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CLARK FORK RIVER RIPARIAN EVALUATION SYSTEM (CFR RipES) FOR IMPACTED SOILS AND VEGETATION AREAS POLYGONS AND SLIGHTLY IMPACTED SOILS AND VEGETATION AREA POLYGONS

This evaluation is intended for use in the field by appropriately trained and qualified personnel. Knowledge of the local flora and of riverine channel and floodplain morphology, as well as visible indications of site contamination by metals, is required. The resulting polygon score is used to rate the degree of phytotoxic effect on site from mining-related metals contamination. Several items involve estimation of vegetation canopy cover. For these estimations, use the Daubenmire (1959) method of canopy cover estimation. This is a very efficient and reliable method for doing work of this nature, ***when the observers are adequately skilled, practiced, and have calibrated their individual assessments for consistency of call.*** Frequent and periodic tests and recalibration exercises are recommended for quality control.

Ocular estimation of detailed site characteristics may be difficult on large, brushy sites where visibility is limited, however extreme precision is not required. It is important to remember that the rating score is not an absolute value. The factor breakout categories and point weighting in the evaluation are based on the collective experience of an array of riparian scientists, soil scientists, range professionals, and land managers.

Each factor below is to be scored according to conditions observed within the polygon. The evaluator will estimate the parameter in question, select the appropriate scoring category, and enter that value on the field form. Do not introduce bias by using some preconceived notion of what the parameters should be under different conditions or at a different time.

Polygon Delineation Criteria

The CFR RipES Field Form for Impacted Soils and Vegetation Areas Polygons and Slightly Impacted Soils and Vegetation Areas Polygons is used on areas located within the historic 100-year floodplain (the area potentially containing tailings and contaminated soils). These polygons are delineated to circumscribe areas that fit the criteria defined above for sites with soils and/or vegetation impacted by mining-related metals contamination. These polygons will be further delineated using property ownership boundaries, certain landform topographic breaks, certain land use breaks (i.e., fences, roads, etc.), and other considerations as needed. A minimum mapping unit (MMU) of 400 square feet will be used to delineate the polygons.

Field Form

The field form for Impacted Soils and Vegetation Area and Slightly Impacted Soils and Vegetation Area Polygons is found in Appendix E. It is comprised of two main components: live vegetation integrity (representing 54.9 percent of the total score), and contamination severity (representing 45.1 percent of the total score). Ecologists view vegetation as an integrator of the environmental factors on the landscape, and it condition reflects back to them this integration. With this in mind, the questions on the field form that pertain to the live vegetation integrity component were designed to access the impact of mine wastes to the vegetation. Therefore, even though the field form distinguishes two main components, both components are measuring the magnitude of mine waste impacts within the polygon.

Live Vegetation Integrity (represents 54.9 percent of total score)
While some land use practices may cause relatively small amounts of bare ground, only phytotoxic soil conditions normally result in large percentages of unvegetated area on natural (wild) plant communities on river floodplain sites in this region. Tufted hairgrass (*Deschampsia cespitosa*) is identified as the plant species on the Upper Clark Fork River floodplain with the greatest positive correlation to near-surface metals contamination (Riparian and Wetland Research Program 1998).

1. **Live vegetative canopy cover (excluding tufted hairgrass [*Deschampsia cespitosa*]).** River floodplains located in inter montane valleys of western Montana, such as the Upper Clark Fork River Valley, will under natural, undisturbed conditions have a nearly complete canopy cover of live vegetation. Lack of vegetation cover indicates severe disturbance to riparian sites. Live vegetation cover helps to stabilize banks, control nutrient cycling, reduce water velocity, provide fish cover and food, trap sediments, reduce erosion, and reduce the rate of evaporation (Platts and others 1987). Live vegetation cover is ocularly estimated using the canopy cover method described by Daubenmire (1959). Do not include the canopy cover of tufted hairgrass (*Deschampsia cespitosa*) in with live vegetative canopy cover estimates, since along the Clark Fork River this species indicates mine waste contamination.

   Scoring (represents 25.6 percent of total points):
   21 = More than 90 percent of the polygon area is covered by the canopy of live plants (excluding tufted hairgrass [*Deschampsia cespitosa*]).
   14 = 80 to 90 percent of the polygon area is covered by the canopy of live plants (excluding tufted hairgrass [*Deschampsia cespitosa*]).
   7 = 70 to 80 percent of the polygon area is covered by the canopy of live plants (excluding tufted hairgrass [*Deschampsia cespitosa*]).
   0 = Less than 70 percent of the polygon area is covered by the canopy of live plants (excluding tufted hairgrass [*Deschampsia cespitosa*]).

2. **Amount of tufted hairgrass (*Deschampsia cespitosa*) present.** Tufted hairgrass (*Deschampsia cespitosa*) has been shown to correlate strongly (in non-agronomic plant communities) with the near-surface presence of contaminated tailings on the Clark Fork River floodplain (Riparian and Wetland Research Program 1998). The most phytotoxic sites (slickens) are devoid of vegetation, but with a lesser degree of contamination, tufted hairgrass is the first species found to survive (scattered, small amounts in stunted growth form). With still less concentration redtop (*Agrostis stolonifera*), sandbar willow (*Salix exigua*), water birch (*Betula occidentalis*), and Baltic rush (*Juncus balticus*) commonly are found along with the tufted hairgrass (*Deschampsia cespitosa*). On sites with very low concentrations of contaminated tailings, the tufted hairgrass is only a very small component of the plant community. On sites with no mine tailing impact, no tufted hairgrass (*Deschampsia cespitosa*) is likely to be found.

   Scoring (represents 29.3 percent of total points):
   24 = Tufted hairgrass (*Deschampsia cespitosa*) has less than 1 percent canopy cover in the polygon.
   18 = Tufted hairgrass (*Deschampsia cespitosa*) represents 1 to 5 percent of the canopy cover in the polygon.
   12 = Tufted hairgrass (*Deschampsia cespitosa*) represents 5 to 20 percent of the canopy cover in the polygon.

6 = Tufted hairgrass (*Deschampsia cespitosa*) represents 20 to 40 percent of the canopy cover in the polygon.
0 = Tufted hairgrass (*Deschampsia cespitosa*) represents over 40 percent of the canopy cover in the polygon.

Contamination Severity (represents 45.1 percent of total score)
Contaminant inputs into riparian systems from tailings and associated metal laden sediment and water (i.e. contaminated material) are responsible for ecological impacts (i.e., phytotoxicity, lack of vegetation in general, or limited species richness, impaired water quality, and detrimental effects to aquatic and terrestrial biota. Severity of contamination is measured by the extent of contaminant deposits (volume and concentration), effects to riparian vegetation (tailing-caused bare ground or sparsely vegetated areas), and risk of release of contamination to the stream by mobilization and due to proximity to the river. Contaminated material includes contaminated tailings, soil/tailing mixtures, buried alluvium, buried soil, and cover soil. These media definitions and contaminant concentrations are reported in Table 3-6 of the *Remedial Investigation* (ARCO 1998).

3. **Percent of polygon area with bare ground caused by tailings.** Bare ground is soil not covered by plants, litter or duff, downed wood, or rocks larger than 2.5 inches. Bare ground caused by tailings must be distinguished from bare ground resulting from other causes by the presence of either of two indicators of metals contamination: 1) the presence of tufted hairgrass (*Deschampsia cespitosa*) in the polygon, and 2) metal salts visible on the soil surface during periods of dry weather.

   Human land uses causing bare ground, such as livestock grazing, recreation, roads, and other agricultural or industrial activities, are excluded from consideration here. Furthermore, not all bare ground represents a deterioration of riparian health. Sediment deposits by the river and other natural bare ground are also excluded. (The authors recognize that sediment deposits can be due to human activities in the watershed. However, it is difficult to train observers to make consistent calls from such criteria. Therefore, we have chosen to not use this in the evaluation system.) The evaluator is to count only the bare ground in the polygon that is attributable to metals contamination.

   Scoring (represents 14.6 percent of total points):
   12 = Less than 1 percent of the polygon is bare ground caused by tailings.
   9 = 1 to 5 percent of the polygon is bare ground caused by tailings.
   6 = 5 to 15 percent of the polygon is bare ground caused by tailings.
   3 = 15 to 30 percent of the polygon is bare ground caused by tailings.
   0 = Over 30 percent of the polygon is bare ground caused by tailings.

4. **Contamination concentration and depth (copper).** The concentration of the COCs, as well as depth of the contamination, are important considerations in selecting appropriate remedial actions. The degree to which contaminated materials impair ecosystem function is related to the depth of contaminated material present in a polygon. Infrequent and thin deposits of contaminants may be assimilated into the ecosystem without major environmental effects, whereas thick and/or spatially extensive deposits can arrest normal ecological processes. Vertical extent of contaminated material (that may include exposed tailings, contaminated soil or sediment, buried contaminated tailings, re-deposited contaminated tailings, etc.) is often difficult to estimate due to the complexity of a fluvial system such as the Upper Clark Fork River. Extensive deposits of thick tailings may abut areas lacking contamination. Analytical data are required because contamination cannot be visually determined. This is especially true where contaminated water has percolated through dark native

soil leaving no visual contaminant marker. A Sampling and Analysis Plan will be developed to specify soil sampling procedures for the CFR RipES.

The degree of impact to riparian ecosystems by contaminated material is a function of the toxicity of contaminants present and the extent of contamination above the levels at which the riparian system can attenuate or assimilate them. Five contaminants were identified as being present in the CFR OU at levels of concern for human and environmental health. Human health risk-based action levels for arsenic are not included in this score. Of the five environmental COCs (Cu, Pb, Zn, Cd, and As) at the site, copper is used as a surrogate for the group of five listed COCs.

The geometric mean value for copper concentration in unimpacted soils was defined in the *Remedial Investigation* (ARCO 1998) as 303 ppm.

Scoring (represents 12.2 percent of total points):
10 = Less than 300 ppm copper in the top 18 inches of the soil profile.
8 = Between 301 and 600 ppm copper in the top 18 inches of the soil profile.
6 = Between 601 and 900 ppm copper in the top 18 inches of the soil profile.
4 = Between 901 and 1,200 ppm copper in the top 18 inches of the soil profile.
2 = Between 1,201 and 1500 ppm copper in the top 18 inches of the soil profile.
0 = More than 1,501 ppm copper in the top 18 inches of the soil profile.

5. **Contamination mobility (geochemical).** Complex biogeochemical processes dictate the degree to which contaminants present in riparian corridors may be released to the environment. Principle factors controlling the release of contamination include physical and geochemical characteristics of the contaminated media. The principal physical factor controlling contaminant release is erosion that is addressed by the degree to which the riparian corridor is covered with stabilizing vegetation and the proximity of the contaminants to the stream channel. Principle geochemical factors implicated in the mobilization of contaminants are pH and the presence of readily soluble metal surface salts (efflorescent salts). Low soil pH conditions result in elevated metal levels in the soil solution and increased probability that metals will be leached deeper in the soil profile, or ultimately delivered to shallow aquifers hydraulically connected to the river.

Scoring (represents 14.6 percent of total points):
12 = pH of top 18 inches of the soil profile is greater than 6.5 s.u.
8 = pH of top 18 inches of the soil profile is between 5.5 and 6.5 s.u.
4 = pH of top 18 inches of the soil profile is between 4.5 and 5.5 s.u.
0 = pH of top 18 inches of the soil profile is less than 4.5 s.u.

Efflorescent metal salts commonly occur on the soil surface of barren tailing deposits and commonly express metal levels that are orders of magnitude above the bulk concentration of the underlying tailing material. The salts are transient features on the landscape, most commonly observed during periods of dry weather, appearing when contaminated waters are wicked to the soil surface and evaporated, thereby precipitating a salt. Surface salts are commonly white in color, but metal salts also may occur as brown, yellow, blue, or green coatings on the soil surface. Not all surface salts have elevated metal content, but when they do occur on contaminated material, elevated metal levels are expected.

Scoring (represents 3.7 percent of total points): (*If the soils are wet, efflorescent metal salts may not be visible. In that case, replace both Actual Score and Possible Score with NA.*)

3 = No efflorescent metal salts are present on the soil surface during dry periods.
0 = Efflorescent metal salts are present on the soil surface during dry periods.

Overall Scoring:
At least 75.0% = Slightly Impacted Soils and Vegetation Area
Below 75.0% = Impacted Soils and Vegetation Area

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