TYGEE CREEK BASIN
WATERSHED ANALYSIS

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1.0 Executive Summary

The Tygee Creek basin is a 37-square mile basin in southeastern Idaho. Land uses are varied, and include mining, timber harvesting, livestock grazing, and agriculture; land ownership is also varied, with the majority being public lands. As new projects are proposed on federally managed lands in the Tygee Creek basin, this Watershed Analysis can be used to provide an overall watershed context in which to assess management actions.

2.0 Introduction

This report has been prepared in accordance with *Ecosystem Analysis at the Watershed Scale, Federal Guide for Watershed Analysis, Version 2.2* (Regional Ecosystem Office, 1995), referred to hereafter as *the guidance*. *The guidance* was developed for use under the Inland Native Fish Strategy (INFISH) program, as outlined by the Upper Columbia River basin Assessment; it directs the user through a series of steps to prepare a Watershed Analysis. Watershed Analyses are used by public land administrators to characterize specific watersheds using ecosystem elements, and to provide an overall watershed context in which to assess management actions.

The United States Forest Service (USFS), Caribou-Targhee National Forest has requested that a Watershed Analysis be prepared for the Tygee Creek basin, as shown in Figure 1. Planned mining of the B & C panels at J.R. Simplot's Smoky Canyon Mine, and the required environmental analysis as required by the National Environmental Policy Act (NEPA), prompted the need to prepare the Watershed Analysis. The proposed mining would occur entirely within headwater tributaries to Tygee Creek. The information provided by the Watershed Analysis, in conjunction with the Smoky Canyon Mine Supplemental Environmental Impact Statement (SEIS), can be used by agency decision makers to assess the consequences of Simplot's project on the Tygee Creek basin. However, it is not the intent of the Watershed Analysis to focus solely on the B & C panel mining project and its potential impacts. Instead, the Watershed Analysis provides an information base within the geographic area of the watershed, to which land managers can turn for support as they make management decisions within the Tygee Creek basin. These management decisions may include approval of Simplot's proposed activities as well as other, unrelated, activities within the National Forest System lands and public lands within Tygee Creek basin.

The report is organized according to the recommendations in *the guidance*. Section 3 of the Watershed Analysis includes brief descriptions of seven separate ecosystem components, and directs the focus of the analysis. These seven components are the key topics as outlined in *the guidance*. Section 4 provides a listing of issues and key questions that arose from the watershed characterization in Section 3. The remaining sections expand upon Section 3 information in order to provide a context within which the identified issues can be addressed. Sections 5 and 6 of the report give time-related aspects of the seven core topics, presenting both their current condition in the watershed and their reference condition. The reference condition is defined in *the guidance* as the historical period over which ecosystem comparisons are made with current conditions. In Section 7, the interrelationship of these seven separate topics is discussed, with comparisons between reference and current conditions. Lastly, Section 8 provides recommendations for overall management within the basin, and recommendations for further evolution of the Watershed Analysis itself.

By its inherent nature as described in *the guidance*, a Watershed Analysis is meant to be an evolving document that is updated and revised as new information becomes available. Therefore, this document was prepared using existing, readily available information, much of which was generated in response to Simplot's existing and proposed mine operations and related permitting needs. Data gaps, either throughout the entire watershed, or in certain areas of it, are described, and recommendations for future studies are made, based upon the stated issues and key questions.

3.0 Watershed Characterization

The majority of Tygee Creek basin is located in southeastern Idaho in eastern Caribou County; a very small portion of its northeastern area spans the Idaho-Wyoming border. The 8,000 to 9,000-foot above mean sea level (AMSL) peaks of the Webster Range form the western boundary of the Tygee Creek basin, and the 7,000 to 7,500-foot AMSL crest of Tygee Ridge forms the eastern boundary, as shown on Figure 2. Buck Mountain makes up the southern boundary. Tygee Creek flows northward through a relatively narrow alluvial valley located toward the eastern side of the basin, thus most contributing drainage area is from the west out of canyons draining the Webster Range.

With a drainage area of about 37 square miles, Tygee Creek (Water Body Unit US-7) is tributary to Stump Creek (Water Body Unit US-6), and joins it about one and one half miles west of the Idaho/Wyoming border. Stump Creek flows eastward into Wyoming and is tributary to the Salt River (Hydrologic Unit Code 17040105). The Salt River flows northward through western Wyoming, and ultimately joins the Snake River; the Snake River is part of the Columbia River system.

Geographically located within both privately owned and federally managed lands, and spanning elevations ranging from about 6,160 feet to about 9,200 feet AMSL, the Tygee Creek basin is characterized by a variety of vegetative types and land uses. These and other watershed elements are characterized in the following discussions, organized by the seven core topics specified in *the guidance*.

3.1 Erosion Processes

Soil factors that are important in a watershed context include site productivity, sedimentation, erosion processes and rates, topsoil/growth medium management, and reclamation potential. This Watershed Analysis focuses on erosion and sedimentation factors. These have been evaluated using the Caribou National Forest Soil Survey (USFS, 1990) and the Soil Survey of Star Valley Area, Wyoming-Idaho (USDA, 1976) and updates to these documents based on the United States Department of Agriculture (USDA) Soil Survey Manual (USDA, 1993) and the USDA National Soil Survey Handbook (USDA, 1998). These documents also include information on soil resource factors other than erosion, that are not discussed herein. Further, Maxim Technologies, Inc. recently completed an Order II survey within a small portion of the Tygee Creek basin (that which would be disturbed by Simplot's development of the B & C panels. This survey provided details on soil characteristics related to revegetation and reclamation of the mine disturbances; its results are described in the Soils and Watershed Technical (JBR Environmental Consultants, 2001a), but are not discussed in this Watershed Analysis.

The hazard of erosion for soils has been determined by the soil surveys conducted within the Tygee Creek basin (USFS, 1990; USDA, 1976). Erosion hazard is a measure of a given soil's susceptibility or potential to erode. It is based both upon the inherent erodibility (as indicated by its K value) of a soil as

determined in large part by its texture, and upon its typical position in the landscape. In general, the upland areas of the Tygee Creek basin are more susceptible to erosion than lowland sites, and the areas with higher coarse fragment content and lower slope steepness have lower potential for water erosion hazard.

3.2 Hydrology

Within the Tygee Creek basin, surface water and groundwater relationships typically drive the dominant hydrologic processes. Springs and diffuse, influent, groundwater provide flow to support perennial and intermittent stream reaches; in turn, those stream reaches may provide recharge to aquifers in other formations as they lose flow downstream. The alluvial valley through which Tygee Creek flows supports a limited regional aquifer. Precipitation averages 30-33 inches annually at the higher elevations in the basin, much of which supports stream flow and recharges the groundwater system. Most runoff in the basin is attributed to snow melt (USGS, 1977), with winter snow pack often in excess of 100 inches annually (Simplot Agribusiness, 2000).

As Tygee Creek flows northward, it captures flow primarily from the east slopes of the Webster Range via Roberts Creek, Smoky Creek, Draney Creek, Salt Lick Creek, Webster Canyon Creek, and Spring Creek as shown by Figure 3. All of these tributaries except Roberts Creek are perennial. The west slopes of Tygee Ridge and the north slopes of Buck Mountain do not have any named streams; the small intermittent or ephemeral channels draining these eastern and northern areas of the Tygee Creek basin likely provide only a very small portion of the basin's total yield.

Springs associated with various geologic formations can be found throughout the basin, as shown on Figure 3. Typically, they supply flow to the headwaters of the tributary streams, as well as to several of the streams at the flanks of the range. For many of these springs, there is little or no information regarding their flow characteristics, although flows are sufficient at some of the springs to support adjudicated water uses such as stock watering and fish rearing. In a few instances, such as at Falls Spring (which supplies water to the Auburn Fish Hatchery) flow records may be kept as part of a water user's operations.

Neither Tygee Creek, nor any of its tributary streams, are gauged as part of the United States Geological Survey's (USGS) stream gauging program. However, some stream flow data have been collected for some areas of the basin as part of the Smoky Canyon Mine's various environmental permit requirements. These data have been used to derive estimates of basin yield and seasonal flow variations. Estimates have been derived for high return period peak flow events using USGS regression equations (Thomas et al, 1994). These various estimates are described in Section 5.0.

3.3 Vegetation

As is common in the western United States, vegetation distribution in the Tygee Creek basin is in large part controlled by altitude, latitude, direction of prevailing winds, and slope exposure. The vegetation on the bottom-lands, toe-slopes and ridges of the basin is characterized by a mosaic of sagebrush/grassland, aspen, and douglas-fir and lodgepole pine communities, as shown on Figure 4. The sagebrush/grassland community type covers approximately 35 percent of the basin, coniferous forest covers about 25 percent, aspen forest about 15 percent, and mixed conifer/aspen forests about 5 percent. Mixed shrub, wetland and riparian communities account for about one percent each, while

agricultural practices have altered native vegetation over about 13 percent of the basin. Existing mining related uses have altered or eliminated vegetation over about 3 percent of the basin.

3.4 Stream Channel

While no comprehensive stream characterization studies have been done across the Tygee Creek basin, limited field observations provide general indications of stream channel conditions.

As expected, the morphology of Tygee Creek and its tributaries is in large part dictated by the topographic positions of various stream reaches. The headwater reaches of the tributary streams are generally confined within narrow canyons, and as such, typify a Rosgen Type A channel. These reaches have a steep gradient and very little meander development; they typically lack a developed floodplain. Where they must compete for space within the narrow canyon bottom with a roadway, such as in Smoky Canyon, stream channels have typically been realigned, channelized, and bermed. As a result, riparian development adjacent to the headwater canyon reaches is generally limited to narrow, stringer features, and in-stream flow velocities are generally fast.

As the streams make their way downstream and canyons open up, the channels tend to increase meandering, with consequent greater bar and riparian development. Floodplains are still generally lacking, or are confined to the meander width. Most of the reaches within this position on the landscape appear to be similar to Rosgen B and C types.

Within the lower alluvial valley of the basin, some of the stream reaches would likely be Rosgen Type E if classified; others may be tending toward F or G where livestock related impacts are seen. E-type streams are very sinuous and have a wide over-bank area and a wide riparian/wetland corridor. Bank erosion and loss of stream side vegetation can destabilize banks, often resulting in a more gully-like appearance similar to an F or G Rosgen type.

3.5 Water Quality

Tygee Creek, its tributaries, and its receiving stream (Stump Creek) are all undesignated surface waters under the Idaho State Water Quality Standards at IDAPA 58.01.02 in regard to their beneficial uses. However, for such undesignated waters, cold water aquatic and contact recreation beneficial uses are presumed by default. In general, the available data indicates that most of the surface waters in the Tygee Creek basin appear to meet the criteria associated with those uses (USFS, 1981 and 1982; Montgomery Watson, 1999).

None of the streams within the Tygee Creek basin are on the current (1998) State of Idaho 303(d) list of impaired waters, nor are they on the list of streams whose quality has been determined to be threatened (State of Idaho, 1999). Both Tygee Creek and Stump Creek were surveyed by the Division of Environmental Quality in the mid 1990's and were found to be of sufficient quality to support their beneficial uses.

In a baseline water quality report prepared by Maxim Technologies, Inc. (2000a), the current water quality of the three streams in the Simplot Project Area (Tygee Creek, Smoky Creek, and Roberts Creek) was described based upon sampling events at six sites during 2000. That report described those surface waters as generally of a calcium-bicarbonate type, of moderate hardness or very hard, neutral pH, and

with low nutrient levels.

3.6 Species and Habitats

Wetland and riparian areas within the Tygee Creek basin provide important habitat for many wildlife species including amphibians and birds. The sagebrush, mixed brush, and forest communities provide food, water, cover, and space for a variety of ungulates, birds, small mammals, and other wildlife. Non-native habitat occurs in areas where mining, timber cutting, and agricultural uses have altered the vegetative landscape.

Several mammalian species are known or expected to occur within the basin. These species include several members of the rodent family; various bats; intermediately sized species such as skunks, coyotes, badgers, bobcats, cottontails, and jackrabbits; and large mammals including deer, elk, moose, black bear, and mountain lions. Elk and mule deer are the two most highly visible and common of the large mammals within the area. There is also potential lynx habitat in the basin.

Raptors, upland game birds (including sage grouse), passerines, song birds, waterfowl, and shorebirds are some of the types of avians present in the basin. Several species of reptiles and amphibians are also found in the Tygee Creek basin.

3.7 Human Uses

Phosphate mining, sheep and cattle grazing, timber harvest, agriculture, and fish rearing represent the dominant human land uses in the Tygee Creek basin. Hunting, fishing, camping, and other forms of outdoor recreation are also important uses; a dairy farm is also present. As shown in Figure 2, the western half of the basin is primarily National Forest System lands, which comprises approximately 53 percent of the total area of the basin. Approximately 42 percent of the basin is private land and 5 percent is administered by the Bureau of Land Management. In the extreme eastern portion of the basin are 46 acres of State of Wyoming land. Part of J.R. Simplot's Smoky Canyon phosphate mine is located in the southern half of the basin. Portions of four USFS grazing allotments, shown on Figure 5, are found in the central and west basin, and agricultural cropping and grazing on private lands are dominant uses in the Tygee Creek valley in the east. No major highways are found in the basin and various paved, gravel, and dirt roads generally support the land uses.

4.0 Issues and Key Questions

The Tygee Creek basin generally appears to be a functioning ecosystem with the ability to support the types of uses that it incurs: overall water quality is good (State of Idaho, 1999; Maxim, 2000; Montgomery Watson, 1999); a variety of animal species are supported by the available vegetative communities, including critical range for deer and elk (Anderson, 2000); and grazing/agricultural interests have been ongoing for many years. One of the major land uses in the basin is phosphate mining by the J.R. Simplot Company. Many of the important issues that need to be addressed within the Tygee Creek basin relate to these mining activities and the types of effects they may have on the basin as Simplot's area of influence expands. Issues specific to timber harvest, ranching, grazing, or other activities have not been identified to be of concern presently in this basin.

One identified issue relates to the overall areal extent of mining operations and the potential to displace

existing biotic ecosystem components such as vegetation and wildlife, and the potential to overtake other existing land uses such as forest harvesting and livestock grazing. These subjects will become important if mining within the basin expands, and will be discussed below.

Another issue that is relevant to the basin is the recently discovered selenium impact potential. While impacts have not been reported to surface waters within the Tygee Creek basin, they have been reported elsewhere in the southeastern Idaho region where phosphate mining occurs, and mining facilities within the basin associated with Simplot's activities do have elevated selenium concentrations. The potential for selenium impacts to water and to other ecosystem components in the Tygee Creek basin will also be discussed in this report.

Thirdly, available soils information indicates that erosion hazard is of concern particularly within the USFS lands where the most intensive land uses are occurring; thus another important issue is whether these land use practices are being accomplished without excessive loss of soil resources in the upland areas and without excessive sediment loading to Tygee Creek and its downstream receiving waters.

All three of these issues can be covered by the following question:

> Do the existing and likely future land uses within the Tygee Creek basin, most noticeably mining, have the ability to continue without compromising other existing land uses and ecosystem functioning?

5.0 Current Conditions

This section describes the current conditions of the same seven core topics as described in Section 3, providing greater detail where the information is available to do so.

5.1 Erosion Processes

The Soil Survey of Star Valley Area, Wyoming-Idaho (USDA, 1976) identifies three major soil associations located in Tygee Creek basin in the eastern half of the area outside of the National Forest boundary. These are the Paulson-Lail-Stony rock land, Robana-Buckskin-Cowdrey, and Turson-Dipman associations, as mapped by the USDA Soil Conservation Service, currently known as the Natural Resource Conservation Service (USDA, 1976). The Paulson-Lail-Stony rock land association is the slight majority soil in this area representing approximately 40 percent of the acreage, the Robana-Buckskin-Cowdrey association represents approximately 35 percent, the Turson-Dipman association represents approximately 5 percent, the remaining land consists of other minor soils.

The Paulson-Lail-Stony rock land association consists of steep to very steep, well-drained silty clay loams and silt loams and Stony rock land on foothills and mountains, generally to the east of Tygee Creek. Paulson soils are steep to very steep deep silty clay loams on side slopes that face south and west. Lail soils are deep silt loams, steep to very steep, and are on forested foot slopes that face north. Stony rock land is very steep and is on mountains that face south and west. It consists of rock outcrop and very stony and gravelly colluvium. Approximately 60 percent of the individual soil series which compose the Paulson-Lail-Stony rock land association are rated as having a high hazard of erosion, with the remaining soils in the slight to moderate or moderate to high range. Vegetation is mainly bunchgrass, shrubs, and

trees. Elevation ranges from approximately 5,800 to 8,000 feet AMSL. (USDA, 1976).

The Robana-Buckskin-Cowdrey association consists of rolling and hilly, deep, well-drained, silt loams and clay loams, generally to the west of Tygee Creek. Robana and Buckskin soils are on uplands and consist of silt loams. Cowdrey soils are clay loams on forested foot slopes that face north. Vegetation is mainly bunchgrass and shrubs, but does contain some areas of trees. Elevation ranges from approximately 5,600 to 7,200 feet AMSL. Overall hazard for erosion is slight to moderate, however the hazard for water erosion is severe in some places and soil and water conservation practices are needed for dryland crops and for homesites. (USDA, 1976).

Within the basin, the Turson-Dipman association consists of nearly level, somewhat poorly drained and poorly drained silt loams and silty clay loams on flood plains of Tygee Creek. The soils of this association formed in alluvium. Vegetation is grasses, sedges, rushes, and willows. Elevation ranges from 5,600 to 7,000 feet AMSL. Hazard for erosion for soils in this association is slight. Turson soils are somewhat poorly drained and consist of silt loams that have a very gravelly loamy sand at a depth of 20 to 40 inches. The water table fluctuates between depths of three and five feet. Dipman soils are poorly drained with a surface layer of silty clay loam in the upper part and silty clay in the lower part (USDA, 1976).

Within the western part of the Tygee Creek basin where land is administered by the USFS, soils were not mapped by the Soil Conservation Service (or the Natural Resource Conservation Service as it is now known). However, the Caribou National Forest performed its own soil survey, so soils in this part of the basin have been mapped (USFS, 1990). These soils have been given numbered mapping units rather than named associations as in the USDA soil survey (USFS, 1990). Over 80 percent of the soils in this part of the Tygee Cree basin are classified as having a moderate to high hazard of erosion. The remaining 20 percent of the soils are approximately evenly represented by moderate or low to moderate hazards of erosion.

Table 5.2-1 shows erosion hazard ratings for soils in the basin. Throughout the entire Tygee Creek basin, as represented by both soil surveys, approximately 80 percent of the soils are classified as having a moderate to high hazard of erosion, approximately 10 percent have a low to moderate hazard of erosion, and approximately 10 percent have a moderate hazard of erosion.

Selenium information regarding soil resources in the basin is described in the Soils and Watershed Technical Report (JBR Environmental Consultants, 2001a).

5.2 Hydrology

The USGS (1977) characterizes annual hydrographs for Tygee Creek and its tributaries as reflective of high spring flood peaks associated with snow melt, and much smaller sustained base flows. For the receiving Stump Creek and Salt Creek streams, however, it notes that flood peaks are relatively low and base flows proportionally higher.

Neither Tygee Creek nor any of its tributary streams are gauged as part of the USGS's stream gaging program. However, some limited stream flow measurements and modeled yield/peak flow predictions have been made in conjunction with Simplot's mining related permitting at some locations in the Tygee Creek basin. For example, Tygee Creek at a point about four miles upstream from its mouth (and

upstream from the major contributing tributaries) has been monitored biannually since 1986 (TRC Mariah Associates, Inc., 2000a). These data show spring season measurements ranging from less than one cubic feet per second (cfs) up to 17 cfs and reflect snowmelt conditions. Fall season measurements are typically much lower (0.2 cfs to 3.1 cfs) and reflect baseflow conditions.

Table 5.2-1 Erosion Potential of Surveyed Soils in the Tygee Creek Basin Area

Soil Association/ Soil Mapping Unit	Erosion Hazard	Approximate Percentage of Basin Area
Paulson-Lail-Stony rock land association	slight to high (60% are rated high)	20
Robana-Buckskin-Cowdrey association	slight to moderate	20
Turson-Dipman association	slight	5
081	moderate to high	2
082	moderate to high	3
300	moderate	4
380	moderate to high	2
404	moderate to high	3
410	moderate to high	6
456	moderate to high	3
551	moderate to high	7
553	moderate to high	3
554	moderate	4
755	moderate to high	3
870	low to moderate	7
911	moderate to high	3
912	moderate to high	5

Sources: USFS, 1990; USDA, 1976

Biannual data collected from this site, which is located in the upper part of the basin, are insufficient to determine yield for the Tygee Creek basin as a whole. However, an estimate of mean daily flow was derived for a site (at the approximate location of site SW-18 shown on Figure 3) on the upper part of Tygee Creek that drains an area of 17.7 square miles (USFS, 1981 and 1982). Extrapolating that value (1.3 cfs) over the entire 37-square mile basin, and converting the mean daily flow rate to a volume of water discharged over an entire year, provides a rough estimate of annual yield for the Tygee Creek basin of close to 2,000 acre-feet.

The recent stream flow measurements for the basin are those obtained by Maxim (2000a). Table 5.2-2 shows the results of their monitoring.

Table 5.2-2 Recent Stream Flow Measurements in the Tygee Creek Basin

Site Location	Site Identification (See Figure 3)	Stream Flow Measurement (cfs)		
		March, 2000	June, 2000	Sept., 2000
Upper Tygee Creek	SW-6	0.34	0.39	0.18
East Tygee Creek	SW-7	0.03	0.42	0.02
Lower Tygee Creek	SW-5	0.37	0.63	0.41
Upper Smoky Creek	SW-1	0.01	0.47	0.21
Lower Smoky Creek	SW-2	0.58	1.17	0.42
Lower Smoky Creek #2	SW-3	No data	0.58	No data
Tygee Creek below Smoky	SW-18	1.20	no data	0.48
Upper Roberts Creek	SW-4	no data	0.42	0.71

Data Taken From: (Maxim Technologies, Inc., 2000a).

Estimates of flood flows (Table 5.2-3) were made using USGS regression equations for estimating regional flood-frequency relations (Thomas et al, 1994).

Table 5.2-3 Flood Flow Estimates - Tygee Creek

10-Year Flood Peak (cfs)	50-Year Flood Peak (cfs)	100-Year Flood Peak (cfs)
369	583	673

Under undisturbed conditions, surface runoff from rainfall is typically low throughout the Tygee Creek basin due to an overall high infiltration rate. Much of the area within the Tygee Creek basin is currently relatively undisturbed, and that trend is not expected to change in the near future. Disturbances that currently occur within the basin include grazing, agriculture, and mining disturbances.

While disturbed areas associated with mining activities in Smoky Creek and Roberts Creek watersheds likely generate more runoff than under natural conditions, runoff from those areas to the main Tygee Creek drainage is currently reduced over natural conditions due to the sediment and runoff retention basins. Although existing streamflow measurements are not adequate to quantify that reduction, it is not expected to be large currently, when looked at proportionally to the whole basin. However, as most runoff in the basin is generated during the spring snowmelt season, the effects of the sediment ponds' reductions are also mostly during that season. As increases in disturbed areas continue, the trend would be to further reduce the amount of flow to the Tygee Creek basin as long as the basins continue to operate as designed.

A tailings pond was constructed in upper Tygee Creek near its confluence with Roberts Creek in the mid-1980s. The pond is unlikely to have had a large influence on the hydrologic regime of Tygee Creek as most of the up-gradient stream flow is diverted around the pond and back into Tygee Creek. However, some portion of Roberts Creek water is withheld from the system when the Smoky Canyon Mine directs its flow into the tailings pond. Because Simplot does not track the frequency or volume of this water use, the effect on the hydrologic regime of Tygee Creek cannot be known with certainty. As the tailings pond

is expanded under future plans, these diversions would be expected to continue.

The upper headwaters of Tygee Creek include its main stem, which flows perennially, and several small, unnamed ephemeral or intermittent channels that drain northward from the southern tip of the basin, or eastward from Tygee Ridge.

Brief characterizations of named tributaries to Tygee Creek are given below. As stated previously, however, flow measurement data for these streams are generally lacking.

5.2.1. Roberts Creek

Roberts Creek is an intermittent stream that drains a 2.5-square-mile watershed in the southwest part of the Tygee Creek basin (see Figure 3). Between 1979 and 1988, flows in Roberts Creek ranged from 0.7 cfs to 3.3 cfs in the spring, and 0.3 to 1.4 cfs in the fall (Mariah, 1990).

5.2.2. Smoky Creek

The Smoky Creek watershed encompasses an area of about 6.6 square miles (see Figure 3). Its flow, as with flow in other streams draining the east side of the Webster Range, varies spatially along its alignment. Groundwater, discharged from distinct in-channel springs and from diffuse sources, contributes to stream flow. Conversely, along other parts of the stream, in-channel surface flow is lost to the substrate, either dispersing to recharge a groundwater system, or reappearing as surface flow at some point downstream. As a result, flows in a down-canyon direction increase or decrease. Such gain/loss characteristics were described in the late 1970s (Ralston, 1979) for portions of Smoky Creek and other streams in the general area.

Due to its proximity to the existing Smoky Canyon Mine, more is known about the hydrologic characteristics of Smoky Creek than of other streams tributary to Tygee Creek. Specifically, the stream flow in Smoky Creek is perennial from about its 7,200-foot elevation downstream about 2,500 feet; in this reach, the stream flows across the Lower Dinwoody and Phosphoria Formations. From that point, downstream to about the 7,000-foot elevation, the stream flows over outcrop of the Wells Formation, Rex Chert, and Dinwoody Formation, where it loses all flow (Ralston, 1979) through percolation downward into the underlying rock with the stream eventually drying up during most seasons in most years. As reported by Ralston, a spring discharging into the Smoky Creek channel in the southwest corner of Section 17 (see Figure 3) supports perennial flow in lower Smoky Creek.

Approximately 20 years of biannual flow data have been obtained on Smoky Creek (TRC Mariah, 2000b) at a site about one mile downstream of the previously mentioned Section 17 spring and about 1.3 miles upstream of the confluence of Smoky Creek with Tygee Creek. Spring flows ranged from 0.2 cfs to 12.9 cfs and fall flows ranged from 0.2 cfs to 2 cfs. This likely represents the general order of magnitude of flows that the Smoky Creek watershed currently contributes to Tygee Creek.

5.2.3. Draney Creek

Draney Creek watershed, at 5.2 square miles, is slightly smaller than the Smoky Creek watershed, but has a similar physiography. Its divide includes Draney Peak, the highest point in the Tygee Creek basin. Geologic conditions are fundamentally different from the Smoky Creek drainage, however perennial flow in Draney Creek is likely similarly supported by groundwater contributions from the Thaynes and Dinwoody formations. Unlike Smoky Creek, Draney Creek does not cross the Wells formation outcrop, and thus may not exhibit as much flow loss to the subsurface.

No flow records are apparently available for Draney Creek.

5.2.4 Salt Lick Creek

Salt Lick Creek flows across the lower flanks of the Webster Range between Draney Creek and Webster Canyon Creeks. It drains about 1.5 square miles, and is mapped as perennial in its lower reaches.

5.2.5 Webster Canyon Creek

Webster Canyon Creek drains an area of about 9.2 square miles and thus is the largest tributary watershed to Tygee Creek. Flow records are lacking for this creek, but it likely supplies a substantial quantity of flow to Tygee Creek. Falls Spring supplies water to the Auburn State Fish Hatchery along Webster Creek; flow rates for the spring have been reported to be approximately 8 cfs (USFS, 1981 and 1982).

Included within the Webster Canyon watershed is a small, intermittent drainage known as Spring Creek. Spring Creek drains the northern part of the Webster Canyon watershed, and enters Webster Canyon Creek just above the Tygee Creek confluence. A spring in this drainage supplies water to a privately owned fish rearing facility known as Star Valley Fish Ranch. The spring discharges flows in the range of 3 to 4 cfs (USFS, 1981 and 1982).

5.3 Vegetation

Information for current vegetative types and conditions within the Tygee Creek basin was obtained by baseline data associated with the Smoky Canyon Mine located in the southern half of the basin. Additional data was compiled from GIS vegetation maps generated by the Caribou-Targhee National Forest. No surveys for vegetation have been performed in the northern half of the basin included in this analysis, therefore, specific vegetative types can only be extrapolated from data from nearby locales.

Topography in the Tygee Creek basin is characterized by bottom-lands, toe-slopes and ridges, and these features are vegetated with a mosaic of sagebrush/grassland, aspen, and douglas-fir and lodgepole pine. Current land use, primarily agricultural and mining, has altered vegetative mosaics in less than 20 percent of the basin. Figure 4 shows major vegetation types found in the basin. The sagebrush/grassland community type covers approximately 8,600 acres in the mid-elevations of the basin. Approximately 6,000 acres of the basin is forested with conifers, approximately 3,700 acres are aspen-dominated, and approximately 1,300 acres are forested with a mix of aspen and conifer; these three forested community types cover approximately 45 percent of the basin, mostly over its higher elevations. Covering much smaller, localized areas are wetland/riparian zones (300 acres) and mixed shrub communities (approximately 400 acres). Agricultural uses of the basin encompass about 3,200 acres and uses related to mining cover about 800 acres.

Vegetation was surveyed in 2000 over parts of the Smoky Canyon watershed, that is within Simplot's proposed mining area in the southern half of the Tygee Creek basin. Though surveys did not extend to the northern half of the Tygee Creek basin, similar topography and hydrology would tend to support similar vegetation there as well, as indicated by USFS geographic information systems (GIS) mapping in the Caribou-Targhee National Forest.

Four principal vegetation types have been identified in the Smoky Canyon Mine area. Valleys and lower elevation south-facing slopes support a big sagebrush (*Artemeisia tridentata*) and grassland community. Higher elevation north and east facing slopes support mixed conifer forest. This habitat type includes Douglas-fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta*), and subalpine fir (*Abies lasiocarpa*). Aspen (*Populus tremuloides*) communities are interspersed throughout the coniferous forest on mesic sites. Riparian vegetation, including willows (*Salix* spp.) and sedges (*Carex* spp.), occurs along

Smoky, Roberts and Tygee Creeks.

Vegetation in the lower valleys of the Tygee Creek basin consists of agricultural pasture lands and contiguous sagebrush/grassland communities dominated by sagebrush, and both native and introduced forage species. Aspen and mixed shrub communities of varying densities occur in scattered patches. These vegetation communities occur predominantly on the eastern side of the valley and extend uninterrupted along the length of the valley floor.

Wetlands in the basin are primarily associated with streams, ponds, springs, and seeps. Wetland vegetation is dominated by willow species, forbs, and grass-like vegetation including rushes, sedges, and other broadleaf shrubs. U.S. Fish and Wildlife wetland maps (USFWS, 2001) for the area indicate that wetlands along the main stem of Tygee Creek and up the lower portions of Spring Creek and Webster Creek are predominantly Palustrine Emergent type with temporary to seasonal flooding and smaller areas of Palustrine Open Water. Wetlands upstream from Tygee Creek on the other tributary channels are predominantly Palustrine Scrub-Shrub type with broadleaf deciduous vegetation.

Toe-slopes and ridges above the valley floor are dominated with pure stands of aspen, mixtures of conifers and aspens, and forests of mixed conifers such as Douglas fir and lodgepole pine. These mosaic canopies form a dense forest cover, while mature stands of Douglas fir and lodgepole pine tend to have an open canopy structure. Pine beetle infestation is a concern in the mature lodgepole pine stands.

Native plant communities have been impacted primarily by mining and range management within the basin. Approximately 60 miles of roads have been built in the analysis area. The majority of these vegetative disturbances have occurred in the southern and eastern portions of the basin. Some timber harvest has occurred, but has been associated primarily with mining. Some of the disturbed areas associated with mining have been seeded with non-native forage grasses, and grazing in riparian areas has reduced the amount of vegetative cover along streams. Impacts to vegetation due to the selenium issue are described in JBR Environmental Consultants (2000a).

Plant species classified as threatened, endangered or candidate under the Endangered Species Act of 1973, were surveyed during the 2000 field season at the Smoky Canyon Mine (Maxim, 2000b). One threatened, one candidate, and two sensitive species were noted to have the potential to occur within the area of the plant surveys, however none of these plants were found during the survey. The moist soils occurring in wet meadows near springs, lakes or perennial streams are the preferred habitat of the threatened Ute ladies'-tresses; such habitat was found within the survey area, however no Ute Ladies Tresses were found. Suitable habitat associated with the slick-spot peppergrass, identified as a Candidate species, was not found during the survey. Both of the sensitive species surveyed (Cache's beardtongue and Payson’s bladderpod) are associated with high elevation open areas; only borderline habitat associated with the former was found during the noted surveys.

5.4 Stream channel

As stated above in Section 3.4, no comprehensive stream characterization studies have been done across the Tygee Creek basin. Aside from the limited field observations that provided the general descriptions in Section 3.4, available information is limited to various studies completed as part of aquatic assessments related to Simplot’s mining activities. The Caribou-Targhee National Forest has Proper Functioning Condition (PFC) Assessments for a number of streams in the watershed. They are: Salt Lick Creek - Functional-at-Risk-High: Draney Creek -Functional-at-Risk-High; Smoky Creek - Functional-at-Risk-Moderate; and Pole Canyon Creek - Functional-at-Risk-Low.

A two-mile reach of Tygee Creek and slightly less than a one-mile reach of lower Roberts Creek have been inundated by Simplot's tailings pond. A diversion, approximately three miles long, and at a lower gradient than the original natural channels, has been constructed around the east side of the pond to replace the channels in those areas. As stipulated by the U.S. Army Corps of Engineers, the Idaho Department of Fish and Game (IDFG), the Idaho Division of Environmental Quality, and the Idaho Department of Water Resources, the diversion must be maintained in a stable, non-eroding condition (Mariah, 1994).

Smoky Creek's channel alignment and cross section, particularly within the canyon, have been altered by various human activities. Primarily, the presence of a road within the narrow canyon confines has resulted in realignment, channelization, and berming throughout much of its length (Maxim Technologies, Inc., 2000b).

TRC Mariah (2000b) describes the Upper Smoky site (TRC-USm) as being confined within the canyon, occurring within forested and riparian vegetation communities, and possessing cobble and earthen banks. They report the base flow channel as having an average width and depth of 3.0 feet and 0.2 feet, respectively. In contrast, the Lower Smoky site (TRC-LSm) is located within shrub/grass communities and its banks are comprised of fine-grained sediments; this site is noted as being impacted by livestock trampling. The base flow channel is reported as having an average width of 6.2 feet and an average depth of 0.6 feet.

They describe upper Tygee Creek (upstream of the tailings pond site) and its east fork as a slow-moving stream with fine-grained bed and banks, with adjacent grass, pasture, and willow. This area is noted as having been impacted by livestock. The base flow channel dimensions are reported as 2.0 feet wide and 0.2 feet deep.

5.5 Water quality

Simplot and/or its consultants have been monitoring water quality biannually at several sites within the Tygee Creek basin since 1979 (Mariah, 1988, 1993-1996; TRC Mariah, 1997-2000b). Summaries of some of those data can be found in TRC Mariah (2000b), and are provided in Table 5.5-1 below.

Table 5.5-1 Historic Water Quality - Range of Reported Values, 1979 - 1999

Parameter, in mg/l unless noted	Lower Smoky Creek (Map ID TRC-LSm)	Lowest Tygee Creek (Map ID TRC-LT3) (data from 1986 - 1999)
Oxygen, D*	6.0 - 14.4	5.4 - 16.2
Temp., ^{o}C	0.0 - 12.0	2 - 18
Aluminum, T**	ND*** - 5.65	ND - 1.01
Arsenic, T	ND - 0.003	ND - 0.002
Barium, T	ND - 0.200	0.090 - 0.171
Boron, D	ND - 0.257	ND - 0.04
Cadmium, T	ND - 0.01	ND - 0.003
Calcium, D	39 - 71	38 - 162
Chromium, T	ND - 0.01	ND - 0.06
Copper, T	ND - 0.03	ND - 0.04
Iron, T	0.12 - 5.86	0.05 - 0.89
Lead, T	ND - 0.10	ND - 0.001
Magnesium, D	14 - 20	15 - 69
Manganese, T	0.050 - 0.540	0.020 - 0.220
Mercury, T	ND - 0.002	ND
Nickel, T	ND - 0.01	ND - 0.03
Potassium, D	ND - 1.1	ND - 2
Selenium, T	ND - 0.001	ND - 0.004
Silver, T	ND - 0.01	ND
Sodium, D	2 - 9	10 - 1,895
Vanadium, T	ND - 0.01	ND - 0.01
Zinc, T	ND - 0.35	ND - 0.09
Bicarbonate ($CaCO_3$)	180 - 221	163- 302
Carbonate ($CaCO_3$)	ND - 16	0 - 24
Total Alkalinity ($CaCO_3$)	186 - 233	163 - 310
Chloride	ND - 14	6 - 1,270
Specific Conductivity, µmhos/cm	231 - 451	402 - 27,900

Parameter, in mg/l unless noted	Lower Smoky Creek (Map ID TRC-LSm)	Lowest Tygee Creek (Map ID TRC-LT3) (data from 1986 - 1999)
Fluoride	ND - 0.4	0.1 - 0.5
Hardness ($CaCO_3$)	208 - 246	195 - 508
Nitrate as N, D	ND - 1.40	ND - 0.16
Nitrate/Nitrite as N, D	ND - 1.40	ND - 0.16
Nitrite as N, D	ND - 0.01	ND - 0.01
Nitrogen Ammonia	ND - 1.12	ND - 0.09
pH	7.8 - 8.6	8.0 -8.7
Phosphorus, ortho, D	ND - 0.220	ND - 0.043
Phosphorus, T	ND - 2.3	0.007 - 0.24
Total Dissolved solids	220 - 448	220 - 17,760
Total Suspended Solids	ND - 240	ND - 28
Sulfate	ND - 33	ND - 290
Turbidity, NTU	0.3 - 133	1.2 - 18

* Dissolved ** Total ***Non-detectable, value below method detection limit

TRC Mariah (2000b) also reports some limited water quality data obtained in Draney Creek in 1999. Those data show total dissolved solids and alkalinity levels as being similar to Smoky Creek.

In recent years, some surface waters in the general region in which the Tygee Creek basin is located have experienced elevated levels of selenium and other metals; reported levels have exceeded relevant aquatic criteria in some instances. These levels are thought to be related to phosphate mining activities, at least in part (Montgomery Watson, 1999). However, this has not been reported for streams within the Tygee Creek basin. Some of the waters within Smoky Canyon Mine's facilities within the Tygee Creek basin, which are not discharged - and thus not held to aquatic criteria - do have elevated concentrations of selenium and cadmium (JBR, 2001b). There have been no reports of elevated selenium levels reporting to Tygee Creek or Smoky Creek from these sources, however. The Water Resources Technical Report (JBR, 2001b) provides a full discussion on the selenium issue in regard to water resources.
Suspended sediment levels (and the related turbidity) within the Smoky Canyon part of the Tygee Creek basin have been analyzed for both the existing conditions and the projected conditions once mining of the B & C panels occurs. Those analyses (JBR Environmental Consultants, 2001b) do not provide a consistent indication that mining has substantially increased sediments in streams.

In a baseline water quality report prepared by Maxim Technologies, Inc. (2000a), the current water quality of the three streams within the basin (Tygee Creek, Smoky Creek, and Roberts Creek) was described based upon sampling events at six sites during 2000. That report described those surface waters as generally of a calcium-bicarbonate type, of moderate hardness or very hard, neutral pH, and with low nutrient levels. Data from those sites met aquatic water quality criteria.

5.6 Species and habitats

Information for the existing habitat types within the Tygee Creek watershed was obtained by baseline data associated with the Smoky Canyon Mine located in the southern half of the basin. Additional data was compiled from GIS vegetation maps generated by the Caribou-Targhee National Forest. Surveys for wildlife have also been associated with mining in the southern portion of the basin. No surveys for wildlife species have been performed in the northern portion of the basin included in this analysis, therefore, specific wildlife species can only be extrapolated from data by nearby locales. Similar vegetation types and subsequent habitat types are found in both the northern and southern portions of the basin.

The dominant habitat types within the Tygee Creek basin, as shown on Figure 4 are forested and sagebrush communities (Maxim, 2000b; USFS, 2000). Forested areas are on the higher elevation slopes and ridges, and are comprised of pockets are dominated by conifer (e.g., Douglas-fir (*Pseudotsuga Menziesii)*, lodgepole pine (*Pinus contorta*) and sub-alpine fir (*Abies Lasiocarpa*)), quaking aspen (*Populus tremuloides*), and aspen/conifer mixtures. Sagebrush communities occur within the valleys and on the lower south facing slopes, and are dominated by mountain big sagebrush (Artemisia tridentata vaseyana) and various grasses. The Tygee Creek basin also contains wetlands, meadows, agricultural fields, and mixed brush communities. The majority of the meadow and agricultural field habitat is located in the eastern portion of the basin. Wetland and riparian areas occur along Tygee, Spring, Webster, Salt Lick, Draney, Roberts and Smoky Creeks, as well as along some of their tributaries. These wetland and riparian areas provide important habitat for many wildlife species including amphibians and birds. These various habitat types provide food, water, cover, and space for a variety of ungulates, raptors, game birds, small mammals, song birds, predators, and other wildlife.

Non-native habitat occurs in areas where mining, timber cutting, and agricultural uses have altered the vegetative landscape. Mining has altered native habitat in the mainly forested, southern portion of the basin and agricultural uses of the landscape have altered the sage and meadow habitat in the eastern portion of the basin.

Several mammalian species are known or expected to occur within the area. These species include several members of the rodent family; several species of bats; mid-size species such as skunks, coyotes, badgers, bobcats, cottontails, and jackrabbits; and large mammals including deer, elk, moose, black bear, and mountain lions. Potential lynx habitat is also present. The Caribou-Targhee National Forest has identified the Rocky Mountain elk (*Cervus canadensis*) and the mule deer (*Odocoileus hemionus*) as Management Indicator Species of general forest health.

5.6.1 Big Game

Elk and mule deer are the two most highly visible and common large mammals that occur within the Tygee Creek basin. Both species can be found within and around the mid and higher elevations during spring, summer, and fall. During winter these species migrate to areas with less snow accumulation and greater forage availability. The Tygee Creek basin currently contains approximately 2,400 acres of critical elk and deer winter range (personal communication, C. Anderson, 2000); Caribou-Targhee National Forest, 2000). This area is generally located on lower-elevation west- and south-facing slopes located to the east of Tygee Creek, as shown on Figure 4. High value elk calving occurs in approximately 2,000 acres in the northwest portion of the analysis area near Draney Peak and north of Webster Canyon.

Regional studies conducted by the IDFG (Kuck, 1984) indicate that most elk in southeast Idaho tend to be nomadic, but do not migrate long distances between summer and winter ranges. The mean year-

round home range for elk was reported as 26 square miles, with a mean migration distance between summer and winter ranges of 4.1 miles. Unlike elk, mule deer migrate greater distances from winter and summer ranges and do not show specificity to particular ranges. Deer migrate through the Tygee Creek basin during the fall months en route to winter range and during the spring months en route to summer range. However, no specific migratory corridors have been identified within the area. Monitoring studies conducted in 1979 and 1980 (Kvale, 1980) found that mule deer migrate north in the spring and cross the basin in the vicinity of Smoky Canyon Mine. This raises the issue that mine activities could adversely affect deer movement.

Optimum habitat for both deer and elk is determined by the amount, and spatial arrangement, of cover and forage areas (Thomas et al., 1979). In general, elk and deer prefer edges between cover and forage areas. Large forage areas lacking sufficient adjacent cover are generally low-use areas. Foraging areas for elk and deer occur along unforested meadows, grasslands, and shrublands; on windswept ridges; and bottomlands near drainages bisecting Tygee Creek. Rubright (1980) monitored radio-collared deer and elk within the Smoky Canyon area. His work revealed that deer in this area tend to select conifer and sagebrush habitat types, whereas elk tend to prefer more closed canopied vegetation types, especially during the summer months, and tend to utilize aspen and riparian areas for forage, and aspen stands for calving activities.

In addition to deer and elk, moose (*Alces alces*) can also be found throughout the Tygee Creek basin at any time of the year (personal communication, C. Anderson, 2000). During baseline data collection efforts associated with Simplot's proposed mining, a cow and calf moose were seen within both the Smoky Creek and Roberts Creek drainages on several occasions. Several other individual moose were also seen in the area. Moose in the area do not concentrate in specific wintering areas, but are widely dispersed in aspen and conifer communities year-round (Kuck, 1984). Moose tend to stay within a small home range and are well adapted for foraging in deep snow. The most recent survey for moose populations in the area was conducted by IDFG in 1999 for Management Unit 76. A total of 140 moose were observed; population estimates for the area are between 437 - 729 (IDFG, 2000).

5.6.2 Birds

A variety of vegetation types occur within the Tygee Creek basin that provide a diversity of habitats for many species of birds. While each vegetation type offers important habitat components, the riparian areas that occur along the creeks are the most heavily utilized habitat by the birds in the area. The riparian areas are important during migration as these are often the only habitats within the arid west that have similar characteristics of more mesic habitats found outside the Intermountain region. The abundance of insects makes riparian areas important foraging habitats for species that nest in the grass or shrublands adjacent to the riparian areas. The following bird species are used by the Caribou-Targhee National Forest as Management Indicator Species for specific habitat types: Northern goshawk (*Accipiter gentilis*), for old growth conifer and aspen; hairy woodpecker (*Picoides villosus*), for snag management; yellow-bellied sapsucker (*Sphyrapicus varius*), for aspen; and sage grouse (*Centrocercus urophasianus*), for sagebrush.

Raptors

The timbered and riparian areas provide numerous nesting opportunities for raptors. Foraging opportunities for raptors are also plentiful and occur throughout the various habitat types found within the area. Surveys for special status raptor species were performed in the spring of 2000 near the Smoky Canyon Mine site (Maxim 2000c) and included: bald eagle (*Haliaeetus leucocephalus)*, Northern goshawk, boreal owl (*Aegolius funereus*), flammulated owl (*Otus flammeolus)*, and great gray owl (*Strix nebulosa)*. Results of these surveys are referenced in the Threatened and Endangered Species Technical Report for Simplot's proposed mining (JBR, 2000b). Other raptors, such as golden eagles (*Aquila chrysaetos)*, red-tailed hawk (*Buteo jamaicensis)*, Swainson's hawk (*Buteo swainsoni)*, Coopers's

Hawk (*Accipiter cooperii)*, great horned owl (*Bubo virginianus*), American kestrel (*Falco sparverius)*, and sharp-shinned hawk *(Accipiter striatus)* may nest in the aspen or conifer stands, or forage within the various vegetation types throughout the analysis area. Northern harrier (*Circus cyaneus*), typically nest in grassland habitat (in the eastern portion of the analysis area) and may also be found foraging in the basin. No studies have been completed within the area concerning the uptake of selenium by predators as a result of feeding on prey species that were exposed to elevated levels of selenium in vegetation.

Upland Game Birds

Prior to the construction of Simplot's tailings ponds, there was an active sage grouse (*Centrocercus urophasianus*) lek within close proximity of the pond location (Mariah, 1980, 1990). Mariah (1996) reported that sage grouse had established a lek on a knoll northwest of the new tailings pond dam site. Sage grouse were also observed to be strutting in the meadow south of the original lek. Recent surveys in and around the Smoky Canyon Mine identified two individual sage grouse and no active leks (Maxim, 2000c). Blue grouse (*Dendragapus obscurus*) and roughed grouse (*Bonasa umbellus*) are commonly found utilizing dense conifer and aspen stands in the area.

Other Birds

Many additional bird species utilize the habitats found in the Tygee Creek basin at some time during the year. In addition to the species discussed above, Maxim (2000c) recorded the presence of approximately 50 additional species including various passerines, waterfowl, and shorebirds. In terms of selenium, Ratti and Garton (2000) collected 98 and 117 eggs from several bird species (many of which were the same as those identified by Maxim, 2000c) at both non-mining and mining areas, respectively, in 1999. Their work revealed that selenium levels in egg tissues on phosphate mining sites were significantly higher than on non-mining sites. However, only 12.8% of the mining site eggs contained selenium exceeding 10 ppm, a level considered problematic for embryo viability (Skorupa, 1998:167).

5.6.2 Amphibians and Reptiles

Amphibian dependence on water limits their potential for distribution in the Tygee Creek basin primarily to areas along perennial streams or near springs. Intermittent and ephemeral water sources that occur in the minor drainages that intersect Tygee Creek may also be used as breeding sites and areas where the young develop. Recent surveys conducted in the vicinity of the Smoky Canyon Mine (Shiva, et al, 2000) revealed the presence of the tiger salamander (*Ambystoma tigrinum*) and the boreal chorus frog (*Pseudacris maculata*); these species may also occur in suitable habitat in other parts of the Tygee Creek Basin. Other amphibians, including the Great Basin spadefoot toad (*Spea intermontanus)*, the Columbia spotted frog (*Rana luteiventris*), the Western toad (*Bufo boreas),* and the Northern leopard frog (*Rana pipiens*), may also occur in the basin, but were not discovered during the Smoky Canyon surveys. The Western toad and the Northern leopard frog are considered as species of special concern by IDFG and the US Fish and Wildlife Service.

Reptile surveys recently conducted near the Smoky Canyon Mine (Shiva, et al, 2000) found the rubber boa (*Charina bottae*) and the Western terrestrial garter snake (*Thamnophis elegans*). Additional reptiles, including the sagebrush lizard (*Sceloporus graciosus*), gopher snake (*Pituophis catenifer*), common garter snake (*Thamnophis sirtalis*), and short-horned lizard (*Phrynosoma douglassii*), were not found during the survey, but may also occur within the Tygee Creek Basin. It is not expected that any reptiles species of special concern occur within the basin.

5.6.3 Fisheries

Data for fisheries in the basin have been obtained primarily from studies on mining operations in the southern part of the Tygee Creek basin. A detailed analysis of fisheries, including selenium issues, for Smoky and Tygee Creeks can be found in the Fisheries and Aquatics Technical Report (JBR, 2000c).

No information is available for fisheries in the northern section of the Tygee Creek basin.
Fish surveys conducted as a part of the original Smoky Canyon Mine Environmental Impact Statement (EIS) (USFS, 1981 & 1982) investigated fish populations present in Sage (just south of the basin), Roberts, Smoky and Tygee Creeks. Fisheries information presented in that EIS indicates that Smoky and Stump Creeks are among streams that serve as important spawning habitat for trout inhabiting the Salt River system. Electrofishing conducted as a part of the original EIS baseline data gathering effort found that both cutthroat and brook trout were present in Smoky Creek, and a small number of cutthroat were found in Tygee Creek. The EIS refers to the Salt River system as "the parent source of fine spotted cutthroat trout that are found in southeast Idaho" (USFS, 1981 & 1982) No salmonids were found in Roberts Creek.

In early August of 2000 (Maxim, 2000d), Maxim sampled fish populations in Smoky Creek. Cutthroat trout, sculpin (*Cottus* sp.), brook trout, and longnose dace (*Rhinichthys cataractae*) were noted during the survey. Near the Tygee Creek/Smoky Creek confluence, cutthroat and brook trout were found. Those two fish were also found, along with leatherside and Utah chub (*Gila copei* and *G. atraria*, respectively), redside shiner (*Richardsonius balteatus*), longnose dace and sculpin, in Tygee Creek below Simplot's tailings ponds (Maxim, 2000d).

The Wyoming Fish and Game Department operates a fish hatchery on Webster Creek located in the northern section of the basin. Due to whirling disease concerns, only the spring water is utilized in hatchery operations.

5.6.4 Threatened, Endangered and Sensitive Animal Species

No animal species classified as threatened or endangered under the Endangered Species Act of 1973 are known to regularly inhabit the Tygee Creek basin. Several species classified as sensitive by USFS that receive special management consideration are known to occur or have the potential to occur in the basin. The following discussion lists these species and provides basin-specific comments on their potential presence if known. JBR (2000b) elaborates on this issue.

The gray wolf (*Canis lupus*), is a threatened species that has recently been reintroduced into central Idaho and Yellowstone. In recent years, a single wolf siting has been reported, but unconfirmed, in the Caribou County area (Vering, 2000), however, Maxim (2000c) did not detect any evidence of wolves during their baseline surveys of the Smoky Canyon area. In the late fall of 2000, a single wolf which had been preying on sheep in Caribou County was killed under a lethal taking provision authorized by the USFWS (Caribou County Sun, December 7, 2000). Track surveys conducted in the area of sheep kills indicated a single wolf was involved in these predations. This wolf may have dispersed from one of the Yellowstone or Idaho releases. During a track survey conducted at the Manning Creek Project Area (just south of the Tygee Creek basin) in January, 2001, a single set of wolf tracks was discovered by JBR biologists (JBR Environmental Consultants, 2001c).

The grizzly bear *(Ursus arctos)* is also listed as threatened. No reported sightings have occurred in the Tygee Creek basin although the original Smoky Canyon Mine EIS (USFS 1981 and 1982) noted that the nearest recent grizzly bear sightings were made on the Targhee National Forest approximately 75 miles north of the basin, while the nearest recorded sightings were made approximately 50 miles north of the area. Grizzly bear tracks were reported near Stump Creek (just north of the basin) in 1974.

Maxim conducted winter track surveys for the threatened Canada Lynx (*Lynx canadensis*) in the Smoky Canyon Mine area in 2000. They found no evidence of lynx. They noted that while the local government trapper working in the area for the past 15 years had never seen evidence of lynx, there were two unconfirmed lynx taken in the area in the 1960's, and an unconfirmed sighting in 1997.

Maxim conducted an aerial winter bald eagle *(Haliaeetus leucocephalus)* survey in February of 2000, following established protocols. The survey area included the Tygee Creek drainage. No bald eagles were recorded during this survey, nor were any bald eagles recorded in the area during other Maxim 2000 survey work. Maxim notes, however, that waterfowl utilized the Smoky Canyon Mine tailings ponds, and represent a prey base which could attract eagles to the area. Bald eagles have been known to winter in the Crow Creek area, south of the Tygee Creek basin (JBR Environmental Consultants, 2001c). This species is listed as threatened.

Maxim did not observe whooping cranes *(Grus americanus*) in the area during their 2000 baseline surveys, nor were any of these endangered birds observed during studies done as part of the original Smoky Canyon Mine EIS (USFS, 1981 & 1982).

Maxim did not detect any spotted bats *(Euderma maculatum)* or Townsend's big-eared bats (*Corynorhinus townsendii*) in the baseline survey area near the Smoky Canyon Mine, and only noted minimal habitat potential for these sensitive species.

Wolverines (*Gulo gulo*) are another sensitive species for which Maxim surveyed in the vicinity of the Smoky Canyon Mine; no evidence of wolverine presence was detected during these surveys.

Listed as sensitive, Harlequin ducks *(Histrionicus histrionicus)* and trumpeter swans (*Cygnus buccinator*) may stop briefly in the basin or on the Simplot tailings ponds, but would not be expected to remain in the area for extended periods. None have been reported.

Maxim conducted northern goshawk *(Accipiter gentilis)* surveys of the Smoky Canyon Mine area in mid-May and mid-July of 2000. Much of the proposed mining area is considered as potential northern goshawk habitat, however there were no goshawks, nests, or other evidence of goshawks (plucking perches, etc.) found. A goshawk nesting territory is reported to exist within the basin, approximately one mile west of the Smoky Canyon Mine (Maxim, 2000c). This species is listed as sensitive.

The sensitive Columbia Sharp-tailed Grouse (*Tympanuchus phasianellus columbianus*) species was not found during the recent Maxim baseline studies, and Maxim further notes that the species has not been reported in earlier baseline reports conducted in the area (Maxim, 2000c).

Three sensitive owl species were surveyed by Maxim in 2000: the boreal owl (*Aegolius funereus*), the flammulated owl (*Otus flammeolus*), and the great gray owl (*Strix nebulosa*).
No boreal owls or great gray owls were detected. Flammulated owls responded to calls at three locations near the Smoky Canyon Mine during the May surveys, but searches conducted following these responses did not locate any flammulated owl nests.

No three-toed woodpeckers *(Picoides tridactylus*) nor evidence of the species were detected in the area.

Designated as sensitive, no spotted frogs *(Rana pretiosa)* were found during Maxim's 2000 surveys.

5.7 Human uses

At present, phosphate mining, livestock grazing, timber harvest, and agriculture are the dominant land uses in the Tygee Creek basin. Outdoor recreational activities such as camping, hunting, fishing, wood gathering, and snowmobile operation, which occur primarily on the Caribou-Targhee National Forest, are also important but affect the basin at a lesser scale than the dominant uses. Most of the USFS land in the basin is within the boundaries of either the Stump Creek Roadless Area (#04173) or the Sage Creek Roadless Area (#04166).

A portion of J.R. Simplot's Smoky Canyon phosphate mine lies within the basin. The existing mine facilities in the basin include the mill site, inactive mine panels, some of which have been partially backfilled, and the two tailings ponds on Roberts Creek and Tygee Creek. The proposed mining of the B & C Panels would include mine panels along Smoky Creek and an external overburden disposal site on the ridge on the west side of Roberts Creek watershed. The tailings pond area would also increase as more tailings are deposited over the years. A summary of existing and proposed mining disturbances in the Tygee Creek basin is given in Table 5.7-1. (Note that some of Simplot's existing disturbances, reclaimed areas, and proposed disturbances are outside of the Tygee Creek basin, to the south.) At full development levels, mining disturbances in the Tygee Creek basin would cover over 1,370 acres, or over 5.8 percent of the total basin area.

Table 5.7-1 Approximate Simplot Disturbance in the Tygee Creek Basin (Acres)

Area Currently Disturbed	Area Currently Reclaimed	Area* Proposed for Disturbance	Proposed Disturbance Area Eventually Reclaimed	Proposed Disturbance Area to Remained Un-Reclaimed
427	5	1374	1361	13

The process of developing the Smoky Canyon Mine began with the Draft EIS in 1981. The current mining and milling operations were authorized by the USFS in 1983 after completion of the Final Smoky Canyon Phosphate Mine EIS (USFS, 1982). Mining operations consist of hauling ore from the pits to the mill where phosphate mineral is separated from the ore. The phosphate mineral slurry is then pumped through a buried pipeline which runs west to Simplot's fertilizer plant in Pocatello, Idaho. Mill tailings are piped to the tailings ponds east of the pits and mill. Makeup water for mine operation is supplied by Roberts Creek and two water wells located near the mill.

Reclamation of land disturbed by mining operations has already begun on the Smoky Canyon mine site by regrading and revegetation directly on mine spoil or on a surface layer of growth medium covering the spoil. Land disturbance for the proposed mine facilities would also be reclaimed but the process has been modified. As information about the problems posed by selenium accumulation in water and vegetation has become available, it became clear that additional steps were necessary to keep selenium in mine spoil sequestered from the environment. The proposed reclamation method for the newly disturbed areas is to cover seleniferous overburden fill with a 10-foot thick layer of non-mineralized chert and an additional layer of topsoil one to three feet thick. This method is expected to prevent selenium accumulation in forage to livestock and wildlife, as well as other non-forage vegetation species, as described in detail JBR Environmental Consultants (2001a). Currently, less than five acres of mining disturbances within the Tygee Creek basin have been reclaimed with waste shale.

Portions of three USFS grazing allotments are included in the basin and one allotment, Salt Lick, lies completely within the basin. The Salt Lick allotment is 1,133 acres in size and 99 head of cattle are grazed from June 6 through September 1, a total of 290 animal unit months. Approximately 80 percent of the Pole Canyon allotment lies within the basin. This rather large sheep allotment encompasses 12,658 acres and is grazed by 1,020 animals from June 27 through September 20, or 2,924 animal unit months. The southern half of the Webster Creek allotment also lies within the basin. This allotment is 6,120 acres in size and is for 1,000 head of sheep from July 1 to August 31, or 2,038 animal unit months. The Webster Creek allotment is currently vacant, with the western third temporarily being used by another permittee. The future of the Webster Creek allotment is currently under review. If the allotment is found to be not viable, portions of it will likely be combined with allotments on its western border (personal communication, L. Mickelsen, 2000). A small portion of the Stump Creek allotment is within the basin, approximately 340 acres. The Stump Creek allotment is 18,541 acres in size and is grazed by 586 head

of cattle from June 6 to September 30, or 2,254 animal months. A new Allotment Management Plan for the Stump Creek allotment is currently going through the NEPA review process and is scheduled to be completed in 2001 (personal communication, L. Mickelsen, 2000). In summary, approximately 15,000 acres, representing 63 percent of the Tygee Creek basin, is subject to grazing by USFS permitees (when the Webster Creek allotment is being utilized); some additional grazing also occurs on other non-forest lands.

Timber harvest in the Tygee Creek basin has been minimal in recent years. Some harvest typically occurs in conjunction with clearing land scheduled for mining. Timber sales on USFS land in the basin also occur at appropriate levels for reducing fire fuel load and managing trees damaged by disease, insects, or storms. However, future timber harvests in the basin may be limited as a result of the recently adopted Forest Service Roadless Area Conservation proposal. The effective date of this rule is May 12, 2001.

Recreational use of the Tygee Creek basin includes deer and elk hunting, fishing, wood gathering, snowmobile operation, and camping, although there are no established campgrounds in the basin. The Webster Ridge Trail is located along the western boundary of the basin. The trail is used mainly by all terrain vehicles, hikers, and horse back riders. The Webster Ridge Trail has been proposed by the USFS to become part of the Great Western Trail system and a Millennium Trail.

The Auburn Fish Hatchery, which is operated by the Wyoming Game and Fish Department, is located on the Caribou-Targhee National Forest in the north-central portion of the basin near Webster Creek. Although it is located in Idaho, the hatchery produces fish for Wyoming under a permit first issued by the USFS in 1941. Most of the existing buildings were constructed in 1942 and new buildings are currently under construction in order to allow expansion of operations and isolate the hatchery from the creek to reduce the risk of whirling disease. About half of the water for hatchery operation comes from springs on the mountainside west of the hatchery and the rest comes from Webster Creek. Approximately 3 million gallons of water per day are used by the hatchery to produce a total of approximately 40,000 pounds of cutthroat and Mackinaw trout per year.

Agriculture and grazing on private lands dominate land use in the eastern portion of the basin. Agricultural lands, shown on Figure 4, cover about 3,000 acres, or 12 percent of the basin. A dairy ranch is also present. No major highways are found in the Tygee Creek basin. Existing roads largely serve the needs of mining, agriculture, and timber harvest operations.

6.0 Reference Conditions

Reference conditions in the Tygee Creek basin are those associated with the time period in history prior to major European influences. The condition of the various ecosystem components during that time period, where known, can be contrasted with current conditions in order to determine how the system has changed and evolved since that time.

6.1 Erosion Processes

Soil in the area is derived primarily from parent materials including sandstone, shale, and siltstone (Maxim, 2000e). The majority of soil associations in the Tygee Creek basin area consist of loamy textured soils and were formed from alluvium, wind-deposited silt, and slope wash. Soils on ridges and plateaus have developed from sandstone, shale, or siltstone residua. Colluvium is the parent material for development of soils on slopes. Soils in drainages and swales have developed from alluvial materials. The sedimentary bedrock formation in the Smoky Canyon area consists primarily of shale, chert, and limestone.

The mountainous terrain does not favor optimal soil development. Soils on nearby mountain slopes are susceptible to increased erosion rates that constantly remove the fine particles from the surface and deposit them on the surfaces of soils occupying the alluvial or valley slopes. Soils in the mountains also tend to have high concentrations of coarse fragments which are transported to the alluvial slopes during landslide events and over time.

6.2 Hydrology

There is no known direct evidence by which to assess whether hydrologic characteristics in the Tygee Creek basin have changed during the previous 100-year time frame. Instead, indirect measures may be used. Stream flow patterns are the result of precipitation characteristics and basin characteristics, so changes in either of these two indices may indicate that changes in stream flow have also occurred.

Precipitation information of a long enough time span to indicate changes in rainfall patterns, average depths, etc. near the basin are not available. However, to provide an indication of whether regional precipitation has changed over the reference period, the Pocatello, Idaho weather station data were examined. Although records don't begin until well into the reference period (1939), the long term average annual precipitation based upon that record is 12.14 inches, as compared with the current average of 11.75 inches (Western Regional Climate Center, 2000).

Watershed characteristics are not thought to have changed drastically over the Tygee Creek basin as a whole. The basin is essentially free of major developments or disturbances that would typically notably alter the soil's ability to intake precipitation, such as pavement or compaction. The Smoky Canyon Mine is the largest such facility in the basin with such a potential, however the Smoky Creek stream flow records obtained biannually since mining began do not indicate that the mine has altered the regime in Smoky Creek (JBR, 2001b). Vegetation is not noted to have been altered substantially during the reference period, as described further below, so it's contribution to runoff patterns has not likely changed.

However, one subtle change that may have affected runoff patterns, although to an undocumented degree, is livestock grazing. Across the western United States, heavy livestock grazing has commonly disrupted at least stream-side riparian vegetation patterns, if not upland areas. Regional streams have commonly seen an increase in flooding, and a decrease in baseflow as a result. Again, these impacts have not been document in the Tygee Creek basin, but may have occurred, as livestock grazing has been a major historical use of the basin lands, and livestock disturbances adjacent and in the basin's streams have been noted (TRC Mariah, 2000b).

6.3 Vegetation

Reference vegetation patterns in the Tygee Creek basin are the result of aspect, elevation, moisture, temperature, and soils. Topographic and climatic conditions in the basin probably limited fire frequency as a major disturbance factor. Fires played a critical role in the forests of southeastern Idaho (Barrett, 1994). Two or three fire-initiated seral age classes in the Caribou-Targhee National Forest indicates that natural fire maintained forest mosaic makeup until the settlement of Europeans in the late 1800's. Landscape patterns suggest most fires were patchy, and only rarely burned extensive areas. Conifer and aspen cover types likely predominated at the upper elevations of the basin and sagebrush/grassland cover types predominated in the valley bottom. Mountain brush was probably intermixed with confer/aspen stands on drier, exposed sites. Riparian/wetland cover was likely found associated with streams, springs, seeps, and ponds primarily at lower elevations. Plant communities consisted of native plant species. Plant community distribution was probably much like current conditions.

6.4 Stream channel

As discussed in Section 6.2, livestock grazing may have had some affect on stream flow conditions. Similarly, it may also have had effects on stream channel morphology. Stream side grazing, in-stream watering, and upland impacts can all contribute to stream destabilization, sediment loading, and disruption of riparian and overbank areas. While the Tygee Creek basin does not appear to have experience major stream channel entrenchment, alluvial dewatering, and gullying that is common throughout the west, some noted livestock-related impacts may have occurred within the reference period.

In addition, roads constructed within narrow canyon bottoms such as Smoky Canyon have altered the streams' alignment, meandering patterns, and overbank flow abilities.

The relatively recent re-routing of lower Roberts Creek and parts of Tygee Creek within the reference period have resulted in a definite morphological change in those natural stream reaches. The existing replacement channel is less sinuous, of flatter gradient, and more ditch-like that the natural stream channels, likely of a Rosgen's C type, that were in place during most of the reference period.

6.5 Water quality

Water quality in the Tygee Creek basin has not been documented throughout most of the reference period. It is assumed that much of the headwater area had good quality waters, similar to the current conditions. However, within the area of Tygee Creek where the tailings pond now occurs, water quality can be assumed to be different now than previously. During the reference period, the stream flowed through natural alkaline soil flats and saline spring discharge, as it did prior to the construction of the pond in the late 1980's (Mariah, 1990). The stream therefore had higher conductivity and dissolved solids downstream of the alkaline flats than upstream of the flats, and the elevated levels may have persisted downstream to the mouth of Tygee Creek, depending upon dilution as Draney and Webster Creeks entered the flow.

When the tailings ponds were constructed, the alkaline spring area was covered by a clay cap and Tygee Creek was diverted, which resulted in improved water quality in Tygee Creek downstream of the tailings pond than was natural for this area (JBR, 2001b).

6.6 Species and Habitats

Past dominant habitat types within the Tygee Creek basin were probably similar to the dominant habitat types found today. Currently, the habitats dominating the Tygee Creek basin are forested and sagebrush communities with riparian corridors along streams. Two animal species currently classified or proposed as threatened or endangered under the Endangered Species Act of 1973 were likely to be occupants in the Tygee Creek basin, the gray wolf and the North American lynx. Extensive trapping and hunting have been factors for their absence in the region. The former ranges of both species included the Tygee Creek basin. The absence of disturbance likely resulted in higher habitat quality in the past. Other threatened or endangered species that potentially occurred in the Tygee Creek basin include: bald eagle, whooping crane, and peregrine falcon. These species may have been transient occupants, much as they are today.

Animal species classified as sensitive by the USFS were likely inhabitants in the basin. With the exception of habitat conversion by mining and agricultural activities, vegetative community mosaics supporting several of these species (wolverine, great gray owl, northern goshawk, and Columbian sharp-tailed grouse) are comparable to current conditions. With the absence of human disturbance, overall habitat quality was probably greater, and favored species such as wolverine, northern goshawk, and great gray owls. However, native shrub communities, as altered by fire regimes and livestock grazing,

could have enhanced habitat for species such as the Columbian sharp-tailed grouse. Habitat conversion (such as fire or plant succession) outside the basin would have likely limited distribution of other sensitive species, much as it currently does.

The Salt River Drainage has historically supported a high quality Yellowstone cutthroat trout fishery. In the early 1960's, efforts were made to eradicate non-game fish species in tributary streams by use of chemicals. The native Yellowstone cutthroat trout fisheries were depleted as a result of this effort and the subsequent stocking of non-native trout (brook, German brown, and rainbow) which in some cases, can out compete native cutthroat trout for resources, have further depleted native trout populations.

6.7 Human Uses

The prehistory of southeast Idaho can be divided into three distinctive periods: Paleo Indian, Archaic, and Proto-historic. Each period is defined by particular tool types and subsistence strategies.

6.7.1 Paleo Indian Period

The Paleo Indian culture thrived in the area from ca. 14,500 BP to 7,000 BP, and can be identified and characterized by three distinct tool assemblages: Clovis, Folsom and Plano. The culture derived much of its subsistence from the Pleistocene megafauna such as mammoth, mastodon, horse, camel and bison. The culture has been characterized as being extremely mobile in that they depended on a migratory food source. While the Paleo Indian period generally is accepted as the earliest period of human occupation in southeastern Idaho, it is possible that groups inhabited the area a few thousand years earlier. The oldest evidence of human occupation in southeastern Idaho comes from Wilson Butte Cave; it consists of lithic and bone artifacts in a radiocarbon-dated context of 14,500 $\pm$ 500 B.P.

Clovis projectile points and tools date from 12,000 to 11,000 BP. Archaeological evidences from this time period demonstrate that a primary source of food was derived from the hunting of large megafauna such as mammoth, mastodon, bison and others.

Folsom-style projectile points have generally been found in association with bison (*bison antiquis*) and represent a different culture period from Clovis that dates from 11,000 to 10,600 BP. Folsom projectile points and tools have been recovered from sites such as Owl Cave and other surface deposits in and around southeastern Idaho. Plano-style points and tools are the most prominent of Paleo Indian tool-types to be found in southeast Idaho. The Plano period dates from 10,600 to 7,800 BP, and is also characteristic of a high degree of mobility and a dependance on large fauna for subsistence.

6.7.2 Archaic Period

The Archaic period (7,000 - 300 BP) is distinctive from the earlier period by the appearance of new projectile point styles (stemmed and notched points) that may have come as a result of new technology, and increased exploitation of other types of food-bearing resources and the first evidences of ground stone and ceramics. The Archaic period is divided into three distinctive parts: early, middle and late.

The Early Archaic period (7,000 - 4,500 BP) is marked by the introduction of large side-notched and bifurcate stemmed points (Northern Side-notched or Bitteroot and Pinto series, respectively). Although evidence supports the continued dependance on large mammals as a source of food, it is also characterized by an expansion of the resource base to include both plants and other types of small mammals. Semi-subterranean structures started appearing toward the end of the early Archaic (4,300 BP) with evidence of occupation near Givens Hot Springs in southeast Idaho.

The Middle Archaic (4,500 - 1,300 BP) is characterized by the discovery of earthen oven features, ground stone, and different projectile point styles (Pinto, Gatecliff, Elko, Humboldt series). Exploitation of a variety of different resources continued and diversified through the middle archaic, and the bow and

arrow is believed to have come into southeast Idaho around 1650 BP. This technological change brought about smaller projectile points and a shift in hunting strategies toward the end of the middle archaic period.

The Late Archaic period in southeastern Idaho is defined by the introduction of ceramics and small triangular projectile points. An increase in sedentary groups and a stronger reliance on smaller animals and a variety of plants are also distinctive characteristics of this period. The Late Archaic can be divided between two culture groups; the Fremont (1300 - 650 BP) and the Shoshonean (700 BP - present). The Fremont are generally considered to be agriculturalists, and although evidences of Fremont pottery have been discovered in southeast Idaho, the evidence of early agriculture has not. Speculation exists about whether or not the Fremont were in Idaho or if the artifacts were brought there by trade. Other arguments claim that the Fremont culture had aspects of hunting and gathering, and aspects of agriculture. Investigations of the Fremont in southeastern Idaho have been hindered because many Fremont artifacts have gone unrecognized or misclassified as Shoshonean. The Shoshonean occupation of this area of Idaho coincides with the expansion of the Numic Speaking peoples from the southwest Great basin area. These cultures exhibit aspects of hunter/gatherer groups and evidence has shown a continual occupation in Idaho from ca. 700 BP.

6.7.3. Proto-Historic Period

Probably the first white men to enter what is now the State of Idaho were the members of the Lewis and Clark expedition in 1805. Their influence in the region was probably negligible but the expedition marked the beginning of the influence of European-Americans. Horses were introduced, and fur trading began, soon after the expedition and provided the initial basis for an expansion of exploration and trade contacts with native Americans. Fur traders were followed by waves of settlers as they passed through the area on their way to lands farther west. The Oregon Trail, which crosses the eastern Idaho border near Montpelier, was established in Idaho in 1843. As the Mormon settlement in Salt Lake prospered and grew in the 1860s, homesteaders expanded outward into surrounding areas and eventually reached southeastern Idaho where farms and small agriculture-based communities were established.

With the introduction of the horse, the lifestyles of the Shoshone and Bannock changed dramatically. Horses brought about a change in subsistence strategies and allowed new methods and techniques for hunting. Transportation of food was facilitated by the introduction of the horse, and a greater area could then be exploited for resources. This led to more permanent villages and hunting forays into Wyoming and other areas that had previously been too distant.

Gold mining in southeastern Idaho was initiated in the early 1860s, further disrupting traditional Native American livestyles. A wave of prospectors and their suppliers moved into the region, and gold mining in the late 1800s and early 1900s generated increased trade with Salt Lake and a further increase in settlement. Roads were continually improved to manage the increase in goods transport, and the completion of the transcontinental railway in 1869 also improved transportation to southern Idaho.

This westward expansion and increasing conflicts with Euroamericans eventually forced most of the Shoshone and Bannock into the reservation system. The Western Shoshone signed a treaty in 1863 with the United States Government which set aside large tracts of Indian land in Idaho, Nevada, Oregon, Utah, and Wyoming. The Bannock were assigned to the Fort Hall Reservation in 1869, and from 1879 to 1907 a number of other Native American groups were relocated to Fort Hall as well. Many sacred sites are located throughout the region; those that can be identified include burials, rock art, monumental rock features and formations, rock structures or rings, sweat lodges, timber and brush structures, eagle catching pits, and prayer and offering locales. Much of the landscape in southeastern Idaho is still considered to be sacred to local Native American groups.

By the early 1900s, agriculture, gold mining, and grazing on public and private lands formed the economic base of southeastern Idaho. In 1920, phosphate mining began near Conda, marking a new phase of economic development in southeastern Idaho. Early underground phosphate mines were eventually replaced by large scale open pit operations as technology improved in the 1940s.

J.R. Simplot has been mining phosphate in southeastern Idaho since 1945. As the original mines were depleted, other phosphate sources, such as the Smoky Canyon Mine, were sought in order to supply Simplot's fertilizer plant in Pocatello, Idaho. Fertilizer produced by the plant is used in agriculture, mainly in the western United States. The other major sources of phosphate rock are found in the eastern United States, giving western phosphate sources a competitive advantage in supplying the needs of the western United States (USFS,1981 and 1982).

7.0 Synthesis and Interpretation

A comparison of current conditions and reference conditions for each of the ecosystem components covered in this analysis shows very few documented changes. However, this is not necessarily indicative that changes have not occurred, rather it reflects the facts that (1) direct information on general reference conditions is lacking, and (2) even for current conditions, the entire basin has not been subject to detailed study. In fact, much of the available information for the Tygee Creek basin comes directly from studies in and around the Smoky Canyon Mine, and this information was only obtained beginning in the early 1980s.

However, although extreme changes in ecosystem functioning have not been documented in the basin, it is likely that some changes have occurred. Given the high erosion hazard of many of the soils, and the long term land uses of grazing and timber production, both of which are generally known to contribute to erosion, it would be reasonable to assume that some changes in water quality, channel morphology, and runoff patterns have occurred since the early reference period beginnings. However, it also appears that any such changes have not comprised the basin's ability to provide a set of diverse habitats and characteristics for both non-human and human uses.

The relatively long list of threatened, endangered, and sensitive species that may have been present in the Tygee Creek basin at one time in the past, but that are no longer found may also indicate that ecosystem functioning has likely changed, at least subtly, over the reference period. However, this is not unusual for the region, and while human uses may be at least partly responsible for these species' decline, the Tygee Creek basin is still relatively undeveloped. Active management in the future can help to insure that the species currently present in the basin can continue to thrive.

Simplot's phosphate mining and associated activities such as road construction have undoubtedly been one of the major human uses in the Tygee Creek basin in recent years. Local erosion, runoff patterns, channel morphology, and water quality may have been affected within their direct disturbed areas, but ongoing sediment control and interim reclamation have apparently been effective as substantial off site sediment impacts have not been indicated through either water quality, stream flow, or aquatic habitat monitoring (JBR, 2000c and 2001b). While local vegetation and habitats have also been altered in specific areas where the mining activities have taken place, these effects have apparently been localized. As active mining areas are completed in the future, and sediment/erosion control becomes indirect due to the level of success of reclamation efforts, the short or long term nature of these effects will become known. It will be important for land managers to recognize the sensitivity of much of the basin's lands to erosion, and to manage land uses accordingly.

Not only mining, but other land uses in the basin can be the subject of best management practices to

reduce erosion and subsequent sediment loading to Tygee Creek and its receiving waters. Basin soil limitations suggest that most disturbed areas will experience increased erosion potential, either by wind or water. Native soils can be lost due to the breakdown of soil structure and discontinuation of natural soil development as a result of surface disturbance. Successful reclamation of disturbed areas associated with mining and with other land uses would expedite these natural processes and create an environment suitable for long-term vegetation establishment. This in turn, reestablishes habitat and maintains water quality.

Another aspect of best management practices in the Tygee Creek basin is more specifically related to mining. As described above, selenium has recently been noted to be of concern in various parts of eastern Idaho where phosphate mining occurs. Just south of the Tygee Creek basin, it is apparent that in some reclaimed areas of the Smoky Canyon Mine, selenium is accumulating in vegetation growing directly in seleniferous overburden (JBR, 2000e). (All of the areas sampled in the JBR (2000e) study were just outside and south of the Tygee Creek basin's southern boundary, not within Tygee Creek basin itself.) Reclamation of the existing and proposed mine disturbances lying within Tygee Creek basin, is planned to utilize selective handling to segregate seleniferous overburden from the surface environment, and thus reduce livestock, vegetation, and wildlife impacts. Similarly, water quality related selenium impacts that have been documented just south of the Tygee Creek basin may not occur within the basin if proposed mitigative measures for future mining activities are effective. The Geology and Minerals Technical Report (JBR Environmental Consultants, 2001d) provides a discussion of recommended best management practices and their effectiveness. Based upon existing selenium information in the basin, and the predicted effectiveness of these practices, the selenium issue can be expected to be of low risk to the Tygee Creek basin.

Timber harvest, livestock grazing, and recreation can be sustainable and compatible land uses if they do not exceed the limits necessary to maintain long term ecosystem health. Currently, timber harvest is occurring on a negligible percentage of basin lands; grazing is occurring on at least 63 percent, and agricultural production is occurring on about 12 percent. On public lands, the NEPA process has, within the recent history of the reference time frame, had a significant effect in ensuring that environmental impacts of land use decisions are thoroughly discussed and weighed against potential economic benefits. Private lands in the basin are not normally subject to the requirements of NEPA and private land use decisions tend to be driven primarily by market conditions, at least in the short term

Almost all of the area in which mining has taken place, as well as other historic land uses including timber harvesting and grazing, is in the upland portions of the basin which are administered by the USFS. The potential for erosion may represent the greatest risk to the basin, given the nature of the soils, and the nature of the land uses that occur in the headwater areas. Given the headwater positions of these public lands, as well as their susceptibility to erosion, thoughtful management is essential to the ecosystem health of the basin as a whole. Without such concerted efforts, future land uses in a functioning ecosystem within the Tygee Creek basin will be unlikely to continue.

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