6.0 ECOLOGICAL EVALUATION

6.1 INTRODUCTION

This ecological risk assessment (ERA) for the Group 2 SWMUs is consistent with the draft version of the Framework for Ecological Risk Assessment (EPA 1992e) and the Supplemental Risk Assessment Guidance for the Superfund Program, Part II, Ecological Risk Assessment (EPA 1989d).

The ERA explores potential risk to biota at the Group 2 SWMUs by addressing four questions:

1. Are contaminants present that have harmful characteristics in concentrations that could be harmful to biota?
2. What vegetation and wildlife species are present that could be harmed, if any?
3. Do pathways exist that expose biota to contaminants?
4. Is there a potential risk to biota from contamination and is this potential risk significant?

The methods used to conduct this screening-level ERA focus on developing and applying criteria to select receptors and contaminants for evaluation, identifying pathways for exposure, and researching the literature to determine the toxicity of the selected contaminants. The receptor and pathways analysis and the COC and toxicity analysis are then integrated to determine whether potential ecological risk is present and to suggest further analysis when significant concerns are apparent.

This process is documented in the following ERA components:

- Determination of potentially exposed biota involving a SWMU-wide habitat characterization and selection of biota receptors for the Group 2 SWMUs
- Selection of COCs
- Performance of a qualitative exposure assessment
- Performance of a toxicity assessment
- Performance of a qualitative risk characterization

6.2 DETERMINATION OF POTENTIALLY EXPOSED BIOTA

This section characterizes the TEAD-S biosphere by describing the SWMU-wide vegetation and wildlife habitats, indicating potential biota receptors and discussing the receptors' behavioral attributes that can lead to exposure.

The following sections include a characterization component and a comparison component. The characterization component describes TEAD-S SWMU-wide habitats and indicates which specific habitats are contained within the Group 2 SWMUs. These habitats are the foundation on which the community analysis and any subsequent qualitative ecological sampling recommendations are based.

6.2.1 Characterization Of TEAD-S Habitats

The vegetation of TEAD-S is best described as a sagebrush community tending toward a desert shrub community on the valley floor. SWMUs 3, 5, 8, 9, and 31 are part of the sagebrush community, whereas SWMU 30 is a part of the desert shrub community (Plate 3). The plant communities are typical of the region. The U.S. Forest Service describes the sagebrush physiographic region as extending into the central portion of the Great Basin (i.e., Utah, Nevada, and southern Idaho) (Garrison et al. 1977). The desert shrub community occurs on the salt flats of the Great Salt Lake, as well as the western third of the Great Basin.

The distribution of the sagebrush and desert shrub communities is influenced at TEAD-S by environmental changes in geomorphology, soil salinity, and soil drainage. In general, geomorphology, salinity, and soil drainage change from the northeastern corner of the installation to the southwestern corner. Well-drained soils distributed on alluvial material characterize the northeastern half of the installation and poorly drained soils distributed on the valley floor characterize the southwestern corner (see Section 2.1.3). Soil salinity changes from relatively low to high in a northeast-to-southwest trend across the installation. Vegetation communities and the species that inhabit them have responded through time to these environmental gradients.

Eighteen distinct vegetation types were identified on TEAD-S (Table 6.2-1). The vegetation types were initially defined using SCS plant associations (SCS, no date), dominant structures (e.g., tree, shrub, grass, etc.), and dominant species (e.g., 60 percent of one species indicates a dominant shrub type). However, the map was created using aerial photographs and then verified in the field during a SWMU-wide survey. Because actual vegetation types reflect responses to physical man-made disturbance, different successional stages and responses to different disturbance regimes are incorporated in the natural landscape.

Each of the vegetation types can be placed into one of six habitat types on the basis of its physiognomy or visual aspects, as shown in Table 6.2-1. These habitat types are the following:

- Upland Shrub
- Upland Grass
- Salt Shrub
- Alkali Meadow

Table 6.2-1 Habitat and Vegetation Types of TEAD-S Page 1 of 2

Habitat/Vegetation Type	Dominant Species
Upland Shrub Habitat	
Big Sagebrush	*Artemesia tridentata*, with grass and forb understory
Big Sagebrush-Greasewood	*Artemesia tridentata* and *Sarcobatus vermiculatus*, with grass and forb understory
Big Sagebrush-Greasewood-Rabbitbrush	*Artemesia tridentata*, *Sarcobatus vermiculatus*, and *Chrysothamnus nauseosus*, with grass and forb understory
Upland Grass Habitat	
Bunchgrass, Annual Forbs	*Elymus cinereus, Sitanion hystrix, Halogeton glomeratus*
Annual Grass and Forbs	*Bromus tectorum*, *Halogeton glomeratus*, *Lepidium perfoliatum*, *Salsola iberica*
Salt Shrub Habitat	
Saltbush	*Atriplex confertifolia*, *Atriplex canescens*
Snakeweed, Saltbush, Grasses	*Guterrezia sarrothrae*, *Artemesia pygmeae*, *Atriplex confertifolia*, *Atriplex canescens*, *Atriplex gardneri*, with some bunchgrasses and forbs
Greasewood	*Sarcobatus vermiculatus* with little understory
Alkali Meadow Habitat	
Rabbitbrush, Alkali Grass, Juncus	*Chrysothamnus nauseosus*, with an understory of *Distichlis spicata*, *Juncus* sp.
Alkali Grass, Juncus, Foxtail Grass	*Distichlis spicata*, *Juncus* sp., *Hordeum jubatum*, and other alkaline tolerant species
Alkali Pan with Saltblite	*Allenofera occidentalis*
Ephemeral Marshland	*Juncus* sp. and other ephemeral wetland species

Table 6.2-1 Habitat and Vegetation Types of TEAD-S Page 2 of 2

Habitat/Vegetation Type	Dominant Species
Riparian Habitat	
Riparian	*Tamarix pentandra* or *Ulmus pumila*
Human-Altered Habitats	
Agricultural Land	Alfalfa, wheat
Managed Grasslands	*Agropyron cristatum*
Reseeded Grasses with Tree Plantings	*Agropyron cristatum*, with *Ulmus pumila*, *Juniperus* sp.
Structures	Human-made structures
Disturbed Areas	*Halogeton glomeratus*, *Salsola iberica*, *Bromus tectorum*, bare ground

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- Riparian
- Human-altered

The habitats are described in detail below. The riparian habitat is not found in the Group 2 SWMUs. Furthermore, not all of the vegetation types that characterize the five remaining habitats are found in the Group 2 SWMUs (Section 6.2.2).

6.2.1.1 Upland Shrub Habitat

The upland shrub habitat is typically found in areas of well-drained soils and low salinity. These areas are relatively dry and generally dominated by sagebrush (*Artemisia* sp.) species that contribute at least one-quarter of the total species composition. Structural components consist of 1- to 6-ft shrubs with an understory of grass and forbs or large amounts of bare ground. Upland shrub habitats are used by a variety of wildlife including year-round residents, winter residents, or summer residents. Year-round residents include red-tailed hawks, great horned owls, and golden eagles. Winter residents include bald eagles, rough-legged hawks, and prairie falcons. Summer species include American kestrels and ferruginous hawks. During periods of migration (spring and fall) the number of these raptors increases due to the addition of migrant populations passing through Rush Valley. The raptors feed on black-tailed jackrabbits, small birds, reptiles, and small rodents, which in turn feed on insects and plants. Wildlife species that specifically characterize the upland shrub habitats are great horned owls, red-tailed hawks, loggerhead shrikes, badgers, Ord's kangaroo rats, horned larks, and sagebrush lizards. The vegetation types associated with the upland shrub habitat are the following:

- Big Sagebrush
- Big Sage, Greasewood, and Rabbitbrush
- Big Sage and Greasewood

As the structures of these vegetation types are similar, the fauna present in each type is also similar.

6.2.1.2 Upland Grass Habitat

Like the upland shrub habitat, the upland grass habitat is found in areas of well-drained soils and low salinity, although it lacks the shrub components in its plant composition. Upland grass habitat may be a successional stage to upland shrub habitat that has been removed by past disturbances or may possess environmental components that enable the grasses to compete better than the shrubs. These areas provide habitat for black-tailed jackrabbits, ground squirrels, and ground-dwelling birds. Vegetation types found in this habitat are the following:

- Bunchgrass and Annual Forbs
- Annual Grasses and Forbs

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6.2.1.3 Salt Shrub Habitat

Salt shrub habitat exists where environmental gradients are in transition. Soil is more poorly drained than in upland areas and has increased salinity. However, soil salinity is not as high, nor soil drainage as low, as on the valley floor (see Section 2.1.3). These areas generally contain xeric shrubs, particularly saltbush (*Atriplex* sp.), which make up at least one-quarter of the total species composition. Structural components consist of 4-inch to 3-ft shrubs with an understory of grass and forbs or large amounts of bare ground. Generally, kangaroo rats and pocket mice are common, as are black-tailed jackrabbits and antelope ground squirrels (Garrison et al. 1977). The most commonly observed raptor was the northern harrier, although all raptors on TEAD-S may utilize any habitat at any time, given their large home range.

Vegetation types associated with this habitat are the following:
- Saltbush
- Snakeweed, Saltbush, and Grasses
- Greasewood

6.2.1.4 Alkali Meadow Habitat

The alkali meadow habitat is typically found in areas of poorly drained soils and high salinity. This habitat is found on the valley floor in the southwestern corner of the installation and may be found in areas that tend to remain flooded during the spring. The vegetation reflects the degree to which the soil retains moisture and salinity: typical species are alkali grass and rushes. Normally, this habitat is devoid of shrubs and therefore has limited habitat structure. Depending on the frequency of flood events, shrubs such as rabbitbrush begin to invade, even though they are often destroyed during the next flood or when groundwater infiltrates the root zone. Areas that are flooded most frequently support ephemeral marshlands where rushes dominate, or support alkali pans devoid of all vegetation except saltblite. As with the salt shrub habitat, the alkali meadow habitat is especially used by northern harriers because the low vegetation height facilitates this raptor's hunting strategy. American kestrels also hunt in the meadow areas. Black-tailed jackrabbits, deer mice, meadow voles, and horned larks are typical residents of alkali meadows and serve as common prey for raptors. During floods, waterfowl, shorebirds, amphibians, and macroinvertebrates frequent the ephemeral marshlands and alkali pan. Vegetation types associated with the alkali meadow habitat are the following:
- Rabbitbrush, Alkali Grass, and Juncus
- Alkali Grass, Juncus, and Foxtail Grass
- Alkali Pan with Saltblite
- Ephemeral Marshlands

6.2.1.5 Riparian Habitat

Riparian habitat is limited at TEAD-S, and is partially or entirely influenced by human activities. It is found along the Ophir Creek drainage near the main entrance and the irrigation ditch that runs parallel to Harrison Road north of the igloo storage area (Plate 3). Additionally, Faust Creek offers riparian habitat along the southwestern border of TEAD-S. These areas include salt cedar trees and taller sagebrush (along the irrigation ditch in the northwestern corner of TEAD-

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S), elms trees and grass (along Ophir Creek in the northeastern corner of TEAD-S), or tall shrubs (along Faust Creek). The flow of Mercur Creek has been diverted around TEAD-S, and its former bed is noticeable only by its gravelly soil and a slight depression. The existing riparian habitat along the irrigation ditch, Ophir Creek, and Faust Creek offer cover for song birds, including cavity-nesting birds, and also serves as perching sites and possible nesting sites for raptors that might otherwise not be present on post. The vegetation type identified for this habitat is listed as riparian.

6.2.1.6 Human-Altered Habitat

TEAD-S contains many areas that have been altered or maintained to serve many uses as part of Depot activities. This habitat is described by the following "vegetation" types:

- Agricultural Land
- Managed Grasslands
- Reseeded Grasses with Tree Plantings
- Structures
- Disturbed Areas

This habitat is intermixed among the native vegetation and is independent of environmental gradients. Managed areas are typically apparent as geometric shapes (Plate 3). All types, excluding disturbed areas, must be maintained to prevent vegetation from reverting to native types. When these types are no longer maintained, their vegetation is naturally replaced by xeric plants. This situation is occurring in the former base housing area, where transplanted and ornamental trees are currently being replaced by xerophytic plants.

The vegetation types in this habitat offer different habitat qualities and uses. Structures (such as fences, buildings, foundations, and telephone poles) provide nesting cover, escape cover, and resting areas for many birds and some rodents and reptiles. Agricultural lands may provide forage for herbivorous species, and if harvesting is timed after the breeding season, nesting cover for many ground-nesting birds. Managed grasslands are typically found in secured areas at TEAD-S, and they are usually mowed, which decreases the inhabitant value for ground-nesting birds and rodents. Conversely, structures found within the managed grasslands offer alternative nesting areas for birds and rodents in quiet areas where human activities are limited. Areas with reseeded grasses and trees were formerly managed as landscaped areas at the main entrance and the former housing areas. Trees provide beneficial additions to an ecosystem typically vegetated by shrub communities, adding special structural components to the habitat that provide nesting sites for wintering raptors and many small birds that might not otherwise be present.

The last vegetation type in the human-altered habitats is found in disturbed areas. These areas are either sparsely vegetated or bare, and are typically associated with annual plants. Disturbances can be a result of chemical interactions or physical disruptions, so this type includes earthen mounds, pits, trenches, and bare areas. These areas may attract wildlife because their disturbed soil provides good burrowing sites for small rodents and dusting areas for rabbits and small birds. Alternatively, some human activities may displace wildlife, at least temporarily.

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Some areas may retain rain water for short periods and thereby provide water for birds and mammals. The prey in disturbed areas in turn attract raptors, badgers, and coyotes.

6.2.2 Habitat Types in the Group 2 SWMUs

Table 6.2-2 lists the habitats and vegetation types identified in the Group 2 SWMUs during ecological surveys. Approximately half (8 of 17) of the vegetation types found on TEAD-S occur in the Group 2 SWMUs. SWMUs 3, 5, and 9 are dominated by upland shrub and grass habitats (Figure 6.2-1). Additionally, SWMU 3 has a small salt shrub component. The vegetation in SWMUs 8 and 31 has sustained heavy physical damage and correspondingly is best characterized as disturbed human-altered habitats, although both SWMUs have some upland grass and salt shrub components (Figure 6.2-2). SWMU 30 is located on the valley floor and contains both greasewood, alkali meadow, and human-altered habitats (Figure 6.2-3).

The vegetation map of TEAD-S (Plate 3) was compared to maps from other Tooele County studies to validate it and place it in context. These studies included in the following:

- U.S. Forest Service, Vegetation and Environmental Features of Forest and Range Ecosystems (Garrison et al. 1977).

- SCS, Soil and Range Survey of the Tooele Army Depot (no date). Supplemented by Tooele County soils maps and descriptions.

- BLM, The Tooele Grazing Draft Environmental Impact Statement (EIS) (1983). The Pony Express Resource Management Plan and Draft Environmental Impact Statement (BLM 1988) was also to be used as a comparative document (EBASCO 1993b), but the draft version of the Tooele Grazing Environmental Impact Statement (BLM 1983) was determined to be more detailed and was used instead.

The information in these three documents adds regional and local perspective to the vegetation map of TEAD-S. The U.S. Forest Service (Garrison et al. 1977) gives descriptions of two ecosystems that characterize the overall sagebrush and desert shrub vegetation at TEAD-S. However, the description of the sagebrush ecosystem best characterizes TEAD-S and also best fits the geographic description of this ecosystem. Furthermore, sagebrush is the predominant vegetation in the upland habitats at TEAD-S.

SCS (no date) plant associations were used as a basis for vegetation mapping. However, the final TEAD-S vegetation map (Plate 3) differs from the SCS plant associations for two reasons. First, the SCS maps are intended to show soil types and the potential vegetation that the soil types will support, whereas actual vegetation mapped during the RFI-Phase II at TEAD-S reflects man-made disturbances and natural disturbance regimes that create various successional stages of the potential climax vegetation. Second, SCS vegetation associations are oriented toward range-management requirements, whereas the TEAD-S map was oriented to broad ecological requirements. Rangeland needs focus on forage production and livestock nutrition, whereas ecological requirements reflect food, cover, and reproductive requirements for each wildlife

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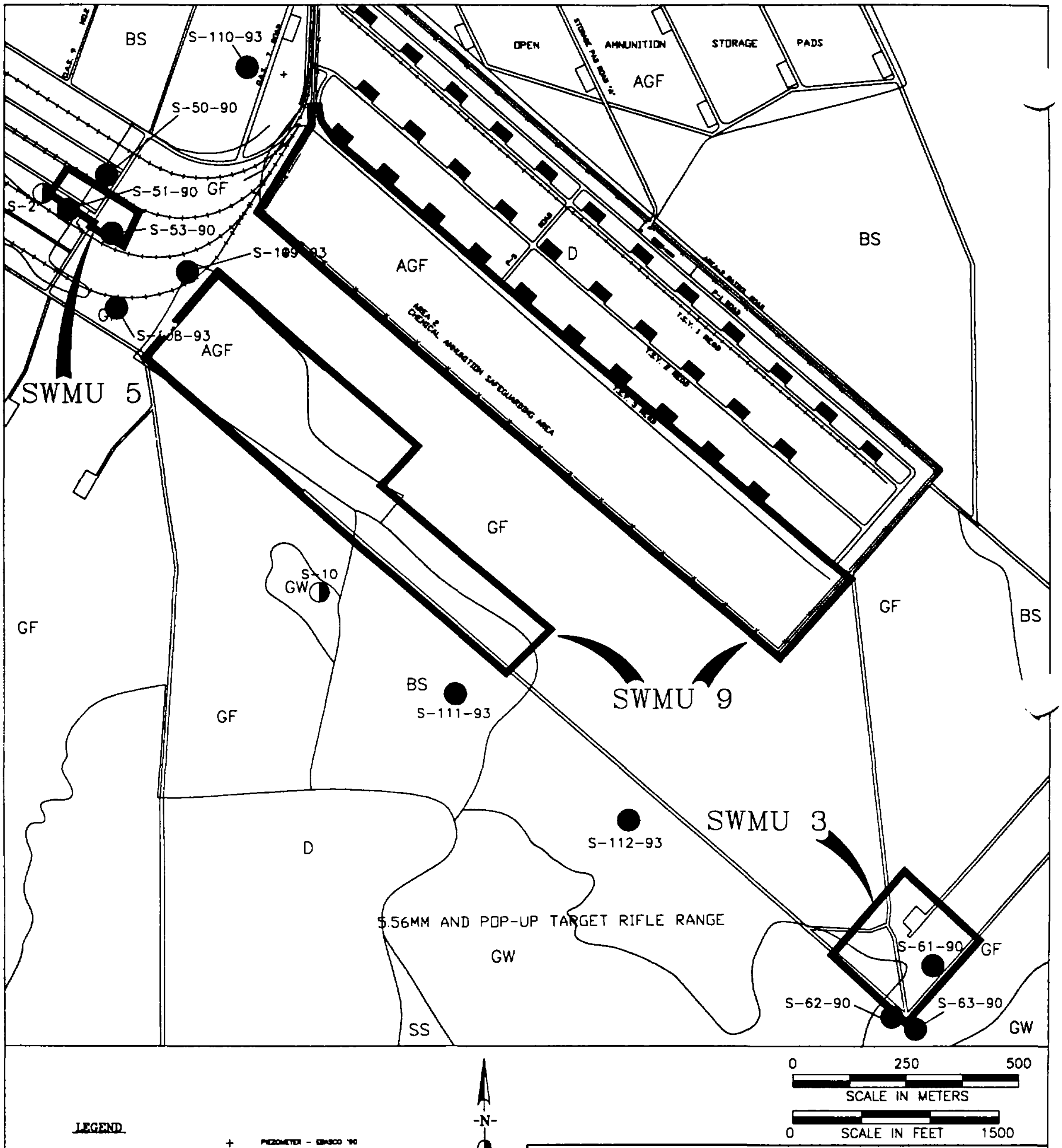
Table 6.2-2 Habitat and Vegetation Types of the Group 2 SWMUs

Page 1 of 1

Habitat Type	SWMU Where Identified
Upland Shrub Habitat	
Big Sagebrush	5, 9
Big Sagebrush-Greasewood	5
Upland Grass Habitat	
Bunchgrass, Annual Forbs	3, 5, 9, 31
Annual Grass and Forbs	9
Salt Shrub Habitat	
Saltbush	31
Greasewood	3, 30
Alkali Meadow Habitat	
Alkali Pan with Saltblite	30
Human-Altered Habitats	
Disturbed Areas	3, 5, 8, 9, 30, 31



LEGEND

▬ BUILDING, PERMANENT
▬ BUILDING, SEMI-PERMANENT
▭ BUILDING, TEMPORARY
— ROADS & PARKING
TRAIL OR EARTH ROAD
RAILROAD
FENCE
● MONITOR WELL - EBASCO
◒ MONITOR WELL - WESTON '8?
◑ MONITOR WELL - ERTEC '82
◐ MONITOR WELL - EA '86
\+ PIEZOMETER - EBASCO '90
■ METEOROLOGICAL STATION

EXPLANATION

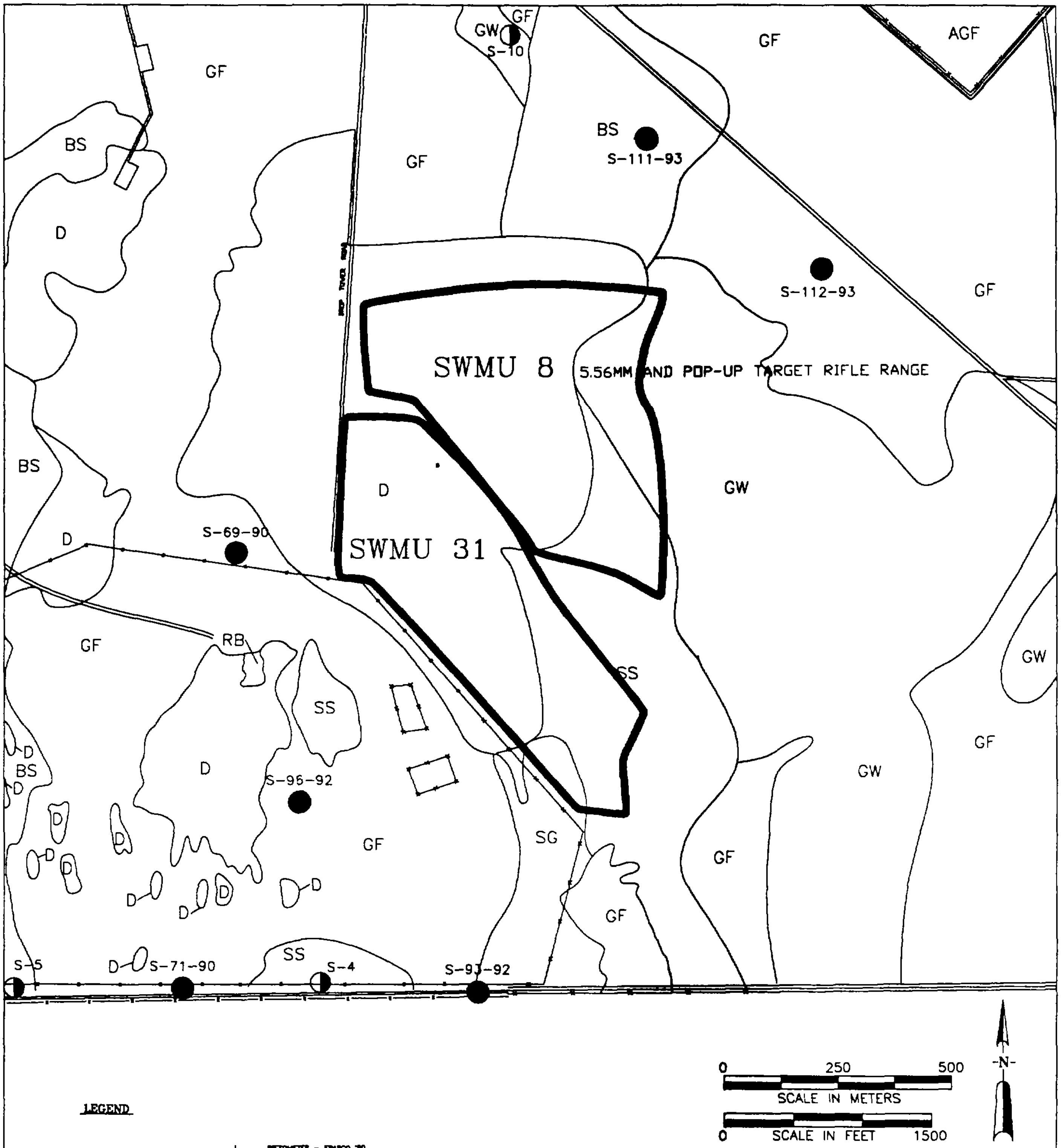
SS = SALTBUSH
SG = BIG SAGE/GREASEWOOD
GW = GREASEWOOD
BS = BIG SAGE BRUSH
WA = ALKALI GRASS, JUNCUS, FOXTAIL GRASS
RB = RABBIT BRUSH, ALKALI GRASS, JUNCUS
D = DISTURBED
AP = ALKALI PAN WITH SALTBUTE
SGR = BIG SAGE, GREASEWOOD, RABBITBRUSH
GF = BUNCHGRASSES/ANNUAL FORBS
SW = SNAKEWEED, PIGMY SAGE, SALTBUSH, GRASSES
R = RIPARIAN
RG = RESEEDED GRASS WITH TREE PLANTINGS
MG = MANAGED GRASSLAND
AGF = ANNUAL GRASSES AND FORBS
AGR = AGRICULTURAL LAND
M = EPHEMERAL MARSHLAND

PREPARED FOR:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 6.2- 1

Vegetation Map of SWMUs 3, 5 and 9

PREPARED BY:
Ebasco Services Incorporated



LEGEND

■ BUILDING, PERMANENT
▨ BUILDING, SEMI-PERMANENT
▭ BUILDING, TEMPORARY
— ROADS & PARKING
TRAIL OR EARTH ROAD
RAILROAD
FENCE
● MONITOR WELL - EBASCO
◒ MONITOR WELL - WESTON '86
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EXPLANATION

SS = SALTBUSH
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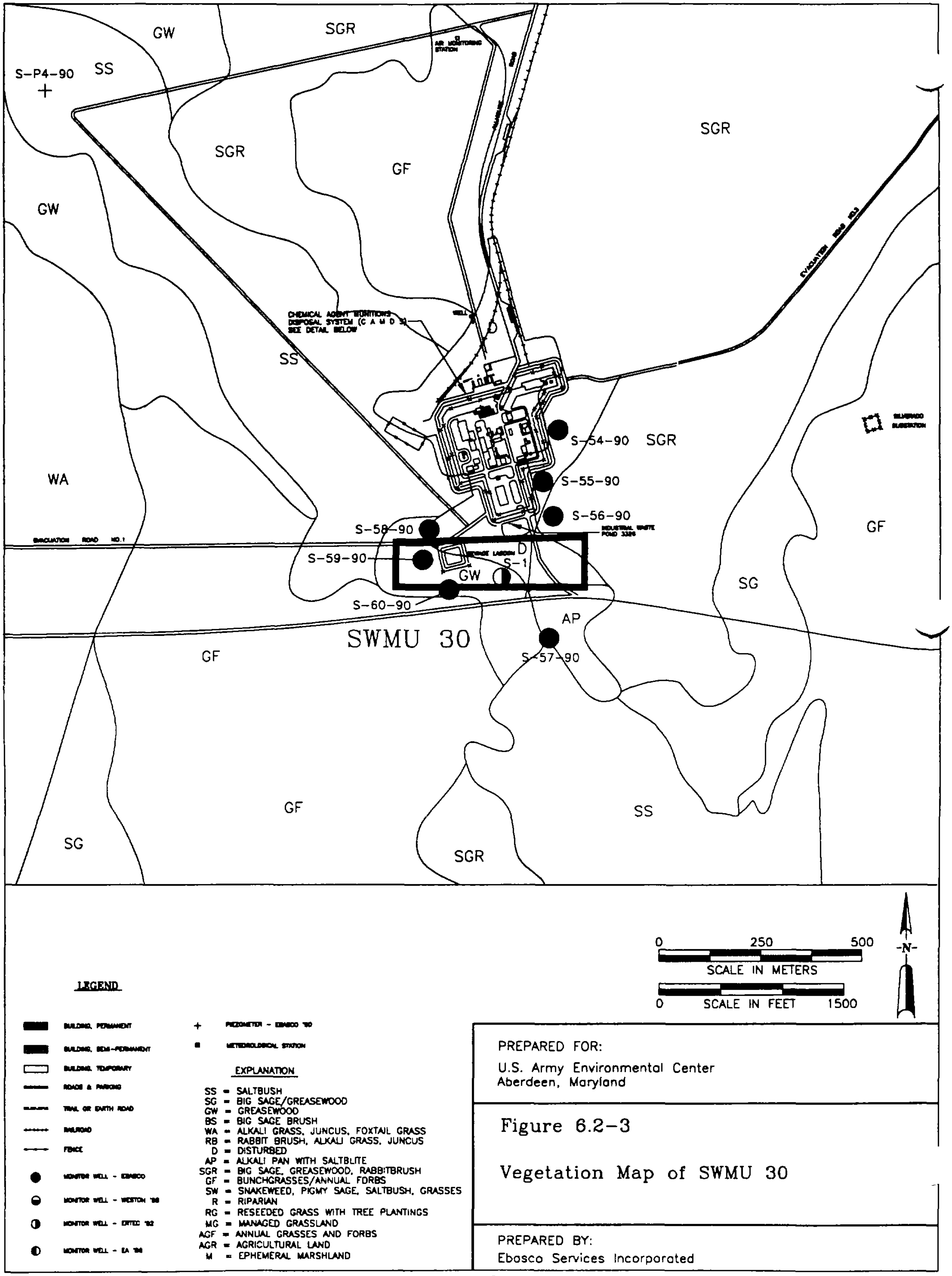
WA = ALKA· GRASS, JUNCUS, FOXTAIL GRASS
RB = RABB.· BRUSH, ALKALI GRASS, JUNCUS
D = DISTURBED
AP = ALKALI PAN WITH SALTBLITE
SGR = BIG SAGE, GREASEWOOD, RABBITBRUSH
GF = BUNCHGRASSES/ANNUAL FORBS
SW = SNAKEWEED, PIGMY SAGE, SALTBUSH, GRASSES
R = RIPARIAN
RG = RESEEDED GRASS WITH TREE PLANTINGS
MG = MANAGED GRASSLAND
AGF = ANNUAL GRASSES AND FORBS
AGR = AGRICULTURAL LAND
M = EPHEMERAL MARSHLAND

PREPARED FOR:
U.S. Army **Environmental** Center
Aberdeen, **Maryland**

Figure 6.2-2

Vegetation Map of SWMUs 8 and 31

PREPARED BY:
Ebasco **Services Incorporated**



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U.S. Army Environmental Center
Aberdeen, Maryland

Figure 6.2-3

Vegetation Map of SWMU 30

PREPARED BY:
Ebasco Services Incorporated

habitat. For these two reasons, the two maps are not directly comparable.

Finally, the habitat types found at TEAD-S were compared to the vegetation types found in the Tooele Grazing Draft EIS (BLM 1983). Table 6.2-3 lists BLM vegetation types corresponding to TEAD-S habitats. Overall, the lists are similar except for the TEAD-S alkali meadow and riparian habitats compared to BLM barren and riparian areas. The species in these areas are similar but are grouped differently. This difference is primarily the result of the scale at which the vegetation types were mapped: the area covered in the Tooele Draft Grazing EIS covers more than 1 million acres, and the TEAD-S vegetation map covers a 19,355-acre area. This difference in area has a profound effect on how vegetation is viewed and mapped. Since smaller areas were mapped for TEAD-S, identification of many more vegetation types was possible. For example, the Tooele Grazing Draft EIS recognizes only one large type of upland shrub habitat, sagebrush. Furthermore, the BLM vegetation scheme does not identify wetland areas as being separate from riparian areas, which explains the difference between alkali meadow habitat in the TEAD-S map and barren/riparian types listed by BLM. Such a difference can also be related to the BLM focus on range-management needs. For example, BLM designates wetlands as a range/vegetation type, even though livestock are unlikely to use these areas.

Overall, the TEAD-S vegetation map is comparable to the other mapping schemes used in the Rush Valley area. It is a relatively detailed representation of actual vegetation at TEAD-S and can serve as a basis for future land-use management and ecological assessment.

6.2.3 SWMU-Wide Wildlife Concerns

TEAD-S harbors a large and diverse winter raptor community. These raptors, including the endangered bald eagle, have migrated from northern regions of the U.S. and Canada to find appropriate habitat (e.g., trees, prey, solitude) at TEAD-S to establish winter roosts. TEAD-S also provides appropriate nesting habitat during the summer for species including golden eagles, red-tailed hawks, ferruginous hawks, American kestrels, and great horned owls.

Federal listings of threatened and endangered species include the bald eagle and the peregrine falcon. Roosting bald eagles have been observed during winter ecological surveys along Mercur Creek and in the elm tree directly north of SWMU 1 and west of SWMU 31. Several bald eagles were also observed along the eastern side of Rush Lake in early December 1993. No peregrine falcons have been observed at TEAD-S. Although unaltered hunting habitat and a prey base at TEAD-S are within 16 kilometers of potential nesting habitat in the Oquirrh Mountains to the east, no peregrine nesting sites are known within this radius (Howe 1992).

The State of Utah threatened species list includes the ferruginous hawk. This species was observed on post during ecological surveys and is a confirmed summer resident and breeding bird in Rush Valley. The ferruginous hawk is highly sensitive to human development. Table 6.2-4 lists all species of concern and their federal and state regulatory status.

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Table 6.2-3 TEAD-S Habitats Compared to Bureau of Land Management Vegetation Classes

Page 1 of 3

TEAD-S Habitats and Vegetation Types		BLM Vegetation Classes*		
Habitat	Vegetation Type	BLM Class	Common Name	Scientific Name
Upland Shrub	Big Sagebrush	Sagebrush	Big Sagebrush	*Artemisia tridentata*
			Black Sagebrush	*Artemisia nova*
	Big Sagebrush, Greasewood		Big Rabbitbrush	*Chrysothamnus nauseosus*
			Little Rabbitbrush	*Chrysothamnus viscidiflorus*
	Big Sagebrush, Greasewood, Rabbitbrush		Bitterbrush	*Purshia tridentata*
			Bluebunch Wheatgrass	*Agropyron spicatum*
			Crested Wheatgrass	*Agropyron cristatum*
			Cheatgrass	*Bromus tectorum*
			Sandberg Bluegrass	*Poa secunda*
Upland Grass	Bunchgrass, Annual Forbs	Perennial Grass	Bluebunch Wheatgrass	*Agropyron spicatum*
			Indian Ricegrass	*Oryzopsis hymenoides*
			Crested Wheatgrass	*Agropyron cristatum*
			Squirreltail	*Sitanion hystrix*
			Needle and Thread	*Stipa comata*
			Salina Wildrye	*Elymus salina*
	Annual Grass and Forbs	Annuals	Cheatgrass	*Bromus tectorum*
			Halogeton	*Halogeton glomeratus*
			Peppergrass	*Lepidium perfoliatum*
			Russian Thistle	*Salsola kali*

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Table 6.2-3 TEAD-S Habitats Compared to Bureau of Land Management Vegetation Classes

TEAD-S Habitats and Vegetation Types		BLM Vegetation Classes*		
Habitat	Vegetation Type	BLM Class	Common Name	Scientific Name
Salt Shrub	Saltbush	Desert Shrub/Saltbush	Shadscale	*Atriplex confertifolia*
			Nuttall's Saltbush	*Atriplex nuttallii*
	Snakewood, Saltbush, Grasses		Little Rabbitbrush	*Chrysothamnus viscidiflorus*
			Mormon Tea	*Ephedra nevadensis*
			Winterfat	*Ceratoides lanata*
			Indian Ricegrass	*Oryzopsis hymenoides*
			Squirreltail	*Sitanion hystrix*
			Cheatgrass	*Bromus tectorum*
			Spineless Horsebrush	*Tetradymia spp.*
			Halogeton	*Halogeton glomeratus*
	Greasewood	Greasewood	Greasewood	*Sarcobatus vermiculatus*
			Bud Sagebrush	*Artemisia spinescens*
			Shadscale	*Atriplex confertifolia*
			Saltgrass	*Distichlis stricta*
			Halogeton	*Halogeton glomeratus*
			Gray Molly	*Kochia americana*
			Russian Thistle	*Salsola kali*
			Alkali Sacaton	*Sporobolus airoides*

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Table 6.2-3 TEAD-S Habitats Compared to Bureau of Land Management Vegetation Classes Page 3 of 3

TEAD-S Habitats and Vegetation Types		BLM Vegetation Classes*		
Habitat	Vegetation Type	BLM Class	Common Name	Scientific Name
Alkali Meadow	Alkali Pan with Saltblite	Barren	Pickleweed	*Allenrolfea occidentalis*
			Saltgrass	*Distichlis stricta*
			Alkali Sacaton	*Sporobolus airoides*
	Rabbitbrush, Alkali Grass, Juncus	Riparian Habitat	Bentgrass	*Agrostis spp.*
	Alkaligrass, Juncus, Foxtail Grass		Brome Grass	*Bromus spp.*
	Ephemeral Marshland		Sedge	*Carex spp.*
			Rush	*Juncus spp.*
			Muhly Grass	*Muhlenbergia spp.*
Riparian	Riparian Areas (Salt Cedar/Elm Trees)		Bluegrass	*Poa spp.*
			Yarrow	*Achillea millefolium*
			Aster	*Aster spp.*
			Indian Paintbrush	*Castilleja spp.*
			Penstemon	*Penstemon spp.*
Human-Altered	Agricultural Land	Cropland		
	Managed Grassland			
	Reseeded Grasses with Tree Planting			
	Structures			
	Disturbed Areas			

* Taken from Tooele Grazing EIS (BLM 1983)

Table 6.2-4 Federal and State of Utah Status for TEAD-S Species of Concern Page 1 of 1

Common Name	Species Name	Federal Status*	State Status**
Bald eagle	*Haliaeetus leucocephalus*	Endangered	Endangered
Peregrine falcon	*Falco peregrinus*	Endangered	Endangered
Ferruginous hawk	*Buteo regalis*	Category 2	Threatened
Loggerhead shrike	*Lanius ludovicianus*	Category 2	Declining population
Black tern	*Chlidonias niger*	Category 2	Declining population
Snowy plover	*Charadrius alexandrinus*	Category 2	Declining population, limited distribution
Long-billed curlew	*Numenius americanus*	Category 2	Declining population, limited distribution
Swainson's hawk	*Buteo swainsoni*	Category 3C	Declining population, limited distribution

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* Category 2 status indicates more research is needed to list this species as threatened or endangered. A Category 3C status indicates more research is desired before delisting or inclusion with Category 2.

** From the current draft form of Native Utah Wildlife Species of Special Concern (UDOW 1993).

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Other species of concern as listed by the State of Utah include the loggerhead shrike, the black tern, the snowy plover, the long-billed curlew, and the Swainson's hawk. These species are of concern due to declining populations or loss of habitat.

6.2.4 Potential Biota Receptors

This section describes how potential biota receptors for which qualitative risk was assessed were selected from plant and wildlife species identified in the SWMUs or in similar habitats elsewhere on TEAD-S (see Appendix G). The appropriate and representative species were selected as potential receptors using standardized criteria.

Vegetation and wildlife can be exposed to contaminants through behavioral attributes, such as birds taking dust baths, rodents burrowing through the soil, or hawks consuming rabbits. If contamination is present, behavioral attributes may cause wildlife species to ingest, or to a lesser extent, inhale or absorb contaminants that may then be assimilated into their tissues. This is also true for plants that may take in contaminants directly from soil or surface water. If enough of a contaminant is assimilated, resultant toxic effects may occur in biota. Toxic effects can include stressed or dying vegetation, or abnormal behavior, reduced productivity, or increased mortality in wildlife.

Biota receptors were selected with these general considerations in mind:

- Game species of commercial or economic importance
- Major prey for species of concern
- Species representative of certain food chains or key trophic levels (e.g., primary producers that provide a food chain foundation)
- Species of local interest to the public (e.g., the pronghorn recently reintroduced into Rush Valley; see BLM 1988)
- Species that have a population sufficiently large at TEAD-S to support any future bioassay testing or monitoring
- Species or taxonomic groups for which toxicity data are available in the scientific literature

Table 6.2-5 lists these attributes along with common names of selected species, their taxonomic groups, and trophic groups. The receptors were selected if at least three of the attributes were present. Sixteen species were selected from the more common ones observed in the Group 2 SWMUs (see Appendix G). In addition, the badger was selected because it is the only mammalian predator at TEAD-S, has a different metabolic rate than an avian predator, and preys exclusively on rodents that burrow in the soil.

Table 6.2-5 Selection of Representative Biota Receptors for SWMUs 1 and 25

Page 1 of 2

Common Name	Taxonomic Group	Trophic Group	Game Species	Major Prey for Species of Concern	Important Representative of Food Chain	Local Interest	Population Sufficiently Large on TEAD-S	Literature Data Available on Toxicity	Selected Species
Big Sagebrush	Shrub	Primary Producer			X		X	X	X
Saltbush	Shrub	Primary Producer			X		X	X	X
Indian Ricegrass	Grass	Primary Producer			X		X	X	X
Crested Wheatgrass	Grass	Primary Producer			X		X	X	X
Pronghorn Antelope	Mammal	Herbivore	X			X		X	X
Mule Deer	Mammal	Herbivore	X					X	
Black-Tailed Jackrabbit	Mammal	Herbivore	X	X	X		X	X	X
Herbivores Ground Beetle/ Grasshoppers	Insect	Herbivore		X	X		X		X
Vesper Sparrow	Bird	Herbivore			X		X	X	X
Horned Lark	Bird	Omnivore			X		X	X	X
Sagebrush Lizard	Reptile	Omnivore		X	X				
Kangaroo Rat	Mammal	Omnivore		X	X		X	X	X
Deer Mouse	Mammal	Omnivore		X	X		X	X	X
Western Meadowlark	Bird	Omnivore			X		X	X	X

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Table 6.2-5 Selection of Representative Biota Receptors for SWMUs 1 and 25 Page 2 of 2

Common Name	Taxonomic Group	Trophic Group	Game Species	Major Prey for Species of Concern	Important Representative of Food Chain	Local Interest	Population Sufficiently Large on TEAD-S	Literature Data Available on Toxicity	Selected Species
Predatory Ground Beetle	Insect	Predator			X				
Great Basin Gopher Snake	Reptile	Predator			X				
Loggerhead Shrike	Bird	Predator			X	X	X		X
Northern Harrier	Bird	Predator			X		X	X	X
American Kestrel	Bird	Predator			X			X	
Badger	Mammal	Predator			X			X	X
Red-Tailed Hawk	Bird	Predator			X		X	X	X

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The 16 receptors were combined into five generalized trophic (feeding) groups: plants, small birds, small mammals, predatory birds, and predatory mammals. These trophic groups were used to interrelate exposure routes and to characterize risk.

6.3 SELECTION OF ECOLOGICAL COCs

Approximately 150 elements, compounds, and anions were analyzed during the RFI-Phase II soil and water sampling at the Group 2 SWMUs. Of these, 65 analytes were detected in surface soil, 52 in subsurface soil, 21 in surface water, and 27 in groundwater, including 17 non-target and 11 tentatively identified compounds. Some analytes were found in subsurface soil but not in surface soil, in surface water but not in groundwater, in groundwater but not in surface water, or in water but not in soil. However, 76 percent of the detected analytes that were found in surficial soil were generally also found in other media.

Contaminants of concern to biota (biota COCs) are those analytes that are detected in sufficient quantities and in sufficiently large areas to pose a potential ecological risk. The biota COCs were selected from analytes detected in surficial soil because it contained the most detected analytes and provides the most likely source of contaminant exposure to biota. Subsurface soil has fewer detected analytes and is less accessible to most biota. Groundwater is not considered a pathway to biota except, potentially, by recharge to surface water that is seasonally present to the west and northwest of SWMU 30. There is no perennial surface water in or near SWMUs 3, 5, 8, 9, or 31, although surface water does accumulate in the demolition craters at SWMU 31.

COCs were chosen using three exposure criteria and two toxicological criteria for evaluating chemicals in the Group 2 surficial soil data set. The exposure criteria are calculations with arbitrary decision points that assess whether significant exposure to a contaminant could occur. The toxicological criteria help determine whether exposure to the analyte is potentially hazardous to ecological receptors. The three exposure criteria are the following:

- Magnitude—The arithmetic mean of all samples must be greater than the background value (or certified reporting limit, or CRL) and the maximum detection must be greater than 10 times background; or for chemicals with means of 0.75 to 1.0 times background, the 95 percent UCL must be compared to background or the CRL.

- Spatial Distribution—The chemical must be detected in at least two of the six Group 2 SWMUs, or professional judgment may be used to include it, based on detection frequency within fewer source areas.

- Detection Frequency—The number of detections divided by the number of samples collected at the Group 2 SWMUs must be greater than or equal to 0.05.

For those analytes that passed the spatial distribution criterion, the magnitude criterion was evaluated. For those samples that also passed the magnitude criterion, the detection frequency was verified. Thus, each of these criteria had to be satisfied before an analyte was selected as a potential COC. Table 6.3-1 provides descriptive statistics for the analytes detected in surficial soil at the Group 2 SWMUs. As shown in Table 6.3-1, silver, cadmium, copper, di-n-butyl phthalate, mercury, toluene, lead, and zinc meet all the exposure criteria and were designated as potential COCs. The ratio of arithmetic mean to background was between 0.75 and 1.0 for arsenic and magnesium, which met the spatial distribution and detection frequency criteria. The ratio comparing the 95 percent UCL of these metals to their background was greater than 1.0 for arsenic (1.13), but not for magnesium (0.97). Thus, arsenic is also designated as a potential COC.

The two toxicological criteria are persistence and toxicological endpoint effects, both of which must be met:

- Persistence—The chemical must reside in surficial soil for a considerable duration (6 months or more) to cause repeated exposure.

- Toxicological Endpoint Effects—The analyte is noted for acute and/or chronic effects, sublethal effects, or bioaccumulation (see Section 6.8).

The following analytes meet both the exposure and toxicological criteria and were selected as biota COCs: arsenic, cadmium, copper, lead, mercury, silver, and zinc (Table 6.3-2). Di-n-butyl phthalate and toluene, while they have toxicological endpoint effects, were not selected as final COCs for the several reasons provided in Howard et al. (1991) and summarized here. Di-n-butyl phthalate may be a laboratory artifact, since it is used as a plasticizer in plastics and rubbers (among other substances) and could have been present in latex gloves or plastic containers used in handling and processing the samples. It may also occur naturally in soils by microbial biosynthesis. Even if it were a true site contaminant, di-n-butyl phthalate would not have been selected as a final COC. It has a maximum half-life value under aerobic conditions of less than one month (Howard et al. 1991), although adsorption to organic carbon or clays may cause it to remain in the soil (albeit in less bioavailable form) for some time. Most of the di-n-butyl-phthalate detections (19 of 34) were in subsurface soils and most surface detections were above such subsurface detections. For all these reasons, di-n-butyl phthalate appears to be minimally bioavailable either directly from the soil or via the food chain even when it is present in the soil.

Toluene also has a maximum half-life value of less than a month (Table 6.3-2). In soil, it is lost by evaporation from near-surface and microbial degradation (especially once microbial populations are acclimated), and may also leach into groundwater. In water, toluene is lost by volatilization and biodegradation. It does not significantly adsorb or bioconcentrate. The 16

Table 6.3-1 Initial Screening of Surficial Soil Analytes for SWMUs 3, 5, 8, 9, 30, and 31 Using Exposure Criteria

Detected Chemical	Certified Reporting Limit (CRL) or Background Value (μg/g)	Arithmetic Mean of Samples [1] (μg/g)	Arithmetic Mean of Detections (μg/g)	Maximum Concentration (μg/g)	Detection Frequency [2]	Spatial Distribution [3]	Magnitude Ratio based on [4]: Total Sample Mean	Magnitude Ratio based on [4]: Maximum Concentration
Organic Compounds								
1,1,2-Trichloro-1,2,2-trifluoroethane (TCLTFE)*	NA	0.007	0.007	0.010	1.00	W	NA	NA
1-Methylnaphthalene (1MNAP)*	NA	0.470	0.470	0.470	1.00	I	NA	NA
2,4,6-Trinitrotoluene (246TNT)[5]	0.456	0.250	0.739	0.958	0.04	I	0.55	2.10
2,4-Dinitrotoluene (24DNT)[5]	0.424	0.254	2.310	2.310	0.02	I	0.60	5.45
2,6,10,14-Tetramethylpentadecane (2TMPD)*	NA	1.607	1.607	2.300	1.00	I	NA	NA
2-Cyclohexen-1-one (2CHE1O)*	NA	0.410	0.410	0.410	1.00	I	NA	NA
2-Methylnapthalene (2MNAP)	0.049	0.031	0.287	0.480	0.02	W	0.63	9.80
2-Propanol (2PROL)*	NA	0.027	0.027	0.027	1.00	I	NA	NA
Acetone (ACET)	0.017	0.009	0.021	0.021	0.01	I	0.53	1.24
Benzene (C6H6)	0.002	0.001	0.005	0.005	0.01	I	0.50	2.50
Bis(2-ethylhexyl) phthalate (B2EHP)	0.62	0.317	0.980	0.980	0.01	I	0.51	1.58
Hexadecanoic acid (C16A)	NA	0.598	0.598	1.200	1.00	W	NA	NA
Heptadecane (C17)	NA	1.300	1.300	1.300	1.00	I	NA	NA
Pentacosane (C25)	NA	0.430	0.430	0.440	1.00	W	NA	NA
Heptacosane (C27)	NA	0.757	0.757	1.300	1.00	W	NA	NA
Octacosane (C28)	NA	0.420	0.420	0.420	1.00	I	NA	NA
Nonacosane (C29)	NA	1.016	1.016	2.300	1.00	W	NA	NA
Di-n-butyl phthalate (DNBP)	0.061	0.264	1.415	10.000	0.17	W	4.33	163.93
Dibenzofuran (DBZFUR)	0.035	0.019	0.110	0.110	0.01	I	0.54	3.14
Diethyl phthalate (DEP)	0.24	0.124	0.470	0.470	0.01	I	0.52	1.96
Dioctyl adipate (DOAD)*	NA	1.650	1.650	5.100	1.00	W	NA	NA
Ethanol (ETOH)*	NA	0.010	0.010	0.012	1.00	I	NA	NA
Fluoranthene (FANT)	0.068	0.035	0.120	0.120	0.01	I	0.51	1.76
gamma-Sitosterol (GSITOS)*	NA	0.818	0.818	0.995	1.00	W	NA	NA
Hexachlorobenzene (CL6BZ)	0.033	0.034	0.840	1.100	0.02	I	1.03	33.33
HMX	0.666	0.377	2.520	2.520	0.02	I	0.57	3.78
Isopropyl methylphosphonic acid (IMPA)	0.5	0.453	15.500	15.500	0.01	I	0.91	31.00
Methylene chloride (CH2CL2)[5]	0.012	0.006	0.010	0.015	0.04	W	0.50	1.25

Table 6.3-1 Initial Screening of Surficial Soil Analytes for SWMUs 3, 5, 8, 9, 30, and 31 Using Exposure Criteria

Page 2 of 3

Detected Chemical	Certified Reporting Limit (CRL) or Background Value (µg/g)	Arithmetic Mean of Samples [1] (µg/g)	Arithmetic Mean of Detections (µg/g)	Maximum Concentration (µg/g)	Detection Frequency [2]	Spatial Distribution [3]	Magnitude Ratio based on [4]: Total Sample Mean	Magnitude Ratio based on [4]: Maximum Concentration
Methylphosphonic acid (MPA)	0.5	0.304	2.267	3.610	0.03	I	0.61	7.22
Naphthalene (NAP)	0.037	0.030	0.355	0.600	0.03	I	0.81	16.22
Octamethylcyclotetrasiloxane (OMCTSX)*	NA	0.031	0.031	0.041	1.00	I	NA	NA
PCB-1248 (PCB248)	0.082	0.049	0.301	0.510	0.03	I	0.60	6.22
PCB-1254 (PCB254)	0.082	0.051	0.373	0.670	0.03	W	0.62	8.17
PCB-1260 (PCB260)	0.080	0.043	0.175	0.193	0.02	W	0.54	2.41
Pentaerythritol tetranitrate (PETN)*	NA	0.320	2.667	2.740	0.12	I	NA	NA
Phenanthrene (PHANTR)	0.033	0.019	0.085	0.130	0.03	W	0.58	3.94
Phthalic anhydride (PHTHAN)*	NA	5.700	5.700	11.000	1.00	I	NA	NA
Pyrene (PYR)	0.033	0.018	0.083	0.083	0.01	I	0.54	2.52
Tetracosane (TCOS)*	NA	0.430	0.430	0.430	1.00	I	NA	NA
Toluene (MEC6H5)	0.001	0.013	0.160	1.100	0.07	W	13.00	1100.00
Trichlorofluoromethane (CCL3F)	0.006	0.003	0.008	0.010	0.06	W	0.50	1.67
<u>Metals and Cyanide</u>								
Aluminum (Al)	25200	11884	11884	50400	1.00	W	0.47	2.00
Antimony (Sb)	11.9	4.38	14.7	25	0.07	W	0.37	2.14
Arsenic (As)	40	32.085	32.085	500	1.00	W	0.80	12.5
Barium (Ba)	11850	196.794	196.794	792	1.00	W	0.02	0.07
Beryllium (Be)	1.21	0.589	0.694	1.670	0.76	W	0.49	1.38
Cadmium (Cd)	0.982	1.164	1.542	22.500	0.68	W	1.19	22.9
Calcium (Ca)	250000	113093.496	113093.496	220000.000	1.00	W	0.45	0.880
Chromium (Cr)	48.5	33.321	33.321	950.000	1.00	W	0.69	19.59
Cobalt (Co)	8.59	5.089	5.089	12.200	1.00	W	0.59	1.42
Copper (Cu)	27.6	37.441	37.441	966.000	1.00	W	1.36	35.00
Cyanide (CYN)[5]	0.92	0.492	2.430	3.130	0.02	I	0.53	3.40
Iron (Fe)	24300	12908.659	12908.659	73200.000	1.00	W	0.53	3.01
Lead (Pb)	35	56.765	56.765	750.000	1.00	W	1.62	21.43
Magnesium (Mg)	16150	14713.252	14713.252	46400.000	1.00	W	0.91	2.87

Table 6.3-1 Initial Screening of Surficial Soil Analytes for SWMUs 3, 5, 8, 9, 30, and 31 Using Exposure Criteria

Detected Chemical	Certified Reporting Limit (CRL) or Background Value (μg/g)	Arithmetic Mean of Samples [1] (μg/g)	Arithmetic Mean of Detections (μg/g)	Maximum Concentration (μg/g)	Detection Frequency [2]	Spatial Distribution [3]	Magnitude Ratio based on [4]: Total Sample Mean	Magnitude Ratio based on [4]: Maximum Concentration
<u>Metals and Cyanide (Cont.)</u>								
Magnesium (Mg)	16150	14713.252	14713.252	46400.000	1.00	W	0.91	2.87
Manganese (Mn)	658	438.220	438.220	744.000	1.00	W	0.67	1.13
Mercury (Hg)	0.143	0.185	0.290	2.800	0.60	W	1.29	19.58
Nickel (Ni)	27.9	16.812	16.812	73.100	1.00	W	0.60	2.62
Potassium (K)	7940	4544.138	4544.138	10100.000	1.00	W	0.57	1.27
Selenium (Se)	0.208	0.108	0.399	0.517	0.02	I	0.52	2.49
Silver (Ag)	0.435	1.008	10.034	78.000	0.07	W	2.32	179.31
Sodium (Na)	5610	1357.508	1357.508	20400.000	1.00	W	0.24	3.64
Thallium (Tl)	49.9	18.162	22.744	54.900	0.76	W	0.36	1.10
Vanadium (V)	62.6	20.801	20.801	72.800	1.00	W	0.33	1.16
Zinc (Zn)	144	176.987	176.987	2950.000	1.00	W	1.23	20.49

* - Nontarget analyte
TIC - Tentatively identified compound
NA - Not available. Chemical is a TIC or nontarget analyte, thus the CRL and a background value are not available. Only detections were reported by the laboratory for these chemicals.

[1] Mean of all samples including a one-half CRL value for all nondetections.

[2] Chemical must have a detection frequency of 0.05 or greater to be considered a potential COC.

[3] Categorized as widespread (W), occurring in two or more SWMUs; or isolated (I), occurring in one SWMU. Chemical must be widespread to be considered a potential COC.

[4] Calculated as the ratio of sample arithmetic mean to background value for metals, or to CRL for organic analytes.
Chemical must have an arithmetic mean ratio of greater than or equal to 1.0, and a maximum detection ratio of greater than or equal to 10 to be considered a potential COC.

[5] These chemicals were also detected at very low levels below one half the CRL, as were nitrobenzene and 1,3-dinitrobenzene; these very low levels were not used in the evaluation of other media and individual SWMUs.

Note: Potential COCs are denoted in bold.

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Table 6.3-2 Final Screening of Potential Surficial Soil COCs for Group 2 SWMUs Using Toxicological Criteria Page 1 of 1

Detected Chemical	Persistence	Toxicological Endpoints[1]	Bioaccumulation[2]
Arsenic (As)	X	X	X (in plants)
Cadmium (Cd)	X	X	X
Copper (Cu)	X	X	X (in plants)
Lead (Pb)	X	X	X (in some plants)
Mercury (Hg)	X	X	X
Silver (Ag)[3]	X	X	X (in plants)
Zinc (Zn)	X	X	X
Di-n-butyl phthalate (DNBP)	-[4]		
Toluene (MEC6H5)	-[5]		

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[1] Lethal or sublethal effects have been noted in the scientific literature for this analyte.

[2] Bioaccumulation either in plants or animals has been noted in the scientific literature for this analyte.

[3] Can be toxic to plants.

[4] Half-life ranges between 2 and 23 days for soil based on unacclimated aerobic soil grab sample data and between 1 and 14 days for groundwater based on unacclimated aerobic river die-away test and freshwater/sediment grab sample data (Howard et al. 1991).

[5] Half-life ranges between 4 and 22 days for soil based on aqueous aerobic biodegradation and between 7 and 28 days for groundwater based on an unacclimated grab sample of aerobic soil from groundwater aquifers (Howard et al. 1991).

detections of toluene at the Group 2 SWMUs were primarily (10 of 16) in subsurface soils. Therefore, toluene also appears to be minimally available via the food chain and to have inplace mechanisms for dissipation. For the above reasons neither di-n-butyl-phthalate nor toluene was selected as a final COC.

In the toxicity assessment and ecological risk characterization, these criteria are applied to surficial soil data combined for the Group 2 SWMUs on the selected biota COCs. However, chemicals that might be of concern in the surficial soil of a particular SWMU or in subsurface soil, surface water, or groundwater were also noted.

6.4 EXPOSURE ASSESSMENT

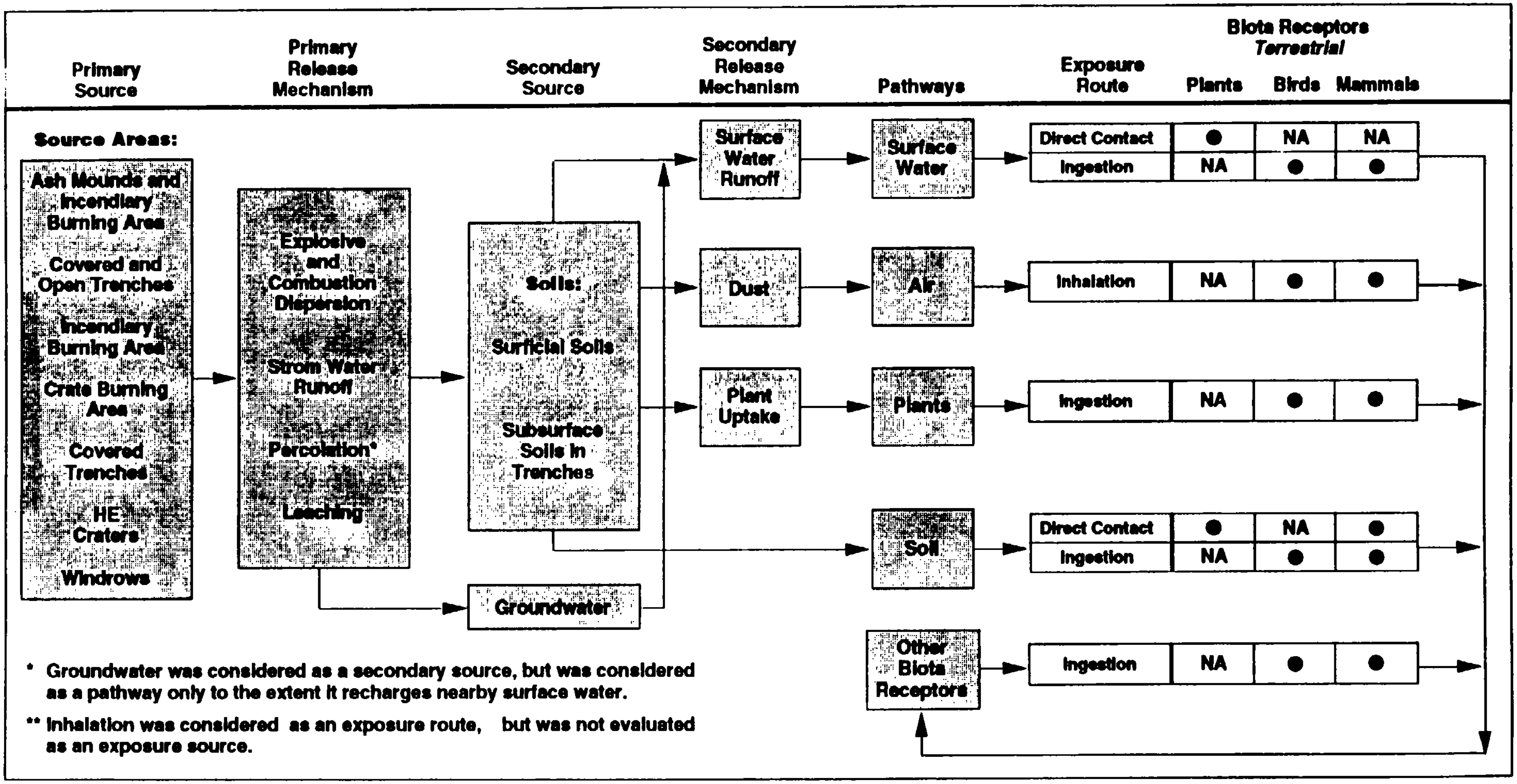
The exposure assessment documents the exposure of biota receptors to environmental contaminants in two steps. First, potential pathways are considered in a conceptual model that demonstrates the mechanisms of potential exposure at the site. Second. exposure is documented through identification of pathways by which the receptors are exposed to the COCs.

A complete exposure pathway consists of four components: a source of potential contamination, a contaminant-release mechanism, a transport medium or secondary source, and a receptor. All four components must be present and functional for exposure to occur. The potential contamination sources at the Group 2 SWMUs are those described in the second subsection of Sections 4.1 to 4.6. The current release mechanisms at SWMUs 3, 5. 8, 9, 31 include storm-water runoff and percolation and leaching of water through contaminated soil, as described in the third subsection of Sections 4.1 to 4.6. From time to time, dispersion of contamination in soil may occur through explosion or combustion. Currently, contamination is being released in this manner at SWMU 31. This dispersion mechanism could also affect SWMU 8, which is adjacent to SWMU 31.

At the Group 2 SWMUs, transport media are surface water, groundwater (SWMU 30 only), and soil, which are also secondary sources of potential contamination. These media carry contaminants from the original source areas and disperse them to the environmental media. For example, storm-water runoff can carry potentially contaminated soil from source areas. The contaminant may stay in the soil and be re-deposited away from the source area, or, depending on its physical and chemical characteristics, go into solution in the surface water (secondary source). This water may then pond, where it is available for ingestion by animals or uptake through plant roots. Groundwater is a potential secondary source at SWMU 30 and may reach biota receptors by resurfacing in the marshlands areas to the west and northwest of SWMU 30 or by infiltrating the root zones of plants.

6.4.1 Conceptual Site Model

Consideration of a conceptual site model is a part of the problem-formulation portion of the ERA (EPA 1989d). The conceptual model is used to identify pathways that may be present at TEAD-S. Only those complete pathways most likely to contribute to risk at TEAD-S were selected for further evaluation. Figure 6.4-1, which illustrates the conceptual model for the Group 2 SWMUs,



* Groundwater was considered as a secondary source, but was considered as a pathway only to the extent it recharges nearby surface water.

** Inhalation was considered as an exposure route, but was not evaluated as an exposure source.

Figure 6.4-1 • TEAD-S Conceptual Model for Biota Receptors at SWMUs 3, 5, 8, 9, 30 and 31

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shows potential pathways for contaminant migration to biota receptors through the secondary sources of soil, surface water, and groundwater.

6.4.2 Exposure Documentation

Exposure at the Group 2 SWMUs was documented for the surface water and soil pathways (Figure 6.4-1). Direct exposure of biota to groundwater and to surface water contaminated by resurfacing groundwater is likely only at SWMU 30. SWMU 30 is located on the valley floor where groundwater is relatively shallow. SWMU 30 is adjacent to known releases SWMU 13 (CAMDS), where groundwater contamination has been detected (Rust 1994). The potential exists for groundwater contaminated by SWMU 13 to pass through SWMU 30 and then to resurface in nearby marshlands, where wildlife could come into contact with contaminants. No groundwater seeps or wetlands resulting from resurfacing groundwater were discovered within or near the other Group 2 SWMUs. Additionally, the potentiometric mapping of groundwater revealed no groundwater flow from SWMUs 3, 5, 8, 9, and 31 to wetland areas toward the northwest. Groundwater uptake from deeply rooted plants is unlikely in all the Group 2 SWMUs except 30. Roots of plant species with the deepest roots (shrubs) probably reach to a depth that ranges from 6 to 9 ft. Studies show the maximum root depth of big sagebrush in Wyoming is between 6 and 7 ft (Sturges 1977) and that of four-wing saltbush in New Mexico between 8 and 9 ft (Stutz and Buchanan 1987). Therefore, roots from shrubs may reach groundwater at certain times of the year at SWMU 30, where groundwater is generally 6 to 10 ft below the ground surface. Roots and therefore plants that do reach groundwater under normal conditions may be killed by its brackishness near SWMU 30 (a total dissolved solids range of 1,200 to 10,000 mg/L) and higher salinity both east and west of SWMU 30, even in the absence of contaminants in the groundwater.

Surface water is a secondary source, especially during spring snow melt It is a potential pathway to biota receptors through plant uptake and direct ingestion by some birds. Most mammals (except coyotes) and many birds (especially those selected as receptors) have adapted to the arid environment of TEAD-S by obtaining sufficient water directly from their food.

Soil is also a secondary source of potential contamination (Figure 6.4-1). There are four potentially complete pathways through soil to biota receptors. The first three pathways are associated with food-web bioaccumulation through plant uptake and animal ingestion. First, contamination is taken up by plant roots, especially during periods of relatively high soil moisture (e.g., spring runoff) and during periods of rapid plant growth in the spring. Second, contamination is incorporated into terrestrial food chains by such processes as ingestion of terrestrial plants by herbivores that are in turn ingested by higher consumers (predators). This pathway is particularly significant if bioaccumulative contaminants are present in soil. Third, contaminated soil can be directly ingested. Both birds and mammals may ingest soil daily (Beyer et al. 1991; Arthur and Gates 1988), accumulating contaminants in their tissues and introducing them into the terrestrial food chain. In fact, all potential pathways, whether through surface water or soil, are linked through the terrestrial food chains at the Group 2 SWMUs. This link is illustrated in the conceptual site model (Figure 6.4-1) by feedback loops to the "ingestion by predators" pathways box. The fourth pathway, inhalation of COCs on particulates or as vapors, was not evaluated. Exposure through inhalation is considered minor relative to food web bioaccumulation.

6.5 TOXICITY ASSESSMENT

To evaluate the toxicity of the seven COCs, toxicological profiles were compiled from the literature, including synoptic publications such as Biological Reports of Contaminant Hazard Reviews by Ronald Eisler, Radioecology (Whicker and Schultz 1982), the World Health Organization Publications from the International Program on Chemical Safety, and the IRIS Database. This toxicological information is summarized below for each COC. Each discussion identifies the general mode of action or effect of the chemical as well as the source of critical exposure concentrations. Appendix H provides further detail on the potential toxic effects of COCs on terrestrial plants and animals.

The critical exposure concentrations (Table 6.5-1) reflect either the lowest observed adverse effect level (LOAEL), or the highest concentration at which no observed adverse effect level (NOAEL) was noted, depending on the available literature. LOAELs were used whenever they were available; NOAELs were used when they were available and LOAELs were not. When only a lethal dose was available in the literature, the value used was one order of magnitude lower than the lethal dose (i.e., the LD50, the lethal dose to 50 percent or more of the subject population, was used with a protection factor of 10). It is important to note that the terms LOAEL or NOAEL are used loosely: the published studies did not always investigate a tightly controlled range of concentrations above and below the reported value. For this reason, the LOAELs were used in preference to NOAELs. For example, reported NOAELs that are not bounded by a higher value than was shown to cause an effect could be much lower than the actual NOAEL.

For plants, critical exposure concentrations are typically expressed in the literature as the concentrations found in the soil to which the plant is exposed. For animals, these concentrations are typically expressed as the concentrations to which the animal is exposed by ingestion. Ingested concentrations are provided as doses (i.e., the intake of the contaminant normalized to a daily rate per gram of body weight [g-bw]) or as dietary intake, which must be normalized.

Table 6.5-1 also provides factors for animals (dietary fraction and feed rate) that allow the conversion of the concentration in the animal's dietary component of soil to a daily dose per gram of its body weight. These conversion factors are specific to the species of test organism used to derive the critical exposure concentrations. Dietary feed rate and fraction were taken from Arthur and Gates (1988), Matsumura (1985), and Beyer et al. (1991). For plants, the critical exposure concentrations can be used without conversion. Site-specific daily doses (for animals) or critical exposure concentrations (for plants) can then be compared to a reference dose (for animals) or critical exposure concentration (for plants) to characterize the ecological risk. The characterization of ecological risk is discussed in Section 6.2.

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Table 6.5-1 Critical Exposure Concentrations and Conversion Factors to Calculate Actual Exposure and Toxicity Reference Values

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	Critical Exposure Concentrations					
	Plants		Animals		Conversion Factors	
COC	LOEC (µg/g)	EC50(µg/g)	LOAEL (µg/g in diet)*	LD50 (µg/g in diet)	FR (g/day)	DF
Arsenic	19 for grasses	NA	31 for rats	NA	15 for rats	0.063 for jack rabbits
Cadmium	15.1 for vegetables	33-171 for vegetables	2 for rodents	3,000 for rodents*	15 for rats	0.063 for jack rabbits
Copper	150 for tomatoes	NA	480 for chickens	NA	110 for chickens	0.1 for chickens
Lead	200 for plants	NA	12 for dogs**	NA	540 for dogs	0.063 jack rabbits
Mercury	2 for plants (cucumbers)	NA	0.5 for ducks	NA	61 for ducks	0.082 for ducks
Silver	NA	NA	1300 for rats**	6,000 for guinea pigs*	15 for rats	0.063 jack rabbits
Zinc	400 for blue grass	2,000 for blue grass	317 for mice*	2,900 for mice*	3 for mice	0.02 for mice

* Body weights assumed in the conversion of diet to dose were: 2300 g for dogs, 1800 g for ducks, 1360 g for chickens, 300 g for rats, and 25 g for mice; values at the low end of the size scale for domestic animals were used to be more representative of terrestrial wildlife at Tooele

** reported as a dose value in the literature, but converted to a portion in diet

PPM = Parts per million
G/DAY = Grams per day
LOEC = Lowest Observable Effects Concentration, NOEC were used when LOEC were not available
EC50 = Effect Concentration where the test plants weigh 50% less than control plants
LOAEL = Lowest Observable Adverse Effects Level, NOAEL were used when LOAELs were not available
LD50 = Lethal Dose to 50% of the test population
FR = Feeding Rate per Day
DF = Dietary Fraction
NA = Not Available

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There are seven COCs, each of which is a metal (arsenic, cadmium, copper, lead, mercury, silver, and zinc). Their general site or mode of action and the basis of their critical exposure concentrations are summarized below. Further information on each COC is provided in Appendix H.

6.5.1 Arsenic

Arsenic occurs naturally in living organisms, but has no confirmed physiological function. It exhibits two inorganic forms, arsenic III (the more toxic form) and arsenic V. These forms are interconverted in nature. Arsenic may be an essential element for plant growth; however, plants may die if they accumulate sufficient arsenic. Nonlethal concentrations of arsenic cause poor germination of seeds, poor regrowth of adult plants, and an overall growth reduction. Field data showed growth reduction in grasses exposed to an arsenic concentration of 19 µg/g; this value has been used as a lowest observed effects concentration (LOEC) for plants. Arsenic is also naturally present in terrestrial vertebrates, although there is little information available on its effects, toxicity, and potential for accumulation. The most conservative LOAEL found in the literature was from a 2-year study of dosed rats and dogs. The rats exhibited pathological changes at a dose of 1.5 µg/g-bw/day (Byron et al. 1967). In nature, the distribution of arsenic through the food chain is greatly limited by its phytotoxic effects, since plant injury often occurs before concentrations injurious to wildlife are reached.

6.5.2 Cadmium

Cadmium is toxic to plants and causes a reduction in growth and yield. Its effect and accumulation are affected by the concentrations of other trace elements. In animals, cadmium tends to accumulate in kidney and liver tissues where it may be complexed with a protein (metallothionein) and rendered less toxic (Klaassen et al. 1986). Cadmium can also cause sublethal effects such as cardiovascular disease, reduced growth rate, and behavioral impacts; high doses can be lethal. Cadmium tends to accumulate with age and in higher food-web trophic levels; it is eliminated by the kidneys with a half-life of about 100 days. Table 6.5-1 provides the critical exposure concentrations of cadmium. Critical exposure concentrations for plants were based on a mean of NOAEL soil concentrations for vegetables (Adema and Henzen 1989). For animals, a LOAEL diet value (Siewicki et al. 1983) for rats was used (see Appendix H).

6.5.3 Copper

Copper is widely distributed in nature and is an essential element for both plants and animals. However, when its concentrations are too high, copper can cause deleterious effects as well. High concentrations of copper cause growth reduction in plants that varies with the pH of the soil. Lower concentrations of copper are deleterious at lower soil pH values. The most conservative LOEC for plants found in the literature was 150 µg/g (soil pH < 6.5), which reduced growth of tomatoes (Rhoads et al. 1989). Small mammals living in the vicinity of copper smelters exhibited whole-body concentrations as high as 12.1 µg/g, with individual organs having higher concentrations. These data indicate potential copper accumulation in terrestrial vertebrates, but are ambiguous. Broiler chicks fed diets low in calcium had an increased sensitivity to copper toxicity and their growth was limited at a copper dose of 48 µg/g-bw/day (Leach et al. 1990).

6.5.4 Lead

Lead reduces plant growth, photosynthesis, mitosis, and water absorption. Perhaps as a result of these effects, it may reduce both pollen and seed germination. However, lead has low bioavailability from soil and does not appear to bioaccumulate appreciably in most plants. Lead tends to demyelinate axons in vertebrate animals, and in high doses it can reduce the numbers of young through spontaneous abortion and stillbirths and increase skeletal malformations. Information in the literature on the biomagnification of lead in higher levels of food webs is somewhat contradictory, but a number of studies show higher concentrations in higher trophic levels. Organic lead is more toxic than inorganic lead. Table 6.5-1 provides the critical exposure concentrations of lead. Critical exposure concentrations for plants were based on a general assumption that adverse effects seem to occur only at total concentrations of several hundred milligrams per kilogram of soil (Eisler 1988). For animals, the selected value was the lowest of several chronic oral doses that resulted in reduced survival of dogs (Eisler 1988). This value was only slightly higher than a sublethal value that caused behavioral abnormalities in monkeys; dogs are a more appropriate surrogate species to evaluate potential risks to the mammalian predators, such as the badger (see Appendix H).

6.5.5 Mercury

In plants, mercury inhibits root growth. In animals, mercury may increase fetal anomalies, reduce fertility, and otherwise affect reproduction and behavior. Elemental mercury and alkylmercurials are more readily absorbed by plant roots than ionic inorganic mercury. The organic form, which is more prevalent in upper levels of food webs, is more toxic. Mercury biomagnifies significantly in food webs, with bioaccumulation factors ranging up to 14 for ducks and 22.5 for mammals (Heinz 1980; Wren et al. 1987). Table 6.5-1 provides the critical exposure concentrations and conversion factors for mercury. Critical exposure concentrations for plants were based on a NOAEL concentration for soil developed from a study of cucumbers (Siegel et al. 1971; Shariatpanahi and Anderson 1986). For animals, a LOAEL was used that resulted in impaired mallard reproduction (Heinz 1979) (see Appendix H).

6.5.6 Silver

Silver appears to bioaccumulate in plants and has been shown to inhibit the action of ethylene on plants and thereby delay etiolation, abscission, and flower senescence in some plants. In animals, there is little evidence of silver bioaccumulation, except perhaps in the spleen. The major effect of absorption of excessive silver is the formation of insoluble complexes in elastic fibers. Table 6.5-1 provides the critical exposure concentrations for silver. No data were found to establish a critical exposure concentration of silver in plants. The critical exposure concentration for animals was based on a NOAEL for rats (Walker 1971) (see Appendix H).

6.5.7 Zinc

Zinc is a micronutrient for plants and has a role in the synthesis of indoleacetic acid, a plant hormone, and in synthesizing proteins. Increased zinc concentrations may increase herbage production, although they may ultimately become toxic to plant roots and crowns and cause growth reduction and chlorosis. In animals, zinc tends to concentrate in the kidneys, liver, and bones; it may also cause anemia, poor growth, and mortality. Most animals have a high tolerance of zinc, perhaps because, like cadmium, it may be complexed with a protein and rendered less toxic. Zinc uptake is affected by the presence of other elements. The literature is unclear on zinc biomagnification in food webs; some studies have found higher concentrations in higher trophic levels, but other studies have not. Zinc uptake is poorly understood. Table 6.5-1 provides the critical exposure concentrations for zinc. The critical exposure concentration for plants was based on a LOAEL for grass from application to soil (White 1991). For animals, a LOAEL from a dose to mice (Aughay et al. 1977) was used (see Appendix H).

6.6 ECOLOGICAL RISK CHARACTERIZATION

The critical exposure concentrations shown in Table 6.5-1 can be used to characterize potential ecological risk at the Group 2 SWMUs by comparing them to average exposure concentrations at the site (Section 6.6.1). Although average exposure concentrations were used, the variability in COC concentrations among and within the six SWMUs influences the likelihood of risk, as does variability in a number of ecological parameters. In addition, the uncertainty associated with ecological risk characterization (see Section 6.7) must be considered when interpreting the summary information and conclusions presented in Section 6.8.

6.6.1 Potential Risk Characterization

6.6.1.1 Characterization Based on Surficial Soil Data and Selected COCs

If concentrations at the site exceed the critical exposure concentrations (Table 6.5-1) when both are expressed in comparable terms, then potential risk is likely. This comparison is made by calculating a hazard quotient (HQ) equal to the ratio of the COC concentration to its critical exposure concentration. Thus, potential risk is likely if the HQ is greater than 1.0. The degree to which potential risk is likely is reflected in the magnitude of the exceedance.

In the calculation of HQs, site concentrations were represented by average surficial soil concentrations for the combined Group 2 SWMUs. Soil concentrations were used because there is only ephemeral surface water present at any of the SWMUs and no exposure pathway exists to groundwater beneath the SWMUs, except possibly west and northwest of SWMU 30 where it may resurface in wetlands. Surficial soil data were used because they better reflect the primary exposure of plants and animals, tended to be higher than subsurface soil data values (particularly for the biota COCs), and contained more detected analytes. Average values were used because, while chemical concentrations are variable in each of the SWMUs, plant root growth and animal mobility result in exposure to a range of COC concentrations. A qualitative characterization of potential risk from surface water, groundwater, and subsurface soil, as well as at individual SWMUs, was also performed.

For plants, the calculation of the HQ for each COC was straightforward, as described above. The HQs calculated for plants are shown in Table 6.6-1 for each of the COCs.

For animals, the critical exposure concentrations provided in Table 6.5-1 are expressed in micrograms of COC per grams of diet. Because animals vary in size and in the amount they eat

Table 6.6-1 Comparison of Exposure Concentrations and Toxicity Reference Values

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Contaminant of Concern	Average Surficial Soil Concentration (μg/g)	Calculated Average Site-Specific Dose from Soil Ingestion by Animals (AID)(μg/g bw/day)	(RV)[1] (μg/g bw/day for animals; μg/g for plants)	HQ (Ratio of AID to RV for Animals and Exposure Soil to RV for Plants[2])
Arsenic				
Animal Comparisons	32.09	0.101	1.55	0.07
Plant Comparisons	32.09	NA	19	**1.69**
Cadmium				
Animal Comparisons	1.16	0.00365	0.10	0.04
Plant Comparisons	1.16	NA	15.1	0.08
Copper				
Animal Comparisons	37.44	0.303	38.8	0.01
Plant Comparisons	37.44	NA	150	0.25
Lead				
Animal Comparisons	56.77	0.840	2.82	0.30

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[1] For animals, RVs are expressed as a dose in micrograms of chemical per gram of the animal's body weight per day.
For plants, RVs are expressed as a soil concentration in micrograms of chemical per gram of soil to which the plant is exposed.

[2] A value less than 1.0 indicates that risk is unlikely because the concentration to which the organism is exposed is less than the dose believed to cause an effect. Values greater than 1.0 are bolded and indicate likely risk.

HQ	Hazard quotient
AID	Average ingested dose
RV	Reference value
MG/G	Micrograms per gram
PPM	Parts per million
bw/day	Body Weight Per Day

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Table 6.6-1 Comparison of Exposure Concentrations and Toxicity Reference Values Page 2 of 2

Contaminant of Concern	Average Surficial Soil Concentration (μg/g)	Calculated Average Site-Specific Dose from Soil Ingestion by Animals (AID)(μg/g bw/day)	(RV)[1] (μg/g bw/day for animals; μg/g for plants)	HQ (Ratio of AID to RV for Animals and Exposure Soil to RV for Plants[2])
Plant Comparisons	56.77	NA	200	0.28
Mercury				
Animal Comparisons	0.18	0.0005	0.0169	0.03
Plant Comparisons	0.18	NA	2	0.09
Silver				
Animal Comparisons	1.01	0.00318	65.0	0.00
Plant Comparisons	1.01	NA	NA	NA
Zinc				
Animal Comparisons	176.99	0.425	38.0	0.01
Plant Comparisons	176.99	NA	400	0.44

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[1] For animals, RVs are expressed as a dose in micrograms of chemical per gram of the animal's body weight per day.
For plants, RVs are expressed as a soil concentration in micrograms of chemical per gram of soil to which the plant is exposed.

[2] A value less than 1.0 indicates that risk is unlikely because the concentration to which the organism is exposed is less than the dose believed to cause an effect. Values greater than 1.0 are bolded and indicate likely risk.

HQ	Hazard quotient
AID	Average ingested dose
RV	Reference value
MG/G	Micrograms per gram
PPM	Parts per million
bw/day	Body Weight Per Day

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per day, the concentration in diet must be converted to a dose that is expressed in terms of micrograms of COC per gram of body weight per day. This conversion normalizes the critical exposure concentration for size and feed rate. For example, the conversion for cadmium would be calculated as follows:

$$RV_{animal} = \frac{2\ \mu g\ Cd}{g\ diet} * \frac{\frac{15\ g\ diet}{300\ g\ bw}}{day} = \frac{0.10\ \mu g\ Cd}{g\ bw\ day} \qquad (6\text{-}1)$$

where RV is the reference value.

A comparable value was then calculated as an estimate of the actual dose received from the average surficial soil concentrations at the Group 2 SWMUs (Table 6.5-1):

$$AID_{animal} = \frac{1.16\ \mu g\ Cd}{g\ soil} * \frac{0.063\ g\ soil}{g\ diet} * \frac{\frac{15\ g\ diet}{300\ g\ bw}}{day} = \frac{0.00365\ \mu g\ Cd}{g\ bw\ day} \qquad (6\text{-}2)$$

where AID is the average ingested dose, and the first two terms in this equation (i.e., the average concentration in soil multiplied by the fraction of soil in the animal's diet) are equivalent to the dietary concentration (or first term) in Equation 6-1. Table 6.6-1 shows the doses for combined Group 2 SWMUs resulting from this calculation for each COC and the HQs calculated for plants and animals.

Table 6.6-2 shows potential risk (i.e., HQ > 1.0) to plants from arsenic. Based on the magnitude of the HQ values shown in the last column of Table 6.6-1, potential risk can be ranked as either low, moderate, or high, as shown in Table 6.6-2. The low ranking was assigned when the soil concentration (or dose to an animal) was below the reference value. This indicates that the likelihood of adverse biological effects of the surficial soil is low. The moderate ranking was assigned when the soil concentration or dose was above the reference value by less than one order of magnitude. This ranking indicates that the soil concentration is at a level that may cause adverse biological effects, but may be within the range of uncertainty in the values. The high ranking would apply where the soil concentration or average ingested dose was one order of magnitude or higher than the reference value. Table 6.6-2 shows that the ranked risk to plants is moderate from arsenic and that the ranked risk to plants and animals from all other COCs, except silver, is low. The potential risk to plants is unknown from silver.

In addition to potential risks from individual COCs in surficial soil across all SWMUs, potential risk from the collective COCs was evaluated by calculation of hazard indices (HIs). The HIs that result from adding the individual HQ values for plants and animals indicate a moderate risk for

Table 6.6-2 Ecological Risk Ranking Relative to Average Surficial Soil Concentrations

Contaminant of Concern	Ecological Risk Ranking	
	Plants	Animals
Arsenic	Moderate	Low
Cadmium	Low	Low
Copper	Low	Low
Lead	Low	Low
Mercury	Low	Low
Silver	Unknown	Low
Zinc	Low	Low

plants from all COCs collectively and a low risk for animals.

6.6.1.2 Characterization Based on Subsurface Soil, Groundwater, and Surface Water Data

The potential risk characterized quantitatively above was based on COCs selected by applying exposure and toxicological criteria to surficial soil data (collected from 0 to 2 inches bgs) from all the Group 2 SWMUs combined. Additional data from the Group 2 SWMUs were also collected from subsurface soil, groundwater, and surface water. The subsurface soil samples were typically collected at 1-ft depth intervals from top-of-sample depths between 0.5 ft (a 6-inch depth interval was sampled at this depth) and 14 ft. Subsurface soil samples comprised 62 percent of the total soil samples and were primarily from 0.5, 2, and 4 ft bgs. Groundwater samples have been collected beneath SWMUs 3, 5, and 9. Surface water samples were collected from detonation craters at SWMU 31. A qualitative characterization of the risk from these other media is presented below.

If the exposure criteria are applied to the subsurface soil samples combined for all six SWMUs, only di-n-butyl phthalate (DNBP) meets all of the spatial distribution, magnitude, and detection frequency criteria. However, DNBP has already been shown to have low persistence and, therefore, to not be of concern for biota. Chemicals with a ratio of maximum value to background (or method detection limit [MDL]) that exceeds 1.0 and also a ratio of arithmetic mean to background between 0.75 and 1.0 are chromium (Cr), copper (Cu), and methylphosphonic acid (MPA). The ratio comparing the 95 percent confidence limit of these chemicals to their background (or MDL) was greater than 1.0 for chromium and copper. MPA did not meet the frequency of detection criterion and was not evaluated further for combined subsurface soil samples. Thus, chromium and copper in subsurface soil are of potential risk to biota, although it must be kept in mind that exposure to subsurface soil is less likely for many wildlife species. Of the 207 subsurface soil samples analyzed, 26 percent are within 2 ft of the surface and 77 percent are within 4 ft of the surface.

Groundwater samples were collected from beneath SWMUs 3, 5, and 9. If the exposure criteria are applied to these groundwater samples, eight chemicals fully meet the spatial distribution, magnitude, and detection frequency criteria: alkalinity (ALK), bicarbonate alkalinity (ALKBIC), calcium (Ca), iron (Fe), potassium (K), magnesium (Mg), sodium (Na), and phosphate (PO4). However, because the groundwater gradient beneath each of these SWMUs slopes away from the surface, there is no known pathway by which biota might be exposed; therefore, these eight chemicals were not evaluated further at these SWMUs. SWMU 30 is the only Group 2 SWMU where groundwater is believed likely to provide a potential exposure pathway to biota by resurfacing in nearby wetlands to the west and northwest. Although no ground water samples were collected beneath this SWMU, groundwater contamination from adjacent known releases is believed to be present beneath SWMU 30 but attributable to contamination from the adjacent SWMU 13. Therefore, any risks that may be associated with groundwater beneath SWMU 30 should be reflected in the risk assessment performed for SWMU 13 by Rust (1994). It should be noted that any such risks would be reduced by the dilution of groundwater by the surface water it joins in the wetlands and by the high natural alkalinity and sodium content of this groundwater, which severely reduce its potability and therefore animal ingestion of it. Alternatively, water at the surface would potentially expose numerous wildlife species because of the attraction of wetlands to both local and migratory wildlife in this arid environment. Further information on the likelihood of potential risk for plants and animals from contaminants in resurfacing groundwater in the wetlands should be provided when the Group 3 SWMUs are evaluated.

If the exposure criteria are applied to the surface water samples from SWMU 31, 13 chemicals meet both the magnitude criteria and the detection frequency criteria at this SWMU: 2,4-dinitrotoluene (24DNT), arsenic (As), barium (Ba), calcium (Ca), copper (Cu), iron (Fe), cyclotetramethylenetetranitramine (HMX), potassium (K), magnesium (Mg), manganese (Mn), sodium (Na), cyclonite (RDX), and selenium (Se). Of these chemicals, the organic compounds (24DNT, HMX, and RDX) are only likely to cause short-term exposure because of their volatility and low persistence. The metals, however, are persistent and at least some are present at concentrations likely to result in potential risk. However, as this standing water is ephemeral and periodic detonation of explosives in the craters has minimized wildlife activity in the vicinity, it is unlikely that these chemicals would affect either populations of relatively sedentary species or individuals of wide-ranging species. Therefore, the toxicological criteria were not investigated and risk was not characterized quantitatively for this medium.

6.6.2 Ecological Significance of Identified Potential Risk

The ecological significance of the potential risks that have been identified is influenced by the spatial distribution of the COCs among and within the Group 2 SWMU soil samples by the degree to which COC concentrations exceed background and by ecological parameters that reflect variations in animal mobility and habitat affinity. These factors determine the degree to which various species may actually experience the potential risk that has been identified.

6.6.2.1 Influence of COC Distribution Patterns

The spatial distribution of COCs across the Group 2 SWMUs influences the ecological significance of the identified potential risks to plants and wildlife populations. The frequency of detections and average soil concentrations within the SWMUs are important considerations in evaluating risk based on have on plant and animal reference values. Potential risk calculated using the average surficial soil concentration in all SWMUs combined implies potential risk throughout the combined areas of the Group 2 SWMUs (SWMU 3, 14 acres [ac]; SWMU 5, 4 ac; SWMU 8, 74 ac; SWMU 9, 144 ac; SWMU 30, 14 ac; and SWMU 31, 66 ac). However, the exceeding average soil concentration might result from a small number of high concentrations in a localized area. This distribution would have much less ecological significance because only a small number of sedentary individuals or a small proportion of more mobile individuals would actually experience risk. As discussed below, the effect on risk results of the spatial distribution of COC detections was investigated by comparing the risk results for combined SWMU data to

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the results for the individual SWMUs separately. The effect on risk results of the spatial distribution of chemicals in groundwater and subsurface soil is also discussed below.

Surficial Soil Distribution Patterns of COCs Among SWMUs

Arsenic, copper, lead, and zinc were detected in all the samples from the Group 2 SWMUs. Cadmium and mercury were detected in 68 and 60 percent of the total samples, respectively, were present at all the Group 2 SWMUs, and were most prevalent at SWMUs 3, 5, and 8. Only silver was restricted in its distribution to three SWMUs (5, 8, and 30), and was detected in a small percentage of the total samples (7 percent). This indicates that the potential for exposure to the COCs is widely distributed among the SWMUs.

If the exposure criteria for magnitude and detection frequency had been applied to surficial soil data on a SWMU-specific basis, the following chemicals would have been identified as potential COCs: SWMU 3—di-n-butyl phthalate; SWMU 5—cadmium, chromium, di-n-butyl phthalate, mercury, naphthalene, lead, silver, and zinc; SWMU 8—zinc; SWMU 9—hexachlorobenzene, copper, di-n-butyl phthalate, and toluene; SWMU 30—none; and SWMU 31—none. As for the overall Group 2 SWMU considerations, the di-n-butyl phthalate and toluene would have been eliminated as final COCs because of their low persistence and bioavailability in soil, groundwater, and surface water. Naphthalene would have also been eliminated on this basis (half-life in soil equals 16.6 to 48 days; in surface water equals 20 days; in groundwater equals 258 days) since it has a long half-life only in groundwater, which would become surface water before biota could be exposed to it. Hexachlorobenzene, however, would have been identified as a SWMU-specific COC at SWMU 9, because of its longer half-life (2.7 to 5.7 years in soil and surface water; 5.3 to 11.4 years in groundwater). Chromium would have been added at SWMU 5. These two chemicals were not added to the final COCs because of their restricted distribution. This restricted distribution results in a low likelihood that they would expose a sufficient number of individuals of relatively sedentary species to affect populations, or that they would sufficiently expose individuals of wide-ranging species that the latter would be affected.

A comparison of plant and animal reference values to average surficial soil concentrations within the individual SWMUs revealed a low risk for plants and animals from all the COCs at all the SWMUs except for plants from arsenic at SWMU 3 and for plants from zinc at SWMU 8.

Background concentrations influence the ecological significance of potential risk because organisms present in an area must be adapted to the conditions there, including the metals concentrations that are present. Therefore, if a reference value for plants (or the soil concentrations that would result in a reference value for animals) is lower than background in a particular area, then at least some species of plants or highly sedentary animals will be absent from or have a different population structure in that area because its soil is toxic to them. Less sedentary animals may be less affected if they also range into areas where background concentrations are higher than the soil concentrations that would result in an animal reference value. In the Group 2 SWMUs, reference concentrations for plants are higher than surface soil background concentrations for both plants and animals for all COCs with two exceptions: the arsenic reference concentration for plants is lower than background and the absence of a silver reference value for plants precludes a conclusion for this COC. The soil concentrations that would result in a reference dose to animals were calculated by substituting the reference value for the average ingested dose in Equation 6-2 and solving for the COC concentration in soil. Therefore, even in the absence of contamination (defined as the presence of concentrations that are higher than naturally-occurring concentrations), plant species that are particularly sensitive to arsenic would likely not be present in at least some parts of the Group 2 SWMUs, or would have acclimated to the concentrations that are present. These comments hold for SWMU-specific comparisons as well as for the data from all SWMUs combined since there was only one background level and one reference value defined for the Group 2 SWMUs collectively.

Groundwater and Subsurface Soil Distribution Patterns of Chemicals Among SWMUs

The chemicals noted above as meeting the spatial distribution criteria and meeting the magnitude criteria at all three SWMUs where groundwater was sampled were alkalinity (ALK), bicarbonate alkalinity (ALKBIC), calcium (Ca), iron (Fe), potassium (K), magnesium (Mg), sodium (Na), and phosphate (PO4). In addition to these chemicals of interest are other chemicals that meet the magnitude criteria at one SWMU, but not at all three: aluminum (Al), barium (Ba), beryllium (Be), manganese (Mn), trichloroethene (TRCLE), and vanadium (V) at SWMU 3; and methylene chloride (CH2CL2) at SWMUs 3 and 5.

Arsenic, cadmium, and lead are persistent and meet the exposure criteria in subsurface soil at SWMUs 5 and 30, and copper meets these criteria in SWMUs 8 and 30. In addition, chromium meets these criteria in SWMU 5, but the magnitude of its background exceedance was not sufficient to drive the overall mean subsurface soil concentration above background. One additional chemical, MPA, met the exposure criteria at SWMU 3, where it was detected only at this small (13.68 ac) SWMU. However, the spatial distribution criterion cannot be met in an individual SWMU.

When the mean concentrations of the COCs were used to calculate plant exposure soil values and animal AID values and were compared to the appropriate reference values, only the values for arsenic at SWMUs 3 and 30 indicated a potential risk for plants.

6.6.2.2 The Influence of Ecological Parameters

In evaluating the potential risk to plants from arsenic, together with the distribution of this COC across the Group 2 SWMUs, animal spatial and habitat requirements must be kept in mind. The spatial and habitat requirements of various animal groups must be related to the size of the SWMUs and the individual exposure areas present in the SWMUs, within the context of ecological threat to the TEAD-S ecosystem.

Typically, the foraging area of a species is smaller for lower trophic levels (e.g., small mammals use a foraging area about three orders of magnitude smaller than their predators). Thus, many individuals of prey species such as insects, rodents, and rabbits could inhabit the largest of the Group 2 SWMUs, SWMU 9, while only one or perhaps two individuals of their predator species might use the area. This means that a high or moderate potential risk related to a widespread COC may equate to local populational effects on prey species, particularly when habitat is uniform across the SWMUs, but may equate to only individual effects on predators.

The assumption of uniform habitat, however, is an over-simplification. Not all areas in the Group 2 SWMUs are of equal habitat quality or type. Therefore, some areas may be occupied by fewer individuals of a certain species than others. The absence or lower quality of a habitat type may therefore reduce the number of individuals exposed in the population. In addition, species of raptors that are wide-ranging and hunt in open habitat (e.g., the northern harrier) may be exposed to the SWMUs in a more uniform fashion than raptors that hunt in an area centered around a nest tree or perch (e.g., the American kestrel). This is particularly true for open-country hunters in the Group 2 SWMUs, where few trees exist. Therefore, the exposure to the SWMUs is much different for a northern harrier than it is for an American kestrel These types of species-specific variations result in different ecological significance of the potential risks identified.

The other major ecological parameter that influences the ecological significance of the potential risk identified is the length of time spent in the Group 2 SWMUs. For wide-ranging predators, such as some raptors, variations in time spent are in part a response to habitat uniformity and quality and therefore the abundance of their prey. Prey species may be absent, patchy in their distribution, or less dense in their occupation of an area, depending on the uniformity and quality of the habitat the area provides. In addition, particularly for birds, the time spent in the SWMUs may vary by season. Some species may migrate through TEAD-S. or may spend only the summer or winter there, while others may be permanent, year-round residents. Large game mammals also migrate, although their free movement is constrained by the TEAD-S fences (which does not impede birds using the area). Finally, population expansions or replacements occur at the end of every breeding season, so the individuals in a given locale during one time period may later move. The calculations of potential risk assume year-round exposure and so are conservative for the individuals of many species.

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6.7 UNCERTAINTY IN POTENTIAL RISK CHARACTERIZATION

There are several sources of uncertainty associated with the characterization of potential risk to plants and animals from chemicals present in the Group 2 SWMUs. These include uncertainties inherent in the representation of exposure concentrations, in the assumption that ingested soil is the only source of COC concentrations, and in the literature values used, as well as uncertainties related to the chemical form and availability of the COCs at the Group 2 SWMUs.

6.7.1 Representation of Exposure Concentrations

The use of average surficial soil concentrations as the basis for exposure leaves uncertainty relating to potential risks from exposure to hot spots versus relatively clean areas. Hot spots have minimal effect on individuals of wide-ranging or migratory species, providing the other areas encountered by these individuals are relatively clean. For small organisms with limited exposure ranges (e.g., insects, small rodents, and reptiles), hot spots are very likely to cause risk to individuals with exposure ranges that are confined to the hot spots and local mortality may occur. For other individuals with small or medium exposure ranges the likelihood of potential risk is dependent on the percentage of the exposure range comprised of the hot spot and the concentrations present in the hot spot relative to the reference value concentrations. Thus, uncertainty remains with regard to the chemical concentrations in other areas encountered by individuals of wide-ranging or migratory species or by other members of the populations of species with small exposure ranges, the percentage contributed by the hot spot to the exposure range of individuals with small or medium exposure ranges, and the average concentration encountered relative to the reference value. However, based on the premise that the Group 2 SWMUs were investigated because they are believed to contain chemicals not present in the area surrounding them, it is likely that the uncertainties above are of little ecological consequence. Hot spots represent a relatively small and atypically contaminated segment of exposure area for individuals of wide-ranging species, which are most likely to be exposed to COC concentrations in the soil throughout their foraging area (i.e., to average concentrations rather than to isolated hot spots). Further, although hot spots are likely to result in adverse effects to individuals of species that forage over a small area, they represent a relatively small and atypically contaminated segment of exposure area for populations of such species. Therefore, the use of average soil concentrations across the SWMUs as an estimate of exposure concentration is generally valid for estimating potential risk to populations of relatively sedentary species and to individuals of wide-ranging species.

The use of average surficial soil concentrations as the basis for exposure also leaves uncertainty resulting from additional exposure to subsurface soils for burrowing animals and for plants. Particularly in xeric ecosystems, animals such as badgers, kangaroo rats and ground squirrels depend upon subsurface burrows for moisture conservation, food storage, and protection from the elements. However, because subsurface soils contained fewer contaminants, lower concentrations of contaminants, and generally provides less exposure for all biota, the potential risk identified by considering surficial soil should generally be a conservative estimate of potential risk from subsurface soil as well.

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Nonetheless, because of the uncertainties just detailed, a qualitative evaluation of risk in individual SWMUs and in subsurface soil is provided in Section 6.6.2.1 as a measure of the potential risk from hot spot and subsurface exposures. The conclusions from this qualitative evaluation are provided in Section 6.8.

6.7.2 Only COC Source Assumption

The assumption that ingested soil is the only source of COC concentrations ingested by animals ignores concentrations that may be ingested in prey. Three of the seven COCs (cadmium, mercury, and zinc) may be bioaccumulative in animals and another three (arsenic, copper, and silver) may be bioaccumulative in plants (Table 6.3-2). Thus, this assumption may underestimate potential risk, especially for upper-trophic-level predators. To evaluate the degree to which the bioaccumulative COCs may be underestimated, bioaccumulation factor (BAF) and the assimilation fraction (AF) values for the COCs were sought in the literature (Table 6.7-1).

Bioaccumulation is the ratio of the concentration of a COC in a predator to its concentration in the predator's collective prey. BAF values for plants and vertebrate animals are higher for mercury than for the other COCs and range as high as 0.45 for plants and 22.5 for animals (Table 6.7-1). Thus, mercury provides a worst-case example. The plant BAF value is less than 1.0, which means that mercury concentrations in plants should be less than in soil. Ingestion of plants containing mercury will, therefore, add mercury to the ingested dose for herbivores, but at less than half the rate of ingested soil. Mercury concentrations in predators that eat these herbivores, however, could be 23 times greater than the mercury concentrations in the herbivores. This 23-fold increase could occur again in the next higher trophic level. To evaluate potential risk from mercury bioaccumulation for the Group 2 SWMUs, the surficial soil concentration resulting in the reference dose value for mercury was back-calculated in equation 6-2 above by setting the AID equal to the RV and then compared to the actual mean exposure surface soil concentration in the Group 2 SWMUs. As this back-calculated soil concentration is approximately 34 times higher than the average SWMU value, only one 23-fold trophic level bioaccumulation could be accommodated before this underestimation of dose would be likely to result in potential risk to plants and animals exposed only to the Group 2 SWMUs. If the high concentrations of mercury in SWMU 5 and especially SWMU 3 are assumed to be absent, the back-calculated soil concentration could accommodate several 23-fold trophic-level bioaccumulations.

The AF indicates the proportion of the ingested COC concentration that is actually assimilated into the predator's tissues. The low values for most of the available assimilation fractions diminish the likelihood of underestimated potential risk. Mercury again provides a worst-case example.

6.7.3 Uncertainties in the Literature Values Used

The literature values used to determine toxic levels at the Group 2 SWMUs were primarily based on vegetables, grasses, rodents, chickens, ducks, and dogs. These subjects must act as surrogates for the wide array of plants and animals at TEAD-S. The use of surrogate species introduces uncertainty to the reference values used for plants and animals because the values used may not

Table 6.7-1 Information to Aid in Assessing Risk Underestimation[1]

	Bioaccumulation Factor Values		
Contaminant of Concern	Plant	Animal	Animal Assimilation Fraction
Arsenic	0.126[2]	0.76[3,4]	0.03
Cadmium	NA	NA	<0.0025
Copper	0.012	NA	0.28
Lead	NA	NA	0.08
Mercury	0.45[5]	bird maximum, 14[6] mammal maximum, 22.5[7]	0.75
Silver	0.15		0.01
Zinc	0.4		0.1

NA Not available

[1] All values taken from Whicker and Schultz (1982) unless otherwise noted

[2] From Stevens et al. (1972) and Weaver et al. (1984)

[3] From Beyer and Cromartie (1987) and National Academy of Sciences (1977)

[4] For animals, a very conservative assumption for nonbioaccumulative chemicals would be 1.0

[5] From Shariatpanahi (1986)

[6] From Heinz (1980)

[7] From Wren et al. (1987)

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be representative of the average species, the average individual in that species, or the average individual in the most sensitive species. Furthermore, too few replicates may have been studied to quantify the range, mean, and variance of a particular parameter, even if it was measured for the species of interest; often only a single value was available.

6.7.4 Uncertainties Due to Chemical Variations

Arsenic and mercury are found in several chemical forms that differ in their degree of toxicity, occurrence, and bioavailability in soil. As stated in Section 6.5, the trivalent and pentavalent forms of arsenic (arsenic III and arsenic V, respectively) are widely distributed in nature, but have different physiological activity, with the trivalent form being more toxic. As also stated in Section 6.5, organic mercury is more toxic than inorganic mercury, but it is also less common in natural abiotic media than inorganic mercury. Thus, the use of values for the more toxic form of mercury is likely an overestimation of potential risk. In addition, the potential risk from silver to plants is unknown because reference values for its plant toxicity were not found in the literature.

6.8 SUMMARY AND CONCLUSIONS

The most likely exposure from contaminants at the Group 2 SWMUs was determined to be through contact and ingestion of surficial soil (i.e., the upper 2 inches). Through the use of term exposure and toxicological criteria, seven metals (arsenic, cadmium, copper, lead, mercury, silver, and zinc) were selected as COCs for biota. For these seven COCs, the scientific literature was searched for reference values that define the concentration at which a dose of the COC results in adverse effects to test organisms. Although subsurface soil, groundwater, and surface water data were not used to formally select COCs, they were evaluated qualitatively. The chemicals of interest for ecological risk characterization, whether or not they were formally selected as COCs, are identified in Table 6.8-1. Chemicals of interest in surficial and subsurface soil are listed separately.

Rankings of potential risk from each COC were established as either low, moderate, or high by comparing exposure concentrations to reference values for both plants and animals. Because exposure concentrations were estimated by surficial soil concentrations averaged across the Group 2 SWMUs, these potential risk rankings were for the entire area comprised by all six SWMUs. All risks were ranked low (i.e., below an HQ value of 1.0), except for a moderate ($1.0 < HQ < 10$) potential risk to plants from arsenic. This risk results almost entirely from the high arsenic concentrations at SWMU 3. When the surficial soil of SWMUs was considered separately, arsenic at SWMU 3 posed moderate potential risk to plants and zinc at SWMU 8 posed moderate potential risk to plants.

In subsurface soil, arsenic concentrations posed moderate potential risk to plants at both SWMUs 3 and 30; however, supplemental background sampling showed that elevated arsenic levels at SWMU 3 are attributable to the presence of Mercur Creek sediments rather than operations at this SWMU. There were no potential risks identified to vertebrate animals from any of the COCs in either surficial or subsurface soil at any of the SWMUs individually or collectively. Therefore, potential risks for all these combinations were ranked as low. Chromium concentrations in subsurface soil were higher than in surficial soil; if subsurface soil had been used to identify

Table 6.8-1 Synopsis of Chemicals of Interest for Ecological Risk Characterization Page 1 of 2

Chemical	Combined Data	SWMU 3	SWMU 5	SWMU 8	SWMU 9	SWMU 30	SWMU 31
<u>Surficial Soil</u>							
AG	X[2]		X[2]				
AS	XX[1,3]	XX[1,2]					
CD	X[2]		X[2]				
CL6BZ					X[2]		
CR			X[2,5]				
CU	X[2]				X[2]		
HG	X[2]	X[2]	X[3]				
PB	X[2]		X[2,5]				
ZN	X[2]		X[2,5]	XX[1,2]			
<u>Subsurface Soil</u>							
AS			X[2]			X[2]	
CD			X[2]			X[2]	
CR	X[3]		X[2]				
CU	X[3]			X[2]		X[2]	
PB			X[2]				
<u>Groundwater</u>							
AL	NC	X[4]					
ALK	NC	X[4]	X[4]		X[4]		
ALKBIC	NC	X[4]	X[4]		X[4]		
BA	NC	X[4]					
BE	NC	X[4]					
CA	NC	X[4]	X[4]		X[4]		
CH2CL2	NC		X[4]		X[4]		
CR	NC						
FE	NC	X[4]	X[4]		X[4]		

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Table 6.8-1 Synopsis of Chemicals of Interest for Ecological Risk Characterization Page 2 of 2

Chemical	Combined Data	SWMU 3	SWMU 5	SWMU 8	**SWMU 9**	SWMU 30	SWMU 31
K	NC	X[4]	X[4]		**X**[4]		
MG	NC	X[4]	X[4]		**X**[4]		
MN	NC	X[4]					
NA	NC	X[4]	X[4]		**X**[4]		
PO4	NC	X[4]	X[4]		**X**[4]		
V	NC	X[4]					
Surface Water							
24DNT							X[4]
AS							X[4]
BA							X[4]
CA							X[4]
CU							X[4]
FE							X[4]
HMX							X[4]
K							X[4]
MG							X[4]
MN							X[4]
NA							X[4]
RDX							X[4]
SE							X[4]

NOTE: Bolded entries were selected as COCs and treated quantitatively. All entries meet detection frequency requirement and have a half-life of less than 30 days.
Please see the Chemical Acronym List for acronym definitions.

[1] A selected COC present in concentrations that result in potential risk for plants and/or animals; used with XX for emphasis.

[2] Meet both magnitude criteria.

[3] Meet magnitude criterion for maximum ratio and 95 percent confidence limit, meets criterion for mean ratio.

[4] Evaluated only by applicable exposure criteria; persistence was not investigated.

[5] Note that at SWMU 5, 3 of the 41 surficial soil samples were taken beneath the concrete sump base at the Building 600 foundation and were actually at a depth of approximately 4 feet.

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COCs, chromium would have been added to the selected COCs on the basis of its extremely high concentrations in subsurface soil at SWMU 5. Subsurface soil was not used to identify COCs because its contaminants are less accessible to most biota.

In general, contaminants in the groundwater beneath the Group 2 SWMUs do not have an exposure pathway to plants and animals. Beneath SWMUs 3, 5, and 9 groundwater tends to flow southeast and away from the wetlands west and northwest of SWMU 30. Furthermore, the most contaminated groundwater was found beneath SWMU 3, which is furthest from the wetlands. These wetlands are the only likely place where groundwater might resurface near the Group 2 SWMUs and result in exposure of wildlife. Potential risk to wildlife in these wetlands would be primarily attributable to contaminants from SWMUs 11 and 13, which are not Group 2 SWMUs. Therefore, although several groundwater chemicals meet the exposure criteria (Table 6.8-1), they were not evaluated for persistence and the other toxicological criteria.

Surface water was present only in a limited number of detonation craters in SWMU 31. The chemicals in this surface water that meet the exposure criteria (except for spatial distribution) were identified (Table 6.8-1), but they were not evaluated further because this water is ephemeral and would not cause potential risk to populations of relatively sedentary species or individuals of wide-ranging species. Furthermore, wildlife populations are minimal in this SWMU since open detonation is conducted there on a daily basis.

The ecological significance of small areas of high concentration is minimal because only resident individuals of relatively sedentary species would be affected by them; populations of more sedentary species and individuals of more wide-ranging species are unlikely to be affected by small areas of high COC concentrations. This should be taken into account when considering the potential risk posed to plants from arsenic concentrations in subsurface soil at SWMU 30 (13.87 ac).

The uncertainties inherent in this assessment of potential risk result from the following:

- Use of average soil concentrations
- Assumption that soil ingestion was the only significant source of contaminant uptake in animals
- Use of toxicological reference values based on surrogate species
- Unknown chemical forms and availability of the COCs in the surficial soil
- Assumption that subsurface soil are relatively inaccessible to biota
- Assumption that biota exposure to groundwater for which there are data is unlikely and exposure to surface water for which there are data is insignificant

Some of these uncertainties tend to result in an underestimation of potential risk (e.g., assuming ingested soil is the only contaminant source for animals), some tend to overestimate potential risk (e.g., using reference values for the more toxic chemical form when it is not the most prevalent in nature), and some of these uncertainties have an unknown effect on potential risk estimates. The underestimation of potential risk appears to be a problem only for organisms that are two

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or more trophic levels above herbivores (except for mercury, where the trophic level above herbivores might be at risk from the high mercury concentrations at SWMU 3).

In conclusion, there is potential ecological risk to plants from arsenic in both surficial and subsurface soil in the Group 2 SWMUs, especially in SWMUs 3 and 30, but arsenic levels at SWMU 3 represent background conditions. There is also potential risk to plants from zinc in surficial soil at SWMU 8. High maximum values of chromium, especially in the subsurface soil primarily at SWMU 5, could be a problem except for the small size of this SWMU (3.57 ac). These potential risks must be considered in the context of the uncertainties inherent in their estimation. They are of particular concern with respect to higher trophic level carnivores (e.g., peregrine falcon), particularly if these receptors are year-round residents (e.g., great horned owl).

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