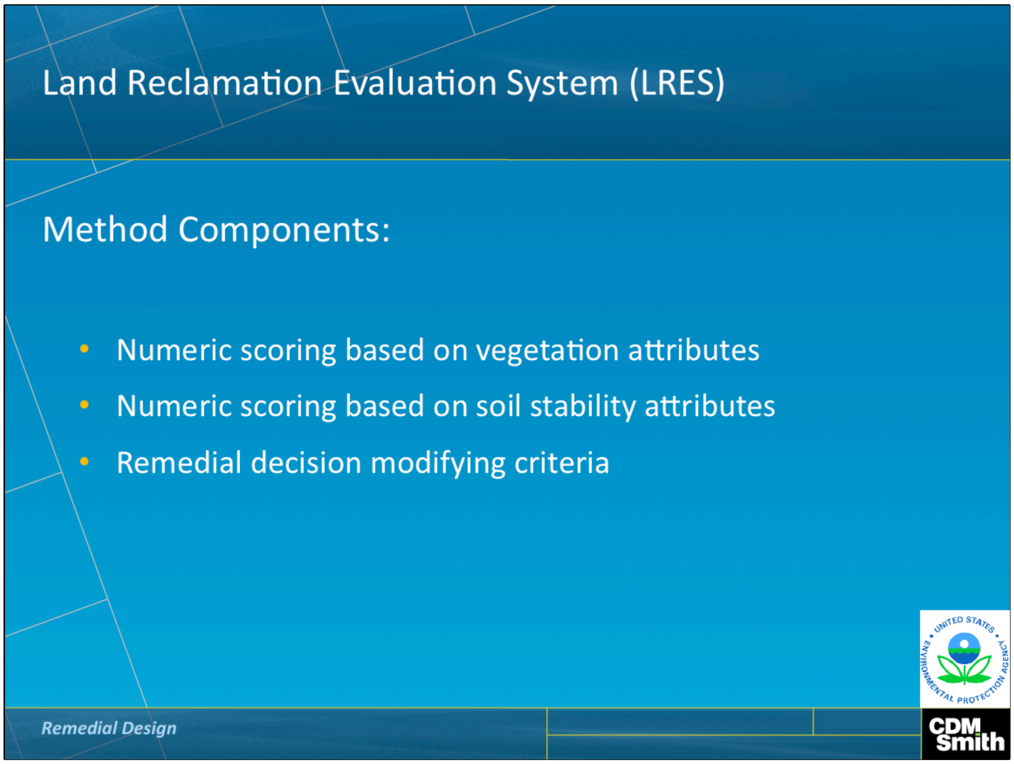
- Be easy and quick to apply
  - Utilize a minimum amount of equipment
  - Use standard soil and vegetation evaluation techniques
- Be as quantitative as possible
- Provide precise (i.e., reproducible) results
  - Method simplicity and evaluator experience/training
- Identify specific remedial approaches
- Consider historic, social, economic, ownership, and other values
- Be developed with buy in from stakeholders

Remedial Design

Method Development Process

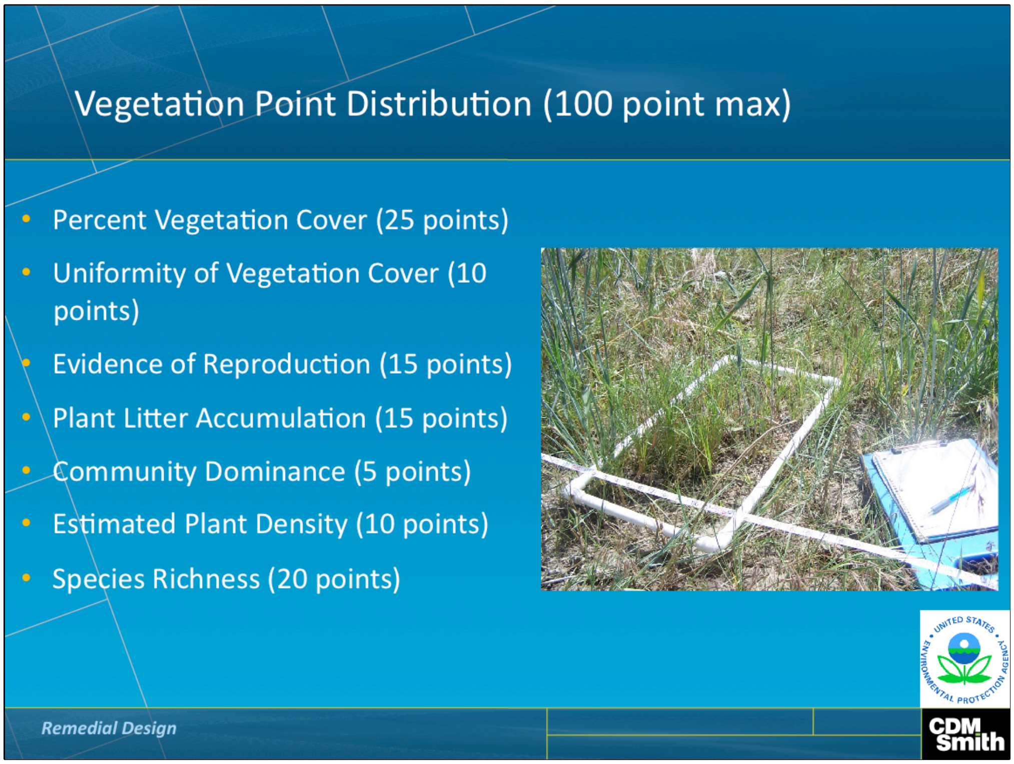
- Identified a set of sites with full range of impacts
- Began with large set of possible vegetation and soil parameters
- Assigned points to the parameters and adjusted point distribution among parameters through trial and error (calibration step)
- Testing and final point adjustments until scores reflected best professional decisions (the validation step)



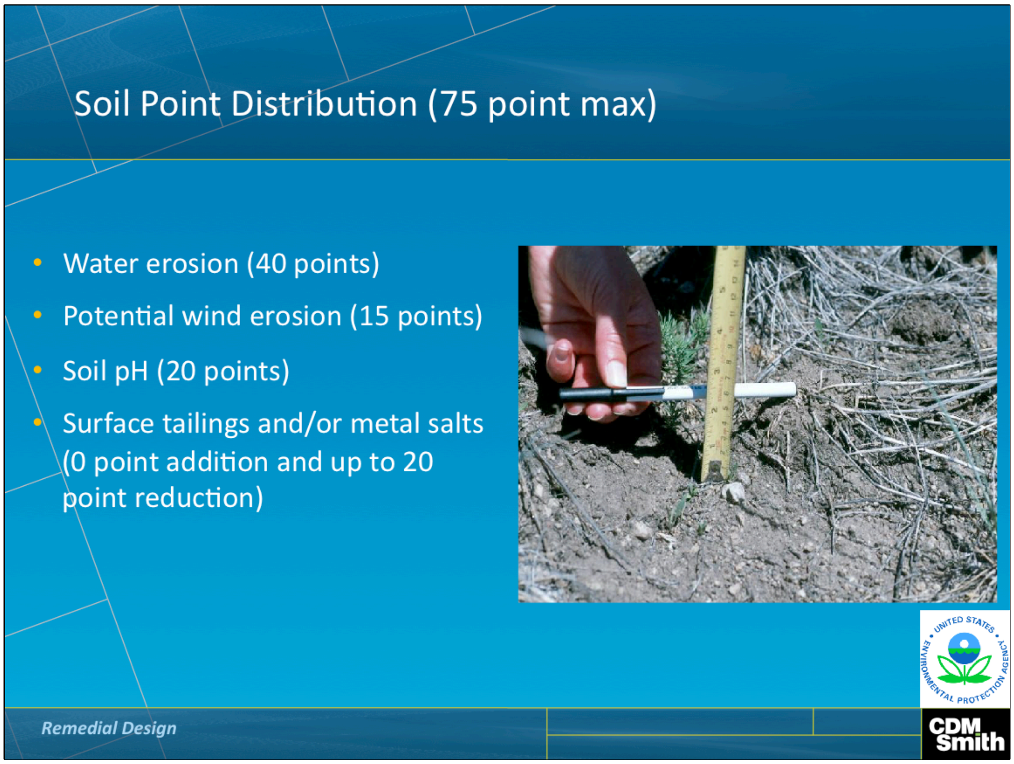


Evaluation method needed to be as objective as possible.

The primary components of the pre-reclamation decision tool are a numeric scoring system that focuses on the condition of the vegetation and soils, and what we call decision modifying criteria.

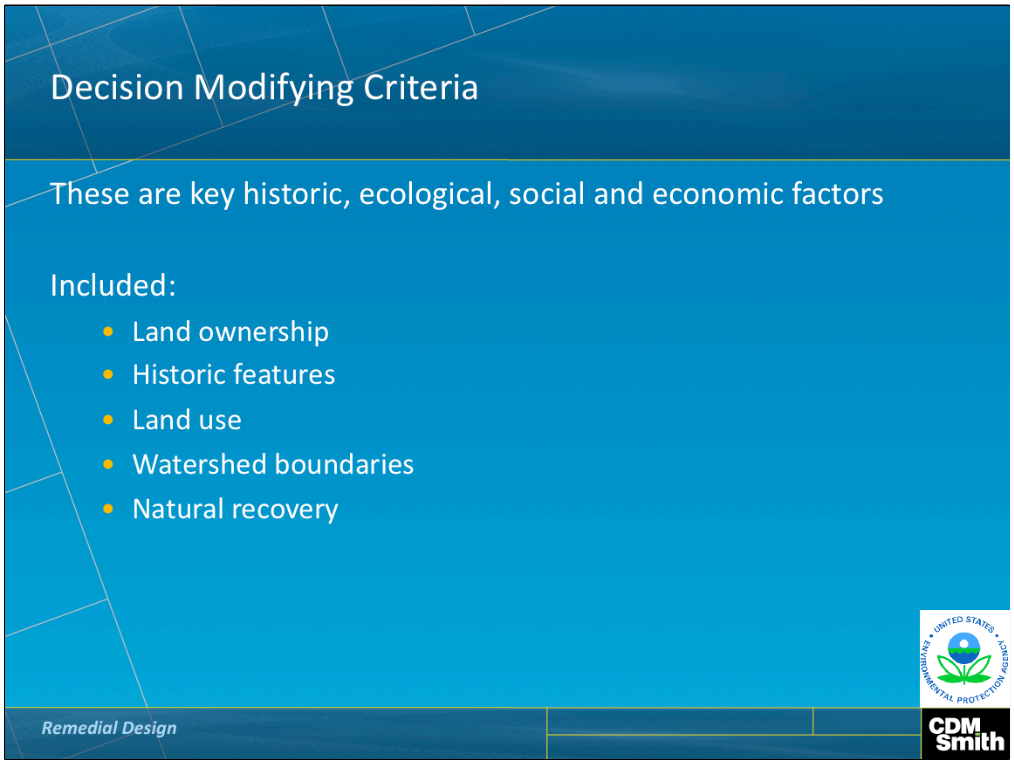


Based on trial and error, the team developed a system of 100 points to rate the quality of the plant community. The parameters used are mean cover, uniformity of cover, plant reproduction, litter, plant dominance, plant density, and species richness.



The soils portion of the scoring system has a total of 75 points and considered water erosion, soil pH, potential for wind erosion, and the presence of tailings or metal salts.

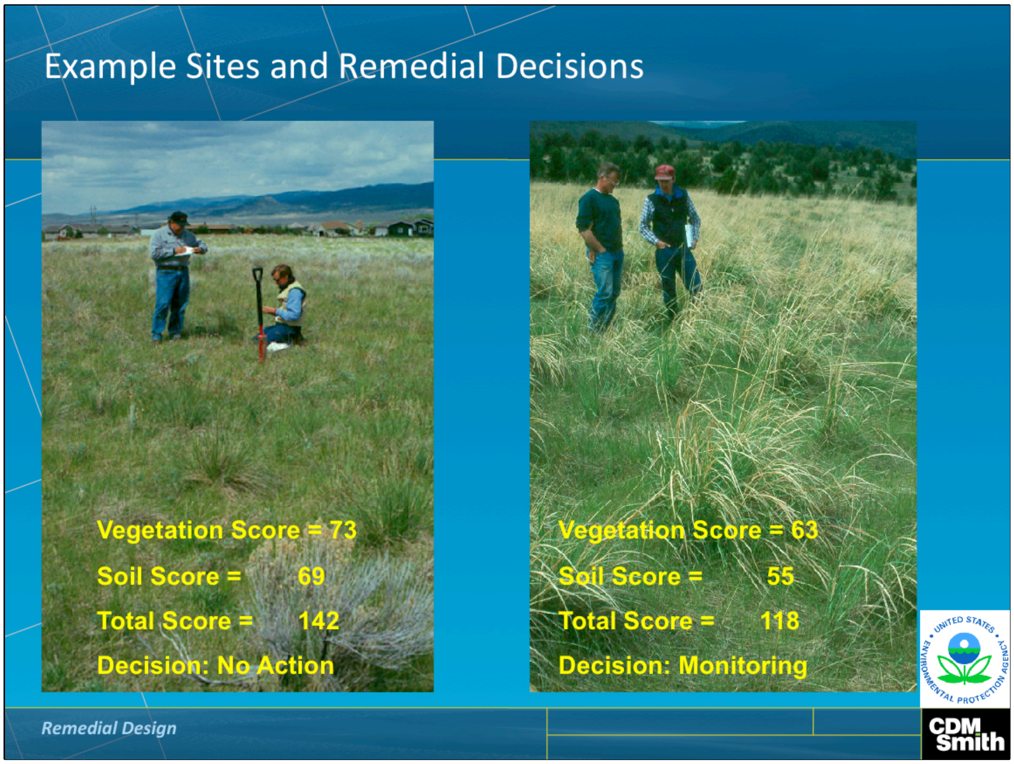
Based on repeated use of the scoring system, the team determined that a total of about 115 points (for both soil and vegetation) was the cutoff for deciding whether some type of reclamation action was needed.



While in the field, the evaluators also collect other types of information that may be important to making the reclamation decision.

The decision modifying criteria include a whole host of political, ecological, social, and economics factor that can effect a remedial decision.

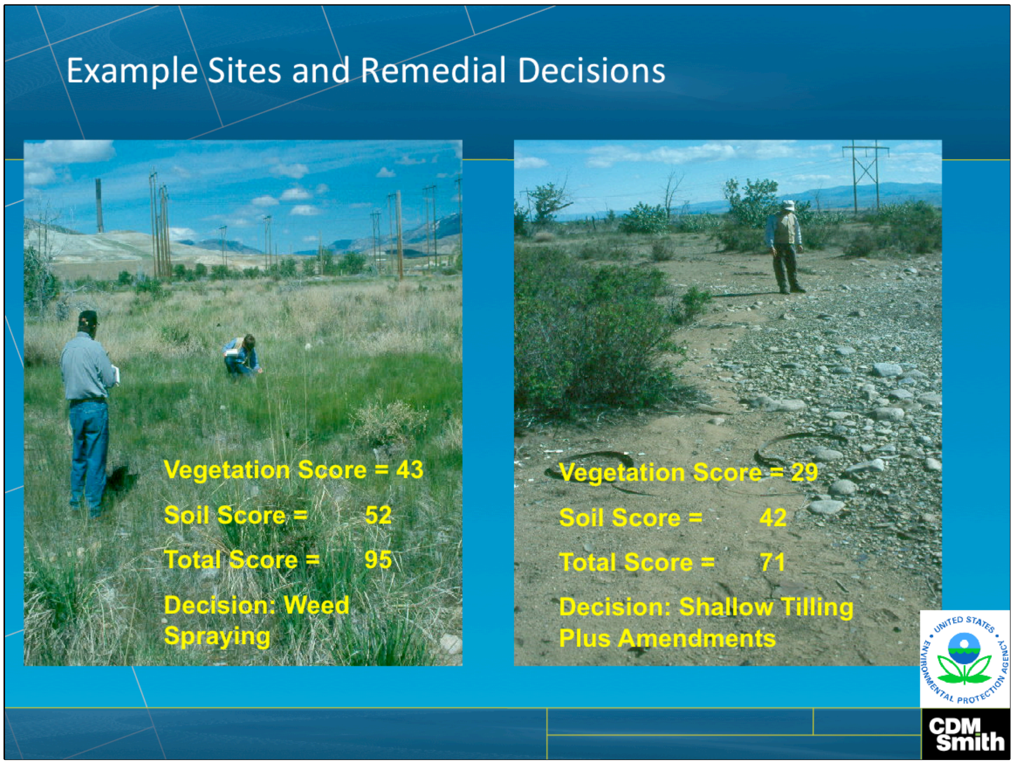
The list of modifying criteria contains about 30 different items to consider. Some of the key criteria are things such as land ownership boundaries, historic features, watershed boundaries, and whether natural site recovery is occurring.



The following set of slides show how some sites were scored and what reclamation approach was taken.

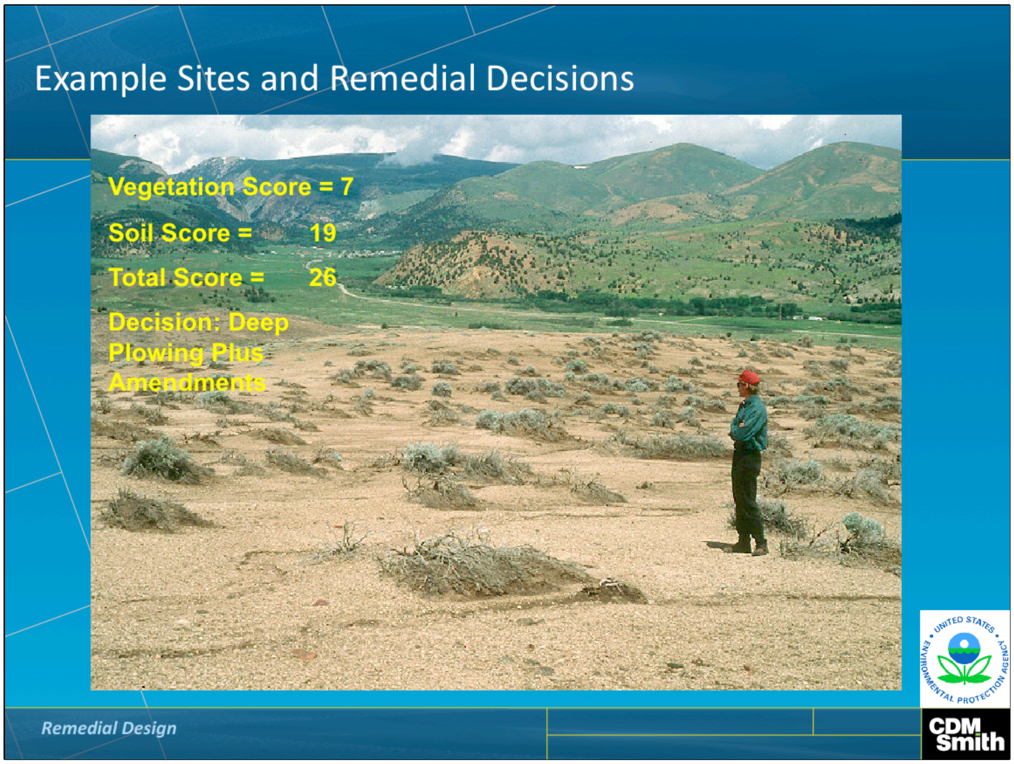
The site on the left had a total vegetation/soil score of 142. The decision for this site was "no action". This site was definite a candidate for de-listing.

The decision for the site on the right, which had a score of 118 was to continue to monitor it to determine if conditions were improving.



The site on the left is in relatively good condition and is begin sprayed to control weeds. This site is being monitored year to year to see if it improves.

The site on the right scored 71points and is being reclaimed using swallow tilling and low quantities of lime and organic amendments.



This site is adjacent to the old smelter at Anaconda. The decision for this severely impacted site is deep plowing and the application of lime and organic amendments.

Results

- Land reclamation remedial alternatives applied to 233 land parcels
- Conceptual-level design for contaminated uplands
- Used by decision makers, engineers and scientists to prepare the remedial action work plans and design reports (2005-2006)

Evaluation technique termed: the Anaconda Land Reclamation Evaluation System (LRES)

Questions?

Part 3 – Remedial Design and Remedial Action

- Using the LRES to determine the appropriate remedial action
- Steep Slope Reclamation
- Basis of Design for Soil Treatment
- Implementation of Soil Treatment

Remedial Action - Large Open Space Areas of ARWW&S OU

- Coversoil or soil removal for severely contaminated areas
- In-place soil tillage for metals dilution (6, 12, 18”)
- Amendments: organic matter, fertilizers, and lime for pH adjustment
- Custom seed mixtures for soil conditions and land uses
- Special “Steep Slope Reclamation” techniques for areas greater than 3H:1V

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Steep Slope Reclamation

- Slopes steeper than 3H:1V cannot be tilled with conventional equipment
- Various degrees of steep slope reclamation, ranging from planting of trees, shrubs and grasses to on-slop grading with dozers, as determined through the LRES
- Storm water engineered controls constructed at most highly impacted areas
- Storm water best management practices constructed at lesser impacted areas or where engineered controls are infeasible
- Still evaluating new techniques (fertilizer demonstrations, aerial application of amendments, etc.)

Remedial Design/Remedial Action

Steep slopes in the Mount Haggin Wildlife Management Area

Remedial Design/Remedial Action

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Aerial application of herbicide to control noxious weeds

Steep Slope Reclamation

Image courtesy of Greg Mullen

Constructing Rock Check Dams

Rock Check Dams work well, but rock is hard to find, and they fill up with sediment after 1-2 field seasons

Images courtesy of Stuart Jennings


May 2012
OM test plots
Incorporation by Hand
July 2014
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Steep Slope Reclamation
Fertilizer Demonstration Plots
Images courtesy of Stuart Jennings
CDM Smith

Constructing Dozer Basins

Steep Slope Reclamation

Image courtesy of Greg Mullen

Planting of Trees, Shrubs and Grasses

Steep Slope Reclamation

Image courtesy of Greg Mullen

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Grading Steep Gullies on Stucky Ridge

Image courtesy of Greg Mullen

Steep Slope Reclamation

Basis of Design for Soil Treatment

- Anaconda Revegetation Treatability Studies (ARTS)
- Stucky Ridge 1995 and 1999 Demonstrations
- Opportunity Ponds Vegetation Improvement Demonstration
- Previously completed remedial actions using in situ treatment as a component of remedy
  - Drag Strip
  - Old Works Industrial Area
- Successes and Failures

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Soil Treatment Design Criteria Issues

- pH
- Organic Matter
- Depth of Treatment
- Liming Rates
- Alkaline Amendment Sources
- Steep Slopes
- Phytotoxicity - Contaminant of Concern (COC) concentrations

Depth of Treatment

- Minimum depth of plant growth media of 18 inches based on >20 years of success/failure
- Depth of incorporation in 6 inch intervals based on experience with equipment (T6 = Treatment to 6 inches)
- T6, T12 – done with conventional tilling equipment (Rhome disc)
- T18 – significantly more expensive (Bomag rotary mixer)
- T12 limitation for aerially-contaminated soils

pH

- Treatment Trigger
  - 0-6 inch interval, must be 6.5 or greater
  - Deeper intervals, must be 6.0 or greater
- Growth Media Treatment Requirements
  - Between 6.5 and 8.5 for tilling alone
  - Between 7.0 and 8.5 if neutralizing amendments are used

Alkaline Amendments

- High cost of lime drove evaluation of alkaline waste by-products (cement and lime kiln dust)
- Concern over trace metals in these materials necessitated greenhouse studies
- Many amendments approved
  - increasing alkaline amendment rates equated to decreased plant productivity based on greenhouse studies

Lime Equation for Soil Treatment

Lime Rate (tons CaCO3/1000 tons waste) =

[(HNO3-S + Residual-S)31.25 + (HCl-S)23.44 + [SMP buffer]]1.25

Modified for areas impacted solely by smelter emissions:

Lime Rate (tons CaCO3/1000 tons waste) = [SMP buffer]1.00

Organic Matter (OM)

- OM content in top six inches of treated growth media must be 1.5%
- Although vegetation is sparse or barren, many areas have intact soil "A" horizons
- Stucky Ridge studies show that intact soil horizons meet the criteria, even after mixing
- Areas with no or partial "A" horizons require post-treatment testing to determine organic matter requirement


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SEP 25 2002


Deep tillage on Stucky Ridge, 2011
Terrogator spreading sugar beet lime
Spreading composted manure
Remedial Action
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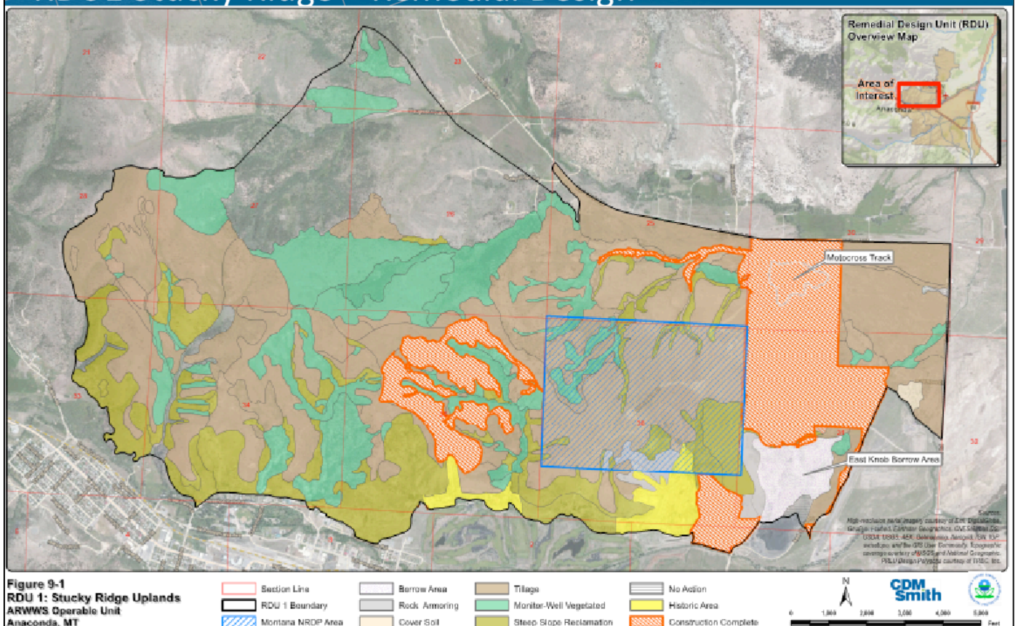
RDU1 Stucky Ridge – Remedial Design



Remedial Design/Remedial Action

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Questions?

- Remedial Design
- Basis of Design
- Implementation

Part 4 - Revegetation Success and Problems (2009-2012)

Topics

- Reclamation success rate and the identification of problem areas (Five-Year Review)
- Vegetation Response Investigation
- Development of the Total Metal Index (TMI) for soil

Revegetation Success and Problems

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Remediation Success

- 2010 Five Year Review inspected approximately 3,500 acres
- Included all lands remediated from the 1990s through 2009
- Most areas (~95%) were determined to be successfully reclaimed

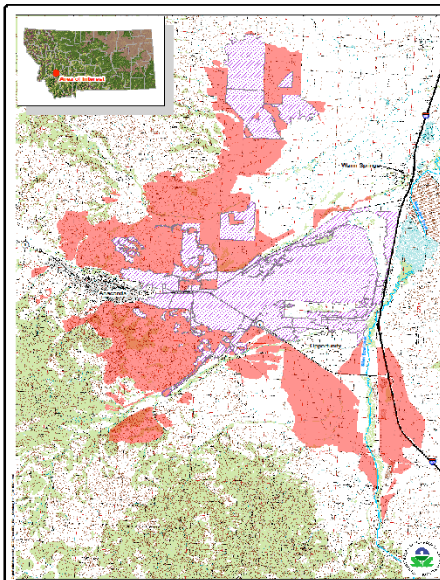
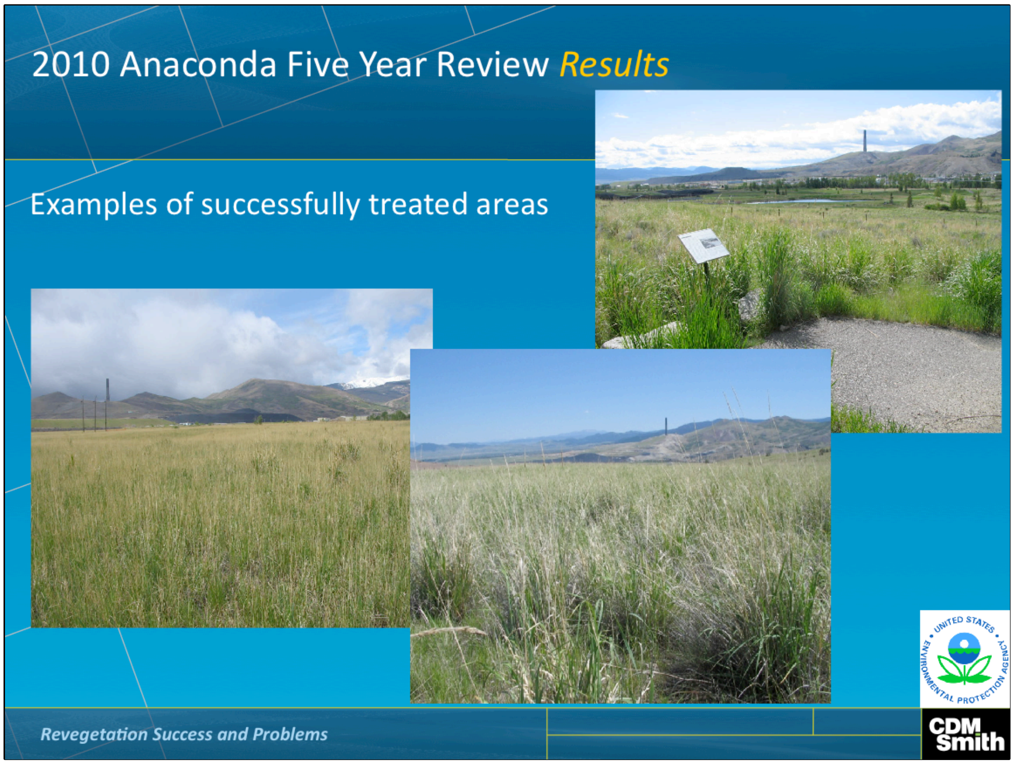


Figure: ES-1
Remedial Design and Remedial Action Implemented Areas



Bunch of unanswered questions. Include: 1) how well are we meeting EPA's objectives? 2) are soil conditions conducive to development of natural micro- flora and faunal populations necessary for natural nutrient cycling. A big problem is residual phytotoxicity.

2010 Anaconda Five Year Review *Results*

Examples of Poor Plant Establishment and Site Conditions

Residual Soil Phytotoxicity?

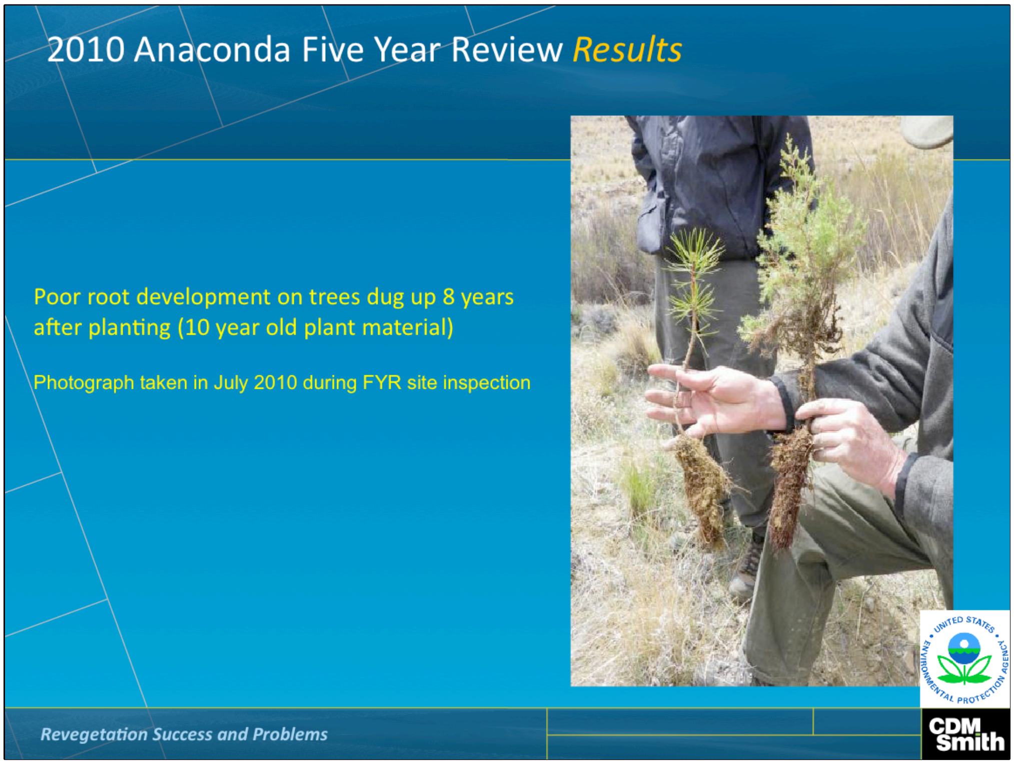
Revegetation Success and Problems

2010 Anaconda Five Year Review *Results*

Stressed, chlorotic bunchgrasses in the Stucky Ridge Moto-X Demo Plots

Photograph taken in July 2010 during FYR site inspection

Revegetation Success and Problems


2010 Anaconda Five Year Review *Results*
Poor root development on trees dug up 8 years after planting (10 year old plant material)
Photograph taken in July 2010 during FYR site inspection
Revegetation Success and Problems
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Concerns Identified in 2010 ARWW&S OU Five Year Review

- **Issues:**
  - "The ground surface in some in-place treated areas is barren and unprotected; exposed to wind and water erosion. These areas have signs of phytotoxicity"
  - "Concerns with phytotoxicity and the long-term permanence of vegetation"
- **Recommendation**:
  - "Determine why certain in-place treated areas have poor plant establishment"

Revegetation Success and Problems

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Principal Study Questions for Vegetation Response Investigation

Soil Properties/Vegetation Response

- What are the primary causes of revegetation shortcomings observed for in-place treated areas?
- To what degree are residual metal concentrations limiting the establishment and development of the reclamation plant species?
- Can the concentration of metals in the root zone be correlated to vegetation response?
- Is there a metal threshold above which in-place soil treatment is likely to fail and the selected remedy should be stripping/removal or coversoil application?

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Principal Study Questions (cont)

Long-term Protection of the Remedial Action

- Can the total residual soil metal concentration be related to the vulnerability of the reestablished plant community?
- What lands may require specific land management practices and more frequent inspections to protect the remedy?
- What are the appropriate types of post-RA land uses given different levels of residual root zone contamination?

2011 Vegetation Response Study Approach

- Correlate soil and vegetation data from in-place treated sites
- Evaluate metal/vegetation response literature
  - General literature
  - Upper Clark Fork River ecological risk studies and models
- Evaluate data from previous Anaconda vegetation/soil greenhouse studies

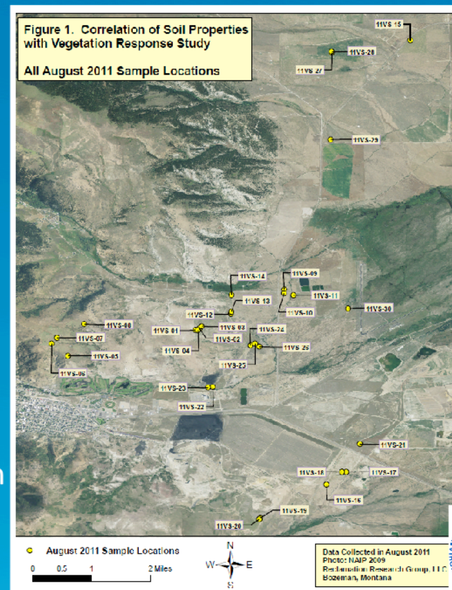
2011 Vegetation Response Study Parameters

- Total metal concentrations (As, Cd, Cu, Pb, Mn, and Zn)
- Soluble metal, cation, and anion concentrations (As, Cd, Cu, Pb, Mn, Zn, Ca, Mg, Na, NO_3, SO_4)
- pH and electrical conductivity
- Exchangeable metal and cation concentrations (As, Cd, Cu, Pb, Mn, Zn, Ca, Mg, Na and K)
- Cation exchange capacity
- Particle size and texture classification
- Percent rock fragments
- Acid base account
- Fertility (available N, P, and K)
- Organic matter
- Soil respiration
- Vegetation cover measurements

Vegetation Response Investigation

2011 Vegetation Response Study

- 30 sites investigated:
  - 26 in-place treated sites
  - 1 stripped and treated site
  - 3 untreated sites
- Sites ranged in age from 3 to 16 years
- Located 0.25 to 6.5 miles from smelters
- Soil contamination ranges from background to very high metal levels



Vegetation Response Investigation

Regional Phytotoxicity and Ecological Risk Research

Upper Clark Fork River NPL Sites

- EPA Baseline Risk Assessments for Anaconda Smelter and Clark Fork River NPL Sites
- ARCO Regional Ecorisk Field Investigation, Upper Clark Fork River Basin
- Several independent investigation of metal and arsenic impacts to soils, vegetation, and habitat in riparian and upland environments near Anaconda
- Spatial effects modeling of plant growth and soil metal concentrations associated with Anaconda smelter

East Helena (Montana) NPL Site

- East Helena Smelter NPL Site metal toxicity investigations

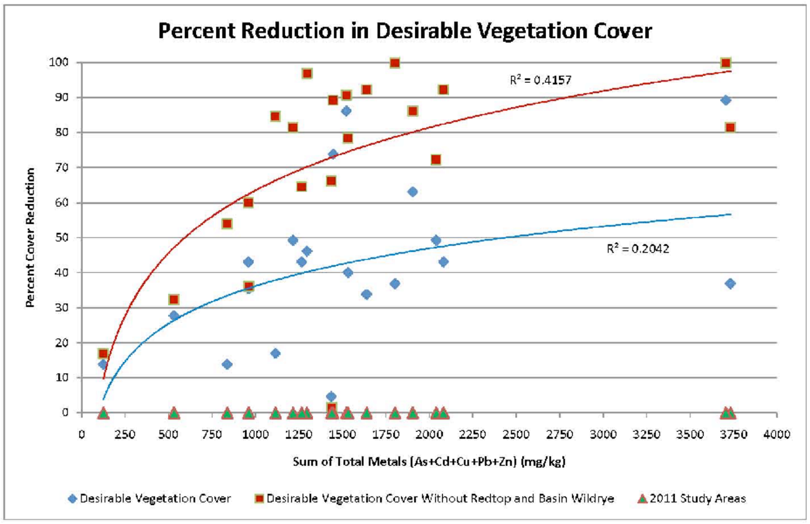
Anaconda Plant Growth Studies

Three well controlled greenhouse studies using Anaconda soil

- Smelter Hill Borrow Soil Greenhouse Investigation (ARCO 2002)
- Clear and Grub Greenhouse Investigation (ARCO 2005)
- Emergence and Growth Investigation (Martin 2009, Montana State Univ.)

Vegetation Response Investigation

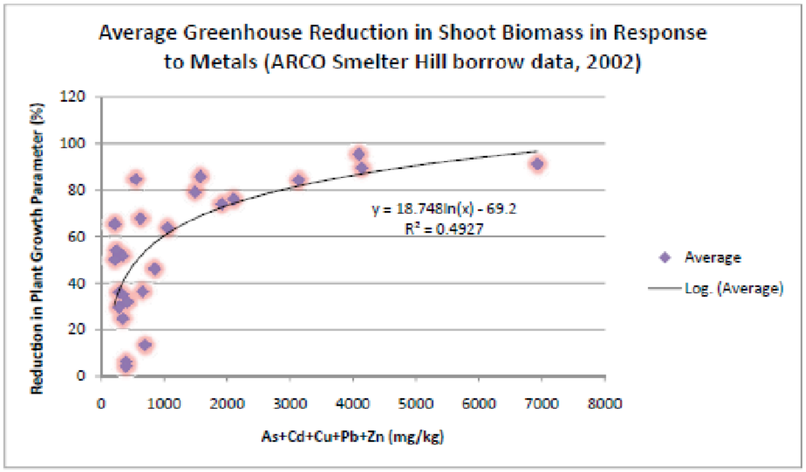
2011 EPA Field Work Results



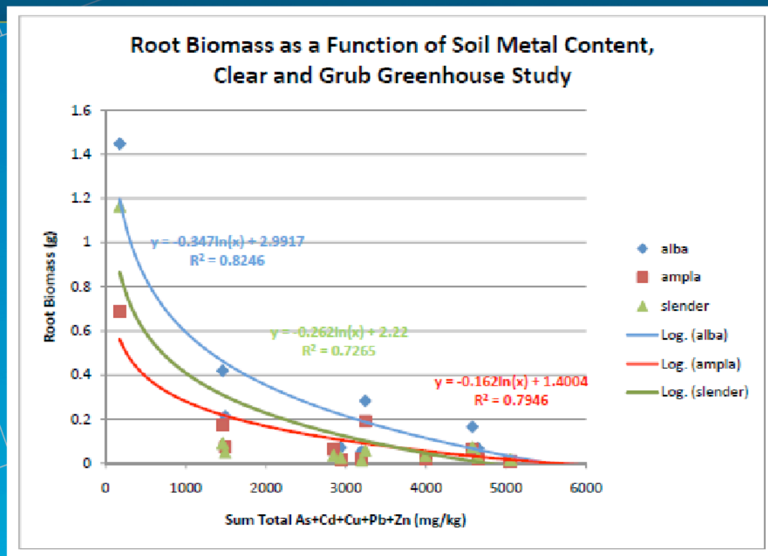
Vegetation Response Investigation

Smelter Hill Borrow Study Results (ARCO 2002)

- Average Plant growth reduction for all species and soil types

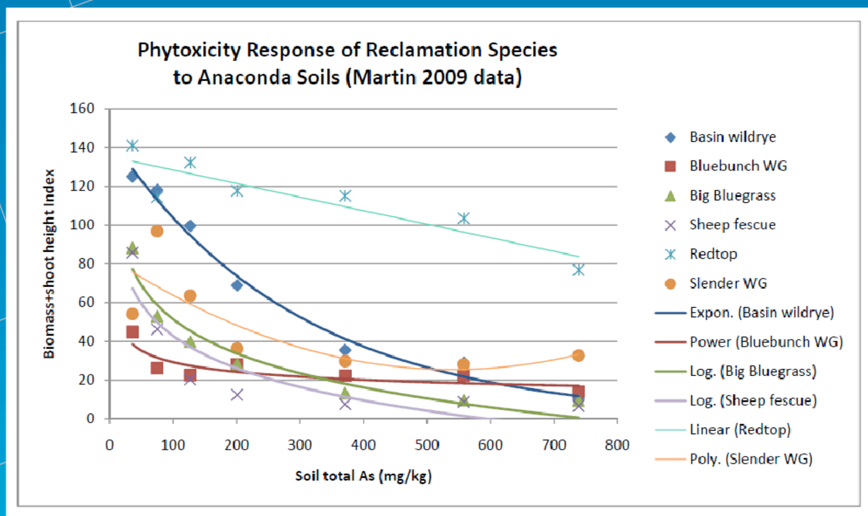


Clear and Grub Study Results (ARCO 2005)



Vegetation Response Investigation

Martin (MSU) Study Results



Vegetation Response Investigation

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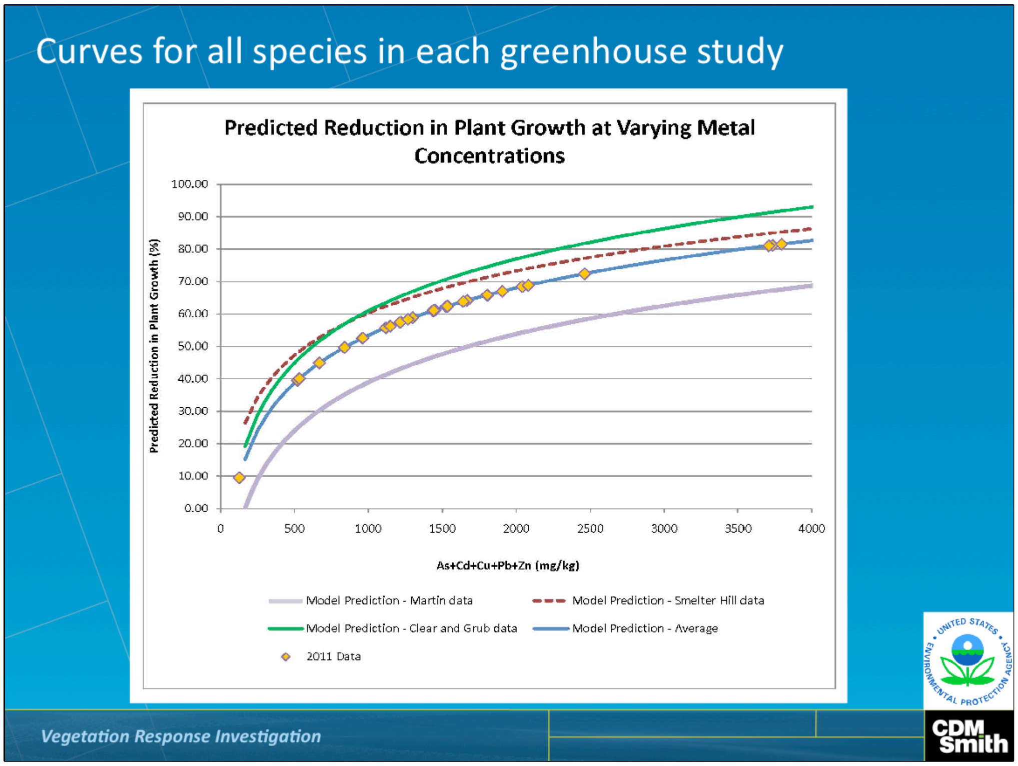

Comparison between three ARWW&S phytotoxicity models based on soil total metal levels and greenhouse measured reductions in plant root and shoot biomass across all species.

The field metal concentrations measured during the 2011 VS Investigation are plotted against each model suggesting expected reductions in field plant growth using greenhouse measured plant response.

Conclusions From 2011 Vegetation Response Investigation

Both the 2011-collected data and the previously conducted greenhouse biomass data showed similar trends:

- At near neutral soil pH, decreases in plant attributes occur with increasing soil contaminant concentrations
- Once soil pH is near neutral, successful revegetation is likely when the sum of total As+Cd+Cu+Pb+Zn concentration is less than about 1,000 mg/kg
- Highly contaminated soil can be revegetated, but when the total As+Cd+Cu+Pb+Zn concentration is more than about 2,000 mg/kg, successful revegetation is significantly jeopardized

But what is the in-place remediation risk threshold?

Development of the Total Metal Index (TMI)

- Developed in 2012 based on the results of the vegetation response study, a soil metal/plant growth index was derived to:
  - describe the general level of contaminant-related plant stress
  - be a remedial decision guideline to predict when in-place soil treatment is likely to result in a remediation failure
  - identify areas that may be under elevated metal-related stress and therefore heightened susceptibility to the additional stress of livestock grazing and other post-reclamation land uses
  - help land managers protect and promote the newly established plant communities on these lands.

Total Metal index

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ARWW&S OU Total Metal Index (TMI)

Soil Metal Index (Sum of Total As+Cu+Zn in mg/kg)	Soil Arsenic Index (mg/kg)	General Plant Stress Level Due to Soil Contaminants
700-	166-	Very Low
1,200	245	Low
1,450	290	Low-Moderate
1,700	330	Moderate
2,300	430	Moderate-High
2,900	530	High
3,500+	630+	Very High

Soil arsenic concentrations correlate well with the TMI and therefore represents a reasonable and valid means to identify areas where residual phytotoxic conditions are likely to exist

Questions?

- Vegetation Response Investigation
- Total Metal Index (TMI)

Vegetation Response Investigation

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Part 5 - Evaluating Remedial Performance (since 2005)

- Vegetation Management Plan (VMP)
- Performance Criteria and Compliance Standards
- Remedial Contingencies

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Vegetation Management Plan (VMP)

- Developed starting in 2003 and approved in 2009
- Revised in 2013
- Describes EPA's requirements for remediated land at ARWW&S OU pursuant to provisions set forth in the 1998 ROD and 2011 ROD Amendment.
- Specifically, the VMP identifies:
  - Agency and PRP responsibilities with respect to monitoring and inspecting reclaimed areas;
  - Evaluation methods and performance standards, and;
  - Requirements for conducting maintenance activities.

Evaluating Remedial Performance

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Remedial Action Performance Evaluations

Steps

1. Vegetation establishment and site stability (marks end of construction phase)
2. Monitoring and maintenance
3. Compliance determination

Criteria and Standards

1. Qualitative inspection by EPA using Operational and Functional (O&F) criteria. Performed after first full growing season
2. Monitoring and maintenance by Atlantic Richfield and EPA. Performed in years 2-10.
3. Compliance determination by EPA. Sites that pass are successfully remediated and move into Long-Term Inspection and Maintenance phase

Evaluating Remedial Performance

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Step 1 - Vegetation Establishment

- Conducted by CDM Smith for EPA

Evaluating Remedial Performance

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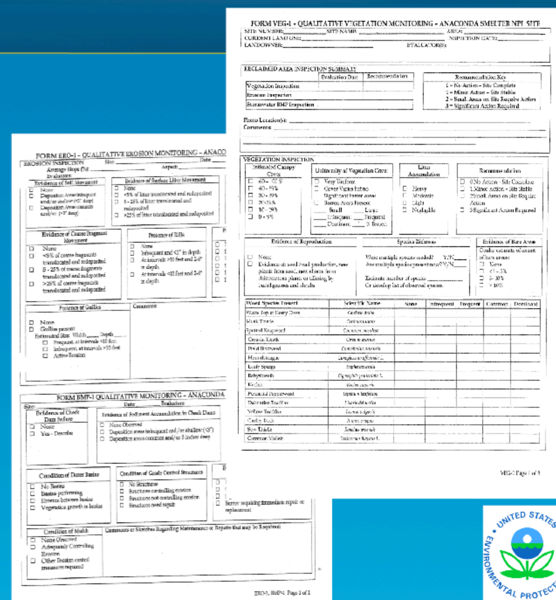
Step 2 - Short-term Monitoring and Maintenance

- Conducted by Atlantic Richfield
- Simplistic, annual evaluation:
  - vegetation condition
  - site stability
  - BMPs
- Generally lasts from 2-10 years
- Pre-compliance application


FORM VEG-1 - QUALITATIVE VEGETATION MONITORING - ANACONDA SMELTER NPL SITE

RECLAIMED AREA INSPECTION SUMMARY

VEGETATION INSPECTION

FORM ERO-1 - QUALITATIVE EROSION MONITORING - ANACO

EROSION INSPECTION

FORM BMP-1 QUALITATIVE MONITORING - ANACONDA

Step 3 - Compliance Determination

- Conducted by CDM Smith for EPA

- Separate methods and criteria for:
  - Upland Areas
  - Waste Management Areas (WMAs)
  - Steep Slope Areas (SSAs)

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Performance Compliance Standard for Upland Areas

Reclaimed Area Attributes	Standard	Description
Plant Community Measures and Soil Stability Indicators	LRES total score ≥115 points	Site is evaluated using LRES methodology. Involves scoring vegetation and soil attributes.

Performance Standards for Other Areas

- Waste Management Areas
  - Semi-quantitative estimates of perennial plant cover, noxious weeds, bare areas, and erosion.
- Steep Slope Areas
  - Semi-quantitative estimates woody plant density and erosion

Questions?

- Vegetation Monitoring
- Performance Standards

Part 6 Post Remediation Land Use and Management

- Coordination with landowners
- Categories
- Land management plans
- Revised Vegetation Management Plan

Coordination with Landowners

- Early soil remediation work was focused on property owned by the responsible party
- As work moved to private property, landowners wanted compensation for loss of grazing land
- Achievement of vegetation performance standards may take several years
- For rural residential developments, developers wanted cleanup to unrestricted use

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Changes to the Vegetation Management Plan

- 2009 Original VMP
  - Considered only vegetation response
  - All remediated soil areas treated the same, regardless of the contaminant concentrations remaining in the soil
  - Required a LRES score of 115 for two consecutive years to meet performance standards
- 2013 Revised VMP
  - Used knowledge gained from Vegetation Response Study to develop 6 land management categories
  - Early "off ramp" for sites cleaned to the highest land use (residential development)
  - Constructing storm water engineered controls around most contaminated lands reduce restrictions on private property

Post Remediation Land Use and Management

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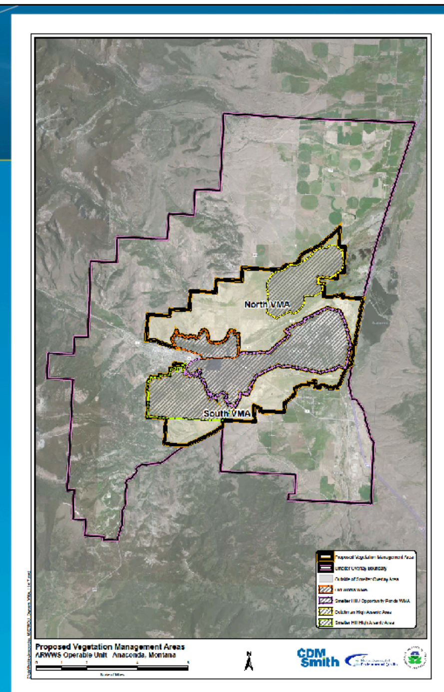
Long Term Land Management

Three Areas/Different Requirements

- Waste Management Areas
  - owned by PRP
  - long term I&M plan
  - EPA five year review
- Outer Areas (low metals/plant stress)
  - privately owned and managed
  - EPA five year review (*only monitoring requirement, not for Category 1 and 2)*
- Vegetation Management Areas
  - privately owned and managed
  - Land Management Plan required
  - PRP annual monitoring required
  - EPA five year review



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Land Management Categories

Based on the wide range of post-RA soil contaminant concentration levels, land ownership, and the various types of anticipated land uses, properties have been divided into six categories for the purposes of monitoring, maintenance, institutional controls, and determining compliance

- Category 1. Unrestricted Use Properties – soil less than 250 mg/kg arsenic;
- Category 2. Upland Properties - Low to Moderate (up to 1,700 mg/kg) total metal index (TMI) having enhanced reclamation;
- Category 3. Upland Properties - Moderate to High (>1,701 mg/kg) TMI having enhanced reclamation and design;
- Category 4. Upland Properties - Moderate to High (>1,701 mg/kg) TMI having enhanced reclamation and a land management plan where enhanced design is not feasible;
- Category 5. High Arsenic Areas (HAAs), and;
- Category 6. Waste Management Areas (WMAs).

Benefits of Improved Vegetation Management Plan

- 2009 Vegetation Management Plan
  - Reduce arsenic concentrations below the 1,000 mg/kg recreational/ open space agricultural land use action level
  - Meet vegetation performance standards (can take up to 10 years)
- 2013 Revised Vegetation Management Plan
  - Creates incentives for responsible party to complete better cleanup (e.g., further reduce arsenic and metals concentrations means less restrictions, monitoring, and maintenance)
  - Private landowners get property back quicker and with less restrictions – "ready for reuse"
  - Better cleanup means less emphasis on institutional controls

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Questions?