Chapter 3. Affected Environment and Environmental Consequences

Soils and Revegetation

Introduction

This section discusses soils and soil productivity in the project area and in the analysis area, as well as revegetation potential as it relates to mine reclamation. Soil consists of the mineral and organic matter on the surface that supports vegetation and stores moisture. Soils are defined by their specific physical, chemical, and biological characteristics. Soil productivity is the ability of a given soil to support plant growth under natural conditions.

Changes from the Draft Environmental Impact Statement

Public concerns regarding the “Soils” resource section of the DEIS were related primarily to the analysis of revegetation potential, in particular a general disbelief in the predicted success of revegetation activities. While the Coronado has expertise in managing vegetation and found the DEIS predictions to be reasonable, it was also recognized after reviewing public comments that making such predictions in the environmental impact statement (EIS) document may be premature. The ultimate outcome of revegetation efforts depends entirely on the selected techniques, adaptive management approaches, and success criteria, which would only be fully identified in the final reclamation and closure plan submitted with the final MPO. Expected revegetation success has been approached in the final environmental impact statement (FEIS) in the following way, which differs from the DEIS. First, the reclamation techniques and revegetation concepts currently proposed by Rosemont Copper are disclosed, including soil salvage techniques and stockpile locations, surface preparation and treatment, and seed application techniques (see the “Revegetation Techniques Proposed by Rosemont Copper” part of this resource section). Second, the available greenhouse studies and onsite reclamation test plot results are reviewed to provide pertinent information about the demonstrated outcome of revegetation attempts (see the “Assessment of Revegetation Potential of Waste Rock and Tailings Facilities” part of this resource section). Finally, the Coronado’s purpose and goals of revegetation are discussed (see the “Desired Condition” and “Revegetation Success Criteria” parts of this resource section).

Species-specific predictions of revegetation success over time have been removed from the FEIS, since there was inadequate information available to support those predictions. Predictions of revegetation success and monitoring requirements will be addressed in a final revegetation plan, to be approved by the Coronado prior to approval of the final MPO. However, general information on desired conditions for vegetation has been included in the “Environmental Consequences” part of this resource section. This information is intended to disclose the best professional judgment of Coronado specialists regarding the expected outcome of revegetation activities (see the “Desired Condition” and “Revegetation Success Criteria” parts of this resource section).

Further detail concerning the phasing and timing of concurrent reclamation has been obtained from Rosemont Copper, and this information is presented in the FEIS (see the “Revegetation Techniques Proposed by Rosemont Copper” part of this resource section).

Disturbance acreage has been updated in the FEIS. Impacts on soil resources are related directly to areas of surface disturbance. For the DEIS, any area contained within the perimeter fence was considered disturbed. This has been refined for the FEIS; areas of disturbance largely lie within the security fence, along the primary access road and utility maintenance road and the utility corridor. The area between the perimeter and security fences would not be disturbed, other than discrete locations for facilities like groundwater test wells and the compliance check dam, which are included...
in the accounting of disturbance (see the “Soil Productivity Directly Lost to Mine Activities” part of this resource section).

**Issues, Cause and Effect Relationships of Concern**

One significant issue was identified during scoping concerning soils and soil productivity. Mine activities that disturb the soil and remove vegetation can cause erosion, loss of the ability of soil to sustain vegetation, and the movement of sediment into surface waters.

**Issue 1: Impact on Land Stability and Soil Productivity**

Ground disturbance from clearing vegetation, grading, and stockpiling soils has the potential to accelerate erosion and reduce soil productivity. The tailings and waste rock facilities could be unstable over time, and reclamation may not adequately result in a stable, revegetated landscape. The geochemical composition of tailings and waste rock facilities may not support native vegetation. Soils are nonrenewable resources. Damage, disturbance, and removal of the soil resource may result in a loss of soil productivity, physical structure, and ecological function across the proposed mine site and across downgradient lands. The mining area could potentially act as a barrier to sourcing and supporting natural downslope transportation of geological material, water, and nutrients through alluvial, eolian, and fluvial processes.

**Issue 1 Factors for Alternative Comparison**

1. Qualitative assessment of long-term stability of tailings and waste rock facilities, including expected results of reclamation
2. Acres and quantitative level of disturbance leading to lost soil productivity
3. Qualitative assessment of the potential for revegetation of tailings and waste rock facilities
4. Qualitative evaluation of alteration of soil productivity and soil development
5. Tons per year of sediment delivery to Davidson Canyon, Cienega Creek, or other streams and washes, compared with background sediment loading

**Analysis Methodology, Assumptions, Uncertain and Unknown Information**

Temporally, any potential impacts on soils would occur during the construction, active mining, and reclamation and closure phases. However, soil is a nonrenewable resource, and the loss of soils within the project area is considered to be permanent unless reclamation occurs that places salvaged soil in these areas and results in successful revegetation to criteria established by the Coronado. Because of the need for reclamation to be completed and successful, the temporal bounds of analysis for soils encompasses the postclosure phase, as well.

The spatial area of analysis for soils encompasses the project area (i.e., mine process facilities, fuel storage tanks, processing fluid pipelines, tailings facility, and waste rock facility), access roads, and utility corridor. The analysis area for soils is depicted in figure 31, and the soil types shown in figure 31 are described in table 17. This is the appropriate area for analyzing direct and indirect impacts to soils, as it contains all soil-disturbing activities associated with the action alternatives. The reroute of the Arizona National Scenic Trail was not included in the analysis area for soils; the level of ground disturbance expected from use of the trail is similar to that experienced from the casual recreational use that already occurs in the area. Further, any vegetation-clearing activities for either the trail or the
Figure 31. Analysis area for soils
trailheads is likely to affect no more than 10 to 20 acres, which represents less than one hundredth of one percent of the watershed area for Upper Cienega Creek, which receives most of the runoff from the area in which the trail reroute is located.

Table 17. Soil characteristics in the analysis area

<table>
<thead>
<tr>
<th>Map Unit Symbol</th>
<th>Map Unit Name</th>
<th>Soil Type</th>
<th>Acres</th>
<th>Erosion Potential</th>
<th>Percent Analysis Area*</th>
<th>Number of Site Locations on Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>McF</td>
<td>Mabray-Chiricahua-Rock outcrop association, steep</td>
<td>Cobbly sandy loam and very gravelly loam</td>
<td>2,753</td>
<td>Severe</td>
<td>21%</td>
<td>4</td>
</tr>
<tr>
<td>LgF</td>
<td>Lampshire-Graham-Rock outcrop association, steep</td>
<td>Very cobbly loam</td>
<td>1,926</td>
<td>Severe</td>
<td>15%</td>
<td>3</td>
</tr>
<tr>
<td>HaF</td>
<td>Hathaway gravelly sandy loam, 20 to 50% slopes</td>
<td>Gravelly sandy loam</td>
<td>1,584</td>
<td>Moderate</td>
<td>12%</td>
<td>2</td>
</tr>
<tr>
<td>LcF</td>
<td>Lampshire-Chiricahua association, steep</td>
<td>Very cobbly loam</td>
<td>1,513</td>
<td>Severe</td>
<td>11%</td>
<td>3</td>
</tr>
<tr>
<td>CoE</td>
<td>Chiricahua cobbly sandy loam, 10 to 45% slopes</td>
<td>Cobbly sandy loam</td>
<td>1,279</td>
<td>Moderate</td>
<td>10%</td>
<td>2</td>
</tr>
<tr>
<td>BhD</td>
<td>Bernardino-Hathaway association, rolling</td>
<td>Gravelly clay loam</td>
<td>910</td>
<td>Slight</td>
<td>7%</td>
<td>2</td>
</tr>
<tr>
<td>FrF</td>
<td>Faraway-Rock outcrop complex, 30 to 60% slopes</td>
<td>Very cobbly fine sandy loam</td>
<td>836</td>
<td>Severe</td>
<td>6%</td>
<td>2</td>
</tr>
<tr>
<td>TrF</td>
<td>Tortugas-Rock outcrop complex, 25 to 60% slopes</td>
<td>Very cobbly loam</td>
<td>414</td>
<td>Severe</td>
<td>3%</td>
<td>3</td>
</tr>
<tr>
<td>WgE</td>
<td>White House gravelly loam, 10 to 35% slopes</td>
<td>Gravelly loam</td>
<td>406</td>
<td>Moderate</td>
<td>3%</td>
<td>3</td>
</tr>
<tr>
<td>CtB</td>
<td>Comoro soils, 0 to 5% slopes</td>
<td>Gravelly sandy loam</td>
<td>386</td>
<td>Slight</td>
<td>3%</td>
<td>4</td>
</tr>
<tr>
<td>HhE2</td>
<td>Hathaway soils, 1 to 40% slopes, eroded</td>
<td>Gravelly sandy loam</td>
<td>267</td>
<td>Moderate</td>
<td>2%</td>
<td>1</td>
</tr>
<tr>
<td>An</td>
<td>Anthony soils</td>
<td>Sandy loam</td>
<td>205</td>
<td>Slight</td>
<td>2%</td>
<td>3</td>
</tr>
<tr>
<td>CmE</td>
<td>Castro very gravelly sandy loam, 10 to 40% slopes</td>
<td>Very gravelly sandy loam</td>
<td>153</td>
<td>Moderate</td>
<td>1%</td>
<td>1</td>
</tr>
<tr>
<td>CgE</td>
<td>Caralampi gravelly sandy loam, 10 to 40% slopes</td>
<td>Gravelly sandy loam</td>
<td>132</td>
<td>Moderate</td>
<td>1%</td>
<td>3</td>
</tr>
<tr>
<td>Rn</td>
<td>Rock outcrop-Lithic Haplustolls association</td>
<td>Not applicable</td>
<td>128</td>
<td>Not Rated</td>
<td>1%</td>
<td>4</td>
</tr>
<tr>
<td>SoB</td>
<td>Sonora gravelly sandy loam, 1 to 8% slopes</td>
<td>Gravelly sandy loam</td>
<td>106</td>
<td>Slight</td>
<td>&lt;1%</td>
<td>6</td>
</tr>
<tr>
<td>BgF</td>
<td>Barkerville-Gaddess association, steep</td>
<td>Cobbly sandy loam</td>
<td>95</td>
<td>Severe</td>
<td>&lt;1%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal – Area with Slight Erosion Potential</strong></td>
<td></td>
<td>1,607</td>
<td></td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal – Area with Moderate Erosion Potential</strong></td>
<td></td>
<td>3,821</td>
<td></td>
<td>29%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal – Area with Severe Erosion Potential</strong></td>
<td></td>
<td>7,537</td>
<td></td>
<td>58%</td>
<td></td>
</tr>
<tr>
<td><strong>Total – Analysis Area</strong></td>
<td></td>
<td></td>
<td>13,093</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

Source: Natural Resources Conservation Service (2010b).

* Excludes soils representing less than 0.5% of analysis area.

Soils of the Coronado National Forest were identified using the National Resources Conservation Service (2010b) Web Soil Survey. In addition, site-specific soil profile surveys were conducted by...
Tetra Tech in March 2007 and August 2010 to assess the potential for soils to support reclamation and revegetation (Tetra Tech 2010b).

Qualitative assessments of long-term stability for waste rock and the character of risks to stability through time are based on stability analysis by Tetra Tech (2010a); for tailings, the qualitative assessments are based on stability analysis by AMEC Earth and Environmental (2009).

The area and quantitative level of disturbance leading to lost soil productivity are measured by the footprint of surface-disturbing mine activities. The qualitative evaluation of alteration of soil productivity and soil development is analyzed by assessing the potential for revegetation and potential for erosion after revegetation occurs. Sediment delivery to Davidson Canyon and Cienega Creek from the watershed as a whole under each alternative was estimated by Zeller (2012; 2010a; 2010b); sediment volume was converted to tonnage using a bulk density of 1.5 grams per cubic centimeter. Expected changes in sediment delivery and total suspended solid concentrations were modeled using the Pacific Southwest Interagency Committee (1968) method for sediment yield analysis. This analysis specifically modeled changes in sediment delivery at the point at which SR 83 crosses Barrel Canyon. Sediment delivery to other streams and washes was not analyzed. In particular, sediment delivery to Upper Cienega Creek was not analyzed, as there is no significant surface disturbance within this watershed. Analysis of sediment delivery is included in this section as an indication of how erosion might change in the watershed; effects on the geomorphology of Davidson Canyon and Cienega Creek from delivery of this sediment downstream are more fully analyzed in the “Surface Water Quality” resource section in chapter 3.

### Summary of Effects by Issue Factor by Alternative

Table 18 presents the summary comparison of impacts from each alternative.

<table>
<thead>
<tr>
<th>Issue Factor</th>
<th>No Action</th>
<th>Proposed Action</th>
<th>Phased Tailings</th>
<th>Barrel</th>
<th>Barrel Trail</th>
<th>Scholefield-McCleary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issue 1.1: Qualitative assessment of long-term stability of tailings and waste rock facilities, including expected results of reclamation</td>
<td>None</td>
<td>Modeling indicates that waste rock and tailings would be more stable than required by regulations</td>
<td>Same as for proposed action</td>
<td>Same as for proposed action</td>
<td>Same as for proposed action</td>
<td>Same as for proposed action</td>
</tr>
</tbody>
</table>
### Chapter 3. Affected Environment and Environmental Consequences

<table>
<thead>
<tr>
<th>Issue Factor</th>
<th>No Action</th>
<th>Proposed Action</th>
<th>Phased Tailings</th>
<th>Barrel</th>
<th>Barrel Trail</th>
<th>Scholefield -McCleary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issue 1.2: Acres and quantitative level of disturbance leading to lost soil productivity</td>
<td>No changes from the proposed mine. Disturbance from grazing, recreation use, and fire activity would continue. Recreation use and fire activity would increase with population and climate change.</td>
<td>5,602</td>
<td>5,471</td>
<td>5,421</td>
<td>5,878</td>
<td>6,187</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Issue 1.3: Qualitative assessment of the potential for revegetation of tailings and waste rock facilities</th>
<th>None</th>
<th>Onsite test plots and greenhouse studies indicate that revegetation can produce a vegetation volume that is similar to historic climax conditions under proper management</th>
<th>Same as for proposed action</th>
<th>Same as for proposed action</th>
<th>Same as for proposed action</th>
<th>Same as for proposed action</th>
</tr>
</thead>
</table>

| Issue 1.4: Qualitative evaluation of alteration of soil productivity and soil development | None | Soil productivity would be reclaimed following placement of soil or soil/rock cover and revegetation, with the exception of 955 acres of mine pit | Same as for proposed action | Same as for proposed action | Same as for proposed action | Same as for proposed action |
Chapter 3. Affected Environment and Environmental Consequences

<table>
<thead>
<tr>
<th>Issue Factor</th>
<th>No Action</th>
<th>Proposed Action</th>
<th>Phased Tailings</th>
<th>Barrel</th>
<th>Barrel Trail</th>
<th>Scholefield -McCleary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issue 1.5: Tons per year of sediment delivery to Davidson Canyon, Cienega Creek, or other streams and washes, compared with background sediment loading</td>
<td>32,600</td>
<td>16,000</td>
<td>16,500</td>
<td>22,170</td>
<td>20,300</td>
<td>24,200</td>
</tr>
</tbody>
</table>

**Affected Environment**

**Relevant Laws, Regulations, Policies, and Plans**


Soil resources and reclamation are managed in accordance with the following guidelines:

- FSM 2550, “Soil Management” (U.S. Forest Service 2010), and R3 Technical Guidance (U.S. Forest Service 2013);
- FSM 2840, “Reclamation” (U.S. Forest Service 1990);
- FSM 2070, “Vegetation Ecology” (U.S. Forest Service 2008);
- FSM 1940, “Inventory, Monitoring, and Assessment Activities” (U.S. Forest Service 2009);
- U.S. Department of Agriculture “Soil Survey Manual” (U.S. Department of Agriculture Soil Survey Division Staff 1993);
- Title 27 Arizona Revised Statutes (ARS) Chapter 1, Article 4;
- Forest Service General Technical Report W0-68, “Terrestrial Ecological Unit Inventory Technical Guide: Landscape and Lane Unit Scales” (Winthers et al. 2005);
- FS-1006, “Native Plant Materials Policy: A Strategic Framework” (U.S. Forest Service 2012a);
- Comprehensive Environmental Response, Compensation, and Liability Act, which establishes prohibitions and requirements concerning closed and abandoned hazardous waste sites and provides for liability of persons responsible for releases of hazardous waste at these sites;
- Arizona Administrative Code (AAC) R18-7-201, “Arizona Soil Remediation Levels:” Soil remediation levels would be applied to determine the extent to which reclamation must mitigate any known soil contamination during mine closure; soil remediation levels are also applicable in the event of contamination or spills that occur during active mine life; and
- AAC R18-9-A209, “Aquifer Protection Permit Closure Requirements:” Investigation and characterization of potential soil contamination is a component of closure and contingency plans required under the Arizona Aquifer Protection Permit process.
Chapter 3. Affected Environment and Environmental Consequences

Forest Service Guidance

General Management Direction for
Soils on the Coronado National Forest

Federal policy for soil management requires the Forest Service, in accordance with FSM 2550, to do the following: promote and sustain biological and hydrological function, manage ecosystems to maintain or improve soil quality, and use soil properties to assess the condition and potential effects on soil while planning and implementing projects (U.S. Forest Service 2010). Soils are managed by the Forest Service in accordance with direction contained in the forest plan (U.S. Forest Service 1986), in recognition of the fact that soil productivity affects the quality and quantity of water that originates in the watersheds of the Coronado National Forest and provides water to southern Arizona and New Mexico. Management activities are directed to protect or enhance watershed conditions in recognition of the connection between hydrologic function and soil productivity. Under management directives in the forest plan, best management practices “will be used to minimize the time of recovery to a satisfactory erosion level, minimize soil productivity loss, improve water quality and minimize channel damage” (U.S. Forest Service 1986:38). Further, the forest plan states that management plans, including those for mineral extraction, should carefully consider activities that affect sensitive soils and riparian areas to minimize soil damage (U.S. Forest Service 1986:38–40).

The Forest Service’s reclamation objectives and management policies for lands disturbed by mineral extraction and associated activities are outlined in FSM 2840. The Forest Service manages reclamation efforts in order to reduce the environmental impacts of mineral extraction and ensure that disturbed lands are returned to a use that is consistent with long-term forest land and resource management plans. According to FSM 2840, the following policies are to be implemented to achieve the Forest Service’s reclamation objectives:

1. Reclamation shall be an integral part of plans of operation that propose surface disturbance.
2. All lands disturbed by mineral activities shall be reclaimed to a condition that is consistent with forest land and resource management plans, including applicable State air and water quality requirements.
3. All reclamation requirements included in a plan of operations shall include measurable performance standards. Reclamation requirements shall be those that are reasonable, practicable, and necessary to attain standards.
4. Reclamation shall be undertaken in a timely fashion and occur sequentially with ongoing mineral activities.
5. Reclamation bonds, sureties, or other financial guarantees shall ordinarily be required for all mineral activities that require a plan of operations; dollar amounts of such guarantees shall be sufficient to cover the full cost of reclamation.
6. To the extent practicable, reclaimed NFS land shall be free of long-term maintenance requirements.

Additional Forest Service objectives and management policies for disturbed lands are also addressed in FSM 2070:

1. The Forest and Rangeland Renewable Resource Planning Act of 1974, as amended by the National Forest Management Act of 1976 (Section 6, codified at 16 U.S.C. §1600(g)), provides for diversity of plant and animal communities based on the suitability and capability of the specific land areas in order to meet overall multiple-use objectives and within the
multiple-use objectives of a land management plan. The act also requires, where appropriate, to the degree practicable, to preserve the diversity of tree species similar to that existing in the region controlled by the plan.

2. Section 515 of the Surface Mining Control and Reclamation Act of 1988 (30 U.S.C. 1201, 1201 (note), 1236, 1272, 1305) directs the establishment on the mine areas, and all other lands affected, of a diverse, effective and permanent vegetative cover of the same seasonal variety native to the areas of land to be affected and capable of self-regeneration and plan succession at least equal in extent of cover to the natural vegetation on the area, except that introduced species may be used in the revegetation process where desirable and necessary to achieve the approved postmining land use plan.

State Requirements
Reclamation is also managed under the Arizona Mined Land Reclamation Act, which provides a mechanism for requiring the reclamation of mined lands to a safe, stable condition.

Title 27 ARS Chapter 1, Article 4, specifies the requirements for new mines to submit a reclamation plan to the Arizona State Mine Inspector. The State Mine Inspector is responsible for reclamation on private property. Two criteria contained in the statute specifically involve soils and soil productivity:

- Section 27-971(B)(9) requires that the plan include information on proposed reclamation measures that would be taken to address erosion control and stability; and
- Section 27-974 specifies that prior to disturbance, soil shall be conserved unless otherwise it is unable to be conserved or it is unnecessary to do so.

Investigation and characterization of potential soil contamination is contained under the Arizona Aquifer Protection Permit regulations. The aquifer protection permit was issued to Rosemont Copper on April 3, 2012. Under these regulations, a closure plan is required that includes the following:

- A site investigation plan that includes a summary of relevant site studies already conducted and a proposed scope of work for any additional site investigation necessary to identify the following: the lateral and vertical extent of contamination in soils and groundwater, using applicable standards; the approximate quantity and chemical, biological, and physical characteristics of each waste, contaminated water, or contaminated soil proposed for removal from the facility; the approximate quantity and chemical, biological, and physical characteristics of each waste, contaminated water, or contaminated soil that would remain at the facility; and information regarding site conditions related to pollutant fate and transport that may influence the scope of sampling necessary to characterize the site for closure.
- A closure design that identifies the following: the method used, if any, to treat any material remaining at the facility; the method used to control the discharge of pollutants from the facility; any limitation on future land or water uses created as a result of the facility’s operations or closure activities; and the methods used to secure the facility.

Existing Conditions
Soil Occurrence and Characteristics
The project area is in the Basin and Range physiographic province of southeastern Arizona.
The range of soil characteristics that occur in the project area includes mixed variations of sandy
Chapter 3. Affected Environment and Environmental Consequences

loam, cobbly loam, and gravelly loams on gentle to steep slopes, along with valley bottoms with rock
outcrops on side slopes.

Surface water and soils transported from the project area flow into various drainages, which then flow
first into Davidson Canyon and eventually into Cienega Creek. Table 17, above, describes each of the
soil units represented in figure 31.

Existing Soil Disturbance

Existing Mineral Related Disturbance

Mineral related disturbance from previous mineral exploration and extraction is evident in the area,
as described in the “Geology, Minerals, and Paleontology” resource section of chapter 3. Historic
mining activity began in the mid-1800s. By the 1880s, the production of mines in the Rosemont and
Helvetia mining districts supported the construction and operation of two smelters, one on each side
of the Santa Rita Mountains. Mine dumps, road ballast, and slag deposits from historic mining
operations are visible, but not a dominant feature in the landscape. A slag deposit in the SW ¼ of
Section 29 (Township 18 South, Range 16 East) is visible from NFSR 4058. Downslope of the
Naragansett Mine works are heavily vegetated dumps. Mining production in the project area ceased in
1951.

Rosemont Copper recently conducted exploratory drilling in the project area to ascertain the location,
distribution, and geological configuration of the mineral deposits within its mineral claim area. Since
2005, Rosemont Copper has drilled 87 boreholes. The most recent drilling occurred in 2011 and 2012,
when 12 boreholes were drilled. These areas of disturbance include well pads, typically measuring
30 by 60 feet, and access roads. In total, 266 locations have been drilled to investigate the ore body.

The University of Arizona’s School of Natural Resources and the Environment, in conjunction with
Rosemont Copper, is currently conducting an onsite revegetation program on privately owned land to
determine which reclaimable soils and overburden within the proposed project area are conducive to
vegetation growth, using slopes and materials similar to the proposed reclaimed waste rock and
tailings facilities. Existing vegetation and topsoil were removed from the test site area and replaced
with a variety of soil materials and treatment covers to test revegetation success. The cumulative total
of the test plots’ disturbance area is approximately 8 acres, located on private land.

Existing Grazing Related Disturbance

The majority of NFS land surrounding the project area is currently under permit for livestock grazing.
The Rosemont Copper property is part of an existing ranching facility. Currently, Rosemont Copper
holds term grazing permits on four allotments: Rosemont, Thurber, Greaterville, and DeBaud.
The four allotments permitted to Rosemont Copper contain a mixture of Federal, State, and private
lands totaling approximately 22,190 acres, with 19,370 acres of land suitable for livestock grazing.
Cattle grazing disturbs soil by removing protective vegetation and compacting soil surfaces (Shaw et
al. 1991). The Coronado currently employs a rotational grazing system on all of its allotments as part
of an adaptive management strategy in order to allow pastures to rest when necessary, which results in
faster recovery. See the “Livestock Grazing” resource section for more detail.

Existing Recreation Related Disturbance

Existing soil disturbance from recreation related activities is the result of trails, access roads, off-
highway vehicle areas, other developed recreation facilities, and recreation such as camping in
undeveloped areas as well. Forest roads, routes, and trails in the project area total 285 miles.
Immediately adjacent to the project area are two off-highway vehicle staging areas that see considerable recreation use. Travel in the project area is restricted to designated routes only; however, some unauthorized off-trail motorized use does occur. See the “Recreation and Wilderness” resource section for more detail on existing use levels and trends.

**Overall Current Condition of Watershed**

The erosion potential for the entire watershed is addressed by a combination of the erosion potential of various soils (see table 17) and the state of vegetation on the watershed. There are two vegetative conditions to consider: the historic climax plant community and the current conditions. The historic climax plant community represents the plant community that existed at the time of European immigration and settlement. It is the plant community that was in dynamic equilibrium with its environment and was best adapted to the unique combination of environmental factors associated with the site. The historic climax plant community was obtained from the Ecological Site Descriptions prepared by the Natural Resources Conservation Service (2006; 2010a). Fehmi (2007) notes that the Rosemont Copper Mine site is visibly degraded from the historic climax plant community, primarily because of the substantial cover of juniper and mesquite present, which resulted from historical fire prevention strategies and overgrazing by cattle. Once the canopy cover of these species increases to more than 25 percent, site instability and soil erosion can occur.

The “General Ecosystem Survey for the Coronado National Forest” (Shaw et al. 1991:5) further compares the current condition of the watershed with the historic climax condition (table 19). In general, vegetation basal area currently represents approximately 5 percent of the surface, whereas under historic climax conditions, it would represent 15 to 25 percent of the surface. Likewise, bare soil would represent 20 to 45 percent of the surface under historic climax conditions, but it currently represents 30 to 60 percent of the surface.

**Table 19. Summary of the potential plant community and soil conditions based on the general ecosystem survey**

<table>
<thead>
<tr>
<th>Landform</th>
<th>State</th>
<th>Overstory</th>
<th>Rock Fragments</th>
<th>Litter</th>
<th>Vegetation Basal Area</th>
<th>Bare Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>South-facing slopes</td>
<td>Historic climax</td>
<td>15%</td>
<td>50%</td>
<td>5%</td>
<td>20%</td>
<td>25%</td>
</tr>
<tr>
<td>South-facing slopes</td>
<td>Current</td>
<td>25%</td>
<td>50%</td>
<td>5%</td>
<td>5%</td>
<td>40%</td>
</tr>
<tr>
<td>North-facing slopes</td>
<td>Historic climax</td>
<td>50%</td>
<td>30%</td>
<td>40%</td>
<td>15%</td>
<td>20%</td>
</tr>
<tr>
<td>North-facing slopes</td>
<td>Current</td>
<td>50%</td>
<td>30%</td>
<td>40%</td>
<td>5%</td>
<td>30%</td>
</tr>
<tr>
<td>Elevated flats</td>
<td>Historic climax</td>
<td>15%</td>
<td>30%</td>
<td>5%</td>
<td>25%</td>
<td>45%</td>
</tr>
<tr>
<td>Elevated flats</td>
<td>Current</td>
<td>25%</td>
<td>30%</td>
<td>5%</td>
<td>5%</td>
<td>60%</td>
</tr>
</tbody>
</table>

Source: Shaw et al. (1991: Map Units 490.1–490.3).

While describing “current” conditions, the general ecosystem survey is a regional document, and the descriptions are both generalized and dated. More recent current rangeland conditions have been monitored by the Coronado but are not directly comparable to the historic climax plant community. Rangeland monitoring results are shown in table 20. Rangeland monitoring analysis collects quantitative data and expresses the results in four categories: poor, fair, good, and excellent. Soil condition is a qualitative assessment of soil characteristics and is expressed as unsatisfactory, impaired, or satisfactory, with “satisfactory” being the highest level obtainable. Rangeland monitoring indicates that both vegetation and soil condition have generally improved over time.
The Forest Service has recently undertaken a comprehensive and consistent assessment of watershed condition on all national forests (U.S. Forest Service 2012b). The Coronado completed the assessment in the analysis area in 2011. The assessment includes soils, forest cover, forest health, terrestrial invasive species, and rangeland condition, all of which are indicative of soil and vegetation conditions. Five watersheds were assessed for 12 specific indicators of watershed health in the project area. The results of these 12 indicators were then used to assign an overall condition classification. These watersheds are more general than those discussed in the “Surface Water Quantity” section; the correlation between the two sections is included in the footnotes to table 21. Also, these conditions only refer to those portions of the watershed that are on the Coronado National Forest (U.S. Forest Service 2012b). These recent watershed conditions are summarized in table 21.

In summary, based on the available surveys, including the General Ecosystem Survey, rangeland surveys, and the watershed condition assessment, the project area is functioning at a sufficient level to support present uses such as livestock grazing. The trends for the condition of vegetation and soils are improving.
### Table 21. Watershed condition classification within the analysis area

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Box Canyon Wash</th>
<th>Davidson Canyon*</th>
<th>Sycamore Canyon</th>
<th>Fortynine Wash–Cienega Creek†</th>
<th>Empire Gulch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquatic biota</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td>Riparian/watershed vegetation</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>Water quality</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Water quantity</td>
<td>Fair</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>Aquatic habitat</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>Roads and trails</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>Soil</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Forest cover</td>
<td>Good</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>Good</td>
</tr>
<tr>
<td>Forest health</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Terrestrial invasive species</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>Rangeland vegetation</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>Overall watershed condition classification</td>
<td>Functioning – at risk</td>
<td>Functioning – at risk</td>
<td>Functioning – at risk</td>
<td>Functioning – at risk</td>
<td>Functioning – at risk</td>
</tr>
</tbody>
</table>

Notes:
- = The indicator is not applicable to these watersheds.

Explanation of ratings (Potyondy and Geier 2011):

- **Good** – A rating of “good” is the expected indicator value in a watershed with high geomorphic, hydrologic, and biotic integrity relative to its natural potential condition, and it suggests that the watershed is functioning properly with respect to that indicator.
- **Fair** – A rating of “fair” is the expected indicator value in a watershed with moderate geomorphic, hydrologic, and biotic integrity relative to its natural potential condition, and it suggests that the watershed is functioning at risk with respect to that indicator.
- **Poor** – A rating of “poor” is the expected indicator value in a watershed with moderate geomorphic, hydrologic, and biotic integrity relative to its natural potential condition, and it suggests that the watershed is functioning at unacceptable risk with respect to that indicator.
- **Functioning – at risk** – The rating “functioning – at risk” is an overall assessment of the overall state of the watershed, based on the combined individual indicator values, and it indicates that the watershed has only moderate geomorphic, hydrologic, and biotic integrity relative to its natural potential condition.

* This watershed includes the areas encompassed by the waste rock, tailings, and plant site facilities. This watershed corresponds to the following watersheds analyzed in the “Surface Water Quantity” resource section of the EIS: Davidson Canyon, Mulberry Canyon, Papago Canyon, Scholefield Canyon, McCleary Canyon, Wasp Canyon, Barrel Canyon, Upper Barrel Canyon, and East Canyon.

† This watershed corresponds to the following watersheds analyzed in the “Surface Water Quantity” resource section of the EIS: Oak Tree Canyon and North Canyon.

### Soils Suitable for Reclamation

In March 2007 and August 2010, Tetra Tech studied soil profiles from 14 sites that represent the characteristic soil types within the project area in order to assess the potential for soils in the project area to be salvaged for vegetation growth media for reclamation (Tetra Tech 2007a; 2007b, 2010b). Salvaging would involve stripping the natural soils from areas to be disturbed by mining and stockpiling those soils for later use in reclamation activities. The study analyzed soils for physical and chemical properties, including soil acidity and alkalinity, electrical conductivity, sodium adsorption ratio, nutrient content, and acid base accounting. Tetra Tech (2010b) concluded that potential soil salvage was available in five general areas: north-aspect soils, south-aspect soils, residual benches and sideslopes, alluvial terraces, and alluvial washes/fans. The locations of the soils suitable for
salvaging approximately correspond to the Bernardino-Hathaway association (BhD) and Hathaway gravelly sandy loam (HaF), as depicted in figure 29.

The north-aspect soils available for salvage are sandy loams with an approximate salvage depth of 12 inches. South-aspect soils available for salvage are sandy loams that have approximately 6 inches of suitable soil for salvage, with occasional deeper deposits in pockets. Residual benches and sideloses consist of clays and clay loams; while soils extend deeper in these areas, the salvage depth is generally limited to approximately 12 inches. Alluvial terraces generally consist of gravelly loams that have a salvage depth of approximately 18 inches. The alluvial washes/fans consist of loamy sands and sandy loams located in the bottoms of drainages, and these have the deepest soil salvage potential—approximately 18 to 36 inches.

Estimated Soil Salvage Volumes

The estimated soil salvage areas and volumes in the dry-stack tailings facility, waste rock facility, and other disturbed areas of the Rosemont Copper Mine are based on soil texture, organic matter, coarse fragments, and nutrient content. The estimated areas and volumes of soil salvage were estimated for all alternatives in November 2010 (Tetra Tech 2010b) and updated in July 2012 to specifically reflect the Barrel Alternative (CDM Smith 2012a). The volume of available soil salvage differs by alternative and is discussed in the “Environmental Consequences” part of this resource section.

Existing Indications of Revegetation Success

Revegetation success has reportedly been observed in the proposed pit area where weathered bedrock material has been used for reclamation of exploration sites (Tetra Tech 2007a). The primary physical properties limiting salvage include high clay content and high coarse-fragment content. Soils on the ridgetops, especially in the northwestern portion of the project area, have high clay concentrations in the subsoil that may require special consideration for reclamation planning. High percentages of coarse fragments are generally common throughout the project area. The primary chemical property limiting salvage is nutrient content. Nutrient content is variable throughout the survey area, according to the results of the sampling conducted in 2007 and 2010 (Tetra Tech 2007b).

The completed studies by the University of Arizona School of Natural Resources and the Environment provide data from greenhouse and onsite test plots that indicate that revegetation success is feasible. These studies are described later in this resource section.

Environmental Consequences

Direct and Indirect Effects of Each Alternative

No Action Alternative

Under the no action alternative, there would be no impact on the existing soil conditions on public lands resulting from mine development, other than that involved with the reclamation of any existing exploration related or baseline collection disturbances. Impacts on soil resources from recreational use, livestock grazing, and fire activity would continue to occur. Levels of soil disturbance from these uses could increase as increasing population in southern Arizona results in additional recreational use of the area. Levels of livestock grazing on NFS lands are expected to be stable in the future, and additional soil disturbance from this use is not expected to occur. Fire activity could increase with expected trends from climate change, potentially resulting in increased soil impacts.
Impacts Common to All Action Alternatives

Impacts common to all action alternatives include stability analyses, descriptions of expected revegetation techniques, and the assessment of the potential for revegetation to successfully occur. Impacts that differ between alternatives include disturbed acreage, sediment delivery, soil salvage volumes, and constraints with respect to reclamation.

Stability of Tailings and Waste Rock Facilities

The overall stability of the tailings and waste rock facilities is critical to reclamation success. Structurally, the tailings and waste rock facilities must be designed to prevent mass wasting and collapse in order to provide a stable surface for vegetation growth. AMEC Earth and Environmental (2009) conducted stability analyses of the dry-stack tailings facility, and Tetra Tech (Mohseni 2010) conducted stability analyses of the waste rock facility. In both cases, modeling indicated that the designed waste rock and tailings facilities are more stable than what is required by regulations, based on the planned crest height, bench widths, and slopes. The minimum factor-of-stability values required under regulations as best available control technology are 1.0 for seismic failure and 1.3 for static failure. As modeled, the factor-of-stability values for the tailings and waste rock facilities range from 1.0 to 1.2 for seismic failure and from 1.9 to 2.3 for static failure.

Soil Development and Productivity Lost to Erosion after Reclamation

During the premining and active mining phases, soil loss from the watershed would be reduced by using structural and engineered sediment controls, as well as concurrent revegetation, primarily on the waste rock perimeter buttresses. Postclosure, reduction of soil loss from the watershed would be dependent on structural and engineered sediment controls and on revegetation of the site to prevent erosion from occurring. Reduction of the actual erosion of soil from surfaces can only be accomplished through revegetation of the site or the use of protective rock cover, which is generally undesirable with respect to recovery of soil productivity.

All in-place natural soils would be lost during premining and active mining phases within the security fence, within the pit area, and along the primary access road and utility maintenance road. During reclamation, replacement growth media would be placed on the site surface and seeded for revegetation. Growth media would be a mix of salvaged soils from the site. The growth media are expected to support vegetation but would not develop a natural soil profile for many decades after closure of the site. The presence of a natural soil profile typically results in higher productivity because of better retention of soil moisture available for plants and less risk of loss by erosion. Unlike the mine site, the soils along the pipeline and power line routes would be disturbed but not removed. These areas would likely use less complicated revegetation techniques, such as hydroseeding and erosion control features, with no need for the placement or treatment of salvaged soils as described later in this section for the waste rock and tailings facilities.

Revegetation would only be considered complete when certain reclamation criteria have been met. It is the responsibility of the Coronado to determine these success criteria and the responsibility of Rosemont Copper to develop methodologies and techniques, including adaptive management that can meet the revegetation criteria. The final reclamation and closure plan would provide further detail on the techniques to be employed, as well as monitoring and success criteria required for approval by the Coronado. The long-term purpose of undertaking revegetation is to create a self-sustainable ecosystem that would promote site stability and repair hydrologic function. Specific goals include providing soil stability to prevent erosion by stormwater runoff and wind and providing vegetation...
cover that is appropriate to support postmining land uses, in this case wildlife habitat, livestock grazing, and recreation.

**Soil Salvage Plans**

Detailed plans for soil salvage have been proposed for the preferred alternative (CDM Smith 2012b). Stockpile locations are specific only to the Barrel Alternative, but the following procedures would be used to manage salvaged soil for all action alternatives.

- Soil salvaging in specific areas would not take place until it is necessary to disturb those areas for mine activities.
- At soil salvage locations, pits would be dug to verify removal depth of salvage soils.
- Erosion and sediment controls would be installed both upslope and downslope of soil removal areas. These controls are required under the stormwater pollution prevention plan that would be mandatory under the mine’s Arizona Pollutant Discharge Elimination System Multi-sector General Permit for stormwater. Dust controls would also be implemented.
- Soil would be transported using haul trucks or other equipment to a stockpile location or directly to the waste rock and tailings facilities. If possible, transportation would be direct, rather than incorporating long-term stockpiles. Stockpiles would be located in four different areas over the life of the mine.
- Stockpile 1 is located immediately east of the phase 2 dry-stack tailings facility, with a footprint of approximately 18 acres and a capacity of 501,000 cubic yards. This stockpile would be used generally through the first 8 years of operations.
- Stockpile 2 is located south of stockpile 1 and would be used for years 8 through 14 of operations. Stockpile 2 has a footprint of approximately 39 acres and a capacity of 502,000 cubic yards.
- Stockpile 3 is located on the top of the waste rock facility and would be used for years 14 through 22 of operations. Stockpile 3 has a footprint of 22 acres and a capacity of 335,000 cubic yards.
- Stockpile 4 is also located on the top of the waste rock facility and would be used for years 14 through 22 of operations and during closure. Stockpile 4 has a footprint of 18 acres and a capacity of 283,000 cubic yards.
- Soil stockpiles would be managed to reduce potential erosion, designed to reduce potential for compaction to maintain air circulation and drainage, and if anticipated to be in existence for at least 1 year, would have vegetative cover using a broadcast seed mix and possibly stabilizers like straw mulch with tackifier.

**Revegetation and Expected Revegetation Success**

**Desired Condition**

The Coronado has determined the general desired vegetation condition for the reclaimed waste rock and tailings facilities over time. The desired vegetation condition represents what can reasonably be expected on disturbed, reclaimed growth medium that would exhibit more xeric soil moisture conditions than those found on natural areas. Desired conditions are included in the FEIS as a somewhat general, qualitative description of what the reclaimed sites will support following revegetation, at different time periods. The desired conditions have been developed through a review of the Natural Resources Conservation Service Ecological Site Descriptions, test plot data, and expertise of Coronado staff and others.
It should be noted that the desired condition is not the same as reclamation success criteria, which are more site specific and quantitative, and will be fully described in the revegetation plan currently being developed and to be approved with the final MPO. This plan will use the process described in the Adaptive Management Technical Guide developed by the U.S. Department of the Interior (Williams et al. 2009), and further detail is shown in the “Revegetation Success Criteria” part of this resource section. Desired vegetation condition varies across the site, influenced primarily by aspect and soil texture and chemistry. There are six revegetation site types that are considered for the reclaimed waste rock and tailings facilities, as summarized in table 22. The spatial distribution over time of these areas across the site is summarized in figures 32 through 35.

**Table 22. Desired vegetation condition over time**

<table>
<thead>
<tr>
<th>Revegetation Site Type</th>
<th>Vegetation Type</th>
<th>Number of Species</th>
<th>Percent Canopy Cover – 5 Years after Planting</th>
<th>Percent Canopy Cover – 10 Years after Planting</th>
<th>Percent Canopy Cover – 15 Years after Planting</th>
<th>Percent Canopy Cover – 20 Years after Planting</th>
</tr>
</thead>
<tbody>
<tr>
<td>East-facing slopes</td>
<td>Grasses</td>
<td>5 to 10</td>
<td>10 to 30</td>
<td>10 to 30</td>
<td>10 to 30</td>
<td>10 to 30</td>
</tr>
<tr>
<td></td>
<td>Shrubs</td>
<td>3 to 5</td>
<td>1 to 5</td>
<td>1 to 5</td>
<td>1 to 15</td>
<td>1 to 15</td>
</tr>
<tr>
<td>West-facing slopes</td>
<td>Grasses</td>
<td>5 to 10</td>
<td>10 to 20</td>
<td>10 to 30</td>
<td>10 to 30</td>
<td>10 to 30</td>
</tr>
<tr>
<td></td>
<td>Shrubs</td>
<td>3 to 5</td>
<td>1 to 5</td>
<td>1 to 5</td>
<td>1 to 15</td>
<td>1 to 15</td>
</tr>
<tr>
<td>Slopes with increased rock cover</td>
<td>Grasses</td>
<td>3 to 7</td>
<td>5 to 20</td>
<td>10 to 20</td>
<td>10 to 20</td>
<td>10 to 20</td>
</tr>
<tr>
<td></td>
<td>Shrubs</td>
<td>1 to 3</td>
<td>0 to 5</td>
<td>1 to 5</td>
<td>3 to 5</td>
<td>3 to 5</td>
</tr>
<tr>
<td>South-facing slopes</td>
<td>Grasses</td>
<td>5 to 10</td>
<td>5 to 15</td>
<td>10 to 20</td>
<td>10 to 20</td>
<td>10 to 30</td>
</tr>
<tr>
<td></td>
<td>Shrubs</td>
<td>1 to 3</td>
<td>1 to 5</td>
<td>1 to 5</td>
<td>1 to 5</td>
<td>1 to 5</td>
</tr>
<tr>
<td></td>
<td>Succulents</td>
<td>1 to 3</td>
<td>1 to 3</td>
<td>1 to 3</td>
<td>1 to 5</td>
<td>1 to 5</td>
</tr>
<tr>
<td>North-facing slopes</td>
<td>Grasses</td>
<td>5 to 10</td>
<td>10 to 30</td>
<td>10 to 30</td>
<td>15 to 45</td>
<td>15 to 45</td>
</tr>
<tr>
<td></td>
<td>Shrubs</td>
<td>3 to 7 (&lt;10 years after planting)</td>
<td>3 to 10</td>
<td>3 to 10</td>
<td>5 to 10</td>
<td>5 to 15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 to 10 (&gt;10 years after planting)</td>
<td>3 to 10</td>
<td>3 to 10</td>
<td>5 to 10</td>
<td>5 to 15</td>
</tr>
<tr>
<td></td>
<td>Trees</td>
<td>1 to 2</td>
<td>0 to 3</td>
<td>1 to 5</td>
<td>1 to 5</td>
<td>2 to 5</td>
</tr>
<tr>
<td>Level areas</td>
<td>Grasses</td>
<td>5 to 10</td>
<td>10 to 30</td>
<td>10 to 30</td>
<td>15 to 40</td>
<td>15 to 40</td>
</tr>
<tr>
<td></td>
<td>Shrubs</td>
<td>3 to 5</td>
<td>1 to 5</td>
<td>1 to 10</td>
<td>1 to 10</td>
<td>1 to 10</td>
</tr>
<tr>
<td></td>
<td>Trees</td>
<td>1 to 2</td>
<td>0 to 3</td>
<td>0 to 3</td>
<td>1 to 3</td>
<td>1 to 3</td>
</tr>
</tbody>
</table>

Preliminary Administrative FEIS – Cooperator Review July 2013
DRAFT – Deliberative – Subject to Change
Figure 33. Reclamation area: revegetation types year 10
Chapter 3. Affected Environment and Environmental Consequences

Figure 34. Reclamation area: revegetation types year 15
Figure 35. Reclamation area: revegetation types year 22
As shown in table 22, while grasses and shrubs would occur across all revegetation site types, trees are likely only to consistently occur on north-facing slopes and level areas, and succulents are most likely to consistently occur on southern exposures. Note that succulents do not offer significant cover, so although the percent cover would not change over time, the density of these plants still would increase. Each revegetation site type is described below. Slope aspect influences soil moisture, with the greatest amount of soil moisture being retained on the north slopes and the least on south-facing slopes. More soil moisture is also retained on flat areas, compared with angled slopes such as on the sides of the waste rock and tailings facilities. Elevation also influences plant communities. The waste rock and tailings facilities fall roughly from 4,600 to 5,500 feet above mean sea level, with some areas extending as high as 5,700 feet above mean sea level.

**East-facing slopes** — Vegetation would be composed primarily of warm season perennial grasses, some forbs, and small shrubs. Small shrubs or sub-shrubs may be present but would not be clearly visible from a distance. Trees may be present but would be very widely distributed and would make up a small amount of the plant community. Long slope runs may require additional rock cover for soil stabilization.

**West-facing slopes** — Vegetation would be composed primarily of warm season perennial grasses, some forbs, and small shrubs. Small shrubs or sub-shrubs may be present but would not be clearly visible from a distance. Trees may be present, but would be very widely distributed and would make up a small amount of the plant community. West-facing aspects would look similar to east-facing aspects but may be composed of different species within the same functional groups.

**Slopes with increased rock cover** — Vegetation would be composed primarily of warm season perennial grasses, mixed forbs, and a minor component of small shrubs, compared with east- and west-facing slopes. Because of the steepness of these slopes, increased rock cover would be placed over the soil cap for erosion protection and increased stability. Species that favor rocky soils would be used. These areas are expected to be stable, even with relatively low amounts of vegetation cover; they would primarily be on the western side of the facilities and would not be visible from SR 83.

**South-facing slopes** — Vegetation would be composed primarily of warm season perennial grasses, some forbs, and small shrubs. Small shrubs or sub-shrubs may be present but would not be clearly visible from a distance. Trees may be present but would be very widely distributed and would make up a small amount of the plant community. Palmer agaves would be transplanted in clumps to mimic how they appear on undisturbed sites. Other culturally significant plans, such as sotol (*Dasylirion wheeleri*) and beargrass (*Nolina microcarpa*), may also be planted in clumped distribution on these portions of the facility. The greater amount of surface rock and less grass cover in these areas would be clearly visible.

**North-facing slopes** — Vegetation would be composed of warm season perennial grasses and forbs, mixed with shrubs and dispersed trees. A higher density of shrubs and trees would establish on these slopes, compared with savannas or level-ground grasslands. It would take a number of years for shrubs and trees to grow large enough to be visible from a distance. Some species of trees may be deciduous, losing their leaves during the winter.

**Level areas** — Vegetation would be composed primarily of warm season perennial grasses, mixed forbs, an increased amount of small shrubs, compared with east- and west-facing slopes, and widely dispersed trees. Shrubs and trees would give a savanna-like appearance and would be visible from a distance once the plant community matures, which would take a number of years.
Plant species — A variety of plant species would be incorporated into the seed mixes used for revegetation, informed in part by greenhouse and test plot studies conducted by Rosemont Copper, reference area vegetation, and the success of previously revegetated areas on the mine site. This seed mix would be expected to adaptively change over time based on the success of different species. In addition, other species not specifically seeded would be expected to opportunistically grow, including those that might be in the natural seed bed in the salvaged soil. It is important to note that the seed/planting mix and desired conditions do not account for mesquite, acacia, mimosa, or one-seed juniper. It is expected that these species would readily colonize the reclaimed sites and therefore would not be seeded. They are not included in desired condition estimates of species richness or canopy cover. Their presence would contribute additional species richness and cover beyond what is described here.

The species currently proposed for the seed mix are summarized in table 23, along with a list of additional species that are being considered for seeding/planting.

### Table 23. Species expected to be present

<table>
<thead>
<tr>
<th>Grasses</th>
<th>Forbs</th>
<th>Shrubs/Succulents</th>
<th>Trees</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Planned Seed Mix</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Scientific Name</strong></td>
<td><strong>Common Name</strong></td>
<td><strong>Scientific Name</strong></td>
<td><strong>Common Name</strong></td>
</tr>
<tr>
<td>Bouteloua curtipendula</td>
<td>Sideoats grama</td>
<td>Baileya multiradiata</td>
<td>Desert marigold</td>
</tr>
<tr>
<td>Eragrostis intermedia</td>
<td>Plains lovegrass</td>
<td>Eschscholzia minutiflora</td>
<td>Mexican gold poppy</td>
</tr>
<tr>
<td>Bouteloua gracilis</td>
<td>Blue grama</td>
<td>Calliandra eriophylla</td>
<td>Fairy duster</td>
</tr>
<tr>
<td>Elymus sp.</td>
<td>Bottlebrush squirreltail</td>
<td>Celtis ehrenbergiana</td>
<td>Desert hackberry</td>
</tr>
<tr>
<td>Digitaria californica</td>
<td>Arizona cottontop</td>
<td>Cercocarpus sp.</td>
<td>Mountain mahogany</td>
</tr>
<tr>
<td>Hilaria belangeri</td>
<td>Curly-mesquite</td>
<td>Dasylirion wheeleri</td>
<td>Desert spoon</td>
</tr>
<tr>
<td>Leptochloa dubia</td>
<td>Green sprangletop</td>
<td>Fouquieria splendens</td>
<td>Ocotillo</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Garrya wrightii</td>
<td>Wright’s silktassel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nolina microcarpa</td>
<td>Beargrass</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rhus trilobata</td>
<td>Skunkbush sumac</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rhus virens</td>
<td>Evergreen sumac</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yucca elata</td>
<td>Soaptree yucca</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yucca schottii</td>
<td>Schott’s yucca</td>
</tr>
</tbody>
</table>
Chapter 3. Affected Environment and Environmental Consequences

<table>
<thead>
<tr>
<th>Grasses</th>
<th>Forbs</th>
<th>Shrubs/Succulents</th>
<th>Trees</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Potential Additions</strong></td>
<td><strong>Scientific Name</strong></td>
<td><strong>Common Name</strong></td>
<td><strong>Scientific Name</strong></td>
</tr>
<tr>
<td>Bothriochloa barbinodis</td>
<td>Cane</td>
<td>beardgrass</td>
<td>Dalea</td>
</tr>
<tr>
<td>Bouteloua hirsuta</td>
<td>Hairy</td>
<td>grama</td>
<td>Eriogonum spp.</td>
</tr>
<tr>
<td>Bouteloua chondrosioides</td>
<td>Sprucetop</td>
<td>grama</td>
<td>Krameria sp.</td>
</tr>
<tr>
<td>Bouteloua repens</td>
<td>Slender</td>
<td>grama</td>
<td>Krascheninnikovia sp.</td>
</tr>
<tr>
<td>Heteropogon contortus</td>
<td>Tanglehead</td>
<td></td>
<td>Menodora sp.</td>
</tr>
<tr>
<td>Lycurus sp.</td>
<td>Wolfstail</td>
<td></td>
<td>Parthenium incanum</td>
</tr>
<tr>
<td>Sporobolus cryptandrus</td>
<td>Sand</td>
<td>dropseed</td>
<td>Zinnia sp.</td>
</tr>
</tbody>
</table>

**Revegetation Success Criteria**

In practice, revegetation would only be considered complete when certain reclamation criteria have been met. An adaptive management approach following the “Adaptive Management Technical Guide” developed by the U.S. Department of the Interior would be used to make adjustments to reach those criteria if monitoring indicates that the currently proposed methods prove ineffective (Williams et al. 2009). In the DEIS, the Coronado made an effort to both establish these success criteria and offer predictions regarding the ultimate revegetation success. After consideration of public comments, the Coronado determined that both of these efforts were premature, as success criteria and predicted success both rely on the final reclamation and closure plan. This final reclamation and closure plan would be incorporated into the final MPO, which would be prepared after publication of the FEIS and ROD. Instead, the following provides a discussion of the goals of undertaking revegetation and the expected types of information that would be provided in the final reclamation and closure plan.

The purpose of undertaking revegetation is to create a self-sustainable ecosystem that would promote site stability and repair hydrologic function. Specific goals include providing soil stability to prevent erosion by stormwater runoff and wind, revegetating with native species that are appropriate for the site and selected for specific growing conditions (considering slope, aspect, and elevation), potentially including species of cultural importance to tribes, and providing vegetation cover that is appropriate to support postmining land uses, in this case wildlife habitat, livestock grazing, and recreation.

The final reclamation and closure plan would provide further detail on the techniques to be employed, as well as monitoring and success criteria for approval by the Coronado. The monitoring plan would identify selected reference sites, protocols for tracking survivorship and growth in terms of both...
amount and type of vegetation, and protocols for tracking soil stability and erosion. The final
reclamation and closure plan would also identify adaptive management strategies to meet these
success criteria. The adaptive management strategy would be based on quantitative monitoring data
from reference plots, test plots, previously revegetated areas, and scientific literature.

Reference areas would serve as a standard of comparison to assess whether mined areas have been
successfully revegetated (Chambers and Brown 1983). Reference areas would be selected as
representative of ecological site descriptions in the vicinity of the mine and would have soil, slope,
aspect, and elevation that are similar to the revegetated sites. Selection of reference areas by the
Coronado is expected to occur in June and July 2013. Collection of pertinent information on the
reference areas would occur in August and September 2013, to coincide with the peak annual
production following the summer monsoon. Data collection would involve the assessment or
measurement of a variety of rangeland health attributes, soil data, and vegetation data. The goal of the
data collection would be to identify undisturbed ecological sites within the immediate project area
that represent the ecological conditions desired for the ultimate reclaimed facility (Rennick and
Antonioli 2013).

Success criteria would be expressed as a percent similarity to the reference sites. Test plots were
established in 2009 by Rosemont Copper, and a number of different grass species were seeded.
Results helped develop the preliminary seed mix (Lawson 2011), and additional species may be
seeded/planted to determine their potential for success on revegetated areas. Revegetation would be
ongoing, with some areas reclaimed as soon as year 1 of the active mining phase. These previously
 revegetated test plots would be monitored like the reference areas, and lessons learned on these plots
would inform future revegetation efforts in terms of what site preparation techniques, seed mixes, or
timing of technique results in the best success. Research on restoration of mined lands continues to
advance our knowledge in this science. Research would be reviewed and incorporated as appropriate
to the Rosemont Copper revegetation efforts.

Data would be used to determine whether success criteria have been met and to indicate whether
adjustments to growth medium, soil amendments, seed/plant mix, seed/plant application rates, site
preparation techniques, and/or additional mitigation measures are needed.

For the purposes of evaluating the potential for revegetation to be successful in this EIS, the
 revegetation techniques proposed by Rosemont Copper are discussed below, along with the results of
greenhouse studies and onsite reclamation test plots.

**Revegetation Techniques Proposed by Rosemont Copper**

Concurrent reclamation would take place over the life of the project, with initial reclamation
beginning on the lowest levels of the waste rock perimeter buttresses by the end of the first year.
The proposed acreage of reclamation activities over time is shown in table 24, and the locations of
these activities are shown in figure 36.

Exact phasing of concurrent reclamation is specific to each alternative. As discussed, the Scholefield-
McCleary and Barrel Trail Alternatives may have longer delays in implementing concurrent
reclamation due to logistics, amount of salvage soil, safety considerations, and the need to rehandle
placed material.
Figure 36. Phasing of concurrent reclamation activities for preferred alternative
### Table 24. Reclamation phasing over active mining phase for preferred alternative

<table>
<thead>
<tr>
<th>Project Phase</th>
<th>Acres Undergoing Reclamation (Federal)</th>
<th>Acres Undergoing Reclamation (State)</th>
<th>Acres Undergoing Reclamation (Private)</th>
<th>Acres Reclaimed (Federal)</th>
<th>Acres Reclaimed (State)</th>
<th>Acres Reclaimed (Private)</th>
</tr>
</thead>
<tbody>
<tr>
<td>End of year 1</td>
<td>104</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>End of year 2</td>
<td>125</td>
<td>10</td>
<td>34</td>
<td>104</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>End of year 3</td>
<td>224</td>
<td>10</td>
<td>25</td>
<td>229</td>
<td>10</td>
<td>44</td>
</tr>
<tr>
<td>End of year 4</td>
<td>51</td>
<td>7</td>
<td>17</td>
<td>453</td>
<td>20</td>
<td>69</td>
</tr>
<tr>
<td>End of year 5</td>
<td>77</td>
<td>5</td>
<td>11</td>
<td>504</td>
<td>27</td>
<td>86</td>
</tr>
<tr>
<td>End of year 10</td>
<td>374</td>
<td>5</td>
<td>11</td>
<td>581</td>
<td>32</td>
<td>97</td>
</tr>
<tr>
<td>End of year 15</td>
<td>374</td>
<td>2</td>
<td>7</td>
<td>955</td>
<td>37</td>
<td>108</td>
</tr>
<tr>
<td>End of year 22</td>
<td>1575</td>
<td>5</td>
<td>184</td>
<td>1329</td>
<td>39</td>
<td>115</td>
</tr>
<tr>
<td>Postclosure</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3196</td>
<td>44</td>
<td>299</td>
</tr>
</tbody>
</table>

Source: CDM Smith (2012a).

Notes:
1. Assumes 1 year for completion of active reclamation activities.
2. Acreage through end of year 22 is for waste rock and tailings facilities; postclosure acreage includes an additional 292 acres for the plant site (Federal). An additional 889 acres of possible reclamation associated with the utility corridor and 226 acres associated with the primary access road are not included in these totals, as portions of these areas may remain in place and therefore may not need reclamation or may be reclaimed early in the process and then remain undisturbed thereafter.
3. Revegetation would be the responsibility of the mine operator. The description of revegetation procedures provided below has been developed by Rosemont Copper. However, the Coronado would dictate the criteria that must be met for the revegetation to be considered successful and complete.
4. Some changes in revegetation efforts are expected over time as actual revegetation progress is monitored for success and methods are modified to achieve the desired results. Appendix B describes the monitoring and reporting requirements that would occur. Evaluation of monitoring results would determine whether revegetation activities were successfully meeting interim success criteria. If not, revegetation strategies would be reviewed and plans developed to improve outcomes and eventually achieve success criteria. The revegetation success criteria would be determined and specified in the final MPO.
5. Revegetation procedures would differ, depending on whether upland or riparian areas are being revegetated. Most of the landform, which consists of the waste rock and tailings facilities, would be covered with growth medium and revegetated with upland vegetation. However, there may be limited areas along drainages where riparian revegetation would be appropriate. Upland revegetation would generally follow these steps: regrading, placement of salvage soils, ripping, transplantation of trees and shrubs, seed application, mulch and tackifier, and maintenance/monitoring activities.
6. Areas would be regraded to obtain stable, permanent slope conditions as designated in the final reclamation plans. Where possible, such as at the plant site, grading would be undertaken with the intention of restoring more natural slopes and minimizing erosion. The potential for restoring natural slopes is limited with respect to the waste rock and tailings facilities, but such regrading will be incorporated to the extent practicable, primarily on top of the facilities.
7. Soils would be salvaged onsite as described previously in this resource section and would be used as surface cover for revegetation. Almost all slopes would receive either a cover of soil or a mixture of...
soil and rock cover, although the Scholefield-McCleary Alternative is unlikely to have sufficient
salvage soil available for complete coverage. In the most recent plans developed for the Barrel
Alternative, several steep slopes on the side of the landform adjacent to the pit would remain solely
rock with no soil cover. Specific surface treatment locations for the waste rock and tailings facilities
are shown in figure 37. For shorter slope runs between benches (less than 300 feet), the surface
treatment is likely to consist primarily of soil cover.

For longer slope runs between benches (more than 300 feet), the soil cover could be limited to the
upper 300 feet of the slope to prevent erosion. The lower 300 feet may consist of rock or a
combination of soil and rock. Other configurations may also be considered, such as the use of soil
islands; these are small areas (probably less than 10 acres) in which soil of greater depth is placed to
improve species’ diversity and benefit planted trees and shrubs. Where present, the total depth of soil
cover would vary but is estimated to be approximately 12 inches (CDM Smith 2012b). Mulched
vegetation material available from site clearance could be used as a soil additive if appropriate.

After placement of salvage soil, the soil surface would be ripped or otherwise mechanically
manipulated in order to create an optimal seedbed. Ripping and furrowing generally would follow
contours to minimize erosion. In addition, larger woody material salvaged during clearing operations
would be placed on the slopes in order to promote soil stability and promote microclimates and
variation in vegetation.

The native seed mix would be agreed upon and approved by the Coronado and would be informed by
the greenhouse studies, test-plot data, reference sites, and results from previously revegetated areas.
The seed mix and application techniques could vary, depending on slope, aspect, elevation, and
underlying growth media. The seed mix may also incorporate native plant species that are culturally
important to tribes.

Appropriate site preparation may include lightly dragging the area after seed application, soil
amendments, and/or application of certified weed-free straw mulch with a tackifier. Slow-release
fertilizer may be incorporated to promote plant growth.

Assessment of Revegetation Potential
of Waste Rock and Tailings Facilities

Analysis of revegetation potential was approached using a two-part strategy through research
conducted by Rosemont Copper in conjunction with the University of Arizona. The first part of the
research focused on the assessment of potential seed mixes for the site, including greenhouse testing
to identify those seed mixes most likely to thrive in actual material from the site. This
experimentation used substrate materials that would be similar to the soil salvaged from the site.
The second part focused on long-term construction and testing of in situ reclamation plots at the mine
site itself.

The revegetation potential of soil on future waste rock and tailings facilities can be both quantitatively
and qualitatively analyzed, based on the University of Arizona greenhouse results. The likely outcome
of reclamation efforts was assessed by comparing soil productivity observed in the greenhouse
experiments with soil productivity under theoretically ideal conditions. Soil productivity is the
amount of vegetation that can be potentially supported by the soil, measured in pounds of vegetation
per acre. The theoretically ideal level of soil productivity is represented by the historic climax plant
Figure 37. Surface treatments for revegetation for preferred alternative
community that existed at the time of European immigration and settlement. These conditions would
not necessarily be reached during reclamation, but they represent a measure for assessing the possible
outcome of revegetation techniques explored by Rosemont Copper. These historic climax plant
communities have been identified for different regions using the Natural Resources Conservation
Service (2013) Ecological Site Descriptions. Based on the ecological site descriptions, acceptable soil
productivity for the Rosemont area ranges from roughly 415 to 3,150 pounds of vegetation per acre,
as shown in table 25.

Table 25. Soil productivity based on ecological site descriptions (in pounds per acre)

<table>
<thead>
<tr>
<th>Ecological Site Description*</th>
<th>Soil Types</th>
<th>Test Plot Material</th>
<th>Low Value</th>
<th>Representative Value</th>
<th>High Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granitic hills (12 to 16)</td>
<td>McF; LgF; LcF; CoE</td>
<td>Glance</td>
<td>525</td>
<td>915</td>
<td>1,545</td>
</tr>
<tr>
<td>Limestone hills (12 to 16)</td>
<td>McF</td>
<td></td>
<td>415</td>
<td>810</td>
<td>1,275</td>
</tr>
<tr>
<td>Volcanic hills (12 to 16)</td>
<td>LgF</td>
<td></td>
<td>430</td>
<td>860</td>
<td>1,360</td>
</tr>
<tr>
<td>Limy slopes (16 to 20)</td>
<td>HaF</td>
<td>Gila</td>
<td>671</td>
<td>1,290</td>
<td>1,685</td>
</tr>
<tr>
<td>Clay loam upland (12 to 16)</td>
<td>BhD</td>
<td></td>
<td>502</td>
<td>865</td>
<td>1,425</td>
</tr>
<tr>
<td>Limy slopes (12 to 16)</td>
<td>BhD; HhE2</td>
<td></td>
<td>555</td>
<td>1,000</td>
<td>1,765</td>
</tr>
<tr>
<td>Sandy wash (12 to 16)</td>
<td>CtB</td>
<td></td>
<td>825</td>
<td>1,800</td>
<td>3,150</td>
</tr>
<tr>
<td>Loamy slopes (16 to 20)</td>
<td>CmE</td>
<td>Arkose</td>
<td>763</td>
<td>1,520</td>
<td>2,350</td>
</tr>
<tr>
<td>Granite hills (16 to 20)</td>
<td>Rn; BgF</td>
<td></td>
<td>524</td>
<td>1,240</td>
<td>1,985</td>
</tr>
<tr>
<td>Loamy slopes (12 to 16)</td>
<td>WgE; CgE</td>
<td>Gila</td>
<td>426</td>
<td>905</td>
<td>1,505</td>
</tr>
<tr>
<td>Limestone hills (16 to 20)</td>
<td>TrF</td>
<td></td>
<td>576</td>
<td>1,165</td>
<td>1,480</td>
</tr>
<tr>
<td>Sandy loam, deep (12 to 16)</td>
<td>An</td>
<td></td>
<td>521</td>
<td>1,005</td>
<td>1,855</td>
</tr>
<tr>
<td>Sandy loam upland (12 to 16)</td>
<td>SoB</td>
<td></td>
<td>602</td>
<td>1,066</td>
<td>1,755</td>
</tr>
</tbody>
</table>


Note:
– = No test plot material coincides with this ecological site description.
* Numbers in parentheses represent precipitation zone, in inches.

Three material types from the Rosemont area were tested by the University of Arizona to represent
future waste rock or tailings: Gila, Glance, and Arkose materials. These materials were created by
mixing the top 3 meters of the existing soil profile. The Gila material was collected at a location
characterized by the Hathaway gravelly sandy loam soil type (HaF). The Glance material was
collected at a location characterized by Chiricahua cobbly sandy loam (CoE). The Arkose material
was collected at a location characterized by Casto very gravelly sandy loam (CmE). These soil
samples were collected from private land. Based on the ecological site descriptions, acceptable soil
productivity for the specific soil types used for the greenhouse studies ranges from roughly 426 to
2,350 pounds of vegetation per acre, as shown in table 25.

Greenhouse results for the recommended seed mix grown in Gila and Glance materials were within
the acceptable soil productivity range: 1,010 and 1,080 pounds of vegetation per acre, respectively.
Arkose material, however, showed limited productivity, at 290 pounds of vegetation per acre, which
suggests that this particular material might have limited revegetation potential. These limitations were
primarily the result of the generally coarser texture of the material and its inability to retain water.
The researchers concluded that mixing it with the other soil types—as would be expected during
mining—would likely improve its performance.

The University of Arizona greenhouse studies represent potential results under ideal conditions:
adequate water, stable growth media, minimal slopes, and thorough and even seed coverage. While
these studies have resulted in selection of a seed mix with the best likelihood of establishing vegetation, they do not represent expected real-world conditions, nor is this likely to be the final seed mix approved by the Coronado in the final MPO. Actual revegetation potential is likely to be less successful and variable overall. Some areas likely would match the results indicated by the greenhouse studies; other areas may experience much less revegetation or may not successfully revegetate at all. Such factors as drought conditions, slope instability, aggressive exotic vegetation (such as Lehmann lovegrass (*Eragrostis lehmanniana*)), poor growth media, and incomplete or patchy seed coverage could reduce revegetation success and would be addressed in an adaptive management approach to continually refine revegetation objectives based on quantifiable data from reference areas, test plots, and previously revegetated sites.

To better address real-world conditions, Rosemont Copper conducted experiments with onsite reclamation test plots. Initial establishment of the plots took place in 2009 (Lawson 2011). Plots were designed to replicate conditions similar to those that would be experienced on the waste rock perimeter buttresses around the tailings and waste rock facilities, with respect to slope (3:1), aspect (east facing), and elevation (4,600 to 5,400 feet above mean sea level). Similar to the greenhouse studies, soil cover at the sites consisted of Gila and Arkose materials at a depth of 12 inches. Forty-eight individual test plots were created to test variables of elevation, soil type, surface roughness, and surface treatment (straw mulch, straw mulch mixed with soil, and no mulch). The seed mix selected for use on the test plots was based on the results of the University of Arizona greenhouse studies.

It should be noted that the test plots were only conducted on east-facing slopes, whereas particularly on south-facing slopes, revegetation efforts may differ substantially due to sun exposure.

The results of the onsite test plots are similar to those of the greenhouse studies. They demonstrate that soil productivity can reach the desired range with appropriate treatment under real-world conditions. Soil productivity or biomass when measured in the cool season ranged from 713 to 2,856 pounds per acre; when measured in the warm season, it ranged from 17 to 1,438 pounds per acre (see table 24 for comparison to theoretical conditions). Vegetation basal cover ranged from 1.7 to 10.9 percent during the cool season and from 0 to 15.3 percent during the warm season (see table 19 for comparison with theoretical conditions). The wide range of results reflects the range of the experimental variables, with some combinations being unsuccessful and other combinations performing much better. The onsite test plots demonstrate that desired conditions can be reached, but they also show that care must be taken during revegetation to select the appropriate surface preparation and treatment to provide the greatest potential for revegetation success.

The current soil conditions at the site are degraded from historic climax conditions, although they are still considered satisfactory. The research conducted by the University of Arizona and Rosemont Copper indicates that use of the selected seed mix and appropriate surface treatment could result in revegetation of soil on waste rock and tailings facilities that would approximate native vegetative conditions. These studies are not a guarantee of revegetation success due to differences in seed mix, slope aspect, and potentially different climatic conditions.

**Proposed Action and Action Alternatives**

**Soil Productivity Directly Lost to Mine Activities**

Soil productivity is the capability of a soil to produce and support plant and vegetation biomass. The primary impact to soil productivity is the actual loss of topsoil directly where mine activities would remove or disturb the soil. This loss of soil productivity would be temporary for many areas, provided that salvaged soil is replaced on these areas and revegetation successfully occurs.
Loss of soil productivity is determined based on the surface area disturbed by mining activities. Recovery of soil productivity means that the soil can support an amount and type of vegetation that are similar to what it supported before the mine. For the DEIS, any lands within the perimeter fence were assumed to be disturbed; it was assumed that these lands would therefore lose soil productivity. For the FEIS, this assumption has been refined. Lands within the security fence are assumed to be disturbed, as are some other areas such as the primary access road and utility maintenance road. However, the lands between the perimeter fence and the security fence would largely not be disturbed, other than discrete areas such as test wells and the compliance point dam, which have been taken into account.

According to the preliminary MPO, the proposed action would impact approximately 5,602 acres of soils within the project area. Of the 5,602 impacted acres, 4,387 acres would lie within the security fence, including 955 acres that would be impacted by the open pit. The remaining 1,215 acres would be impacted by the power line, pipeline, primary access road and utility maintenance road, activities associated with forest road decommissioning or construction, and the Arizona National Scenic Trail reroute. The acreage of the other action alternatives varies slightly but is similar, ranging from 5,421 to 6,187 acres (table 26). The acreage includes areas disturbed by facilities, the power line, pipeline, primary access road, utility maintenance road, forest road decommissioning or construction, and the Arizona National Scenic Trail reroute.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Acres Impacted</th>
<th>Soil Salvage Volume (cubic yards)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No action</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Proposed action</td>
<td>5,602</td>
<td>4,234,000</td>
</tr>
<tr>
<td>Phased Tailings</td>
<td>5,471</td>
<td>3,947,000</td>
</tr>
<tr>
<td>Barrel</td>
<td>5,421</td>
<td>4,252,000</td>
</tr>
<tr>
<td>Barrel Trail</td>
<td>5,878</td>
<td>4,267,000</td>
</tr>
<tr>
<td>Scholefield-McCleary</td>
<td>6,187</td>
<td>2,111,000</td>
</tr>
</tbody>
</table>

Note: Soil salvage volume is the total of pit area, plant site, and waste rock and tailings facilities, plus an additional 1.4 million cubic yards of opportunistic salvage.

Estimated Soil Salvage Volumes
The volume of soil available for salvage and use for reclamation differs by alternative. Salvage volume calculations are based on four components: salvage of soil from the pit area, salvage of soil from the plant site area, salvage of soil from the areas occupied by the waste rock and tailings facilities, and opportunistic soil salvage. Opportunistic soil salvage encompasses salvage of soil from other disturbed areas, or areas where soil might occur in scattered pockets for which volume is not able to be calculated.

The pit area and plant site remain identical between alternatives and account for 268,000 cubic yards and 12,000 cubic yards of soil salvage, respectively. Soil salvage from the waste rock and tailings areas differs between alternatives and ranges from 431,000 cubic yards (Scholefield-McCleary) to 2,587,000 cubic yards (Barrel Trail). Opportunistic soil salvage is difficult to estimate but has been approximated as 1,400,000 cubic yards (CDM Smith 2012b). The estimated total soil salvage volumes by alternative are shown in table 26.
The total amount of salvage material needed for reclamation activities will depend on the final soil cover requirements, which will be determined in the final reclamation and closure plan. Overall, it may be determined that some areas would remain primarily rock cover, such as is shown in figure 31, whereas other areas would receive a 12-inch cover of salvaged soil material. Preliminary estimates for the Barrel Alternative indicate that approximately 3,689,000 cubic yards of material would be needed to address all areas receiving soil cover (CDM Smith 2012b). Based on these estimates, sufficient soil salvage material would be available to meet expected reclamation needs for all alternatives except for the Schoolefield-McCleary Alternative.

Sediment Delivery

Sediment enters stormwater through erosion of native soils, tailings facility, and waste rock facility. The stormwater management facilities that are part of the action alternatives have been designed to maintain total suspended sediment concentrations in stormwater runoff similar to baseline conditions. Total suspended sediment concentrations have been analyzed in stormwater flows at the site for about a half-dozen flow events that occurred between January 2010 and September 2011. The observed concentrations are highly variable, ranging from near zero to more than 44,000 milligrams per liter. Note that the analysis of postmine sediment concentrations was based on modeling.

Sediment delivery was modeled to the USGS gaging station in Barrel Canyon at the SR 83 bridge, the downstream stormwater analysis point for postmining conditions for each alternative (Zeller 2012; Zeller 2010a, 2010b). The sediment delivery for the baseline conditions (no action) and all the action alternatives is summarized in table 27.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Contributing Watershed Area (square miles)</th>
<th>Average Annual Sediment Delivery (acre-feet)</th>
<th>Average Annual Sediment Delivery (tons)</th>
<th>Sediment Concentration (parts per million)</th>
<th>Percent Change from Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>No action</td>
<td>14</td>
<td>16.10</td>
<td>32,600</td>
<td>16,407</td>
<td>–</td>
</tr>
<tr>
<td>Proposed action</td>
<td>6.82</td>
<td>7.84</td>
<td>16,000</td>
<td>16,194</td>
<td>−50.9</td>
</tr>
<tr>
<td>Phased Tailings</td>
<td>7.06</td>
<td>8.12</td>
<td>16,500</td>
<td>16,210</td>
<td>−49.4</td>
</tr>
<tr>
<td>Barrel</td>
<td>11.33</td>
<td>10.88</td>
<td>22,170</td>
<td>13,686</td>
<td>−32.0</td>
</tr>
<tr>
<td>Barrel Trail</td>
<td>8.65</td>
<td>9.95</td>
<td>20,300</td>
<td>16,273</td>
<td>−37.7</td>
</tr>
<tr>
<td>Schoolefield-McCleary</td>
<td>10.35</td>
<td>11.90</td>
<td>24,200</td>
<td>16,317</td>
<td>−25.8</td>
</tr>
</tbody>
</table>

Based on the sediment modeling, sediment delivery to the downstream watershed is expected to decrease from baseline conditions, while suspended sediment concentrations are expected to remain relatively unchanged. The primary reason for a decrease in sediment delivery to the downstream watershed would be a reduction in contributing watershed size. Contributing watershed size would be reduced because diversions and stormwater ponds would cause a decrease in stormwater runoff from the mine site, reducing the amount of water running off the watershed and carrying sediment.

Cumulative Effects

None of the reasonably foreseeable actions as identified on the Coronado ID team’s list of reasonably foreseeable future actions, provided in the introduction to chapter 3, fall within the analysis area for soils; therefore, these actions are not analyzed for their effect on soil or soil productivity. Trends in past and present actions, such as increased recreation from an increasing population, are expected to
affect areas that have already been impacted; these areas have been analyzed as part of the affected environment.

**Climate Change**

Expected climate change conditions could have an effect on the success rate of revegetation and therefore on long-term soil stability. Revegetation could become more difficult due to the potential for more variable temperatures and precipitation. Some models predict higher temperatures and prolonged droughts, whereas other models predict warmer and wetter conditions in the Southwest.

Initial completion of revegetation would be based on Coronado success criteria, not on a specified level of effort. Revegetated sites would be compared with reference sites, and these comparisons would be used to monitor the effects of climate change on both disturbed and undisturbed sites. This would allow for adjustments in species composition based on the monitoring results. Therefore, initial revegetation can be assumed to be eventually successful, even if additional work must be conducted by Rosemont Copper in order to meet Coronado success criteria. However, the effects of climate change could increase the vulnerability of vegetation cover on the site years or decades after successful revegetation has been accomplished. Revegetation success would be monitored and compared with reference sites. Seed mix, soil preparation, and planting procedures could be modified using monitoring results to respond to changing climatic conditions.

**Mitigation Effectiveness**

**Mitigation and Monitoring – Forest Service**

- **Growth media salvage and application.** In order to support reclamation activities, soil and other growth media would be salvaged, stored, and applied to the surface of the perimeter waste rock buttress and waste rock and tailings facilities in order to facilitate revegetation.

- **Revegetate disturbed areas with native species.** Reclamation efforts would include revegetation of native grasses, forbs, shrubs, and trees on areas disturbed by mining and mine related activities. Revegetation would include detecting and treating of invasive weed species.

- **Concurrent placement of perimeter buttress.** Placement of the perimeter buttress would allow for reclamation activities to take place earlier, concurrent with mine operations.

- **Sediment transport monitoring.** The movement of sediment between the mine facility and SR 83 would be monitored to identify areas of scour or aggradation that could be caused by changes in sediment load and surface flow.

- **Limit ground-disturbing activities between perimeter fence and security fence.** Any additional soil disturbance between the security fence and perimeter fence would be limited, which would reduce erosion and loss of soil productivity.

**Mitigation and Monitoring – Other Regulatory and Permitting Agencies**

- **Power line and water line locations.** The final location of the power line as considered by the Arizona Corporation Commission (ACC) is the shortest route, minimizing soil disturbance.

- **Paving mine roads.** Paving of certain roads with the mine is required under the air quality permits and would also serve to reduce the potential for erosion of soil from disturbed road areas.
• Tailings would be processed and placed to reduce water content and overall footprint. The use of dry-stack tailings instead of traditional slurry tailings would allow for a much smaller footprint for the tailings facility, minimizing soil disturbance.

• Implementation of stormwater pollution prevention plan. Required under the stormwater permit for the mine, implementation of the stormwater pollution prevention plan would include use of structural sediment controls and best management practices intended to minimize the potential for erosion from the mine site.

**Mitigation and Monitoring – Rosemont Copper**

• Eliminate future development of private lands on top of waste rock and tailings. Disallowing future soil disturbance on top of the reclaimed waste rock and tailings facilities would minimize the potential for future soil disturbance that would reverse reclamation and revegetation efforts.

**Conclusion of Mitigation Effectiveness**

The design of the proposed action and other action alternatives includes a mine footprint that is substantially smaller than conventional mines with similar production capacity. This reduced mine footprint would avoid surface disturbance of soils and loss of soil productivity from these areas, compared with conventional designs. This is attributable to the use of dry-stack tailings technology. Also as part of the design, waste rock perimeter buttresses would be built around the dry-stack tailings and the waste rock facilities. The waste rock perimeter buttresses would be built early in the stages of the mine; once each lift or stage of the waste rock perimeter buttress is complete, concurrent reclamation can begin. Concurrent reclamation of the first portions of the waste rock perimeter buttresses can occur as early as year 1 of mine operations. Early reclamation would allow salvaged soil to be placed back on the surface and soil productivity to be reestablished.

A mine reclamation plan is required by Forest Service regulations and is subject to approval by the Arizona State mine inspector and the Coronado. The policy requires that disturbed lands be reclaimed to a condition that is consistent with forest land and resource management plans. Revegetation of disturbed areas is a key aspect of the reclamation plan. In order to enhance revegetation efforts, specifications and goals for the salvage, storage, and reuse of growth media (topsoil) from disturbed areas have been developed with the goal of providing sufficient cover on all disturbed areas to be reclaimed. Control of noxious and invasive weeds would be critical to success of the revegetation efforts. Additional revegetation would take place through the salvage, propagation, and planting of agave plants. All of these efforts, if successful at meeting Coronado revegetation objectives, would be effective at reestablishing soil cover and vegetation on bare waste rock slopes, which would be effective at reducing soil erosion, soil loss, and downstream sedimentation.

With the exception of eliminating future development of the waste rock and tailings facilities, the mitigation measures described above are part of the design of the action alternatives and thus have been incorporated into the analysis of direct and indirect impacts on soil resources. The impacts described earlier in this section include these mitigation measures.

Revegetation success is expected to improve over time, as natural vegetation communities slowly become reestablished. Any future development of the waste rock and tailings facilities would necessarily involve soil disturbance and removal or destruction of vegetation placed during the mine reclamation activities. By eliminating the potential for any development in the future, the revegetation would be allowed to mature, further establish communities similar to the natural environment, and continue to help prevent erosion or loss of soil cover.