Appendix A: Geologic Units

The surface units include alluvium (Qa), colluvium (Qc), dune sand (Qd), Missoula Flood deposits (which include fluvial gravel [Qg], fluvial and lacustrine sand [Qs], and lacustrine fine sand and silt [Qss]), loess deposits of the Palouse Formation (Ql), and the Tertiary Ringold Formation (Tr), consisting of fluvial and lacustrine sediments. The surface of the Study area reflects the scouring and erosional remnants from the large glacial catastrophic floods. The area is characterized by undisturbed uplands mantled with loess that are dissected by eroded channels, or coulees, where the underlying bedrock is exposed and where fluvial and lacustrine flood materials were deposited during the large flood events (Grolier and Bingham 1971 and 1978). The surface units are described from recent to oldest in the list below.

Quaternary Alluvium (Qa) Quaternary alluvium (Qa) consists of sand and silt, including fossiliferous lacustrine silt and silty peat deposited by existing streams in channels and along the bottoms of the larger coulees. The alluvium is reworked outburst flood deposits or loess and is sometimes difficult to distinguish from the older material.

Quaternary Colluvium (Qc) The Quaternary colluvium (Qc) is generally silt- to boulder-sized, mostly subangular basaltic debris, and includes talus and alluvial fan deposits carried down from the steeper slopes and cliffs in the coulees and valleys.

Quaternary Dune Sand (Qd) The Quaternary dune sand (Qd) is generally fine to medium sand, mostly quartz, feldspar, and basalt, and includes active barchan (crescent-shaped) dunes in the Lower Crab Creek valley that consist of sand derived from floodplain deposits of the Columbia River.

Quaternary Fluvial Gravel (Qg) The Quaternary fluvial gravel (Qg) is Missoula flood gravel deposits ranging from boulders to sand, with laminated silts derived from the numerous outburst floods from the glacial Lake Missoula. The material was deposited at points where scabland channels emptied into basins or large river valleys and diminished water velocity resulted in deposition of the floodwater sediment load.

Quaternary Fluvial-Lacustrine Sand and Silt (Qs) The Quaternary fluvial-lacustrine sand and silt (Qs) are generally a finer-grained facies of the Missoula flood deposits, consisting of fine to coarse, horizontally bedded basaltic sand and silt. As with the fluvial gravel, the material was deposited at points where scabland channels emptied into basins or large river valleys and diminished water velocity resulted in deposition of the floodwater sediment load.

Quaternary Lacustrine Fine Sand and Silt (Qss) The Quaternary glacial-lacustrine (Missoula flood) fine sand and silt (Qss) were deposited in temporary lakes formed as ice and debris dammed the Columbia River. Two principal periods of deposition of lacustrine silt are recognized, based on two faintly defined shorelines, at elevations of 1, 200 and 1,350 feet in the Quincy basin (Grolier and Bingham 1971 and 1978). The deposits are calcareous throughout, loosely compacted, slightly cohesive, and temporarily stand in steep walls in ravines and cuts. Another characteristic of the lacustrine fine sand and silt is the presence of numerous clastic dikes. The upper limit of the glacial-lacustrine deposits is marked by the presence of erratic pebbles and boulders interpreted as ice-rafted debris that was stranded along the shoreline of the lakes in which deposition of the silt occurred.

Quaternary Palouse Formation (Ql) The Quaternary Palouse Formation (Ql) consists of eolian loess (windblown silt) that covers the majority of the surface area of the Study area. Deposits consist primarily of silt, but include some fine sand, clay, and volcanic ash. Wind action and loess deposition occurred during the Pleistocene, with glacial drift providing a source of silt. The loess occurs throughout much of the Columbia River Plateau and reaches its greatest thickness and continuity in the southeastern part of the Palouse Subprovince, where locally it is as much as 250 feet thick (Hansen et al. 1994). Within the Study area, the loess ranges in thickness from 10 to 50 feet in the upland,s where it was not removed by the scouring effects of outburst floods. The loess can be very stable when dry, but it is susceptible to piping, as well as subsidence and settlement when saturated.

Tertiary Ringold Formation (Tr) The Tertiary Ringold Formation (Tr) consists of three facies divided into lower, middle, and upper. The lower is largely clayey silt with sand and gravel, the middle is composed of gravel and cobbles with a silt matrix, and the upper sediments are composed of sand and silt with some minor fine gravel (Lillie et al. 1978). The unit is exposed along the west shore of Potholes Reservoir, Frenchman Hills, and Saddle Mountains, and along the Columbia River south and west of the Study area. The Ringold is up to 600 feet thick in exposures in the Pasco Basin.

Bedrock Units

Bedrock underlying the Study area is composed of volcanic rocks of the Columbia River Basalt Group. Within the Study area, the Columbia River Basalt Group is composed of, from youngest to oldest, the Saddle Mountains, Wanapum, and Grande Ronde Formations. The long periods between eruptions allowed for the deposition of sediments between flows. These sediments, known as the Ellensburg Formation, include sand-and-gravel-bar deposits from the Columbia River and finer-grained silt and clay layers deposited in shallow lakes formed by temporary damming of the Columbia River.

Saddle Mountains Formation - Undifferentiated (Tsm)

The formation consists of four basaltic members and three sedimentary interbed units that are part of the Ellensburg Formation. The basaltic units are the Elephant Mountain, Pomona, Esquatzel, and Umatilla Basalt Members consisting generally of fine- to medium-grained, slightly weathered, hard, intensely to moderately fractured basalt. The sedimentary units are the Rattlesnake Ridge, Selah, and Mabton, and they are composed of weathered basaltic fragments and tuffaceous silt and clay. The Saddle Mountains Formation is exposed at the surface along the ridge north of the Lower Crab Creek dam site and is presumed to underlie the Saddle Mountains Thrust Fault on the left abutment of the proposed Lower Crab Creek dam site.

Wanapum Basalt Formation

The Wanapum Basalt Formation is divided into the Priest Rapids (Tp), Roza (Trz), and Frenchman Springs (Tf) Members. Locally, the Ellensburg Formation is represented by the Quincy Interbed within the Wanapum Formation and the Vantage Member that overlies the Grand Ronde Basalt Formations. The Wanapum Basalt is exposed in the folded belt west of the Study area and in scoured coulees and river channels.

Priest Rapids Basalt (Tp) The Priest Rapids Basalt Member (Tp) is the uppermost basaltic flow in the Wanapum Basalt Formation. The Priest Rapids Member consists of grayish black, medium to coarse-grained, dense to vesicular basalt. The rock weathers to reddish-brown, and often has large columns and platy partings in basal flows, with pillow-palagonite containing petrified wood at the base (Grolier and Bingham 1971 and 1978). The unit consists of four flows and is about 200 feet thick in the northwest part of the Study area. The Priest Rapids Basalt forms the bedrock on the right abutment and channel section for the proposed Lower Crab Creek dam site.

Quincy Diatomite (Tq) The Quincy Member (Tq) is a sedimentary unit between the Priest Rapids and Roza Basalt Members. The unit consists of diatomite and is about 30 feet thick based on well logs. Diatomite is a friable, earthy deposit composed of silica consisting of frustules (siliceous shell) of microscopic plants called diatoms. Diatoms secrete silica frustules that may accumulate in enormous numbers in fresh water, likely in lakes ponded behind lava flow dammed streams. The Quincy Diatomite is not present in the near surface foundation at any of the potential dam sites.

Roza Basalt (Trz) The Roza Member (Trz) is near the middle of the Wanapum Basalt Formation. The Roza Basalt is dark blue-gray and medium- to coarse-grained, porphyritic (1 centimeter plagioclase phenocrysts), and weathers to deep reddish-brown. The Roza Basalt has large columnar joints throughout that generally range from 5 to 10 feet across. The columns also have platy parting planes mostly normal to the axis of columns (Grolier and Bingham 1971 and 1978). The unit consists of one or two flows and is about 100 feet thick in the northwest part of the Study area. The Roza Basalt forms the upper abutments at the proposed Upper Dry Coulee, Black Rock Coulee, and Rocky Coulee dam sites.

Frenchman Springs Basalt (Tf) The Frenchman Springs Member (Tf) is the lowest flow in the Wanapum Basalt Formation. The Frenchman Springs Basalt is dark gray, fine to medium-grained, and porphyritic (10 to 25 millimeter plagioclase phenogrysts). The upper contact is marked by cherty concretions and sandy clay, and the basal part of the flows have thin (less than 1-foot thick) pillow-palagonite zones containing petrified logs (Reidel and Campbell 1989). The unit consists of four flows and is about 200 feet thick in the northwest part of the Study area. The Frenchman Springs Basalt forms the foundation for the abutments and channel sections at the proposed Upper Dry Coulee, Black Rock Coulee, and Rocky Coulee dam sites.

Vantage Sandstone (Tv) The Vantage Member (Tv) is a sedimentary unit between the Wanapum and Grande Ronde Formations. The unit consists of light colored, weakly cemented tuffaceous sandstone and siltstone, and ranges from 1 to about 35 feet thick based on well logs. The Vantage Sandstone is generally concealed by talus that has fallen from overlying flows onto lower basaltic benches. The sedimentary unit may be present in the deeper foundation under the upper abutments at the proposed Lower Dry Coulee dam site, and the channel section at the proposed Upper Dry Coulee dam site at the contact between the Grande Ronde (Tgr) and Frenchman Springs (Tf) Basalt units.

Grande Ronde Basalt Formation - Undifferentiated (Tgr)

The Grande Ronde Formation is the most aerially extensive unit of the Columbia River Basalt Group and it underlies the entire Study area to depths of several hundred feet. The basalt is black or dark gray, fine-grained to aphanitic, and often with hackly jointing. Columns are commonly smaller than in the Frenchman Springs, Roza, and Priest Rapids Members, and the unit includes thick zones of pillows and palagonite (Grolier and Bingham 1971 and 1978). The Grande Ronde consists of multiple flows with rare interbeds, and contacts between individual flows are sometimes rubbly and fractured. These contact zones tend to be zones of higher permeability (Hansen et al. 1994). The Grande Ronde forms the foundation for a portion of the channel section at the proposed Upper Dry Coulee dam site and the entire foundation at the proposed Lower Dry Coulee dam site.

Appendix B: Birds, Mammals, and Reptiles that May Be in the Study Area

Birds

Common Name	Scientific Name
Turkey vulture	*Cathartes aura*
Osprey	*Pandion haliaetus*
Bald eagle	*Haliaeetus leucocephalus*
Sharp-shinned hawk	*Accipiter stratus*
Cooper's hawk	*A. cooperii*
Northern harrier	*Circus cyaneus*
Swainson's hawk	*Buteo swainsoni*
Red-tailed hawk	*B. jamaicensis*
Ferruginous hawk	*B. regalis*
Golden eagle	*Aquila chrysaetos*
American kestrel	*Falco sparverius*
Prairie falcon	*F. mexicanus*
Peregrine falcon	*F. perigrinus*
Barn owl	*Tyta alba*
Western screech owl	*Otis kennicotti*
Great-horned owl	*Bubo virginianus*
Northern pygmy owl	*Glaucinium gnoma*
Northern saw-whet owl	*Aegolius arcadicus*
Burrowing owl	*Athene cunicularia*
Long-eared owl	*Asio otis*
Short-eared owl	*A. flammeus*
Great-blue heron	*Ardea herodias*
Ruffed grouse	*Bonasa umbellus*
Sage grouse	*Centrocercus urophasianus*
Sharp-tailed grouse	*Tympanuchus phasianellus*
Mountain quail	*Oreotyx pictus*
California quail	*Callipepla californica*
Sandhill crane	*Grus canadensis*
Upland sandpiper	*Bartramia longicauda*
Killdeer	*Charadrius vociferus*
Long-billed curlew	*Numenius americanus*
Rock dove	*Columba livia*
Mourning dove	*Zenaida macroura*
Yellow-billed cuckoo	*Coccyzus americanus*
Common poorwill	*Phalaenoptilus nuttalli*
Common nighthawk	*Chordelles minor*
Black swift	*Cypseloides niger*
White-throated swift	*Aeronautes saxatalis*
Black-chinned hummingbird	*Archilochus alexanri*
Calliope hummingbird	*Stellula calliope*
Broad-tailed hummingbird	*Selasphorus platycercus*
Rufous hummingbird	*S. rufus*
Belted kingfisher	*Ceryle alcyon*
Lewis' woodpecker	*Melanerpes lewisi*
Red-naped sapsucker	*Sphyrapicus nuchalis*

Downy woodpecker	*Picoides pubescens*
Hairy woodpecker	*P. villosus*
Northern flicker	*Colaptes auratus*
Pileated woodpecker	*Dryocopus pileatus*
Western wood-pewee	*Contupus sordidulus*
Willow flycatcher	*Epidonax traillii*
Least flycatcher	*E. minimus*
Dusky flycatcher	*E. oberholseri*
Cordilleran flycatcher	*E. occidentalis*
Gray flycatcher	*E. wrightii*
Ash-throated flycatcher	*Myiarchius cinerascens*
Say's phoebe	*Sayornis saya*
Western kingbird	*Tyrannus verticallis*
Eastern kingbird	*T. tyrannus*
Horned lark	*Eremophila alpestris*
Tree swallow	*Tachycineta bicolor*
Violet-green swallow	*T. thalassina*
Northern rough-winged swallow	*Stelgidopterix serripennis*
Bank swallow	*Ripariariparia*
American robin	*Turdus migratorius*
Cliff swallow	*Petrochilodon pyrrhonota*
Loggerhead shrike	*Lanius ludovicianus*
Cedar waxwing	*Bombycilla cedrorum*
American dipper	*Cinclus mexicanus*
Rock wren	*Salpinctus obsoletus*
Canyon wren	*Catherpes mexicanus*
House wren	*Troglodytes aedon*
Sage thrasher	*Oreoscoptes montanus*
Gray catbird	*Dumetella carolinensis*
Western bluebird	*Sialia mexicana*
Veery	*Catharus fuscescens*
Blue-gray gnatcatcher	*Polioptila caerulea*
Bushtit	*Psaltriparus minimus*
Black-capped chickadee	*Poecile atricapilla*
White-breasted nuthatch	*Sitta carolinensis*
Brown creeper	*Certhia americana*
Juniper titmouse	*Baeolophus ridgwayi*
Song sparrow	*Melospizo melodia*
White-crowned sparrow	*Zonotrichia leucophrys*
Savannah sparrow	*Passerculus sandwichensis*
Grasshopper sparrow	*Ammodramus savannarum*
Brewers sparrow	*Spizella breweri*
Vesper sparrow	*Pooecetes gramineus*
Lark sparrow	*Chondestes grammacus*
Black-throated sparrow	*Amphispiza bileata*
Sage sparrow	*A. belli*
Chipping sparrow	*Spizelia passerina*
Dark-eyed junco	*Junco hyemalis*
Spotted towhee	*Pipilo maculatus*
Green-tailed towhee	*P. chlorurus*
Black-headed grosbeak	*Pheucticus melanocephalus*
Lazuli bunting	*Passerina amoena*
Western tanager	*Piranga ludoviciana*
Orange-crowned warbler	*Vermivora celata*
Nashville warbler	*V. ruficapilla*
Yellow warbler	*Dendroica petechia*
Black-throated gray warbler	*D. nigrescens*
Virginia's warbler	*V. virginae*

American redstart	*Setophaga ruticilla*
Northern waterthrush	*Seiurius noveboracensis*
Common yellowthroat	*Geothlypis trichas*
MacGillivary's warbler	*Oporornis tolmieri*
Wilson's warbler	*Wilsonia pusilla*
Yellow-breasted chat	*Icteria virens*
Cassin's vireo	*Vireo cassenni*
Red-eyed vireo	*V. olivaceous*
Warbling vireo	*V. gilvus*
Bullock's oriole	*Icterus bullocki*
Western meadowlark	*Sturnella neglecta*
Red-winged blackbird	*Aeelaius phoeniceus*
Brewer's blackbird	*Euphagus cyanocephalus*
Brown-headed cowbird	*Molothrus ater*
Bobolink	*Dolichonyx oryzivorous*
American goldfinch	*Carduelis tristis*
Cassin's finch	*Carpodacus cassinni*
House finch	*C. mexicanus*
Pinyon jay	*Gymnorhinus cyanocephalus*
Black-billed magpie	*Pica hudsonia*
American crow	*Corvus brachyrhynchos*
Common raven	*Corvus corax*

Mammals

Common Name	Scientific Name
Merriam's shrew	*Sorex trowbridgii*
Water shrew	*Sorex palustris*
Wandering shrew	*S. vagrans*
Northern grasshopper mouse	*Onychomys leucogaster*
Sagebrush vole	*Lagurus curtatus*
Montane vole	*Microtus montanus*
Columbian ground squirrel	*Citellus columbianus*
Deer mouse	*Peromyscus maniculatus*
Forest deer mouse	*P. keenii*
Western jumping mouse	*Zapus princesp*
Porcupine	*Erethizon dorsatum*
Western harvest mouse	*Reithrodontomys megalotis*
Least chipmunk	*Eutamias minimus*
Yellow-bellied marmot	*Marmota flaviventris*
Yellow-pine chipmunk	*Tamias amoenus*
Ord's kangaroo rat	*Dipodomys ordii*
Northern pocket gopher	*Thomomys talpoides*
Beaver	*Castor canadensis*
Muskrat	*Onadontra zibethica*
Washington ground squirrel	*Spermophilus washingtoni*
Townsend's ground squirrel	*S. townsendii*
California ground squirrel	*S. beecheyii*
Columbia Basin pygmy rabbit	*Brachylagus idahoensis*
White-tailed jackrabbit	*Lepus townsendii*
Black tailed jackrabbit	*L. californicus*
Nuttall's cottontail	*Sylvilagus nuttalli*
Bushy-tail woodrat	*Neotomys cinerea*

Common Name	Scientific Name
Badger	*Taxidea taxus*
Mink	*Mustela vison*
River otter	*Lutra canadensis*
Long-tailed weasel	*Mustela frenata*
Short-tailed weasel	*M. erminea*
Bobcat	*Lyns rufus*
Cougar	*Felis concolor*
Raccoon	*Procyon lotor*
Black bear	*Ursus americanus*
Gray wolf	
Coyote	*Canis latrans*
Muledeer	*Odocoileus hemionus*
Whitetail deer	*O. virginianus*
Elk	*Cervus elaphe*
Yuma myotis	*Myotis yumanensis*
Small-footed myotis	*M. ciliolabrum*
Long-eared myotis	*M. evotis*
Fringed myotis	*M. thysanodes*
Pale Townsend’s big-eared bat	*Plecotus townsendii pallescens*
Little brown bat	*M. lucifigis*
Keen’s myotis	*M. keenii*
Long-legged myotis	*M. volans*
California myotis	*M. californicus*
Silver-haired bat	*Lasionycterus noctivagans*
Western pipistrelle	*Pipistrellus hesperus*
Big brown bat	*Eptesicus fuscus*
Pallid bat	*Antrozous pallidus*
Hoary bat	*Lasiurus cineurus*
Townsend’s big-eared bat	*Corynorhinus townsendii*
Spotted bat	*Euderma maculata*
Western small-footed myotis	*Myotis coopabari*

Reptiles and Amphibians

Common Name	Scientific Name
Garter snake	*Thamnophis sirtalis*
Short-horned lizard	*Phrynosoma douglassi*
Sagebrush lizard	*Sceloporus graciosus*
Side-blotched lizard	*Uta stansburiana*
Western skink	*Eumeces skiltonianus*
Racer	*Coluber constrictor*
Rubber boa	*Charina bottae*
Striped whipsnake	*Masticophis taeniatus*
Ringneck snake	*Diadophus punctatus*
Sharptail snake	*Contia tenius*
Gopher snake	*Pituophis catenifer*
Western rattlesnake	*Crotalus viridis*
Night snake	*Hypsiglena torquata*
Long-toed salamander	*Ambystoma macrodactylum*
Tiger salamander	*A. tiginum*
Pacific treefrog	*Pseudacris regilla*
Bullfrog	*Rana catesbiana*
Columbia spotted frog	*R. luteiventris*
Northern leopard frog	*R. pipiens*
Western toad	*Bufo boreas*

Common Name	Scientific Name
Woodhouse’s toad	*B. woodhousei*

Appendix C: Description of Federally Protected Species

The following information is based on communications with the Fish and Wildlife Service (2007 [First PAM]).

Federal Endangered Species

Four species are listed under the ESA and administered by the FWS in the general Study area. These are described here.

Pygmy Rabbit

The pygmy rabbit (*Brachylagus idahoensis*) is a federally endangered mammal. The pygmy rabbit depends largely upon sagebrush, primarily big sagebrush, *artemisia tridentata*, and is usually found in very dense big sagebrush. It selects sites with the greatest sagebrush cover and feeds primarily on big sagebrush, sometimes even climbing into the tops of the larger plants. In winter, big sagebrush may comprise up to 99 percent of their diet; grasses may comprise 30-40 percent of their diet in the summer (Bailey 1936, Green 1978, and Wilde 1978).

The pygmy rabbit is found throughout much of the sagebrush area of the Great Basin, as well as some of the adjacent intermountain areas (Green and Flinders 1980). In Washington, the pygmy rabbit was historically found in several areas in the Columbia River basin (Couch 1923). The rabbit has more recently been found in two separate locations within Douglas County and at Sagebrush Flat. However, no pygmy rabbits are thought to exist in the wild within Washington. About 100 pygmy rabbits are kept in captivity. Reintroduction of pygmy rabbits within recovery emphasis areas in the Study area is planned for the future.

The burrowing habit of the pygmy rabbit is unique among the western North American rabbits. Burrows are usually under big sagebrush and are only rarely located in an opening of vegetation, reinforcing the dependence of this rabbit on dense sagebrush clumps (Green 1978, Green and Flinders 1980, and Wilde 1978). Proper soil structure is thought to be a key feature because the rabbit makes its own burrows. Generally soft, deep soils are required for burrowing. Pygmy rabbits will only live where the soil is deep enough and of a certain quality (Wilde 1978). Pygmy rabbits also use holes in volcanic rock, rock piles, and around abandoned buildings. These cares (burrows) are associated with pygmy rabbits using typically deep soil and sagebrush burrow sites and may only be an energy efficient alternative to digging a burrow or may give added protection against predators that excavate burrows (Green and Flinders 1980).

Because of low numbers and limited distribution, pygmy rabbit populations in Washington are vulnerable to fire, disease, intense predation, and genetic and demographic parameters that sometimes cause the collapse of small populations. Habitat degradation and loss are likely to continue without active prevention efforts. The primary threats to pygmy rabbit habitat include the fragmentation or removal of sagebrush rangeland for development and agriculture or through wildfire, which isolate populations. As the “islands” of habitat are smaller, local extinctions may occur. The probability of extinction increases when habitat modification and removal or genetically related stochastic events occur. These local extinctions contribute to a reduction of the species distribution (Dobler and Dixon 1996).

Figure C-1 shows the pygmy rabbit historic range (magenta polygon), location of two past wild populations that are recovery emphasis areas where future reintroduction may occur (solid cream polygons), and areas of possible remnant habitat or populations (light green areas). The areas shown as potentially occupied are areas where suitable soil types and sagesteppe occur; although pygmy rabbits are thought to no longer exist there.

Ute Ladies’-tresses

Ute ladies’-tresses (*Spiranthes diluvialis*), federally listed as threatened, is a wetland-dependant member of the orchid family, found in areas of Washington.

Ute ladies’-tresses are typically found in wet meadows, riparian areas, abandoned riparian zones, or in damp areas near natural water sources or water bodies (NatureServe 2006).

No Ute ladies’-tresses are known to occur in the Study area. However suitable habitat has not yet been surveyed.

Spalding’s Catchfly

Spalding’s catchfly (*Silene spaldingii*) is an herbaceous perennial plant, federally listed as threatened. A total of 66 populations (12 in Idaho; 8 in Montana/British Columbia, Canada; 8 in Oregon; and 38 in Washington) have been documented. Most of the Spalding’s catchfly populations are small in size and located on privately-owned parcels. Fifty-two percent of its populations have less than 100 plants each. Five extirpations have been recorded to date rangewide. Potential unsurveyed habitat exists in all physiographic regions in which Spalding’s catchfly occurs.

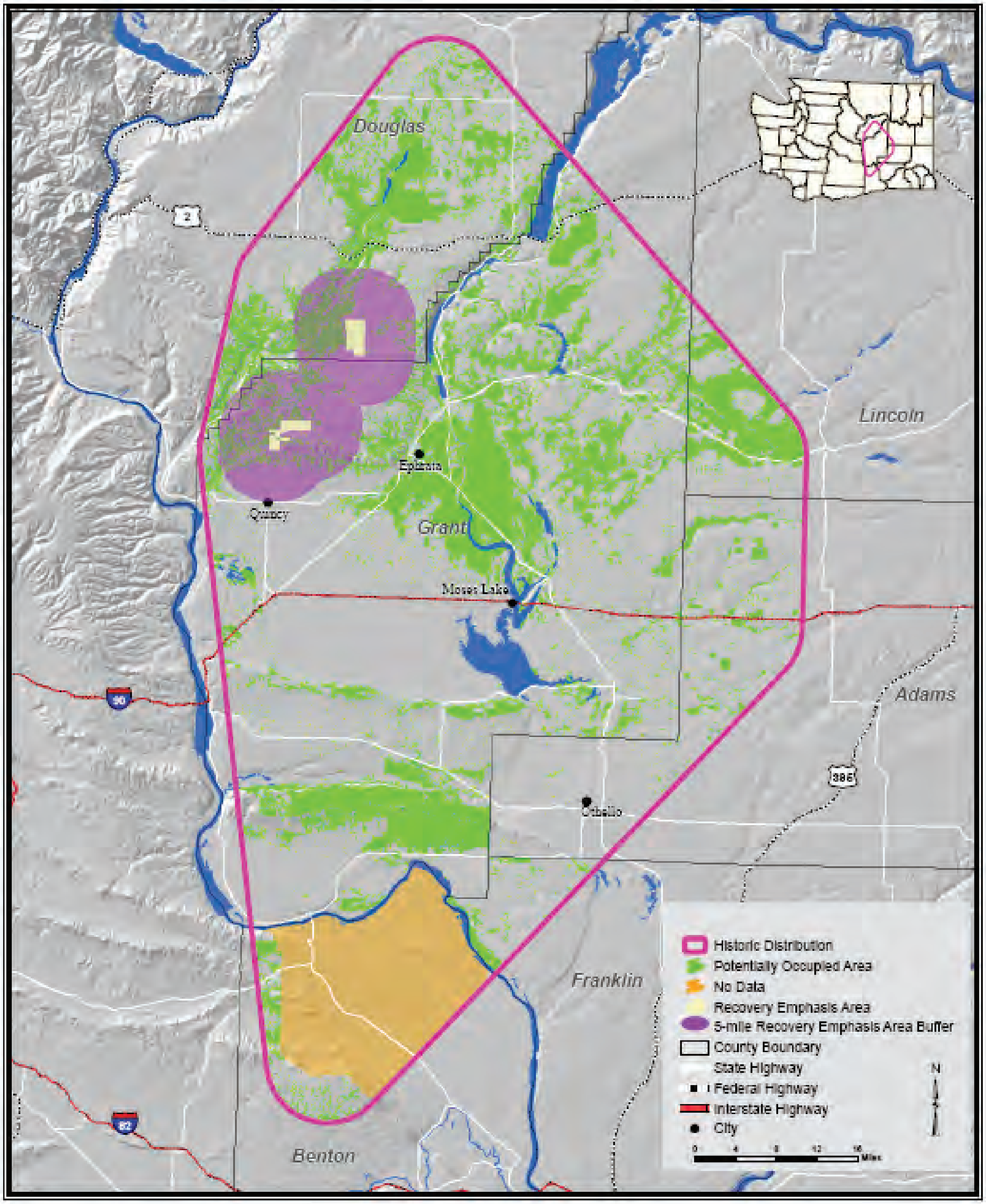

Figure C-1. Range of the Columbia Basin pygmy rabbit within the Study area.

Roughly 18 percent of the plants in Washington are found on U.S. Forest Service lands (997 out of 5,264 plants). In Washington, two populations are located entirely on the Umatilla National Forest in the Blue Mountains.

Spalding's catchfly is a regional endemic, restricted to remnant grasslands in the channeled scablands. It is generally found in open mesic grassland communities of the Pacific Northwest Bunchgrass Grasslands type, with deep productive loess soils (Tisdale 1983). Plants are generally found in swales or on north or east facing slopes where soil moisture is relatively higher (FWS 2005). This habitat is often characterized by high cover of perennial bunchgrasses, a relatively abundant and diverse perennial forb component, often a minor shrub component, and a well-developed cryptogamic crust layer. Spalding's catchfly is occasionally found in shrub and forest habitat types, including sagebrush-fescue and open canopy pine-fescue types. The fescue associations in these shrub- and tree-dominated communities are very similar to the mesic fescue grassland habitat types (Daubenmire 1968). Within Washington, Oregon, and Idaho, spalding's catchfly is associated with Idaho fescue (*Fescue idahoensis*).

Spalding's catchfly's current threats are habitat loss due to human development, habitat degradation associated with domestic livestock and wildlife grazing, and invasions of aggressive nonnative plants (FWS 2005). Drought conditions have also had a negative effect on Spalding's catchfly populations by limiting growth and reproduction (Lesica 1988).

Bull Trout

Bull trout *(Salvelinus confluentus)* is a federally threatened char found throughout the coastal and inland streams and lakes in Washington. Bull trout are not known to spawn in any of the streams or inhabit any aquatic habitat, other than the mainstem Columbia River, within the Study area. Although some individuals may spend their entire life in a small segment of a stream, most are highly migratory, traveling to headwater streams to spawn and later migrate back to larger stream segments or lakes to rear (McPhail and Murray 1979). Bull trout exhibit three life-history forms: a resident, fluvial, and anadromous. The multiple life-history strategies found in bull trout populations provide important spatial and genetic diversity that helps protect these populations from environmental stochasticity.

Bull trout spawn in cold, high elevation streams located in the upper reaches of clear streams, where areas of flat gradient, uniform flow, and uniform gravel or small cobble are found. Strict habitat requirements make spawning and incubation habitat for bull trout limited and valuable (Fraley et al. 1989). Bull trout require hiding cover, such as logs and undercut banks, when spawning and relatively little streambed sediment. Fry are found in shallow, slow backwater side channels and eddies (Shepard et al. 1984 and Elliott 1986). Adults are often found in pools sheltered by large, organic debris or "clean" coble substrate (McPhail and Murray 1979). Juveniles are primarily bottom dwellers, occupying positions above, on, or below the bottom.

Bull trout feed on a variety of water column organisms and bottom dwellers (Thompson and Tufts 1967; Shepard et al. 1984, and Pratt 1984).

The maintenance of riparian vegetation for controlling stream temperature, providing cover, and protecting against lateral erosion (WDW 1991) is important for bull trout. Removing streamside vegetation lowers canopy density (shading) and increases sedimentation. Increases in solar radiation raise stream temperatures, thereby negatively impacting spawning, hatching, and rearing survival. Increased sedimentation contributes to the loss of spawning habitat and decreases the diversity of aquatic invertebrates and other food items (Newbold et al. 1977).

Federal Candidate Species

Candidate species are those petitioned species that are actively being considered for listing as endangered or threatened under the ESA, as well as those species for which NMFS or FWS has initiated an ESA status review announced in the *Federal Register*. Candidate species receive no statutory protection under the ESA. However, the FWS and NMFS encourage forming partnerships to conserve these species, since they are, by definition, species that may warrant future protection under the ESA.

Washington Ground Squirrel

The Washington ground squirrel (*Spermophilus Washingtoni)* is a Federal candidate species that depends highly on sage-steppe habitat. It prefers sandy soils in dry, open sagebrush and grassland habitats. Land development and conversion to agricultural use are threats to its habitat.

Washington ground squirrels are not known to exist in the Study area. However, all existing habitat has not been surveyed.

White Bluffs Bladderpod

The White Bluffs bladderpod (*Lesquerella tuplashensis*) is a Federal candidate plant species that is limited to the White Bluffs area of Hanford National Monument, particularly a 1.5-to 12-meter strip along the top of the White Bluffs, in Franklin County, Washington.

Northern Wormwood

Northern wormwood (*Artemisia campestris* ssp. *borealis* var) is a Federal candidate plant species that is restricted to exposed basalt, cobbly-sandy terraces, and sand habitat along the shore and on islands in the Columbia River. It is currently only known in two sites in Klickitat and Grant counties. No additional plants have been detected in recent surveys of apparently suitable habitat along the Hanford Reach of the Columbia River (FWS 2006).

Threats to northern wormwood include direct loss of suitable habitat through changing water levels in the Columbia River, placement of riprap along the river bank, trampling of plants as a result of recreational use, competition with nonnative invasive species, a small population size that makes both sites susceptible to genetic drift and inbreeding, and the potential for hybridization with two other species of *Artemisia*.

Federal Species of Concern

Species of concern are those species about which FWS or NMFS have some concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the ESA. "Species of concern" do not carry any procedural or substantive protections under the ESA. Animals identified by FWS as Federal Species of Concern (FWS 2007 [First Letter]) include:

Common Name	Scientific Name
Animals	
Burrowing owl	*Athene cunicular*
Northern goshawk	*Accipiter gentilis*
Kincaid meadow vole	*Microtus pennsylvanicus kincaidi*
Wolverine	*Gulo gulo*
Greater sage grouse Columbia Basin distinct population segment	*Centrocercus urophasianus*
Olive-sided flycatcher	*Contopus cooperi*
Columbian sharp-tailed grouse	*Tympanuchus phasianellus columbianus*
Western brook lamprey	*Lampetra richardsoni*
River lamprey	*Lampetra ayresi*
Redband trout	*Oncorhynchus mykiss*
Pacific lamprey	*Lampetra tridentata*
Giant Columbia spire snail	*Fluminicola columbiana*
Ferruginous hawk	*Buteo regalis*
Loggerhead shrike	*Lanius ludovicianus*
Long-eared myotis	*Myotis evotis*
Northern leopard frog	*Rana pipiens*
Pallid Townsend's big-eared bat	*Corynorhinus townsendii pallenscens*
Dragonfly	
Columbia clubtail	*Gomphus lynnae*
Mussel	
California floater	*Anodonta californiensis*
Sagebrush lizard	*Sceloporus graciosus*

Common Name	Scientific Name
Vascular Plants	
Washington polemonium	*Polemonium pectinatum*
Gray cryptantha	*Cryptantha leucophaea*
Hoover's desert-parsley	*Lomatium tuberosum*
Wanapum	*Oxytropis campestris* var. *wanapum*
Crazyweed	*Oxytropis lambertii*
Prairie lupin	*Lupinus cusickii*

Appendix D: Summary of Public Feedback

Reclamation solicited feedback about the appraisal-level investigation. Eighty-four written comments were received from a variety of stakeholders. Reclamation conducted a content analysis and categorized the comments according to stakeholder category. This analysis and copies of all written comments are available in Reclamation 2008, located in Reclamation files. The following summarizes the comments received, grouped by those specific to water delivery alternatives and water supply options.

Water Delivery Alternatives

- Address the restricted capacity of the East Low Canal south of I-90; make it a Study priority.
- The selected alternative needs to deliver water south of I-90 as there are significant aquifer declines there.
- Building major infrastructure to meet needs of Odessa Subarea irrigators on a scale that would facilitate expanding the CBP in the future is unnecessary and not justified.
- Invest in the East High canal system infrastructure now to more cost effectively facilitate future CBP development.
- Alternative must supply water to every acre currently irrigated.
- Alternative A offers the best opportunity for potentially reducing aquifer depletion. However, alternative A may be the most difficult to implement, involve more environmental issues, and take longer to study and construct.
- Alternative B can be phased to deliver water to Odessa Subarea lands expeditiously by implementing the East Low Canal component first; full implementation will deliver water to sufficient acreage to help declining aquifer.
- Combine elements of alternatives B and C in a phased manner; will address the current East Low Canal capacity restrictions south of I-90 and has the most operational and implementation flexibility.

- Alternatives C and D may have less potential fish and wildlife impacts than alternatives A and B.

- Combine elements of alternatives C and D, looking at a phased implementation approach.

- Alternative C would not provide a replacement water supply to sufficient acreage but would have a slight advantage over alternative D because it would provide water to lands south of I-90.

- Alternative D would not provide a replacement water supply to sufficient acreage to address the declining aquifer problem; it does not deliver water to lands located south of I-90.

- Sustain agriculture in the Odessa Subarea in a cost effective, environmentally sensitive manner by examining alternatives that rely on the East Low Canal and reoperations at existing water storage facilities in combination with water conservation and efficiency, water markets, conservation reserves, well reconstruction, and conversion to dryland farming, as opposed to building significant new infrastructure.

- Do not support providing surface water to groundwater farmers.

Water Supply Options

- Examine options that use existing storage facilities in combination with water conservation, efficiency, and water markets as opposed to building new dams.

- Water supply options involving minor operational modifications to Banks Lake and Potholes Reservoir in combination with a smaller sized storage reservoir may result in less impact to wildlife.

- Using existing CBP storage facilities (e.g. Banks Lake drawdown or operational raise); it would cost less and have less environmental effects compared to building new storage facilities.

- Banks Lake drawdown would have recreation-related impacts to Coulee City and the surrounding area.

- Dry Creek Coulee is an ideal location from an operational standpoint; it could potentially provide a water supply for future full CBP development if used in combination with Banks Lake and Potholes Reservoir reoperation.

- Reconsider Lind Coulee and Black Rock Coulee as potential new water storage sites; sites have lower potential wildlife impacts than other proposed storage facilities.

- Proposed Rocky Coulee reservoir provides increased operational flexibility and reliability, costs less to construct, and has less potential impact to wildlife than other new storage facilities examined.

- Opposition to a proposed Lower Crab Creek Reservoir:
  - Because of impacts to fish, wildlife, recreation, CNWR, and private property

  - Releases from the proposed reservoir would impact the Columbia River fishery as opposed to benefiting it because of anticipated high water temperatures

  - Not ideally located from a CBP operational standpoint. Energy requirements to operate would be high as water would be pumped twice - first in the fall season to fill the proposed reservoir and a second time during irrigation season to deliver water to Study area lands.

  - Operating the reservoir would result in Columbia River flow reductions from Grand Coulee Dam to Lower Crab Creek confluence during the summer and may affect ESA species.

  - Significant economic and environmental costs compared to other water supply options.

Other

- Ability to implement quickly should be a factor in selecting alternatives and options.

- Support alternatives that sustain existing agricultural acreage in the Odessa Subarea.

- Partner to implement immediate actions consistent with Study objectives to expedite and facilitate Study solutions.

- Seek least cost approaches and innovative financing such as local improvement districts.

- Convene stakeholders group to review future information to facilitate public confidence and support of Study results.

- Avoid water delivery and storage alternatives that eliminate large acreages of shrub-steppe habitat.

- Cost estimates may be deficient because they do not include operating costs or environmental costs.

- Two recent economic studies identified significant regional economic impacts associated with continued decline of the aquifer. Others have questioned the studies' validity and the economic impacts identified.

- Insufficient opportunities provided for public comment.

- Recreation benefits associated with the CBP have often come at the loss of river recreation opportunities. The Study should quantify and consider impacts to river-based recreation.

- Design the selected alternative in sequential, incremental steps to facilitate understanding of implementation actions required.