RECLAMATION

Managing Water in the West

Windy Gap Firming Project

Vegetation Resources Technical Report

U.S. Department of the Interior
Bureau of Reclamation
Great Plains Region

September 2007

Vegetation Resources Technical Report

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1.0 INTRODUCTION

The Bureau of Reclamation (Reclamation) has received a proposal from the Municipal Subdistrict, Northern Colorado Water Conservancy District, acting by and through the Windy Gap Firming Project Water Activity Enterprise (Subdistrict) to improve the firm yield from the existing Windy Gap Project water supply by constructing the Windy Gap Firming Project (WGFP). The proposal includes a connection of WGFP facilities to the Colorado-Big Thompson Project. For more information on the background and purpose of the WGFP see the Windy Gap Firming Project Purpose and Need Report (ERO 2005a). This technical report was prepared to address the potential environmental effects on wildlife associated with the alternatives described below and will be used in the preparation of the Environmental Impact Statement (EIS).

2.0 ALTERNATIVES

The Windy Gap Firming Project Alternatives Report (ERO 2005b) identified four action alternatives in addition to the No Action alternative for evaluation in the EIS. All action alternatives include development of 90,000 acre-feet (AF) of new storage in either a single reservoir on the East Slope, or a combination of East Slope and West Slope reservoirs. The Subdistrict's Proposed Action is the construction of a 90,000-AF Chimney Hollow Reservoir with prepositioning. The alternatives are—

- Alternative 1 (No Action) – Continuation of existing operations and agreements between Reclamation and the Subdistrict for conveyance of Windy Gap water through the Colorado-Big Thompson facilities including the enlargement of Ralph Price Reservoir by the City of Longmont
- Alternative 2 (Proposed Action) – Chimney Hollow Reservoir (90,000 AF) with prepositioning
- Alternative 3 – Chimney Hollow Reservoir (70,000 AF) and Jasper East Reservoir (20,000 AF)
- Alternative 4 – Chimney Hollow Reservoir (70,000 AF) and Rockwell/Mueller Creek Reservoir (20,000 AF)
- Alternative 5 – Dry Creek Reservoir (60,000 AF) and Rockwell/Mueller Creek Reservoir (30,000 AF)

Prepositioning, under the Proposed Action, involves the storage of Colorado-Big Thompson (C-BT) water in Chimney Hollow Reservoir. Windy Gap water pumped into Lake Granby would then be exchanged for C-BT water stored in Chimney Hollow Reservoir. Windy Gap water stored in Chimney Hollow Reservoir would be delivered and allocated to the WGFP Participants. This arrangement ensures temporary space in Lake Granby to introduce and store Windy Gap water. Total allowable C-BT storage would not change and the existing C-BT water rights and diversions would not be expanded. To prevent the C-BT Project from expanding their diversions through

prepositioning, total modeled C-BT storage in Lake Granby and Chimney Hollow Reservoir was limited to the capacity of Lake Granby, which is 539,758 AF. If this capacity limitation is reached, the model forces the C-BT Project to bypass water at Lake Granby. This water is then available for diversion at Windy Gap. Therefore, under prepositioning, C-BT diversions would not be expanded with respect to their current water rights and capacity limitations.

In addition to the action alternatives, a No Action alternative was identified based on what is reasonably likely to occur if Reclamation does not approve the connection of the new Windy Gap Firming Project facilities to C-BT facilities. Under this alternative, the existing contractual arrangements between Reclamation and the Subdistrict for storage and transport of Windy Gap water through the C-BT system would remain in place. All WGFP Participants in the near term would maximize delivery of Windy Gap water according to their demand, Windy Gap water rights, and C-BT facility capacity constraints, including availability of storage space in Lake Granby and the Adams Tunnel conveyance constraints. The City of Longmont would develop storage independently for firming Windy Gap water if the WGFP is not implemented. Most WGFP Participants indicate that, in the long term, they would seek other storage options, individually or jointly, to firm Windy Gap water because of their need for reliable Windy Gap deliveries and the substantial investment in existing infrastructure.

Those WGFP Participants that do not have a currently defined storage option would take delivery of Windy Gap water whenever it is available within the capacity of their existing water systems and delivery points under the terms of the existing Carriage Contract with Reclamation and the Northern Colorado Water Conservancy District (NCWCD). The WGFP Participants that would operate under this scenario include Broomfield, Central Weld County Water District, Erie, Evans, Fort Lupton, Greeley, Little Thompson Water District, Louisville, Loveland, Platte River Power Authority, and Superior. The City of Lafayette anticipates that it would withdraw from participating in the WGFP and dispose of existing Windy Gap units, and not pursue acquisition of future units if the WGFP is not constructed.

The City of Longmont indicates that it would develop storage facilities for Windy Gap water independently if Reclamation does not approve a connection of WGFP facilities to C-BT facilities. Longmont would evaluate the enlargement of the existing Ralph Price Reservoir (Button Rock Dam) located on North St. Vrain Creek, or Union Reservoir located east of Longmont. The enlargement of Ralph Price Reservoir by 13,000 AF would be Longmont's preferred option because Union Reservoir would not have sufficient capacity for Windy Gap water, and conveyance and distribution would be more efficient from a higher elevation reservoir.

Middle Park Water Conservancy District (MPWCD), under No Action, would continue to use Windy Gap water to provide augmentation flows for other water diversions in a manner similar to current operations. MPWCD can store up to 3,000 AF of Windy Gap water in Lake Granby each year if Windy Gap water can be diverted and storage space is available.

Detailed descriptions of the components and operation of the alternatives are included in the Draft Windy Gap EIS Alternatives Descriptions report (Boyle 2005).

3.0 STUDY AREA AND ENVIRONMENTAL SETTING

3.1. Ralph Price Study Area

Ralph Price Reservoir (Button Rock Dam) is located on North St. Vrain Creek, west of the town of Lyons in Boulder County in Sections 17, 18, 19, and 20, T5N, R70W in the Lyons, Colorado USGS Quadrangle map (Figure 1) at an elevation of about 6,500 feet. Currently, the reservoir has a storage capacity of about 16,000 AF. The study area for the enlargement of Ralph Price Reservoir includes the potential area of additional inundation surrounding the reservoir including an enlarged dam, new spillway, and possible borrow areas that could provide material for dam enlargement. No new pipelines or other infrastructure is needed. The study area consists mostly of a mixture of ponderosa pine and Douglas-fir forest. North St. Vrain Creek, which flows into the reservoir from the west, is the primary source of water to the reservoir. Other small drainages, including Rattlesnake Gulch from the north and Long Gulch from the south, flow into the reservoir.

3.2. Chimney Hollow Study Area

The Chimney Hollow study area is in Larimer County in Section 33, T5N, R70W and Sections 4, 5, and 9 of T4N, R70W in the Carter Lake Reservoir Colorado USGS Quadrangle map (Figure 2). The average elevation at the Chimney Hollow Reservoir site is about 5,700 feet. The study area includes the north-south trending valley between a hogback ridge to the east and foothills to the west where the reservoir, dam, pipelines, roads, relocated transmission line, and other facilities would be located. Chimney Hollow, a small intermittent creek, flows into Flatiron Reservoir, which is located at the north end of the site. Several ephemeral to intermittent tributaries drain from the west into the creek. Carter Lake is located directly east on the other side of a hogback ridge. Ponderosa pine forests cover the foothills to the west with mostly native grasslands occurring in openings within the forest. Native and nonnative grasslands cover the valley floor with riparian woodlands and shrublands occurring along the drainages. Native shrublands cover the slopes on the rocky hogback to the east.

3.3. Dry Creek Study Area

The Dry Creek study area is located in Sections 16, 20, 21, and 28, T4N, R70W in Larimer County on the Carter Lake Reservoir Colorado USGS Quadrangle map (Figure 3). The reservoir would be located at an elevation of about 5,500 feet. The study area includes the reservoir, dam, and spillway, as well as pipeline connections to C-BT facilities through Chimney Hollow and across the hogback to Carter Lake, and proposed access roads. Dry Creek Reservoir would be located in the valley south of Chimney Hollow separated by a gentle saddle. Dry Creek, an intermittent tributary to the Little Thompson River, flows to the south. Several small, intermittent or ephemeral tributaries from the foothills to the west and the hogback to the east flow into Dry Creek. The forest, shrubland, and grassland vegetation in the Dry Creek study area is similar to the Chimney Hollow study area.

3.4. Jasper East Study Area

The Jasper East study area is located in Grand County in Sections 8, 9, 16, and 17, T2N, R76W, on the Trail Mountain, Colorado USGS quadrangle map (Figure 4), at an

elevation of about 8,100 feet. The study area for the proposed Jasper East Reservoir includes the area encompassing the new reservoir, dam, and spillway, a new pipeline to the existing Windy Gap pipeline, the relocation of the Willow Creek pump station, canal and forebay, and new and realigned roads. Also included are the adjacent lands that would be temporarily affected during construction. The study area consists mainly of flood-irrigated meadows bordered by areas of sagebrush shrublands and stands of lodgepole pine. An intermittent, unnamed tributary to Church Creek flows from east to west through the study area. Natural flows in the tributary are supplemented by irrigation return flow and seepage from the Willow Creek Pump Canal and Forebay. The property is currently used for livestock grazing and hay production.

3.5. Rockwell/Mueller Creek Study Area

The Rockwell/Mueller Creek study area is located in Grand County in Section 1 of T2N, R77W, and Sections 1 and 12 of T1N, R76 ½W, and an unsurveyed area (Figure 5). Elevations in the study area range from about 8,000 feet to about 8,200 feet. The study area for the Rockwell/Mueller Creek Reservoir includes the area encompassing the reservoir dam, including a pipeline to Windy Gap Reservoir, borrow areas, and adjacent lands that would be temporarily affected during construction. The study area consists mainly of big sagebrush shrublands, with areas of lodgepole pine forest, meadow, and wetland and riparian areas. Rockwell Creek flows from south to north through the study area, and Mueller Creek flows from east to west, joining Rockwell Creek in the northeast portion of the study area.

4.0 METHODS

This section describes the site investigations to collect data, the classification of vegetation cover types, the delineation or assessment of wetlands, and the survey for plant species of concern. Vegetation resources were evaluated at potential new reservoir sites including, Jasper East, Rockwell/Mueller Creek, Chimney Hollow, and Dry Creek and the area of enlargement at Ralph Price Reservoir. Riparian and wetland vegetation was also characterized at locations where changes in streamflow are expected including the Colorado River and Willow Creek on the West Slope and several East Slope streams, including the Big Thompson River, North St. Vrain Creek, St. Vrain Creek, Coal Creek, and Big Dry Creek.

4.1. Site Investigations

ERO Resources Corporation (ERO) conducted site visits at the Jasper East and Rockwell/Mueller Creek study areas on May 11, August 5, and November 3, 2004. In addition, site visits in portions of the Jasper East study area were conducted in July 2003 by ERO. Investigators did not have access to the Rockwell/Mueller Creek study area, so the study area was viewed from nearby roads and vegetation was mapped on aerial photographs using information from similar vegetation communities present at the Jasper East study area, which is located about 6 miles to the north.

Site investigations for the Chimney Hollow study area were conducted by ERO on October 11, 2000, November 2, 2000, July 16, 2003, July 25, 2003, August 26, 2003, with some follow-up investigations on November 12, 2004. The Dry Creek study area was investigated on September 7, 10, 16, 23, and 24, October 22, November 12, and

December 9, 2004, and July 8, 2005. Wetlands were determined based on the presence of three wetland indicators: hydrophytic vegetation, hydric soils, and wetland hydrology. Some of the Dry Creek study area was inaccessible; therefore, vegetation and wetlands for areas not accessed were mapped on aerial photographs based on observations from roads and identification of nearby vegetation communities.

ERO personnel conducted a site visit to the Ralph Price Reservoir site on August 25, 2005. Vegetation communities and wetland areas were reviewed on foot and by boat around the immediate perimeter of the existing reservoir. Vegetation communities were mapped from field observations and aerial photography.

4.2. Vegetation Cover Types

Using available data, each reservoir study area was evaluated to determine vegetation composition. ERO collected data on the dominant species in each vegetation community and grouped similar communities into vegetation cover types based on such factors as dominance by native or introduced species, moisture regime, and dominant growth type (forest, shrubs, or grasses). Each vegetation cover type may contain more than one vegetation community distinguished by different dominant species. For example, the Native Grassland vegetation type is a complex of communities that includes grasslands dominated by blue grama and grasslands dominated by a mixture of western wheatgrass, dropseed, and blue grama. The dominant species found in each cover type are discussed in more detail in the description of each cover type. Included is a description of community types designated as state vulnerable to extinction/imperiled, imperiled, or very imperiled by the Colorado Natural Heritage Program.

The boundaries of each vegetation cover type were delineated on aerial photography based on field observation or photo interpretation depending on access. The vegetation cover types were then digitized into a Geographic Information System (GIS). Appendix A lists the scientific names for all species referenced in this report.

4.3. Wetlands and Other Waters

Wetlands and waters of the U.S. are protected resources under Section 404 of the Clean Water Act. Activities that result in the discharge of fill material into wetlands or waters of the U.S. are regulated by the U.S. Army Corps of Engineers (Corps). Federal agencies also have the responsibility pursuant to Executive Order 11990 to avoid, minimize, and mitigate unavoidable effects to wetlands and waters. This report includes an assessment of all wetlands and other waters of the U.S. regardless of whether they fall under the jurisdiction of the Corps.

Wetlands at the Chimney Hollow, Dry Creek, and Jasper East reservoirs sites were identified and mapped in the field using methods outlined in the 1987 *Corps of Engineers Wetland Delineation Manual*. Wetlands were determined based on the presence of three wetland indicators: hydrophytic vegetation, hydric soils, and wetland hydrology. Results of the wetland delineation were documented in wetland delineation reports for each of these three study areas (ERO 2003, 2004a, 2004b). For the Chimney Hollow study area, ERO submitted the delineation report to the Corps in October 2003 and the Corps issued a preliminary jurisdictional determination (Corps 2003). To issue an approved jurisdictional determination, the Corps would need to visit the site. This site visit has not

occurred at the time of this report. Subsequent to the submittal of the wetland delineation report to the Corps, additional wetlands were delineated at Chimney Hollow based on additional information on construction disturbance. The wetland delineation report for the Jasper East reservoir site was submitted to the Corps in August 2003. The Corps reviewed the site, but has not made a jurisdictional determination. The wetland delineation report for the Dry Creek Reservoir site has not been submitted to the Corps. Small portions of the Dry Creek Reservoir study area were not delineated because landowner access was not secured. In these areas, wetlands were mapped using aerial photographs.

A field wetland delineation was not conducted at the Rockwell/Mueller Creek study area because the landowners denied access. Wetlands at the Rockwell/Mueller Creek study area were mapped using aerial photographs, USGS quadrangle maps, National Wetland Inventory (NWI) maps from the U.S. Fish and Wildlife Service (FWS), and a review of the site conducted from nearby public roads.

A wetland delineation was not conducted at Ralph Price Reservoir. Wetlands at this location were mapped using aerial photography, NWI maps, USGS quadrangle maps, and field observations of wetlands on the existing reservoir shoreline and below the dam.

Additionally, wetlands at the Chimney Hollow, Dry Creek, and Jasper East were rated for functions and values according to specific criteria using a modified Montana Method (Burgland 1999). This method provides a rating of low, moderate, high, or not applicable based on observations of wetland characteristics.

4.4. Plant Species of Concern

Two categories of plant species of concern were evaluated for the study areas—federally listed threatened, endangered, or candidate species listed under the Endangered Species Act and plants tracked by the Colorado Natural Heritage Program (CNHP). ERO reviewed the Boulder, Grand, and Larimer County lists of federally listed threatened, endangered, or candidate species provided by the FWS (U.S. Fish and Wildlife Service updated 2008) and data from the CNHP (CNHP 2004a) to determine potential plant species that could be present in the study areas.

The CNHP is a nonprofit organization that tracks and ranks Colorado's rare and imperiled plant and animal species. The CNHP maintains a database on the status of species and locations or element occurrences where species of concern have been previously found. Plant species tracked by the CNHP are ranked according to their rarity based on the following classification:

- Critically imperiled
- Imperiled
- Vulnerable to extirpation
- Apparently secure
- Demonstrated widespread, abundant, and secure

Element occurrence records in the CNHP database were obtained for species that have been found to occur in the vicinity of the study areas (CNHP 2004b, 2004c, 2004d, 2004e).

Field surveys for plant species of concern were conducted at the Jasper East, Chimney Hollow, and Dry Creek study areas. Field surveys for plant species of concern were not conducted at the Rockwell/Mueller Creek study area because investigators did not have access to the study area. Field surveys at Ralph Price were not conducted because this site was not identified as an alternative until after the peak growing season. For both the Rockwell/Mueller Creek Reservoir and Ralph Price Reservoir sites, the potential for plant species occurrence was based on suitable habitat.

4.5. Riparian and Wetland Vegetation

Riparian and wetland vegetation potentially affected by hydrologic changes were evaluated using several data sources. Existing riparian and wetland vegetation along the Colorado River, Willow Creek, and affected East Slope streams were characterized based on aerial photography, National Wetland Inventory maps, previous studies, and reconnaissance field investigations. Because the study areas are geographically extensive, the study methods used differed from those used at reservoir sites.

5.0 AFFECTED ENVIRONMENT

5.1. Ralph Price Study Area

The Ralph Price study area (Figure 6) contains three prominent vegetation cover types: upland native grasslands, upland native shrublands, and upland native forests dominated by a mixture of ponderosa pine/Douglas-fir. Small areas of wetlands occur along fringes of the reservoir and stream inlets. Vegetation cover types, wetlands, and plant species of concern are discussed in the following sections.

5.1.1. Vegetation Cover Types

5.1.1.1. Upland Native Grassland

Upland native grasslands occur in meadow areas north and west of Ralph Price Reservoir primarily at potential borrow areas for dam construction. Species likely found in upland meadow areas include western wheatgrass, blue grama, smooth brome, and various needle grasses. Fringed sage, rose, mullein, and various Indian paintbrushes may occur in these areas.

5.1.1.2. Upland Native Shrubland

Small upland shrub communities exist along the eastern and northern end of the reservoir. Although not dense, the dominant shrub in these areas consists of mountain mahogany. A mix of small shrubs, forbs, and grasses also occurs in these areas. Grasses include western wheatgrass, blue grama, needle and thread grass, and bottlebrush squirreltail. Some introduced grasses such as smooth brome and cheatgrass are present, but are not dominant. Other species in shrub areas include fringed sage, common mullein, yellow sweetclover, Wood's rose, and bitterbrush. A few ponderosa pine trees also are present in these areas, but are not dominant.

5.1.1.3. Upland Native Forest

Mixed ponderosa pine and Douglas-fir forests cover the foothills surrounding Ralph Price Reservoir. The forests range from dense stands of conifers, with little understory, especially on north- and west-facing slopes, to more open stands with higher numbers of shrubs, grasses, and forbs in the understory. North-facing slopes in the study area consist of denser stands of Douglas-fir with some ponderosa pine and scattered blue spruce. Ponderosa pine forests tend to dominate south-facing slopes along the northern end of the study area. Common grasses in forested areas include junegrass, needle-and-thread grass, bottlebrush squirreltail, and western wheatgrass. Cheatgrass was present within low density stands of ponderosa pine in the northern portion of the study area. Other forbs include fringed sage, paintbrush, and various asters (*Aster* spp.). Shrubs include Wood's rose, kinnikinnik, common juniper, bitterbrush, and currant (*Ribes* spp.).

5.1.2. Wetlands and Waters

5.1.2.1. Wetlands

No other wetlands in the area of potential reservoir enlargement or the potential borrow areas are indicated on NWI maps. Field observations indicate small areas of shoreline wetlands and wetland vegetation bordering the North St. Vrain Creek inlet. Potential wetlands are indicated on Figure 7 based on reconnaissance field observations and aerial photography. Dominant species in the wetland areas include Nebraska sedge, Baltic rush, softstem bulrush, and redtop.

5.1.2.2. Waters

Ralph Price Reservoir is an existing water body with a surface area of about 227 acres when full. Other waters potentially affected by enlargement of Ralph Price Reservoir include upstream and downstream portions of North St. Vrain Creek and possibly ephemeral tributaries to the reservoir including Rattlesnake Gulch, Long Gulch, and other unnamed drainages. Potential waters were estimated based on the inundation of upstream portion of North St. Vrain Creek using aerial photography and USGS maps (Figure 7).

5.1.3. Plant Species of Concern

Table 1 lists the plant species of concern with potential to occur in the habitats present at the Ralph Price study area. The FWS has identified two federally threatened plant species with potential to occur in this portion of Boulder County (FWS 2005): the Ute ladies'-tresses orchid and Colorado butterfly plant. Ralph Price Reservoir is located at an elevation above the normal range of both species; therefore, the study area does not contain potentially suitable habitat for either species.

The CNHP database indicates there are 17 imperiled or vulnerable plant species of concern (including Ute ladies'-tresses orchid and Colorado butterfly plant) in this portion of Boulder County (Table 1). An evaluation of the Ralph Price study area indicates that suitable habitat for five of these species—Larimer aletes, rattlesnake fern, broad-leaved twayblade, Rocky Mountain cinquefoil, and prairie violet—is possible. Field surveys were not conducted to determine the presence of these species in the Ralph Price study area because this reservoir site was not identified until after the 2006 field season.

Table 1. Plant species of concern with potential to occur in the Ralph Price study area.

Common Name	Scientific Name	CNHP Rank[1]	Federal Status[2]	Habitat[3]	Suitable Habitat in Study Area
Bell's twinpod	*Physaria bellii*	G2/S2		Niobrara shale outcrops.	N
Black spleenwort	*Asplenium adiantum-nigrum*	G5/S1		Sandstone cliffs ~ 5,200 ft.	N
Broad-leaved twayblade	*Listera convallarioides*	G5/S2		Cool ravines, forests 5,700–8,300 ft .	Y
Clawless draba	*Draba exunguiculata*	G3/S2		Alpine species 12,000–14,000 ft.	N
Clustered lady's slipper	*Cypripedium fasciculatum*	G4, S3		Open to densely shaded lodgepole pine or spruce forests.	N
Colorado butterfly plant	*Gaura neomexicana coloradensis*	G3/T2 S1	T	Sloping floodplains, wet meadows below 6,000 ft.	N
Gay feather	*Liatris ligulistylis*	G5 S1/S2		Wet meadows.	N
Ice grass	*Phippsia algida*	G5 S2		Snowmelt streamlets, sandy areas 11,700–14,000 ft.	N
Larimer aletes	*Aletes humilis*	G2/G3 S2/S3		Large west- and north-facing cliffs of Silver Plume Granite. In cracks in massive rocks and in adjacent thin soils composed of disintegrated granite. Also in duff with ponderosa pine.	Y
Moonwort	*Botrychium lineare*	G1/S1	C	Grassy slopes, stream sides above 7,900 ft.	N
Pale moonwort	*Botrychium pallidum*	G2/S2		Open hillsides above 9,800 ft.	N
Prairie violet	*Viola pedatifida*	G5/S2		Prairies, open woodlands, forests openings in rocky areas.	Y
Rattlesnake fern	*Botrypus virginianus* ssp. *europaeus*	G5/S1		Springs and moist areas; in cool ravines 6,000–9,500 ft.	Y
Reflected moonwort	*Botrychium echo*	G2/S2		Gravelly soils above 9,500 ft.	N
Rocky Mountain cinquefoil	*Potentilla rupincola*	G2/S2		Granite outcrops in pine forests.	Y
Rocky Mountain columbine	*Aquilegia saximontana*	G3/S3		Cliffs in alpine and subalpine areas.	N

Common Name	Scientific Name	CNHP Rank[1]	Federal Status[2]	Habitat[3]	Suitable Habitat in Study Area
Ute ladies'-tresses orchid	*Spiranthes diluvialis*	G2/S2	T	Sub-irrigated alluvial soils along streams and in floodplains 6,000 ft.	N

[1]CNHP species ranking.

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction. (Critically endangered throughout its range.)

G2 = Imperiled globally because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extinction throughout its range. (Endangered throughout its range.)

G3 = Vulnerable throughout its range or found locally in a restricted range (21 to 100 occurrences). (Threatened throughout its range.)

G4 = Apparently secure globally, though it might be quite rare in parts of its range, especially at the periphery.

G5 = Globally secure.

GU = Unable to assign rank due to lack of available information.

S1 = Critically imperiled in state because of extreme rarity (5 or fewer occurrences, or very few remaining individuals, or because of some factor of its biology making it especially vulnerable to extirpation from the state. (Critically endangered in state.)

S2 = Imperiled in state because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extirpation from the state. (Endangered or threatened in state.)

S3 = Vulnerable in state (21 to 100 occurrences).

S4 = Apparently secure in the state, though it might be quite rare in parts of its range, especially at the periphery.

T(1-5) = Trinomial Rank – Used for subspecies. These species are ranked on the same criteria as G1 to G5.

[2]T = threatened, E = endangered, C = candidate for listing.

[3]Plant species of concern habitat descriptions are from Spackman et al. 1997; Hurd et al. 1998; Dorn 1992; Weber 1996.

5.2. Chimney Hollow Study Area

The Chimney Hollow study area (Figure 8) contains seven primary vegetation cover types in addition to wetlands that support both native and introduced grass, shrubs, and woodlands. Vegetation cover types, wetlands, and plant species of concern in the Chimney Hollow study area are discussed in the following sections.

5.2.1. Vegetation Cover Types

5.2.1.1. Upland Native Grassland

Upland native grasslands occur on the upper slopes of the Chimney Hollow valley and in pockets within the forests and shrublands of the foothills and hogbacks. Species composition varies depending on slope aspect, soil conditions, moisture regime, and past livestock grazing. On the drier slopes, blue grama is the dominant species along with sideoats grama in some areas and needle-and-thread grass in other areas. On moister slopes, western wheatgrass is the dominant species with various needlegrass species, little bluestem, and sideoats grama. In some moister areas, big bluestem is a common component of the grasslands. Small sub-shrubs such as yucca and fringed sage are common throughout the grasslands. Ponderosa pine and mountain mahogany shrubs occasionally occur in parts of the grasslands.

The noxious annual weed cheatgrass commonly occurs in the native grasslands with the density depending on the yearly precipitation. During the drought of 2003, cheatgrass was abundant, dominating large portions of the grasslands with little evidence of native species. In years with more moisture (2000 and 2004), native species were more prevalent and cheatgrass less dominant, although patches dominated by cheatgrass were still common.

5.2.1.2. Upland Introduced Grassland

Grasslands dominated by introduced species occur along the valley floor where grazing has been the most intense. Smooth brome, crested wheatgrass, other wheatgrasses, and cheatgrass dominate these upland introduced grasslands. Weedy species such as kochia are common in some areas.

5.2.1.3. Mesic Mixed Grassland

A mixture of native and nonnative grasses, and mesic mixed grasslands are found on the eastern side of the Chimney Hollow valley and along the western side of the valley. Native species such as western wheatgrass and various needlegrasses are mixed with nonnative species such as smooth brome, crested wheatgrass, and cheatgrass.

5.2.1.4. Upland Native Shrubland

The upland native shrubland vegetation cover type commonly occurs along the low ridges and slopes west of Chimney Hollow and on the eastern hogback slopes. Mountain mahogany is the dominant species with skunkbush common especially on lower slopes. Ponderosa pines occur occasionally in some of the shrublands. The understory contains a variety of grasses and forbs including blue grama, needlegrasses, fringed sage, prickly pear cactus, and cheatgrass. On some of the drier rockier ridges, the understory is sparse and contains only a few grasses, such as Indian ricegrass and forbs. Included in the upland native shrubland vegetation cover type is the mountain mahogany/New Mexico

needlegrass shrublands plant community, which is tracked by the CNHP as state vulnerable or imperiled. Patches of mountain mahogany/New Mexico needlegrass shrublands occur within the hogback on the east side of the study area and are present within about 30 percent of the upland native shrubland. The CNHP describes this community as of moderate size within the Carter Lake Reservoir Hogback Potential Conservation area, which is partially in the study area. This plant community is somewhat degraded in the study area because the noxious weed cheatgrass is a large component. Additionally, the mountain mahogany/needle-and-thread grass community tracked by the CNHP as state imperiled also has the potential to occur within the Chimney Hollow study area; although, this community was not found during field surveys.

5.2.1.5. Mesic Native Shrubland

This mesic community type occurs in the moist to wet drainages on the west side of the Chimney Hollow valley. Dense thickets of chokecherry and wild plum occur in the intermittent drainages. Other shrubs such as skunkbush, sandbar willow, and currants also occur in these drainages. Depending on the moisture regime, a variety of species grow under the shrubs including western wheatgrass, cheatgrass, and the noxious weed, Canada thistle. Included in this vegetation type within the drier drainages on both sides of the Chimney Hollow valley are small patches of the skunkbush riparian shrubland community tracked by the CNHP as state imperiled.

5.2.1.6. Upland Native Forest

Ponderosa pine forests cover the foothills on the west side of the Chimney Hollow study area. Ponderosa pine forests range from dense stands, with little shrub understory, especially on north- and west-facing slopes, to more open stands with dense mountain mahogany understory, to open savannahs with widely spaced trees and grassland understory. In rocky areas where moisture collects between rocks, the understory is dominated by little bluestem, big bluestem, switchgrass, and blue grama. In other less rocky areas, the understory consists of western wheatgrass, prairie dropseed, blue grama, little bluestem, and mountain muhly. A variety of needlegrasses, yucca, fringed sage, and other species are scattered throughout the forest.

As with upland native grasslands, cheatgrass also occurs in upland native forests. The predominance of this annual weed depends on the yearly moisture regime. In 2003, most of the forest understory was cheatgrass with few native grasses. In 2004, native grasses were more prevalent, although some ponderosa pine stands still had a dominant understory of cheatgrass.

Included in the upland native forest vegetation cover type are the ponderosa pine/mountain mahogany/big bluestem woodlands on the west side of the study area, especially in rockier areas. The CNHP tracks this community as vulnerable or imperiled in the state. At Chimney Hollow, this community has been degraded by grazing and drought, which has resulted in seasonal changes in the amount of big bluestem. In 2003, after several years of drought, big bluestem had almost disappeared and cheatgrass dominated the Ponderosa pine understory. In 2004 after more precipitation, big bluestem

became more prevalent and occurred in about 40 percent of the upland native forest, although cheatgrass-dominated patches were still present.

5.2.1.7. Mesic Native Woodland

Mesic native woodlands occur along the Chimney Hollow drainage and in scattered locations on the intermittent channels on the west side of the study area. Along Chimney Hollow, plains cottonwoods and peachleaf willows are common. In a few locations, patches of the nonnative crack willow are present. The understory ranges from dense patches of sandbar willow to more open grasslands dominated by smooth brome, western wheatgrass, and redtop, with patches of snowberry. In intermittent drainages, a variety of cottonwoods including plains cottonwood, narrowleaf cottonwood, and a natural hybrid—lanceleaf cottonwood—dominate the overstory. The understory is generally a thick layer of chokecherry, wild plum, and other shrubs. Wild grapes and other vines are common. Included in this vegetation cover type are patches of cottonwood/common chokecherry, a community tracked as state critically imperiled by the CNHP.

5.2.2. Wetlands and Waters

5.2.2.1. Wetlands

Wetlands occur along the drainages and in isolated pockets within the study area (Figure 9). Wetland plant communities along Chimney Hollow include plains cottonwood/sandbar willow wetlands, with herbaceous wetlands dominated by Nebraska sedge and redtop. A variety of wetland communities are interspersed along the intermittent drainages flowing into Chimney Hollow. These include sandbar willow-dominated patches with occasional narrowleaf cottonwoods and herbaceous wetlands dominated by redtop, sedges, or cattails. Wetland functions were assessed for three representative wetlands—one on the mainstem and two on intermittent tributaries to Chimney Hollow. The wetlands on the mainstem and tributary 5 are classified as a combination of Riverine cobble-gravel, palustrine persistent emergent, and palustrine scrub-shrub wetlands. Tributary 7-1 is classified as Riverine cobble-gravel. Wetlands functions and values are summarized as follows:

- Federally listed, Proposed or Candidate Threatened or Endangered Plants or Animals (none)
- Rare or Imperiled CNHP-Tracked Species (high based on animal species)
- General Wildlife Habitat (moderate)
- General Fish/Aquatic Habitat (low)
- Flood Attenuation and Storage (low)
- Sediment/Nutrient/Toxicant Retention and Removal (low)
- Sediment/Shoreline Stabilization (low to moderate)
- Production Export/Food Chain Support (low to moderate)
- Ground Water Discharge/Recharge (high)
- Uniqueness (low)
- Recreation/Education Potential (low)
- Dynamic Surface Water Storage (none)

5.2.2.2. Waters

At the Chimney Hollow study area, waters include reaches of the Chimney Hollow drainage and several side drainages on the west side of the valley (Figure 9). Generally, waters in the study area are characterized by either flowing water or unvegetated drainages with evidence of flowing water in the last 2 years.

5.2.3. Plant Species of Concern

The FWS indicates two federally listed threatened species with potential for occurrence in Larimer County—Colorado butterfly plant and Ute ladies'-tresses orchid (Table 2). The Colorado butterfly plant is a short-lived perennial herb found in moist areas of floodplains occurring on sub-irrigated, alluvial soils on level or slightly sloping floodplains and drainage bottoms at elevations 5,000 to 6,000 feet (Spackman et al. 1997). The riparian areas along Chimney Hollow do not provide high quality habitat for this species because of grazing, weed infestation, and lack of an active floodplain. Colorado butterfly plant was not found during the August 16, 2003 survey for this species in the study area. The Chimney Hollow study area does not meet the survey protocol criteria for Ute ladies'-tresses orchid, which requires the presence of wetlands along a perennial tributary to the South Platte River (FWS 1992). Chimney Hollow and its tributaries are not perennial streams. However, a survey for Ute ladies'-tresses orchid was conducted concurrent with the survey for Colorado butterfly plant. No Ute ladies'-tresses orchid was found.

Table 2 lists plant species of concern that the CNHP tracks as having potential habitat in Larimer County. Potentially suitable habitat occurs in the study area for 14 of these species including the Colorado butterfly plant. Of these species, the CNHP (2004e) has element occurrence records of three species near the study area: Larimer aletes, strap-style gayfeather, and Bell's twinpod. There are, however, no records of known occurrences of any of the CNHP-tracked species within the study area. Additionally, the CNHP records lavender hyssop as possibly occurring within the northern portion of the study area; however, this is a general location from a 1910 record with a margin of error of 5 miles (CNHP 2004e). The CNHP plants with potentially suitable habitat in the study area are discussed below.

Five of the CNHP-tracked species with suitable habitat within the study area are restricted to specific substrates. Bell's twinpod occurs on Niobrara shale and in rare occurrences on red sandstone outcrops (CNHP 2004g). Although Niobrara shale outcrops do not occur in the study area, red sandstone outcrops are present. Surveys for Bell's twinpod were conducted in July 25, 2004 and none were found. Larimer aletes, purple cliff-brake, Rocky Mountain cinquefoil, and western polypody fern occur on granitic and other types of cliffs and rock outcrops. Granitic and other rock outcrops and cliffs occur along the intermittent drainages within the foothills at the west side of the study area. None of these four species were found during field investigations in July 16, 2003, July 25, 2004, August 26, 2003, and July 8, 2005.

Table 2. Plant species of concern with potential to occur in the Chimney Hollow and Dry Creek study areas.

Common Name	*Scientific Name*	CNHP Rank[1]	Federal Status[2]	Habitat[3]	Suitable Habitat in Combined Study Area	Found at Chimney Hollow	Found at Dry Creek
American currant	*Ribes americanum*	G5/S2		Moist woods in foothills.	Y	N	N
American yellow lady's slipper	*Cypripedium calceolus* ssp. *Parviflorum*	G5/S2		Aspen groves, ponderosa pine/Douglas-fir forests 7,400–8,500 ft.	N	N	N
Autumn willow	*Salix serissima*	G4/S1		Marshes or fens 7,800–9,300 ft.	N	N	N
Bell's twinpod	*Physaria bellii*	G2/S2		Niobrara shale outcrops.	Y	N	N
Broad-leaved twayblade	*Listera convallarioides*	G5/S2		Cool ravines in subalpine forest.	N	N	N
Clustered lady's-slipper	*Cypripedium fasciculatum*	G4/S3		Lodgepole pine or spruce-fir forests 8,000–10,500 ft.	N	N	N
Colorado butterfly weed	*Gaura neomexicana* ssp. *Coloradensis*	G3T2/S1	T	Mesic grasslands in floodplains.	Y	N	N
Colorado Divide whitlow-grass	*Draba streptobrachia*	G3/S3		High alpine.	N	N	N
Forked three-awn	*Aristida basiramea*	G5/S1		Dry, open, sandy areas.	Y	N	N
Gray's Peak whitlow-grass	*Draba grayana*	G2/S2		Alpine.	N	N	N
Hall fescue	*Festuca hallii*	G4/SH		Alpine.	N	N	N
Hoary or Silver willow	*Salix candida*	G5/S2		Rich fens, subalpine.	N	N	N
Kotzebuei grass-of-parnassus	*Parnassia kotzebuei*	G4/S2		Subalpine and alpine.	N	N	N
Larch-leaf beardtongue	*Penstemon laricifolius* ssp. *exilifolius*	G4T2Q/ S2		Dry grasslands.	Y	N	N
Larimer Aletes	*Aletes humilis*	G2G3/S2S3		Cliffs, cracks, and soil composed of disintegrated granite. Also ponderosa pine duff 6,500–8,700 ft.	Y	N	N

Common Name	*Scientific Name*	CNHP Rank[1]	Federal Status[2]	Habitat[3]	Suitable Habitat in Combined Study Area	Found at Chimney Hollow	Found at Dry Creek
Lavender hyssop	*Agastache foeniculum*	G4G5/S1		Woodlands, mesic meadows, streambanks.	Y	N	N
Leathery grape-fern	*Botrychium multifidum* ssp. *coulteri*	G5TNRQ/S1		Mountain meadows.	N	N	N
Lesser panicled sedge	*Carex diandra*	G5/S1		Subalpine willow carrs.	N	N	N
Livid sedge	*Carex livida*	G5/S1		Rich fens above 10,000 ft.	N	N	N
Mingans moonwort	*Botrychium minganense*	G4/S1		Generally subalpine.	N	N	N
Mud sedge	*Carex limosa*	G5/S2		Subalpine fens and wet meadows.	N	N	N
Northern twayblade	*Listera borealis*	G4/S2		Spruce forests.	N	N	N
Northwestern thelypody	*Thelypodium paniculatum*	G2/S1		Wet meadows in mountains.	N	N	N
Pale blue-eyed grass	*Sisyrinchium pallidum*	G2G3/S2		Wetlands 7,900–9,500 ft.	N	N	N
Peck sedge	*Carex peckii*	G4G5/S1		Cool valleys in Front Range foothills.	Y	N	N
Prairie golden rod	*Solidago ptarmicoides*	G5/S2S3		Dry open meadows 7,500–9,300 ft.	N	N	N
Purple cliff-brake	*Pellaea atropurpurea*	G5/S2S3		Exposed or partially shaded cliffs 5,200–9,599 ft.	Y	N	N
Rabbit ears gilia	*Ipomopsis aggregata* ssp. *weberi*	G5T2/S2		Coniferous forests 8,000–9,600 ft.	N	N	N
Reflected moonwort	*Botrychium echo*	G3/S3		Subalpine, alpine.	N	N	N
Rocky Mountain columbine	*Aquilegia saximontana*	G3/S3		Cliffs above 9,000 ft.	N	N	N
Rocky Mountain sedge	*Carex saximontana*	G5/S1		Pine forests and thickets. Moist, often shady places.	Y	N	N
Rocky Mountain cinquefoil	*Potentilla rupincola effusa* var. *rupincola (wasn't named w/effuse)*	G2/S2 (G5?T2/S2)		Granite cliffs.	Y	N	N

Common Name	*Scientific Name*	CNHP Rank[1]	Federal Status[2]	Habitat[3]	Suitable Habitat in Combined Study Area	Found at Chimney Hollow	Found at Dry Creek
Selkirk violet	*Viola selkirkii*	G5?/SH		Cold mountain forests 8,500–9,100 ft.	N	N	N
Slender sedge	*Carex lasiocarpa*	G5/S1		Subalpine fens.	N	N	N
Southern Rocky Mountain cinquefoil	*Potentilla ambigens*	G3/S1S2		Middle elevations in mountains.	N	N	N
Spiny spore quillwort	*Isoetes echinospora* ssp. *muricata*	G5?/SNR		Mountains.	N	N	N
Spreading woodfern	*Dryopteris expansa*	G5/S1		Rich subalpine forests.	N	N	N
Strap-style gayfeather	*Liatris ligulistylis*	G5?/S1S2		Wet meadows in the Piedmont.	Y	N	N
Sweetflag	*Acorus calamus*	G4?/SH		Shallow waters and wetlands on plains.	Y	N	N
Tweedy's rush	*Juncus tweedyi*	G3Q/S1		Mountains.	N	N	N
Ute ladies'-tresses Orchid	*Spiranthes diluvialis*	G2/S2	T	Subirrigated alluvial soils 4,500–6,800 ft.	N	N	N
Vasey bulrush	*Juncus vaseyi*	G5?/S1		Mountain wetlands.	N	N	N
Water awlwort	*Subularia aquatica*	G5/S1		Subalpine ponds.	N	N	N
Weber's monkeyflower	*Mimulus gemmiparus*	G1/S1		Granite seeps 8,500–10,500 ft.	N	N	N
Western moonwort	*Botrychium hesperium*	G3/S2		Higher elevations in early successional habitat.	N	N	N
Western polypody fern	*Polypodium hesperium*	G5/S1S2		Cracks and cliffs.	Y	N	N
White arctic whitlow-grass (Artic draba)	*Draba fladnizensis*	G4/S2S3		High mountains.	N	N	N
White-flowered rhododendron	*Rhododendron albiflorum*	G4/S2		Lake shores, moist forests of mountains.	N	N	N

[1]CNHP species ranking.

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction. (Critically endangered throughout its range.)

G2 = Imperiled globally because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extinction throughout its range. (Endangered throughout its range.)

G3 = Vulnerable throughout its range or found locally in a restricted range (21 to 100 occurrences). (Threatened throughout its range.)

G4 = Apparently secure globally, though it might be quite rare in parts of its range, especially at the periphery.

G5 = Globally secure.

GU = Unable to assign rank due to lack of available information.

S1 = Critically imperiled in state because of extreme rarity (5 or fewer occurrences, or very few remaining individuals, or because of some factor of its biology making it especially vulnerable to extirpation from the state. (Critically endangered in state.)

S2 = Imperiled in state because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extirpation from the state. (Endangered or threatened in state.)

S3 = Vulnerable in state (21 to 100 occurrences).

S4 = Apparently secure in the state, though it might be quite rare in parts of its range, especially at the periphery.

T(1-5) = Trinomial Rank – Used for subspecies. These species are ranked on the same criteria as G1 to G5.

[2]T = threatened, E = endangered, C = candidate for listing.

[3]Plant species of concern habitat descriptions are from Spackman et al. 1997; Hurd et al. 1998; Dorn 1992; Weber 1996.

Wooded riparian areas and wetlands provide potential habitat for four state critically imperiled and imperiled species. Peck's sedge occurs in wet areas within thickets and ravines with box elder and other woody species (USFS 2004.). This type of habitat occurs in the narrow ravines on the west side of the study area. Lavender hyssop and wild black currant also occur in moist woodlands similar to the riparian woodlands along the main stem of Chimney Hollow and the intermittent tributaries. Rocky Mountain sedge occurs in moist areas within pine forests and thickets; this type of vegetation occurs in the upper drainages within the ponderosa pine forest on the western edge of the study area. None of the four species that prefer wooded riparian areas and wetlands were found during field investigations in July 16, 2003, August 26, 2003, July 25, 2004, and July 8, 2005.

Sweetflag is a wetland species with historical observations in the state, but there are no current records. Strap-style gayfeather is an imperiled species that occurs in wet meadows. Wetlands are limited to small, grazed patches within the main stem of Chimney Hollow and a few of the intermittent tributaries. Neither of these species was found during field investigations in July 16, 2003, August 26, 2003, July 25, 2004, and July 8, 2005.

Upland grasslands in the Chimney Hollow valley provide potential habitat for two state imperiled species, forked three-awn and larch-leaf beardtongue. Neither of these species was found during the field studies in July 16, 2003, August 26, 2003, July 25, 2004, and July 8, 2005.

5.3. Dry Creek Study Area

The vegetation cover types within the Dry Creek Study area (Figure 10) are similar to those present in Chimney Hollow, except that the species composition differs slightly. Also, wetlands in the Dry Creek study area are more extensive. Vegetation cover types, wetlands, and plant species of concern in the Dry Creek study area are discussed in the following sections.

5.3.1. Vegetation Cover Types

5.3.1.1. Upland Native Grassland

Native grasslands occur on the upper slopes of the Dry Creek Valley and in pockets within the forests and shrublands of the foothills and hogbacks (Figure 10). The species composition varies depending on slope aspect, soil conditions, moisture regime, and amount of grazing. On drier slopes, blue grama is the dominant species, along with fringed sage, sideoats grama in some areas, and needle-and-thread grass in other areas. On moister slopes, western wheatgrass and dropseed are dominant along with various needlegrass species, little bluestem, and sideoats grama. In some areas, big bluestem is a common component of the grasslands. Mountain mahogany, yucca, and other shrubs occasionally occur in parts of the grasslands. Cheatgrass is a common component, although it is less common than in Chimney Hollow. The needle-and-thread grass-blue grama grasslands, tracked by the CNHP as state vulnerable or imperiled, may also occur within the upland native grasslands particularly in the southern portion of the study area.

5.3.1.2. Upland Introduced Grassland

Upland introduced grasslands dominated by introduced species occur around the corrals near the center of the reservoir site and near the dam. Smooth brome, crested wheatgrass, fescues, and cheatgrass dominate these grasslands. Weedy species such as kochia, musk thistle, and Canada thistle are common.

5.3.1.3. Mesic Mixed Grassland

This mixture of native and nonnative grasses occurs in the center of the Dry Creek valley where current and historical ranching activities are concentrated. Native species such as dropseed, western wheatgrass, and various needlegrasses are mixed with nonnative species such as smooth brome, crested wheatgrass, mullein, musk thistle, and cheatgrass.

5.3.1.4. Upland Native Shrubland

This native shrubland is the largest vegetative cover type within the study area and occurs along the west-facing hogback slopes and in large portions of the foothills west of the valley. Mountain mahogany is the dominant species with skunkbush common, especially on the lower portions of slopes. Ponderosa pines occur occasionally in some of the shrublands. The understory contains a variety of grasses and forbs including blue grama, needlegrasses, fringed sage, prickly pear cactus, and cheatgrass. On drier, rockier ridges, the understory is sparse, containing only a few grasses such as Indian ricegrass and forbs. Three plant communities tracked by the CNHP as state vulnerable/imperiled or imperiled possibly occur within this vegetation cover type, although these communities were not noted during the field surveys. These communities include mountain mahogany/New Mexico needlegrass, mountain mahogany/needle-and-thread grass, and mountain mahogany-skunkbush/big bluestem shrublands.

5.3.1.5. Mesic Native Shrubland

The riparian shrubland community type occurs in the drainages tributary to Dry Creek. Dense thickets of skunkbush with snowberry and other shrubs occur along ephemeral drainages. Moister drainages contain thickets of chokecherry and wild plum. Cheatgrass is a common component of the understory. The skunkbush riparian community, which is tracked by the CNHP as state imperiled, is found in the narrow dry drainages on both sides of the Dry Creek valley.

5.3.1.6. Upland Native Forest

Ponderosa pine-dominated forest covers the foothills on the west side of the study area and pockets along the hogback. This forest ranges from dense stands of pine with little shrub understory especially on north- and west-facing slopes, to more open stands with dense mountain mahogany understory, to open savannahs with widely spaced trees and grassland understory. In the northern portion and in scattered patches of the study area, big bluestem and little bluestem are common components of the understory with mountain mahogany shrubs. The CNHP lists this type of plant community (Ponderosa pine/mountain mahogany/big bluestem) as state vulnerable/imperiled. In other areas, big bluestem is less common and the dominant understory species are blue grama, dropseed, needlegrasses, and a variety of other grasses. Yucca, fringed sage, and other species are scattered throughout the forest.

5.3.1.7. Mesic Native Woodland

Mesic native woodlands occur along Dry Creek and the lower ends of a few tributaries. Narrowleaf and plains cottonwoods with box elder form the overstory. The understory ranges from dense patches of sandbar willow, chokecherry, and other shrubs to open areas dominated by a mixture of native grasses, such as western wheatgrass and Canada wildrye, and introduced species such as smooth brome and Canada bluegrass. Included in this vegetation cover type are patches of skunkbush riparian shrublands rated by the CNHP as state imperiled.

5.3.2. Wetlands and Waters

5.3.2.1. Wetlands

Wetlands occur along the drainages and seeps especially on the western side of the valley (Figure 11a and 11b). Dry Creek contains the largest amount of wetlands with a 1- to 20-foot wetland fringe bordering portions of the creek and a series of agricultural ponds. Smaller wetlands occur along the intermittent tributary drainages and seeps particularly near rock outcrops. The wetlands along Dry Creek support cottonwoods, especially around the ponds. Patches of sandbar willow wetlands are interspersed with herbaceous wetlands dominated by redtop, cattails, and other graminoids. Along the tributaries, wetlands generally consist of patches of herbaceous species interspersed with sandbar willow. The small seeps on the western hillsides tend to be dominated by herbaceous species such as Nebraska sedge and cattails

ERO evaluated the functions and value of two representative wetlands in the Dry Creek reservoir study area along the mainstem of Dry Creek and in one of the tributaries. The mainstem wetland is classified as a combination of Riverine cobble-gravel, palustrine persistent emergent, and palustrine scrub-shrub. The wetlands along the tributary are classified as Riverine palustrine scrub-shrub. Wetland functions and values are rated as follows:

- Federally listed, Proposed or Candidate Threatened or Endangered Plants or Animals (none)
- Rare or Imperiled CNHP-tracked species (high based on wildlife species)
- General Wildlife Habitat (moderate to high)
- General Fish/Aquatic Habitat (none to low)
- Flood Attenuation and Storage (low to moderate)
- Sediment/Nutrient/Toxicant Retention and Removal (moderate)
- Sediment/Shoreline Stabilization (high)
- Production Export/Food Chain Support (low to high)
- Ground Water Discharge/Recharge (high)
- Uniqueness (low)
- Recreation/Education Potential (low)
- Dynamic Surface Water Storage (none to low)

5.3.2.2. Waters

Waters within the Dry Creek study area include reaches of Dry Creek and its tributaries (Figure 11a and 11b). Generally, waters in the study area are characterized by either flowing water or unvegetated areas with evidence of flowing water in the last 2 years. Several small ponds also are present along Dry Creek.

5.3.3. Plant Species of Concern

Table 2 lists plant species of concern that the CNHP tracks as having potential habitat in Larimer County. Two of these species are listed by the FWS as threatened: Colorado butterfly plant and Ute ladies'-tresses orchid. Dry Creek and its tributaries are not perennial streams. Potentially suitable habitat for Colorado butterfly plant is present in the Dry Creek study area, but none were found during field surveys in September of 2004. The Dry Creek site does not meet the FWS Ute ladies'-tresses orchid survey protocol for Larimer County, which requires surveys only for areas with suitable habitat along perennial streams (FWS 1992). However, a survey for Ute ladies'-tresses orchid was conducted concurrent with the survey for Colorado butterfly plant. No Ute ladies'-tresses orchids were found at Dry Creek.

As with the Chimney Hollow study area, 15 plant species of concern have potentially suitable habitat in the Dry Creek study area (Table 2). Of these species, the CNHP has element occurrences of four species occurring near the study area, although there are no known occurrences of any of the species within the study area (CNHP 2004d). These four species are lavender hyssop, Larimer aletes, strap-style gayfeather, and Bell's twinpod.

Bell's twinpod occurs on Niobrara shale and in rare occurrences on red sandstone outcrops (CNHP 2004g). One occurrence is documented by the CNHP southeast of the Dry Creek study area in Meadow Hollow, and the species has also been found south of the study area (CNHP 2004g). Suitable rock outcrop habitat in the study areas was surveyed in 2004, and Bell's twinpod was not found.

Four plant species of concern with potential habitat within the study area—Larimer aletes, purple cliff-brake, Rocky Mountain cinquefoil, and western polypody fern—are restricted to granitic and other types of cliffs and rock outcrops. These types of rock outcrops occur along the intermittent drainages within the foothills at the west side of the study area. None of these four species were found during field investigations on July 8, September 10, 16, 23, and 24, 2005.

Wooded riparian areas and wetlands in the Dry Creek study area provide potentially suitable habitat for four state critically imperiled and imperiled species: Peck's sedge, wild black currant, lavender hyssop, and Rocky Mountain sedge. None of these species were found during field investigations on July 8, September 10, 16, 23, and 24, 2005. Sweetflag and strap-style gayfeather occur in wet meadows. This vegetation type is limited to small, heavily grazed patches within the Dry Creek study area. Neither of these species was found during field investigations on July 8, September 10, 16, 23, and 24, 2005.

Upland grasslands, such as those present in the Dry Creek valley, provide potential habitat for forked three-awn and larch-leaf beardtongue. Neither of these species was found during field studies on July 8, September 10, 16, 23, and 24, 2005.

5.4. Jasper East Study Area

The Jasper East study area contains six vegetation cover types: upland native shrublands, upland native forests (dominated by lodgepole pine), mesic mixed grasslands (consisting of irrigated meadow), upland mixed grasslands, mesic native shrublands, and wetlands (Figure 12). Vegetation cover types, wetlands, and plant species of concern are discussed in the following sections.

5.4.1. Vegetation Cover Types

5.4.1.1. Upland Native Shrubland

Sagebrush dominates the upland native shrub vegetation cover type, which is common in basins and valleys in the northern half of the southern Rocky Mountains, including North Park and Middle Park, at elevations that range from 7,000 to 10,000 feet. In the study area, upland native shrublands occur on the lower flanks of hillsides in soils that are well drained and friable. Common species include a diverse mix of shrubs, grasses, and forbs. Grasses include western wheatgrass, prairie junegrass, Nelson needlegrass, Sandberg bluegrass, mountain brome, bluebunch wheatgrass, Indian ricegrass, Canada wildrye, mountain muhly, Idaho fescue, bluegrass, mutton-grass, cheatgrass, and some Thurber's fescue. Forbs include fringed sage, sulphur flower, scarlet gilia, Indian paintbrush, milkvetch, Middle Park penstemon, Watson penstemon, Rocky Mountain penstemon, mariposa lily, phlox, owl clover, spiny aster, locoweed, green gentian, pussy-toes, and yarrow. Other shrubs include snakeweed, bitterbrush, and snowberry.

5.4.1.2. Upland Native Forest

Lodgepole pine dominates this vegetation cover type, which is found throughout the Rocky Mountains in the upper montane and lower subalpine zones at elevations from 8,500 to 10,000 feet. In the study area, lodgepole pine forests are found primarily on north-facing hillsides. Dominant understory species include grouse whortleberry, heartleaf arnica, elk sedge, and pinegrass. Common grasses include Nelson needlegrass, bluegrass, spike trisetum, and Idaho fescue. Other forbs include strawberry, lupine, bedstraw, goldenrod, harebells, Canada thistle, and hawkweed. Shrubs include Wood's rose, Say's rose, kinnikinnik, common juniper, buffaloberry, Oregon grape, and some bitterbrush. Douglas-fir and aspen are also present.

5.4.1.3. Mesic Mixed Grassland

In the lower valleys of the study area, upland native shrublands are replaced by irrigated hayfields. Hay is gathered once or twice a year and stored for winter livestock forage. The mesic mixed grasslands, or irrigated meadows, range from mesic to some wetter areas along drainages, although the mesic mixed grassland vegetation type does not include wetlands. Species present include meadow foxtail, Kentucky bluegrass, smooth brome, timothy, clover, clustered field sedge, Baltic rush, dandelion, slender wheatgrass, and northwest cinquefoil.

5.4.1.4. Upland Mixed Grassland

Upland mixed grasslands in the study area are dominated by species such as mountain brome, smooth brome, slender wheatgrass, timothy, yarrow, dandelion, blue-eyed grass, mountain wormwood, green gentian, and Canada thistle.

5.4.1.5. Mesic Native Shrubland

Mesic native shrublands occur in riparian areas near the Willow Creek pump station and along the unnamed drainage. Planeleaf, stapleaf, and Geyer's willow dominate riparian areas. Understory species in drier areas include shrubs such as currant and shrubby cinquefoil; graminoids such as bluejoint reedgrass, Kentucky bluegrass, clustered field sedge, and Baltic rush; and forbs such as buttercup, bluebells, dandelion, strawberry, and willowherb.

5.4.2. Wetlands and Waters

5.4.2.1. Wetlands

Wetlands occur along several intermittent and ephemeral drainages and within irrigated meadows (Figure 13). Most of the wetland areas support herbaceous plant species. Herbaceous wetlands typically are dominated by beaked sedge, small-winged sedge, water sedge, short-beaked sedge, and tufted hairgrass. Other common species include Baltic rush and Jacob's ladder. The species composition of irrigated meadows is described in the mesic mixed grassland section above. Planeleaf willow and Geyer's willow occur in some wetlands.

ERO completed field evaluations for two representative wetlands and prepared a function and value summary for the proposed reservoir study area. Functions and ratings assessed at Jasper East included—

- Federally listed, Proposed or Candidate Threatened or Endangered Plants or Animals (none)
- Rare or Imperiled CNHP-Tracked Species (none)
- General Wildlife Habitat (moderate)
- General Fish/Aquatic Habitat (low)
- Flood Attenuation and Storage (low to moderate)
- Sediment/Nutrient/Toxicant Retention and Removal (low to moderate)
- Sediment/Shoreline Stabilization (high where applicable)
- Production Export/Food Chain Support (moderate to high)
- Ground Water Discharge/Recharge (high)
- Uniqueness (low to moderate)
- Recreation/Education Potential (low)
- Dynamic Surface Water Storage (moderate to high)

A wetland delineation report was submitted to the Corps Sacramento District Regulatory offices – Frisco office on July 22, 2004. A Corps representative met with

ERO at the study area on August 5, 2004 to review the delineation. At this time, the Corps has not issued a letter approving the wetland delineation (ERO 2004a).

The wetland delineation report did not attempt to separate wetlands that had formed as a result of irrigation from wetlands that are naturally occurring; however, a preliminary assessment of wetlands that appear to be primarily supported by irrigation or canal seepage was made. This assessment was based on topography, soil development, and observations about irrigation practices in the study area. The preliminary assessment indicates that about eight acres of wetlands appear to be supported entirely by irrigation, and that up to 50 percent of several other wetlands may be partially supported by irrigation (Figure 13). Additional studies would be necessary to determine the extent of wetlands supported by irrigation. All wetlands (including irrigated wetlands) are discussed in this report regardless of whether they fall under the jurisdiction of the Corps.

5.4.2.2. Waters

Ditches, canals, and creeks occur in the study area (Figure 13). Irrigation ditches distribute water to the irrigated hay meadows. The Willow Creek Canal and pump station forebay are located in the study area. In addition, an unnamed tributary to Church Creek is located in the study area.

5.4.3. Plant Species of Concern

Table 3 lists the plant species of concern with potential to occur in the habitats in the Jasper East study area. The FWS has identified two endangered plant species with potential to occur in Grand County (FWS 2004): the osterhout milkvetch and penland beardtongue. The study area contains potentially suitable habitat for both species. Osterhout milkvetch occurs in highly seleniferous, grayish brown clay soils derived from shales of the Niobrara, Pierre, and Troublesome formations, often in sagebrush shrublands (Spackman et al. 1997). Osterhout milkvetch was recorded near the area in 1961 (CNHP 2004c). Penland beardtongue occurs in strongly seleniferous clay-shales of the Troublesome Formation, in areas with sparse plant cover, often in sagebrush (Spackman 1997). Some of the soils on the site are formed from shales, but it is unknown if they are highly seleniferous. Neither Osterhout milkvetch nor Penland beardtongue were found during surveys of the study area in 2004.

The CNHP tracks 29 imperiled and vulnerable plant species of concern in Grand County, including federally listed Osterhout milkvetch and Penland beardtongue (Table 3). Potentially suitable habitat in the Jasper East study area is present for nine CNHP species. Of these nine species, the CNHP (2004c) lists historical element occurrences for three CNHP-tracked plants near the study area: Bodin milkvetch was observed in 1961; Nagoon berry was observed in 1935; and bitterroot was observed in 1961. All three species have potential to occur within the study area, although there are no known occurrences of any of the species within the study area based on existing records (CNHP 2004c). ERO plant ecologists searched suitable habitat in the study area in 2004 for all of the CNHP plant species of concern and the results are discussed below.

Table 3. Plant species of concern with potential to occur in the Jasper East and Rockwell/Mueller Creek study areas.

Common Name	Scientific Name	CNHP Rank[1]	USFS/BLM Sensitive Species	Federal Status[2]	Habitat[3]	Suitable Habitat in Combined Study Areas	Found in Jasper East Study Area[4]
Alpine aster	*Aster alpinus* var. *vierhapperi*	G5/T5, S1			Tundra on Berthoud Pass.	N	N
Bitterroot	*Lewisia rediviva*	G5, S2			Gravelly flats, and seasonally wet sagebrush benches.	Y	N
Bodin milkvetch	*Astragalus bodinii*	G4, S2			Meadows and streambanks.	Y	N
Bristle-stalk sedge	*Carex leptalea*	G5, S1	USFS		Rich fens, graminoid-dominated mineral rich wetlands 9,000–10,000 ft.	N	N
Clawless draba	*Draba exunguiculata*	G2, S2	USFS		Alpine.	N	N
Clustered lady's slipper	*Cypripedium fasciculatum*	G4, S3			Open to densely shaded lodgepole pine or spruce forests.	Y	N
Dog parsley	*Aletes nuttallii*	G3, S1			Black shale sagebrush slopes near Kremmling.	N	N
Gray's Peak whitlow-grass	*Draba grayana*	G2, S2	USFS		Alpine.	N	N
Harrington beardtongue	*Penstemon harringtonii*	G3, S3	USFS/BLM		Open sagebrush or piñon-juniper. Rocky and rocky clay loams derived from coarse calcareous parent materials.	N	N
Kotzebue's grass-of-parnassus	*Parnassia kotzebuei*	G4, S2	USFS		Subalpine and alpine wet, rocky ledges, in streamlets and moss mats 10,000–12,000 ft.	N	N
Lancepod whitlowgrass	*Draba lonchocarpa* var. *lonchocarpa*	G4/T4, S2			Alpine.	N	N
Least moonwort	*Botrychium simplex*	G5, S1			Alpine and subalpine disturbed areas, coarse soil.	N	N
Middle Park penstemon	*Penstemon cyathophorus*	G3, S3/S4		NA	Sagebrush slopes.	Y	Y
Mingan's moonwort	*Botrychium minganense*	G4, S1			Alpine and subalpine disturbed areas, coarse soil.	N	N
Mountain bladder fern	*Cystopteris montana*	G5, S1			Alpine.	N	N
Mud sedge	*Carex limosa*	G5, S2			Sphagnum bogs and wet meadows.	N	N

Common Name	Scientific Name	CNHP Rank[1]	USFS/BLM Sensitive Species	Federal Status[2]	Habitat[3]	Suitable Habitat in Combined Study Areas	Found in Jasper East Study Area[4]
Nagoon berry	*Rubus arcticus* ssp. *acaulis*	G5/T5, S1	FS		Willow carrs, mossy streamsides 8,600–9,700 ft.	Y	N
Northern twayblade	*Listera borealis*	G4, S2	BLM		Barren slopes.	N	N
Osterhout milkvetch	*Astragalus osterhoutii*	G1, S1		E	Highly seleniferous, grayish-brown clay soils derived from shales of the Niobrara, Pierre, and Troublesome formations, sagebrush.	Y	N
Penland beardtongue	*Penstemon penlandii*	G1, S1		E	Strongly seleniferous clay-shales of the Troublesome Formation; sagebrush badlands.	Y	N
Rabbit ears gilia	*Ipomopsis aggregata* ssp. *weberi*	G5/T2, S2	USFS		Openings in coniferous forests.	Y	N
Riverbank sedge	*Carex stenoptila*	G2, S2			Woods, rocks, and slopes in mountains.	Y	N
Roundleaf sundew	*Drosera rotundifolia*	G5, S2	USFS		Floating peat mats, margins of acidic ponds, and fens.	N	N
Slender cottongrass	*Eriophorum gracile*	G5, S2	BLM/ USFS		Fens, wet meadows, and pond edges.	Y	N
Slender rock brake	*Cryptogramma stelleri*	G5, S2	BLM		Rocky places and wet limestone.	N	N
Spreading wood fern	*Dryopteris expansa*	G5, S1			Rich subalpine forests.	N	N
Thick-leaf whitlow-grass	*Draba crassa*	G3, S3			High mountain cliffs.	N	N
Vasey bulrush	*Juncus vaseyi*	G5?, S1			Springy slopes and meadows.	Y	N
Weber's monkeyflower	*Mimulus gemmiparus*	G1, S1	USFS		Granitic seeps, slopes, and alluvium in open sites within spruce-fir and aspen forests.	N	N

[1]CNHP species ranking.

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction. (Critically endangered throughout its range.)

G2 = Imperiled globally because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extinction throughout its range. (Endangered throughout its range.)

G3 = Vulnerable throughout its range or found locally in a restricted range (21 to 100 occurrences). (Threatened throughout its range.)

G4 = Apparently secure globally, though it might be quite rare in parts of its range, especially at the periphery.

G5 = Globally secure.

GU = Unable to assign rank due to lack of available information.

S1 = Critically imperiled in state because of extreme rarity (5 or fewer occurrences, or very few remaining individuals, or because of some factor of its biology making it especially vulnerable to extirpation from the state. (Critically endangered in state.)

S2 = Imperiled in state because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extirpation from the state. (Endangered or threatened in state.)

S3 = Vulnerable in state (21 to 100 occurrences).

S4 = Apparently secure in the state, though it might be quite rare in parts of its range, especially at the periphery.

T(1-5) = Trinomial Rank – Used for subspecies. These species are ranked on the same criteria as G1 to G5.

[2]T = threatened, E = endangered, C = candidate for listing.

[3]Plant species of concern habitat descriptions are from Spackman et al. 1997; Hurd et al. 1998; Dorn 1992; Weber 1996.

[4] Field surveys were only conducted at Jasper East.

Four plant species of concern have potential to occur in riparian and wetland areas in the Jasper East study area: Bodin milkvetch, slender cottongrass, Vasey bulrush, and Nagoon berry. Wetlands in the study area have been flood irrigated and grazed for many years, and the wetlands and riparian habitats are not pristine. None of these species were found during surveys in 2004.

Two CNHP plant species of concern, bitterroot and Middle Park Penstemon, have potential to occur in sagebrush habitats in the study area. The only CNHP-tracked species found during the 2004 surveys was Middle Park penstemon, a species considered vulnerable to secure in Colorado. Middle Park penstemon was found in most of the sagebrush communities in the study area, generally at fairly low densities (less than one plant per 10,000 square feet); however, in small areas, its density was moderate (up to one plant per 100 square feet). Occurrences of Middle Park penstemon generally occupy the entire sagebrush community; therefore, specific populations or occurrences were not mapped individually.

Three CNHP-tracked plants have potential to occur in lodgepole pine habitats in the study area: riverbank sedge, clustered ladies' slipper, and rabbit ears gilia. None of these species were found during 2004 surveys.

5.5. Rockwell/Mueller Creek Study Area

The vegetation cover types in the Rockwell/Mueller Creek study area are similar to the Jasper East study area (Figure 14). Vegetation mapping in the Rockwell/Mueller Creek study area was conducted from secondary sources including aerial photos and access from County roads because ecologists did not have permission from landowners to access the site. The Rockwell/Mueller Creek study area also includes a pipeline from the proposed reservoir to the Windy Gap Reservoir and access roads. Vegetation cover types, wetlands, and plant species of concern for the Rockwell/Mueller Creek study area are described below.

5.5.1. Vegetation Cover Types

5.5.1.1. Upland Mixed Grassland

Upland mixed grasslands occur in valley floors and side slopes in the Rockwell/Mueller Creek study area. In some areas, sagebrush has been cleared to create meadows. ERO ecologists could not determine if any of the meadows in the Rockwell/Mueller Creek study area were irrigated.

5.5.1.2. Upland Native Shrubland

Upland native shrublands are the most widespread vegetation cover type in the Rockwell/Mueller Creek study area. The upland native shrublands in the Rockwell/Mueller Creek study area are dominated by sagebrush and it is likely that they have a vegetation composition similar to the upland native shrublands in the Jasper East study area.

5.5.1.3. Mesic Native Shrubland

Mesic native shrublands occur in riparian areas along Rockwell and Mueller creeks, and include areas of wetlands as discussed below. The species composition is likely similar to the mesic native shrubland cover type described for Jasper East Reservoir.

Plant species in this community include planeleaf willow, Geyer's willow, currant, shrubby cinquefoil, bluejoint reedgrass, Kentucky bluegrass, clustered field sedge, Baltic rush, and various forbs.

5.5.1.4. Upland Native Forest

Two communities are included in the upland native forest vegetation cover type in the Rockwell/Mueller Creek study area—lodgepole pine forests and aspen stands. Lodgepole pine forests are present in the upper elevations of the Rockwell/Mueller Creek study area. It is likely that the lodgepole pine forests in the Rockwell/Mueller Creek study area are similar to the lodgepole pine forests in the Jasper East study area.

Aspen stands are found in mountainous areas throughout the state to elevations of about 11,000 feet. Most aspen forests in Colorado become established after disturbance (typically fire) and are seral communities that change species composition over time, eventually becoming dominated by other forest types. In the study area, aspen stands occur at the edges of the lodgepole pine forests. Shrubs commonly found in the aspen forests include bitterbrush, shrubby cinquefoil, Wood's rose, grouse whortleberry, common juniper, and common gooseberry. Grasses include bluebunch wheatgrass, pinegrass, Kentucky bluegrass, Thurber fescue, Nelson needlegrass, and Nelson needlegrass. Forbs include lupine, Watson penstemon, Northwest cinquefoil, bedstraw, common harebell, and Colorado columbine.

5.5.2. Wetlands and Waters

5.5.2.1. Wetlands

Wetlands were mapped using aerial photography (Figure 15) and National Wetland Inventory mapping conducted by the FWS because there was no access to the site. Field verification would be needed to more accurately map wetlands. Because the site could not be visited, it was not possible to delineate wetlands or to differentiate wetlands from mesic native shrublands, which commonly occur in riparian areas. The wetland and mesic native shrubland vegetation cover types likely have a species composition similar to the wetland and mesic native shrublands described in the Jasper East study area. Wetlands and mesic native shrublands occur along drainages and in swales in the study area.

5.5.2.2. Waters

The study area (including the reservoir area and the pipeline to Windy Gap Reservoir) contains ditches, creeks, and a small stockpond (Figure 15). The pipeline connection to Windy Gap Reservoir would cross the Colorado River.

5.5.3. Plant Species of Concern

Table 3 lists the plant species of concern with potential to occur in the habitats in the Rockwell/Mueller Creek study area. Field surveys were not conducted for species of concern in the Rockwell/Mueller Creek study area because no access to the site was provided. The species with potential to occur in the Jasper East study area also have potential to occur in the Rockwell/Mueller Creek study area.

5.6. Colorado River

The study area used to evaluate potential effects to riparian and wetland vegetation along the Colorado River extends from below Lake Granby to the top of Gore Canyon downstream of Kremmling. This reach of the river has broad floodplains supporting riparian vegetation, as well as narrow canyons with minimal riparian development. Riparian vegetation along the Colorado River diminishes sharply from the top of Gore Canyon downstream for many miles because of the steep surrounding topography. Thus, the study focused on areas above Gore Canyon where riparian areas are more developed and where projected hydrologic changes would be greatest.

5.6.1. Vegetation Cover Types

Vegetation along the Colorado River is influenced by stream channel morphology (defined by stream channel width, depth, gradient, and pattern), floodplain topography, ground water, streamflow, and agricultural irrigation. Topography along the Colorado River includes open valleys of alluvial deposits supporting riparian vegetation below Lake Granby (Figures 18 through 21) and near the confluence with the Fraser River. The floodplain narrows below Windy Gap Reservoir (Figure 21) and widens again to a width of about ¼ mile, before narrowing substantially in Byers Canyon downstream of the town of Hot Sulphur Springs (Figure 22). Downstream of Byers Canyon, the floodplain widens again, ranging from about ¼ to ½ mile wide (Figures 23 through 26). Below the study area, the Colorado River floodplain constricts sharply through Gore Canyon (Figure 26).

Where the Colorado River floodplain is wide, vegetation typically includes riparian tree and shrub communities adjacent to the stream and irrigated hay meadows and rangeland on terraces above the channel (Figures 23 through 26). Streambank riparian areas are dominated by narrow-leaved cottonwoods, willows, sedges, and grasses such as orchardgrass, Kentucky bluegrass, and other pasture and upland grasses. Many of the meadows along the Colorado River are irrigated by ditches for hay production and are dominated by species such as meadow foxtail, smooth brome, and Kentucky bluegrass (Figures 20, Figure 23, Figure 24, and Figure 25). In areas where the Colorado River flows through narrow valleys (Figure 22), there is minimal to no floodplain and wetland or riparian vegetation occurs in narrow bands on the generally rocky and steep slopes adjacent to the river channel. Dominant vegetation in these areas includes upland grasses, shrubs, and trees.

To gain perspective on possible historical changes in the distribution and composition of riparian vegetation along the Colorado River, ERO ecologists examined aerial photographs from the 1970s and 2005 (Figures 18-26). From this comparison, the extent of riparian vegetation does not appear to have changed extensively since the 1970s. Observed changes include an increase in the size of shrub stands in some areas (Figure 18), an increase in the cover of shrubs in some areas (Figure 18), and a decrease in tree and shrub cover in other areas (Figure 20). Other changes observed along the Colorado River over the last 30 years include construction of Windy Gap Reservoir and off-channel small lakes or stockponds (Figure 19 and Figure 21). Riparian vegetation types are dynamic and variable over time, and from examination of the aerial photographs, the changes that have occurred fall within the natural variability expected.

Aerial photography also indicates that many of the terraces adjacent to the Colorado River are flood irrigated for hay production (Figures 23 through 26). Irrigation provides water to meadows in the floodplains and likely helps support riparian areas down gradient of the meadows.

5.6.2. Wetlands and Other Waters

NWI maps indicate wetlands along streambanks of the Colorado River, along irrigation ditches, below irrigated areas, in depressions in the floodplain, downslope of irrigation ditches, and along drainages that are tributary to the Colorado River, such as Williams Fork and Troublesome Creek (Figures 18-26) (FWS 1975 and 1983a through 1983d). This mapping shows areas of riparian vegetation and flood irrigated hay meadows. Aerial photography and field observations were used to verify the location of NWI-mapped wetlands. Wetlands are typically dominated by willows, shrubby cinquefoil, and graminoids such as reed canarygrass, sedges, rushes, Kentucky bluegrass, and bluejoint reedgrass. The Colorado River is a perennial stream.

5.7. Willow Creek

The Willow Creek study area extends from below Willow Creek Reservoir to the confluence with the Colorado River, where projected changes in Willow Creek Reservoir releases would occur (Figure 28).

5.7.1. Vegetation Cover Types

Riparian vegetation along Willow Creek is influenced by ground water, releases from Willow Creek Reservoir, stream channel characteristics, and irrigation practices in the area. The valley below Willow Creek Reservoir (Figure 28), contains irrigated hay meadows, wetlands, and riparian areas. Hay meadows along Willow Creek are dominated by species such as meadow foxtail, smooth brome, timothy, beaked sedge, redtop, and Kentucky bluegrass. They are supported primarily by irrigation, with a high water table from irrigation return flows above the floodplain and natural lateral flow from surrounding hillsides. Riparian areas near Willow Creek are dominated by willows, narrow-leaved cottonwoods, and grasses such as orchardgrass, Kentucky bluegrass, and other pasture and upland grasses (Figure 28). Below the existing Windy Gap pipeline crossing of Willow Creek (Figure 28), the topography constricts the stream channel and the floodplain narrows. Riparian vegetation is confined to the streambank and is dominated by pasture grasses, shrubs, and some trees.

5.7.2. Wetlands and Other Waters

Wetlands along Willow Creek below Willow Creek Reservoir include species such as Booth's willow, mountain willow, narrowleaf cottonwood, field sedge, water sedge, and beaked sedge (ERO 2001). Fens, which contain a surface horizon of organic material, are present in the valley at the toe of the hillside slopes away from the stream channel indicating a long history of natural seeps and ground water discharges. Areas that were not mapped during previous studies were examined using a 2005 aerial photograph and NWI maps (Figure 28). Based on field observations, willows, shrubby cinquefoil, and graminoids such as sedges, rushes, Kentucky bluegrass, bluejoint reedgrass, dominate these wetlands.

5.8. East Slope Streams

The East Slope study area for evaluating potential effects to riparian and wetland vegetation includes several streams. The Big Thompson River between Lake Estes and the Hansen Feeder Canal would experience an increase in flow from additional Windy Gap deliveries. Streams projected to receive additional wastewater treatment return flows include the Big Thompson River, St. Vrain Creek, Big Dry Creek, and Coal Creek. Under the No Action alternative, changes in flow would occur below Ralph Price Reservoir on North St. Vrain Creek and on St. Vrain Creek to the St. Vrain Supply Canal crossing (ERO and Boyle 2007).

5.8.1. Vegetation Cover Types, Wetlands, and Waters

5.8.1.1. North St. Vrain and St. Vrain Creeks

Below Ralph Price Reservoir, North St. Vrain Creek flows through narrow wooded valleys to the confluence with St. Vrain Creek. These wooded valleys are dominated by species such as Douglas-fir and ponderosa pine. At lower elevations and on south-facing slopes, upland native shrublands dominated by mountain mahogany are common. Riparian vegetation on North St. Vrain Creek is limited to a narrow band along the often-incised stream channel. Streambank vegetation includes willow, alder, cottonwood, chokecherry, and shrubby cinquefoil. Riparian vegetation along North St. Vrain Creek is particularly limited where the channel has been constricted by construction of Highway 36. St. Vrain Creek continues through a narrow valley until it flows out onto the plains near Lyons where the floodplain broadens. Cottonwoods dominate riparian areas along St. Vrain Creek along with palustrine persistent emergent and scrub-shrub wetlands. North St. Vrain and St. Vrain Creek are perennial tributaries to the South Platte River.

5.8.1.2. Big Thompson River

The Big Thompson River between Lake Estes, which is located at an elevation of about 8,000 feet at Estes Park, and the Hansen Feeder Canal, which is located in the plains on the west side of Loveland, would experience an increase in flow from additional Windy Gap deliveries. Immediately downstream of Lake Estes, the Big Thompson River flows through a broad grassy meadow. Narrow valleys and canyons characterize most of the reach of the Big Thompson River in the study area. In many places, fill placed for the embankment of U.S. Highway 34 and for other structures and roads, constrict the river, creating a narrow channel with steep banks. In these narrow valleys and canyons, riparian vegetation and wetlands occur primarily in narrow bands along the streambank and areas where the valley widens or where tributaries flow into the Big Thompson River. Riparian vegetation includes blue spruce, cottonwood, willow, aspen, alder, hawthorn, and sedges and forbs in wetter areas. When the Big Thompson flows onto the plains, riparian areas are dominated by plains cottonwood and palustrine persistent emergent and scrub-shrub wetlands. The Big Thompson River is a perennial tributary to the South Platte River.

5.8.1.3. Coal Creek

Coal Creek is a narrow perennial creek with cottonwood- and willow-dominated riparian areas and patches of palustrine persistent emergent and palustrine scrub-shrub wetlands. In many reaches, Coal Creek is incised, with steep banks. Coal Creek is a perennial tributary to Boulder Creek and the South Platte River.

5.8.1.4. Big Dry Creek

Big Dry Creek flows through urban and suburban areas, then through the plains to near Fort Lupton, where it enters the South Platte River. Vegetation along Big Dry Creek ranges from grasslands where the channel banks are steep, to hay meadows and other agricultural areas, to mixed mesic woodlands and shrublands. Areas of palustrine persistent emergent and palustrine scrub-shrub wetlands also are present.

6.0 ENVIRONMENTAL CONSEQUENCES

Environmental consequences for the WGFP alternatives include direct effects to vegetation resources including vegetation cover types, wetlands, and plant species of concern. This section describes the methods used for assessing potential effects, the types of effects common to all alternatives, and the potential environmental consequences for each alternative.

6.1. Methods Used for Evaluating Direct Effects to Vegetation Resources

Direct effects to vegetation resources were assessed quantitatively using GIS to overlay proposed project features on maps of vegetation cover types and wetlands. Permanent effects to vegetation resources would occur in areas that are inundated or permanently filled by project features such as a dam footprint and permanent access roads. Temporary effects to vegetation resources would occur in areas that would be returned to their approximate original contour and revegetated following construction, such as pipeline routes and staging areas.

6.1.1. Effects to Vegetation Cover Types

The area of each vegetation type that would be temporarily or permanently impacted at each of the alternative reservoir study areas was calculated using ArcMap computer software. These calculations were based on the size of the reservoir, dam footprint and other facilities. The potential effect to the CNHP-tracked plant communities is also discussed, although the area of potential effect was not quantified because of mixed composition of these communities and the gradation between other Vegetation Cover Types.

6.1.2. Effects to Wetlands and Waters

Effects to wetlands were evaluated by overlaying maps of project facilities with wetland mapping from field delineations or other data sources. Potential effects were quantified as either a permanent effect from inundation, dam construction, other surface affect, or a temporary affect associated with pipeline crossings and other short-term disturbances. Due to lack of access at the Rockwell/Mueller Creek study area, effects to wetlands were based on secondary data sources, including photo interpretation of potential riparian/wetland areas and NWI maps. Estimates of wetlands effects at Ralph Price Reservoir also were based on NWI mapping and field observations.

Potential effects to waters were determined from field investigations and the expected loss or disturbance from reservoir and facility construction. The potential area of effect was calculated from GIS mapping of the drainage and estimates of average widths of the drainages at Chimney Hollow, Jasper East, and Dry Creek. For the Rockwell/Mueller

Creek Reservoir site and Ralph Price Reservoir, waters were estimated from USGS 1:24,000 topographic quadrangles and aerial photographs.

There may be opportunities to reduce effects to wetlands and waters during final design by shifts in project features, staging areas, and other disturbances.

6.1.3. Effects to Plant Species of Concern

Potential effects to plant species of concern were evaluated based on either the presence of the species in the study area or the presence of suitable habitat where field surveys were not conducted. The effect to a species is discussed in light of the plant's rarity.

6.1.4. Effects to Riparian Vegetation

The assessment of potential indirect effects to riparian vegetation was based primarily on changing hydrologic conditions associated with each alternative. Key considerations were potential changes in channel morphology, changes in stream stage or reservoir elevation, and changes in ground water elevation. Hydrologic modeling and an assessment of stream channel morphology summarized in the Water Resources Technical Report (ERO and Boyle 2007) provide the primary basis for assessing potential effects on riparian and wetland vegetation due to changes in streamflow in the Colorado River and Willow Creek study areas. Comparison of historical and current channel morphology provides an indication of stream stability and the potential for future changes in channel morphology.

The hydrologic model generated streamflows at various gages and nodes and stream stage at calibrated gage sites. The model also generated reservoir water surface elevations. Hydrologic model output of daily and monthly average, wet, and dry years under each alternative was examined to determine changes in stream stage. Stream stage typically increases in May and June from snowmelt runoff and then recedes in July and August. Monthly stream stage values were found to be representative of the relative magnitude of changes in stage between Existing Conditions and the alternatives for comparison purposes. The average daily range of differences in stream stage between alternatives is both higher and lower than monthly values (Table 4). Changes in stream stage were evaluated in relation to natural variability in streamflow and published literature regarding the effects of changes in stream stage on riparian vegetation. Changes in stream stage may affect the elevation of alluvial ground water and riparian vegetation that is supported by ground water.

In addition, ERO examined aerial photographs from the 1970s and 2005, and NWI mapping to assess riparian and wetland vegetation in the Willow Creek and Colorado River study areas to compare the trend in riparian vegetation distribution. Field visits along the Colorado River study area were used to verify aerial photos and determine the location of riparian and wetland vegetation along Willow Creek and the Colorado River, and the influence of flood irrigation and tributary streams on riparian and wetland vegetation.

Table 4. Monthly average and daily average range of decreases in Colorado River stream stage compared to existing conditions for average years.

Month	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Hot Sulphur Springs Gage					
feet					
May					
Monthly Average	0.03	0.9	0.08	0.08	0.09
Daily Range	0.01–0.07	0.4–0.18	0.03–0.15	0.03–0.15	0.04–0.16
June					
Monthly Average	0.10	0.23	019	0.19	0.20
Daily Range	0.08–0.14	0.19–0.24	0.16–0.23	0.16–0.23	0.17–0.23
July					
Monthly Average	0.16	0.19	0.23	0.23	0.23
Daily Range	0.10–0.21	0.13–0.24	0.15–0.31	0.15–0.30	0.15–0.30
August					
Monthly Average	0.04	0.06	0.07	0.07	0.06
Daily Range	0.01–0.10	0.02–0.12	0.03–0.14	0.03–0.14	0.03–0.14
Kremmling Gage					
feet					
May					
Monthly Average	0.04	0.10	0.09	0.09	0.11
Daily Range	0.02–0.09	0.04–0.21	0.04–0.18	0.04–0.18	0.04–0.19
June					
Monthly Average	0.12	0.28	0.23	0.23	0.24
Daily Range	0.10–0.16	0.23–0.29	0.19–0.26	0.19–0.26	0.21–0.26
July					
Monthly Average	0.17	0.20	0.25	0.24	0.24
Daily Range	0.11–0.22	0.13–0.26	0.17–0.32	0.17–0.32	0.16–0.31
August					
Monthly Average	0.04	0.06	0.07	0.07	0.07
Daily Range	0.02–0.10	0.04–0.12	0.04–0.15	0.04–0.15	0.04–0.15

The effects to riparian vegetation focused primarily on changes in streamflow on the Colorado River where the greatest changes in streamflow and potential for effects to riparian vegetation might occur. Effects to riparian vegetation from changes in streamflow on Willow Creek below Willow Creek Reservoir also were evaluated, although stream stage data for Willow Creek were not available. Changes in reservoir water levels at Lake Granby, Horsetooth Reservoir, and Carter Lake were evaluated for the potential effect on shoreline riparian vegetation. Water surface elevations at Shadow Mountain Reservoir, Grand Lake, and Willow Creek Reservoir would not vary from Existing Conditions under any alternative; therefore, no analysis of effects to riparian vegetation at these three reservoirs was conducted. The projected changes in riparian vegetation on East Slope streams from additional wastewater return flows and changes in streamflow in the Big Thompson River below Lake Estes and in North St. Vrain Creek and St. Vrain Creek were evaluated based on available hydrologic data.

The following factors were considered in the evaluation of potential effects to riparian and wetland vegetation along rivers and streams under each of the alternatives.

Topography—Relatively flat floodplains provide opportunities for the establishment and maintenance of riparian and wetland vegetation that establish roots in alluvial ground

water. The assessment of possible effects to riparian resources focused on stream reaches with topography favorable for the establishment of riparian vegetation as determined from reviews of aerial photography. Canyons such as Byers Canyon (Figure 22) do not support large areas of riparian vegetation; wide floodplains (Figures 18 through 26) are more likely to support riparian and wetland vegetation.

Stream morphology—Stream channel morphology influences the composition, distribution, and maintenance of riparian vegetation. Gregory et al. (1991) describe riparian zones in terms of the spatial and temporal patterns of hydrologic and geomorphic processes, based on the premise that geomorphic processes create a mosaic of stream channels and floodplains. The assessment of potential effects to riparian resources focused on changes in channel maintenance flows and the potential for changes in flow to affect the channel and in turn, the conditions necessary to support riparian vegetation. The magnitude, duration, timing, and frequency of channel maintenance flows can affect riparian vegetation, which in turn affects channel dynamics (Schmidt and Potyondy 2004). For example, a reduction in channel maintenance flows can allow riparian vegetation to encroach into the channel. An increase in channel maintenance flows can increase streambank erosion and reduce riparian vegetation in areas where streamflow velocities are high. Flows above the top of the streambank inundate the floodplain and create moist substrates, scour the floodplain, deposit sediment, and provide for water storage and nutrient cycling. Scouring flows mobilize and redistribute sediments that can provide opportunities for the establishment of riparian vegetation. Several authors have found relationships between channel maintenance discharges (specifically the bankfull discharge, which occurs on average every 1.5 to 2 years) and riparian and wetland vegetation (Johnson, et al. 1999; Linsley et al. 1975; FWS 2001; Mitsch and Gosselink 1993; Smith and Hill 2000). Schmidt and Potyondy (2004) note, however, that although bankfull elevation is related to vegetation along the channel, a range of channel maintenance flows is necessary to keep vegetation from encroaching on the channel.

Hydrology—Topography and stream morphology set the physical stage for the establishment of riparian vegetation; however, a site must have a supportive hydrology to maintain riparian vegetation. Because the alternatives would affect streamflows, the assessment of potential effects to riparian resources also evaluated the relationship between stream stage and ground water levels. Stream stage (the elevation of water in the channel) can affect the elevation of the alluvial ground water. A direct relationship between stream stage and alluvial ground water elevations typically occurs on stream reaches where streamflow is the primary source of water for the alluvial ground water. In montane environments, alluvial ground water levels are frequently supported by ground water that moves from higher elevations to river valleys. In these situations, long-term ground water elevations are controlled more by the inflow of ground water from higher elevations draining to the stream than by fluctuations of streamflows. Stream reaches with ground water elevations that are relatively independent of streamflows are characterized by ground water discharging to the stream and are referred to as gaining streams. Riparian vegetation on stream reaches with ground water elevations that are independent of streamflows are unlikely to be affected by changes in streamflow.

6.2. Vegetation Effects Common to All Alternatives

6.2.1. Temporary Vegetation Disturbance

All of the alternatives would result in temporary disturbances to vegetation from construction of the dam, spillway, roads, pipeline installation, and other facilities. Temporarily impacted areas would be revegetated following construction. Revegetated areas are likely to take several years to recover and species composition may differ from current conditions, particularly where forested or upland shrub vegetation is removed.

6.2.2. Noxious Weeds

Construction activities and disturbed soils are susceptible to invasion and spread of noxious weeds. Implementation of a noxious weed control plan would be used to control the establishment and spread of weeds.

6.2.3. Change in Existing Reservoir Water Levels

Each alternative would result in changes in reservoir storage of several existing C-BT reservoirs—Lake Granby, Carter Lake, and Horsetooth Reservoir. In general, all the alternatives, including No Action, would result in lower water surface levels in Lake Granby throughout the year and during the growing season. On average, Lake Granby would be about 2.1 feet lower from May to September under the No Action alternative than Existing Conditions, and the Proposed Action would be about 5.4 feet lower. For the other alternatives, the change in water levels would fall in between these values. The range of change in water level in Horsetooth Reservoir would be similar to Lake Granby. Decreases in water levels in both reservoirs would be slightly more in dry years and less in wet years for all alternatives. Historically, Horsetooth Reservoir has fluctuated up to 45 feet, and Lake Granby water levels have fluctuated by nearly 90 feet. The vegetation types bordering Lake Granby and Horsetooth Reservoir include upland and riparian species not dependent on lake levels. Lower water levels in Lake Granby and Horsetooth Reservoir are unlikely to substantially affect vegetation for any of the alternatives because reservoir fluctuations would fall within the historical operations of the reservoir. In addition, the water surface elevation in the reservoirs fluctuates considerably as part of reservoir operations and existing shoreline vegetation developed in response to fluctuations in water surface elevations and is supported by multiple water sources.

Changes in reservoir levels in Carter Lake would be less than 2 feet for all of the alternatives under wet, dry, and average conditions and would fluctuate within the levels maintained as part of existing reservoir operations. Therefore, changes in reservoir elevation under Alternatives 1 through 5 would have no measurable effect on the limited riparian vegetation bordering the lake.

None of the alternatives would affect reservoir water levels in Shadow Mountain Lake, Grand Lake, Willow Creek Reservoir, or other smaller C-BT reservoirs. Thus, there would be no effect on vegetation resources at these reservoirs. Shadow Mountain Reservoir and Grand Lake fluctuate less than 1 foot, and the riparian vegetation around these reservoirs likely has developed based on stable water levels. In all of the reservoirs, riparian vegetation is unlikely to be affected by the alternative actions because the reservoirs would continue to operate within existing operational pools (i.e., the reservoir elevation would not exceed current maximum or minimum size and/or elevation).

6.2.4. Riparian and Wetland Vegetation Downstream of New Reservoirs

The development of riparian or wetland vegetation downstream from each of the potential reservoir sites at Chimney Hollow, Dry Creek, Jasper East, and Rockwell/Mueller Creek is possible. All of these drainages are on ephemeral channels and releases would be made as necessary to bypass flows similar to existing conditions. However, seepage below the dam could result in greater streamflow or perennial flows below the dam that may cause development of riparian or wetland vegetation.

6.2.5. Wetland and Waters Permitting

A Clean Water Act 404 permit would be necessary for temporary and permanent impacts to wetlands or other waters at each of the alternative sites. The permitting and any mitigation requirements for impacts to wetlands and waters would be coordinated with the Corps for the selected alternative.

6.3. Alternative 1—Ralph Price Reservoir Expansion (No Action)

6.3.1. Vegetation Cover Types

About 77 acres of vegetation in the Ralph Price study area would be permanently affected by inundation and dam enlargement (Table 5). Upland native forests would have the largest area of permanent effects (71.7 acres) along with small areas of upland native shrub and upland native grassland. Temporary effects to vegetation at borrow areas and construction staging areas have not been determined, but forested areas and grasslands are most likely to be affected. Construction of the reservoir could result in the development of new vegetation communities around the lake margin. This could include shoreline wetlands and riparian species; however, because of the steep terrain, substantial riparian vegetation development is unlikely.

6.3.2. Wetlands and Waters

The area of wetlands that would be impacted at the Ralph Price study area was estimated using aerial photography and NWI mapping. It is estimated that about 0.3 acre of wetlands would be affected by expansion of the current reservoir. The wetlands observed during the site visit occur near stream inlets and shallow areas adjacent to the current reservoir shoreline. New wetlands would likely develop along stream inlets and shoreline areas of the expanded reservoir, similar to those currently present. Wetland functions lost would likely be replaced with redevelopment of similar communities around the expanded reservoir. The temporary drawdown of the reservoir during construction to access borrow areas would affect the supporting hydrology for existing wetlands and the waters created by the existing reservoir.

Expansion of Ralph Price Reservoir would inundate about 500 feet or 0.1 acre of the North St. Vrain Creek at the upstream end of the reservoir (Figure 7). It is uncertain if raising the existing dam by 50 feet would require additional fill in North St. Vrain below the dam. Small tributaries to Ralph Price Reservoir, such as Rattlesnake Gulch, Long Gulch, and other unnamed drainages may also have waters that would be within the new reservoir pool. The enlarged reservoir would create about 77 acres of additional open water.

Table 5. Alternative 1—Summary of direct effects to vegetation cover types.

Vegetation Cover Type	Permanent Effects (acres)
Upland native shrublands	3.3
Upland native grasslands	1.3
Upland native forest	71.7
Wetlands	0.28
Waters	0.1
Total	**76.68**

6.3.3. Plant Species of Concern

The Ralph Price Reservoir study area does not contain suitable habitat for federally listed threatened plant species—Ute ladies'-tresses orchid and Colorado butterfly plant. Hence, there would be no affect to these species.

The CNHP database indicates five plant species of concern that could potentially occur in the study area—the Larimer aletes, rattlesnake fern, broad-leaved twayblade, Rocky Mountain cinquefoil, and prairie violet. Each of the five species occurs in montane locations within the elevation range of the study area. Larimer aletes, broad-leaved twayblade, and Rocky Mountain cinquefoil could potentially be affected by the loss of upland native forest from reservoir expansion or at borrow areas. Rattlesnake fern prefers moist ravines and springs. The potential for this species to be affected is low because very little habitat of this nature would be affected by the expansion. Furthermore, rattlesnake fern is only known to occur in southern Boulder County. Potential effects to potential prairie violet habitat, which occurs in meadows surrounded by woodlands, would be minor from reservoir construction because permanent effects to native grasslands would be less than 1 acre, although additional grassland disturbance at borrow areas is possible.

6.4. Alternative 2—Chimney Hollow Reservoir (90,000 AF) (Proposed Action)

6.4.1. Vegetation Cover Types

In the Chimney Hollow study area, a total of about 794 acres would be permanently affected, and 123 acres would be temporarily disturbed. The largest permanent effect would occur to upland native shrubs, mixed grasslands, and forest (Table 6). Native vegetation generally provides higher quality wildlife habitat, greater biodiversity, and is less disturbed than areas dominated by introduced species. However, many of the native vegetation communities have a large component of cheatgrass, thereby reducing their wildlife value and biodiversity compared to native areas in the region not infested with this noxious weed.

Table 6. Alternative 2—Summary of direct effects to vegetation cover types.

Vegetation Cover Type	Permanent Effects (acres)[1]	Temporary Effects (acres)[2]
Upland native shrublands	260.6	21.3
Upland native grasslands	119.4	38.7
Upland native forest	135.3	3.6
Upland introduced grasslands	31.7	10.4
Mesic mixed grasslands	192.5	24.2
Mesic native woodlands	40.2	6.0
Mesic native shrublands	8.2	18.6
Disturbed	3.8	0.2
Wetlands	1.6	0.1
Waters	1.3	0.1
Total	**794.6**	**123.2**

[1]Permanent effects include the reservoir footprint and dam, and access roads.
[2]Temporary effects include pipeline corridors, construction staging areas, and borrow areas.

Additionally, four plant communities tracked by the CNHP would be temporarily and permanently impacted by the proposed Chimney Hollow Reservoir site. The CNHP imperiled to vulnerable mountain mahogany/New Mexico needlegrass shrublands found in the upland native shrubland and the imperiled ponderosa pine/mountain mahogany/big bluestem forest found in the upland native forest would be lost or disturbed by reservoir construction. The narrowleaf cottonwood/common chokecherry riparian area is rated as state critically imperiled because five or fewer sites are known. However, the very small site found at Chimney Hollow is not listed by the CNHP as a known location and therefore is not included in its ranking criteria. A small area of skunkbush riparian community found in small patches of the drier drainages would be affected by reservoir construction. Most of these CNHP-tracked plant communities are somewhat degraded (CNHP 2004g) by the invasion of cheatgrass and other weeds or grazing activities. The relative rarity of these plant communities is based on known populations within the CNHP database, which may not reflect the actual statewide population. Additionally, small patches of the mountain mahogany/needle-and-thread grass community may potentially be impacted by this project, although this community was not delineated.

For temporarily impacted areas, including the pipeline connection to C-BT facilities and construction staging areas, it is assumed that disturbed areas would be revegetated with native grasses and forbs and possibly some woody plantings. This would change the characteristics of about 10 acres of existing forest and woodland and about 40 acres of shrublands to grasslands until the woody vegetation matures. Mountain mahogany-dominated shrublands and mature ponderosa pine forests in particular may take many years to re-establish.

Relocation of the transmission line would result in small areas of permanent disturbance associated with placement of the tower pads and temporary disturbances during installation. Under the power line, trees would need to be cleared to a width up to

80 feet. This would result in a change in vegetation cover type from forest to shrubland or grassland. In addition, there would be disturbances associated with construction of access and maintenance roads to the transmission line. Construction access roads for the transmission line would not be identified until final design, but would take advantage of existing roads as much as possible.

An additional disturbance to vegetation would occur from construction of a parking area and other recreation facilities on the west side of the reservoir near the dam. Upland native grasslands and upland native shrublands would be the primary vegetation cover types affected. Trail construction on Municipal Subdistrict property would result in the loss or disturbance of vegetation along designated trail corridors and from shoreline fishing. The specific placement of recreation facilities would not be determined until final design.

6.4.2. Wetlands and Waters

About 1.6 acres of wetlands would be permanently impacted and about 0.1 acre of wetlands would be temporarily disturbed from construction of a 90,000 AF Chimney Hollow reservoir and facilities (Table 6). Permanently impacted wetlands along Chimney Hollow have been previously disturbed by grazing, while the wetlands in the tributaries are relatively undisturbed. Impacted wetlands are rated with a high function for rare or imperiled CNHP-tracked wildlife species habitat and ground water discharge.

Waters within the study area are narrow intermittent streams. Construction of Chimney Hollow Reservoir would permanently affect 1.3 acre of waters along Chimney Hollow and several small drainages. Temporary effects to waters would be about 0.1 acre.

Construction of the reservoir may result in the development of new vegetation communities around the lake margin because the reservoir would remain near capacity throughout the growing season and the rest of year. Stable water levels would help support shoreline wetlands and riparian species, although steep banks would prevent substantial riparian development. Seepage below the dam could also increase the potential for wetland or riparian vegetation establishment.

6.4.3. Plant Species of Concern

There would be no effect to federally listed threatened Ute ladies'-tresses orchid or Colorado butterfly plant from construction of Chimney Hollow Reservoir and facilities because no suitable habitat is present and/or the species were not found during field surveys. Potential habitat for several CNHP species of concern is present in the study area, but none were found during field surveys and there are no historical records in the Chimney Hollow study area for these species. Thus, there would be no effect to CNHP-tracked species.

6.5. Alternative 3—Chimney Hollow Reservoir (70,000 AF) and Jasper East Reservoir (20,000 AF)

6.5.1. Chimney Hollow Reservoir (70,000 AF)

6.5.1.1. Vegetation Cover Types

In the Chimney Hollow (70,000 AF) study area, a total of about 675 acres would be permanently affected, and 131 acres would be temporarily disturbed by reservoir construction and facilities (Table 7). The largest permanent effect would occur to native shrub, mixed grassland, and forest vegetation. Native vegetation generally provides higher quality wildlife habitat, greater biodiversity, and is less disturbed than areas dominated by introduced species. However at Chimney Hollow, many of the areas of native vegetation have a large component of the noxious weed cheatgrass thereby reducing their ecological value compared to native areas in the region not infested with this noxious weed.

Table 7. Effects to vegetation at the Chimney Hollow study area (70,000 AF) Reservoir.

Vegetation Cover Type	Permanent Effects (acres)[1]	Temporary Effects (acres)[2]
Upland native shrublands	204.4	29.9
Upland native grasslands	100.3	52.2
Upland native forest	116.8	11.7
Upland introduced grasslands	31.0	10.5
Mesic mixed grasslands	168.9	20.4
Mesic native shrublands	7.7	0.1
Mesic native forest	39.9	5.8
Disturbed	3.8	0.2
Wetlands	1.5	0.1
Waters	1.3	0.1
Total	**675.6**	**131**

[1]Permanent effects include the reservoir footprint and dam, access roads, and pump stations.
[2]Temporary effects include pipeline corridors and a 40-foot buffer along access roads.

Additionally, four plant communities and one possible plant community tracked by the CNHP as state vulnerable/imperiled or imperiled would be affected by construction of a 70,000 AF Chimney Hollow Reservoir. Potential effects to these four communities would be similar to those described for Alternative 2.

It is assumed that temporary disturbance areas would be revegetated with appropriate native grasses and forbs and possibly some woody plantings. This would change the characteristics of about 12 acres of native forest and 40 acres of shrublands to grasslands at least until the woody vegetation matures. Mountain mahogany-dominated shrublands and mature ponderosa pine forests in particular may take many years to re-establish. Potential effects to vegetation from relocation of the transmission line and construction of recreation facilities would be the same as described for Alternative 2.

6.5.1.2. Wetlands and Waters

Permanent effects to wetlands from a 70,000 AF Chimney Hollow Reservoir would be slightly less (0.09 acre) than the 90,000 AF Chimney Hollow Reservoir in Alternative 2. About 1.5 acres of wetlands would be permanently affected and about 0.1 acre of wetlands would be temporarily affected from construction of a 70,000 AF Chimney Hollow Reservoir (Table 7). Wetlands along Chimney Hollow that would be permanently impacted have been somewhat disturbed by grazing, although the wetlands in the tributaries are relatively undisturbed. This alternative would affect wetlands rated as high for rare or imperiled CNHP wildlife species habitat, general wildlife habitat, and ground water discharge.

On average, Chimney Hollow Reservoir levels would remain fairly stable throughout the year, but generally below capacity. The establishment of riparian vegetation tolerant of periodic inundation on the reservoir perimeter where the shoreline is less steep is possible.

Effects to waters would be the same as Alternative 2.

6.5.1.3. Plant Species of Concern

Similar to the 90,000 AF Chimney Hollow Reservoir in Alternative 2, historical records and field surveys did not locate any threatened, endangered, or CNHP plant species in the Chimney Hollow study area; hence, there would be no effect to these species from reservoir and facility construction.

6.5.2. Jasper East Study Area

6.5.2.1. Vegetation Cover Types

In the Jasper East study area, 482 acres would be permanently affected from reservoir and dam construction, roads, and relocation of Willow Creek pipeline and pump station (Table 8). Mesic mixed grasslands (irrigated grasslands) would have the largest area of permanent effects (290 acres), followed by upland native shrubland (107 acres), and upland mixed grassland (23 acres).

A total of 130 acres would be temporarily impacted during construction. Upland native shrubland would have the greatest area of temporary effect (58 acres), and 47 acres of mesic mixed grassland would be temporarily impacted. About 11 acres of temporary effects would occur in areas that have been disturbed by past activities. Temporary disturbance to 1 acre of upland native forest and about 66 acres of upland native shrubland and mesic native shrubland would be revegetated, but it would take a number of years before woody vegetation would re-establish.

The study area also contains irrigation ditches that may need relocation to supply irrigated hay meadows not affected by the reservoir and facilities.

Table 8. Effects to vegetation at the Jasper East study area.

Vegetation Cover Type	Permanent Effects (acre)[1]	Temporary Effects (acre)[2]
Upland native shrublands	106.7	57.8
Upland native forest	13.3	1.3
Upland mixed grasslands	22.9	0.0
Mesic mixed grasslands	289.5	46.9
Mesic native shrublands	3.1	8.3
Disturbed	19.6	11.4
Wetlands	21.2	4.8
Ditches	6.0	0.11
Waters	0.3	0.2
Total	**482.6**	**130.6**

[1]Permanent effects include the reservoir footprint and dam, access roads, and pump stations.
[2]Temporary effects include pipeline corridors and a 40-foot buffer along access roads.

6.5.2.2. Wetlands and Waters

About 21 acres of wetlands would be permanently impacted in the footprint of the pump station, dam, access road, and reservoir. About 5 acres of wetlands would be temporarily disturbed during construction of pipelines and access roads. Some of the wetlands (an estimated 8 acres, or 38 percent of the wetlands impacted) that would be permanently impacted are likely created as a result of flood irrigation and have been affected by grazing and hay harvesting. The development of shoreline wetlands and riparian vegetation communities around the reservoir margin is unlikely because of projected large annual fluctuations in reservoir elevations that would limit plant establishment to those communities that can tolerate periodic flooding and drawdown. Seepage below the dam could also increase the potential for wetland or riparian vegetation establishment.

About 0.3 acre of effects to waters in the form of intermittent creek channel would be permanently impacted as a result of construction of the reservoir and dam. About 0.1 acre of effects to the intermittent creek channel would be temporarily impacted during construction of the reservoir, dams, and pipeline. The new reservoir would create about 434 acres of open water. The existing approximate 6-acre forebay and the Willow Creek Pump Canal would be replaced by a similar sized pond and canal.

6.5.2.3. Plant Species of Concern

There would be no effect to the endangered plants—osterhout milkvetch and penland beardtongue from construction of Jasper East Reservoir and facilities because neither species was found during field surveys.

Middle Park penstemon, a CNHP-tracked species, was found in most of the Wyoming big sagebrush/bluebunch wheatgrass shrubland in the study area, generally at fairly low densities (less than one plant per 10,000 square feet). About 107 acres of native

shrubland that contains Middle Park penstemon would be permanently affected, and about 58 acres would be temporarily disturbed. Middle Park penstemon is listed as G4, S3/S4 (globally secure, but apparently secure to vulnerable in Colorado). Large areas of sagebrush-dominated upland native shrubland occur in the vicinity of the study area, and Middle Park penstemon likely occurs in these shrublands as well as in the Jasper East study area. Temporary and permanent effects to Middle Park penstemon are unlikely to substantially affect the long-term viability of this species range-wide because suitable habitat is common in the vicinity of the study area.

6.5.3. Summary of Vegetation and Wetland Effects under Alternative 3

Table 9 summarizes the combined direct effect to vegetation that would occur from construction of Chimney Hollow Reservoir and Jasper East Reservoir under Alternative 3.

Table 9. Alternative 3—Summary of direct effects to vegetation cover types.

Vegetation Cover Type	Permanent Effects (acres)[1]	Temporary Effects (acres)[2]
Upland native shrublands	311.1	87.7
Upland native grasslands	100.3	52.2
Upland native forest	130.1	13.0
Upland introduced/Mixed grasslands	53.9	10.5
Mesic mixed grasslands	458.4	67.3
Mesic native shrublands	10.8	8.4
Mesic native forest	39.9	5.8
Disturbed	23.4	11.6
Wetlands	23.0	5.0
Waters	0.1	0.2
Ditches	6.0	0.1
Total	**1157.0**	**261.8**

[1]Permanent effects include the reservoir footprint and dam, and access roads.
[2]Temporary effects include pipeline corridors and borrow areas.

6.6. Alternative 4—Chimney Hollow Reservoir (70,000 AF) and Rockwell/Mueller Creek Reservoir (20,000 AF)

6.6.1. Chimney Hollow Reservoir (70,000 AF)

The affect to vegetation, wetlands, and plant species of concern from constructing a 70,000 AF reservoir at Chimney Hollow would be the same as those discussed for Alternative 3.

6.6.2. Rockwell/Mueller Creek Reservoir (20,000 AF)

6.6.2.1. Vegetation Cover Types

Construction of Rockwell/Mueller Creek Reservoir and associated facilities would permanently affect a total of about 313 acres (Table 10). Permanent effects would result from construction of the pump station, dam, access and realigned roads, spillway, and the reservoir. Upland native shrublands would have the largest area of permanent effects (261 acres), followed by upland mixed grassland (24 acres). About 14 acres of mesic native shrublands that include wetlands would be permanently impacted.

A total of 159 acres of vegetation would be temporarily impacted during the placement of pipelines, borrow areas, and roads. Upland native shrubland would have the greatest area of temporary effects (103 acres), and 14 acres of upland mixed grassland and about 15 acres of mesic mixed grassland would be temporarily impacted.

Temporary disturbance to 14 acres of upland native forest and about 108 acres of upland native shrubland and mesic native shrubland would be revegetated, but it would take a number of years before woody vegetation would re-establish.

Table 10. Effects to vegetation at the Rockwell/Mueller Creek study area (20,000 AF).

Vegetation Cover Type	Permanent Effects (acres)[1]	Temporary Effects (acres)[2]
Upland native shrublands	261.1	102.5
Upland native forest	5.1	14.3
Upland mixed grasslands	24.0	14.2
Mesic mixed grasslands	0.3	14.9
Mesic native shrubland/ Wetlands[3]	13.6	5.0
Disturbed	5.0	5.9
Wetlands	3–13.6[3]	2–5[3]
Waters	3.6	1.7
Ditches	—	0.1
Total	**312.7**	**158.6**[3]

[1]Permanent effects include the reservoir footprint and dam, access roads, and pump stations.
[2]Temporary effects include pipeline corridors and a 40-foot buffer along access roads.
[3]Wetland effects at Rockwell/Mueller Creek were based on aerial photography and NWI maps. The mesic native shrubland cover type includes potential permanent wetland impacts of 3 to 13.6 acres and temporary wetland impacts of 2 to 5 acres.

6.6.2.2. Wetlands and Waters

Wetlands that would be affected by construction of the Rockwell/Mueller Creek Reservoir were estimated using aerial photography and NWI mapping. Assuming wetlands comprise a portion of the mesic native shrubland community, this alternative would permanently affect a maximum of about 14 acres and temporarily disturb a maximum of 5 acres of wetlands (Table 10). NWI maps for the study area show that about 3 acres of wetlands would be permanently impacted and less than 2 acres would be temporarily impacted. The NWI mapping likely represents the minimum amount of

wetlands that would be affected. The pipeline connection to Windy Gap Reservoir would cross the Colorado River and adjacent wetlands. Wetland functions and values were not investigated in the Rockwell/Mueller Creek study area, but are likely similar to those in the Jasper East study area.

The development of shoreline wetlands and riparian vegetation communities around the Rockwell/Mueller Creek Reservoir margin is unlikely because of projected large annual fluctuations in reservoir elevations that would limit plant establishment to those communities that can tolerate periodic flooding and drawdown. Seepage below the dam could also increase the potential for wetland or riparian vegetation establishment.

Although not field verified, it is assumed that Rockwell and Mueller creeks are intermittent creeks. Construction of the 30,000 AF Rockwell/Mueller Creek Reservoir is estimated to inundate or permanently fill from dam construction about 0.6 acre of stream channel (Figure 15). An approximate 3-acre stockpond would be inundated at the Rockwell/Mueller Creek Reservoir site. In addition, about 1.6 acres of waters would be temporarily impacted during placement of the raw water pipeline across the Colorado River.

6.6.2.3. Plant Species of Concern

The Rockwell/Mueller Creek Reservoir site contains potential habitat for the endangered Osterhout milkvetch and Penland beardtongue, but no field surveys were conducted to determine if they are present.

Sagebrush dominates most of the upland native shrublands in the study area. Middle Park penstemon, a vulnerable state species tracked by the CNHP, potentially occurs in Wyoming big sagebrush shrublands. About 261 acres of upland native shrubland would be permanently impacted and about 103 acres would be temporarily impacted. The loss or disturbance of sagebrush habitat would reduce the habitat and population of Middle Park penstemon.

6.6.2.4. Summary of Vegetation and Wetland Effects Under Alternative 4

Table 11 summarizes the combined direct effects to vegetation that would occur from construction of Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir under Alternative 4. Wetland impacts for the Rockwell/Mueller Creek Reservoir and the pipeline between the reservoir and the Windy Gap Reservoir were based on aerial photography and NWI maps. Permanent wetland impacts could range between about 5 acres and about 15 acres for Alternative 4. Temporary impacts to wetlands could range between about 2 acres and 5 acres for this alternative.

Table 11. Alternative 4—Summary of direct effects to vegetation and wetlands.

Vegetation Cover Type	Permanent Effects (acres)[1]	Temporary Effects (acres)[2]
Upland native shrublands	465.5	132.4
Upland native grasslands	100.3	52.2
Upland native forest	121.9	26.0
Upland introduced/Mixed grasslands	55.0	24.7
Mesic mixed grasslands	169.2	35.3
Mesic native shrublands	21.3	5.1
Mesic native forest	39.9	5.8
Disturbed	8.8	6.1
Wetlands[3]	4.5-15.1	2.1-5.1
Waters	4.9	1.8
Ditches	0.0	0.1
Total[4]	**988.6**	**289.7**

[1]Permanent effects include the reservoir footprint and dam, access roads, and pump stations.
[2]Temporary effects include pipeline corridors and a 40-foot buffer along access roads.
[3]Permanent wetland impacts at Rockwell/Mueller Creek site could range from 3 to 13.6 acres and temporary impacts could range from 2 to 5 acres.
[4]Wetlands at Rockwell/Mueller are included in both mesic native shrubland cover type and wetlands and are not double counted in total.

6.7. Alternative 5—Dry Creek Reservoir (60,000 AF) and Rockwell/Mueller Creek Reservoir (30,000 AF)

6.7.1. Dry Creek Reservoir

6.7.1.1. Vegetation Cover Types

About 656 acres of vegetation in the Dry Creek study area would be permanently impacted by reservoir and facility construction (Table 12). The largest effect would occur to upland native forest (201 acres), mesic mixed grassland (160 acres), and upland native shrublands (149 acres). About 158 acres of vegetation would be temporarily disturbed during construction. The majority of the temporary impacts would occur in mesic mixed grasslands, upland native grasslands, and upland native forest.

Table 12. Effects to vegetation at the Dry Creek Reservoir study area.

Vegetation Cover Type	Permanent Effects (acres)[1]	Temporary Effects (acres)[2]
Upland native shrublands	149.1	31.1
Upland native grasslands	89.7	24.5
Upland native forest	200.8	35.9
Upland introduced grasslands	10.7	5.0
Mesic mixed grasslands	159.6	42.1
Mesic native shrublands	11.8	2.1
Mesic native woodlands	24.3	8.4
Disturbed	2.0	7.6
Wetlands	6.2	0.3
Waters	2.8	0.3
Total	**657.0**	**157.3**

[1]Permanent effects include the reservoir footprint and dam, borrow areas, access roads, and pump stations.
[2]Temporary effects include pipeline corridors and a 40-foot buffer along access roads.

Additionally, two plant communities tracked by the CNHP would be affected by the construction of Chimney Hollow Reservoir—ponderosa pine/mountain mahogany/big bluestem forest and skunkbush riparian. Most of these communities are somewhat degraded by the invasion of cheatgrass and other weeds or grazing activities (CNHP 2004g). The ponderosa pine/mountain mahogany/big bluestem forest community is rated by the CNHP as state vulnerable/imperiled and the skunkbush riparian community is state imperiled. The relative rarity of these plant communities is based on known populations within the CNHP database, which may not reflect the actual statewide population. Four other communities tracked by the CNHP as vulnerable/imperiled or imperiled also may be affected by the proposed reservoir. These four communities are mountain mahogany/New Mexico needlegrass, mountain mahogany/needle-and-thread grass, mountain mahogany-threeleaf sumac/big bluestem, and needle-and-thread grass-blue grama. These communities were not found during field surveys.

It is assumed that all temporarily disturbed areas would be revegetated with appropriate native grasses and forbs and possibly some woody plantings. However, this would change the characteristics of 44 acres of upland native forests and mesic native woodlands, and 33 acres of upland and mesic native shrublands to grasslands at least until the woody vegetation matures. Mountain mahogany-dominated shrublands and mature ponderosa pine forests in particular may take many years to re-establish.

A potential southern access road south of the reservoir along an existing road could result in additional effects to vegetation. Because the size and need for this road have not been determined, potential effects to vegetation have not been quantified.

6.7.1.2. Wetlands and Waters

About 6.2 acres of wetlands would be permanently impacted and about 0.3 acre of wetlands would be temporarily impacted from construction of Dry Creek Reservoir and facilities. Along Dry Creek, wetlands that would be permanently impacted have been

somewhat disturbed by grazing; however, wetlands in the tributaries are relatively undisturbed. This alternative would affect wetlands rated with a high function for rare or imperiled CNHP-tracked wildlife species habitat, general wildlife habitat, and ground water discharge.

Construction of Dry Creek Reservoir would permanently affect about 2.8 acres of waters including Dry Creek and several tributaries, either from inundation or fill from dam construction. The new reservoir would create about 590 acres of open water.

Construction of the reservoir may result in the development of new vegetation communities around the lake margin because the reservoir would remain near capacity throughout the growing season and the rest of year. Stable water levels would help support shoreline wetlands and riparian species, although steep banks would prevent substantial riparian development. Seepage below the dam could also increase the potential for wetland or riparian vegetation establishment.

6.7.1.3. Plant Species of Concern

There would be no effect to federally listed threatened Ute ladies'-tresses orchid or Colorado butterfly plant from construction of Dry Creek Reservoir and facilities because no suitable habitat is present and/or the species were not found during field surveys. Potential habitat for several CNHP species is present in the study area, but none were found during field surveys and there are no historical records in the Dry Creek study area for these species. Thus, there would be no effect to CNHP-tracked species.

6.7.2. Rockwell/Mueller Creek Reservoir (30,000 AF)

6.7.2.1. Vegetation Cover Types

Construction of the 30,000 AF Rockwell/Mueller Creek Reservoir and associated facilities would permanently affect a total of about 387 acres of vegetation (Table 13). Upland native shrublands would have the largest area of permanent effects (326 acres), followed by upland mixed grassland (30 acres). About 15 acres of mesic native shrub/wetland would be permanently impacted.

A total of 165 acres would be temporarily disturbed during the placement of pipelines and roads. Upland native shrublands would have the greatest area of temporary effects (108 acres), followed by 15 acres of mesic mixed grassland, and about 14 acres of both upland native forest and upland mixed grassland. About 6 acres of temporary effects would occur in areas that have been disturbed by past activities.

Table 13. Effects to vegetation at the Rockwell/Mueller Creek study area (30,000 AF Reservoir).

Vegetation Cover Type	Permanent Effects (acres)[1]	Temporary Effects (acres)[2]
Upland native shrublands	325.5	108.3
Upland native forest	8.5	14.4
Upland mixed grasslands	29.6	14.2
Mesic mixed grasslands	0.3	14.9
Mesic native shrublands/Wetlands[3]	15.6	4.8
Disturbed	6.5	6.2
Wetlands	N/A[3]	N/A[3]
Waters	3.7	1.6
Ditches	—	0.1
Total	**389.7**	**164.5**

[1]Permanent effects include the reservoir footprint and dam, access roads, and pump stations.
[2]Temporary effects include pipeline corridors and a 40-foot buffer along access roads.
[3]Wetland effects at Rockwell/Mueller Creek were based on aerial photography and NWI maps. The mesic native shrubland cover type includes potential permanent wetland impacts of 3 to 15.6 acres and temporary wetland impacts of 2 to 5 acres.

6.7.2.2. Wetlands and Waters

Effects to wetlands at the Rockwell/Mueller Creek study area were estimated using aerial photography and NWI mapping. Assuming wetlands occur within the mesic native shrub community, this alternative would permanently affect a maximum of about 16 acres or temporarily affect a maximum of about 5 acres of wetlands (Table 13). NWI mapping likely represents the minimum acres of wetlands that would be impacted at the Rockwell/Mueller Creek study area. NWI maps for the study area show that about 3 acres of wetlands would be permanently impacted and about 2 acres of wetlands would be temporarily impacted.

The development of shoreline wetlands and riparian vegetation communities around the Rockwell/Mueller Creek Reservoir margin is unlikely because of projected large annual fluctuations in reservoir elevations that would limit plant establishment to those communities that can tolerate periodic flooding and drawdown.

Although not field verified, it is assumed that Rockwell and Mueller creeks are intermittent creeks. Construction of the 30,000 AF Rockwell/Mueller Creek Reservoir is estimated to inundate or permanently fill from dam construction about 0.7 acre of stream channel (Figure 15). An approximate 3-acre stockpond would be inundated at the Rockwell/Mueller Creek Reservoir site. Other waters could be impacted at the Rockwell/Mueller Creek Reservoir site, but waters could not be accurately mapped because investigators did not have access to the site. In addition, about 1.6 acres of waters would be temporarily impacted during placement of the raw water pipeline across the Colorado River.

6.7.2.3. Plant Species of Concern

The Rockwell/Mueller Creek Reservoir site contains potential habitat for the endangered osterhout milkvetch and penland beardtongue, but no field surveys were conducted to determine if they are present.

Wyoming big sagebrush/bluebunch wheatgrass shrubland comprises most of the upland native shrublands in the study area. Middle Park penstemon, a vulnerable state species tracked by the CNHP, could potentially occur in these shrublands. About 326 acres of upland native shrubland would be permanently impacted and about 108 acres would be temporarily impacted. The loss or disturbance of sagebrush habitat would reduce the population and distribution of Middle Park penstemon.

6.7.2.4. Summary of Vegetation and Wetland Effects Under Alternative 5

Table 14 summarizes the combined direct effects to vegetation from construction of Dry Creek and Rockwell/Muller Creek reservoirs that would occur under Alternative 5. Wetland impacts for the Rockwell/Mueller Creek Reservoir and the pipeline from the reservoir to the Windy Gap Reservoir were based on aerial photography and NWI maps. Permanent wetland impacts could range between 8.6 acres and 21.2 acres. Temporary impacts to wetlands could range between about 2.9 acres and about 5.7 acres for this alternative.

Table 14. Alternative 5—Summary of direct effects to vegetation cover types and wetlands.

Vegetation Cover Type	Permanent Effects (acres)[1]	Temporary Effects (acres)[2]
Upland native shrublands	474.6	139.4
Upland native grasslands	89.7	24.5
Upland native forest	209.3	50.3
Upland introduced/Mixed grasslands	40.3	19.2
Mesic mixed grasslands	159.9	57.0
Mesic native shrublands (includes Wetlands at Rockwell/Mueller Creek)	27.4	6.9
Mesic native forest	24.3	8.4
Disturbed	8.5	13.8
Wetlands (Dry Creek only)[3]	9.2–21.8	2.3–5.3
Waters	6.5	2.0
Ditches	0.0	0.1
Total[4]	**1,046.1**	**322.7**

[1]Permanent effects include the reservoir footprint and dam, access roads, spillway, and pump stations.
[2]Temporary effects include pipeline corridors and a 40-foot buffer along access roads.
[3]Permanent wetland impacts at Rockwell/Mueller Creek site could range from 3 to 15.6 acres and temporary impacts could range from 2 to 4.8 acres.
[4]Wetlands at Rockwell/Mueller are included in both mesic native shrubland cover type and wetlands and are not double counted in total.

6.7.3. Summary of Vegetation, Wetland, and Waters Impacts

A summary of the estimated permanent and temporary impacts to vegetation, wetlands, and waters for each of the alternatives is shown in Table 15. Vegetation impacts include the effect on vegetation cover types previously described, but do not include lands currently disturbed by roads, ditches, or other features. Permanent impacts include lands where there would be a long-term loss in vegetation cover, while temporary areas would be reclaimed and revegetated following construction. Waters are not vegetated, but are included in this summary because they are usually associated with wetlands and are subject to 404 permitting.

Table 15. Summary of direct effects to vegetation, wetlands, and waters.

Alternative	Vegetation	Wetlands	Waters	Total
	acres			
Alternative 1—No Action				
Permanent	76.3	0.3	0.1	76.7
Temporary[1]	NA	NA	NA	NA
Alternative 2—Proposed Action				
Permanent	787.9	1.6	1.3	790.8
Temporary	122.8	0.1	0.1	123.0
TOTAL	910.7	1.7	1.4	913.8
Alternative 3				
Permanent	1,104.5	22.7	7.6	1134.8
Temporary	244.9	4.9	0.3	250.1
TOTAL	1,349.4	27.6	7.9	1384.9
Alternative 4[2]				
Permanent	959.5	4.8–15.1	4.9	969.2-979.8
Temporary	267.5	2.1–5.1	1.8	271.4-274.4
TOTAL	1227	6.9–20.5	6.7	1240.6-1254.2
Alternative 5[3]				
Permanent	1,009.9	9.2–21.8	6.5	1,025.6–1,038.2
Temporary	300.9	2.3–5.3	2.0	305.2–308.2
TOTAL	**1,310.8**	**11.5–27.1**	**8.5**	**1,330.8–1,346.4**

[1]Temporary impacts to vegetation from borrow areas, construction staging areas, and other temporary disturbances have not been identified.

[2]Available data indicates that permanent wetland impacts at the 20,000 AF Rockwell/Mueller Creek Reservoir site could range from about 3 to 14 acres and temporary impacts from 2 to 5 acres.

[3]Available data indicates that permanent wetland impacts at the 30,000 AF Rockwell/Mueller Creek Reservoir site could range from about 3 to 16 acres and temporary impacts from 3 to 5 acres.

The No Action alternative would have the least effect on vegetation and wetlands because it only includes increasing existing storage 13,000 AF. The Proposed Action would have the least effect to vegetation and wetlands of the action alternatives because only one reservoir would be constructed. Alternative 3, which includes the construction of Chimney Hollow Reservoir and Jasper East Reservoir, would have the greatest total vegetation and wetland impact of the alternates evaluated. The amount of wetlands present at the Rockwell/Mueller Reservoir site included in Alternatives 4 and 5 would need field verification to more specifically quantify actual impacts.

6.8. Effects to Riparian Areas and Wetlands on the Colorado River

Riparian areas and wetlands, which are supported by consistently available water supplies, are most likely to be affected by changes in streamflows. Although hydrologic conditions are very important in the maintenance of wetlands, simple cause-and-effect relationships are difficult to establish (Mitsch and Gosselink 1993). Riparian and wetland vegetation may establish where the ground water table is close to the surface, where surface water runoff is retained in depressions, where springs or seeps emerge on the soil surface, along the edges of streams and lakes, and wherever water is sufficient to support hydrophytes. In fluvial systems, wetlands and riparian areas may occur in the floodplain where the alluvial ground water table is near the surface. The ground water table adjacent to a stream may be higher or lower than the stream, depending on the discharge/recharge relationship between the stream and adjacent ground water.

Potential effects to riparian areas and wetlands along the Colorado River were assessed based on an analysis of potential changes in stream morphology, ground water, and stream stage discussed in the Water Resource Technical Report (ERO and Boyle 2007). In addition, NWI maps, aerial photography, and field observations were used to evaluate potential effects to riparian and wetlands vegetation.

6.8.1.1. Stream Morphology

Stream channel morphology influences the composition, distribution, and maintenance of riparian vegetation. Riparian vegetation protects streambanks from erosion, but vegetation encroachment can lead to constriction of the channel that reduces the ability of the stream to carry high flows. Streamflow must be adequate to convey water and sediment, but also sufficient to support riparian vegetation, while maintaining an open clear channel (Schmidt and Potyondy 2004).

Previous studies have indicated that although the flow of the Colorado River has varied over the period of record, in part due to diversions and storage, no changes in river morphology were observable in four sets of aerial photographs taken between 1938 and 1974 (Ward and Eckhardt 1981). A review comparing aerial photographs of the Colorado River from the 1970s and 2005 revealed that, with the exception of the addition of Windy Gap Reservoir, there have only been minor noticeable changes in river morphology (ERO and Boyle 2007) (Figures 18 through 26). Aerial photography indicates little change in channel pattern of the Colorado River before and after Windy Gap Reservoir was completed (ERO and Boyle 2007).

Channel Maintenance Flows

Channel maintenance flows are composed of a range of flows that maintain the physical characteristics of the stream channel, including the conditions necessary to help support riparian and wetland vegetation. Channel maintenance flows, defined as ranging from 80 percent of the 1.5-year peak flow to the 25-year instantaneous peak flow, were used in the evaluation of the flows necessary for channel maintenance in the Colorado River (ERO and Boyle 2007). Flow duration curves also were examined at the Hot Sulphur Springs gage on the Colorado River. Because there would be a change in the frequency and size of spills below Lake Granby under each of the WGFP alternatives, potential changes in stream morphology below Lake Granby also were reviewed for possible effects on riparian and wetland vegetation.

The lower range of channel maintenance flows helps to maintain an open channel free of vegetation. Scouring flows that occur infrequently at the upper range of channel maintenance flows have velocities high enough to move and redistribute sediment from the streambanks and/or floodplain, and possibly remove vegetation. Scouring flows can reduce vegetation encroachment and possibly help regenerate some types of riparian vegetation by scouring the floodplain and creating soil conditions favorable for regeneration (Stromberg et al. 1990). To establish riparian species, such as cottonwood, the timing of scouring flows must coincide with seed dispersal, which generally is in June.

Compared to Existing Conditions, under all of the alternatives there would be a 3- to 4-day reduction in the average number of days per year that streamflow equals or exceeds the lower range of channel maintenance flows (510 cfs) at Hot Sulphur Springs (ERO and Boyle 2007). The percentage of years that a flow of 510 cfs or more would occur would also decrease—from 62 percent under Existing Conditions to 53 to 55 percent under the alternatives. In addition, the potential for reaching the upper range of channel maintenance flows would be reduced by less than 10 percent under the alternatives. Scouring flows would continue to occur in June, but would be slightly less frequent (ERO and Boyle 2007). The effect to channel maintenance flows would diminish farther downstream on the Colorado River with additional tributary flows from Williams Fork, Troublesome Creek, Muddy Creek, and the Blue River. The projected changes in the magnitude, timing, and frequency of channel maintenance flows for all of the alternatives compared to Existing Conditions are minor and are not expected to alter channel morphology or sediment movement at or below Hot Sulphur Springs. As a result, the conditions for growth, establishment, and scouring of riparian and wetland vegetation below the Windy Gap diversion are not expected to change significantly as a result of the WGFP.

Flow duration curves provide a comparison between Existing Conditions and No Action for the two USGS gages located at Hot Sulphur Springs and near Kremmling (ERO and Boyle 2007). By comparing the flow duration curves, the maximum difference between Existing Conditions and the alternatives for a given exceedance percentage can be determined. Because many of the morphologic characteristics of a channel are formed when a stream flows at its bankfull discharge (1½- to 2-year peak flow) (Rosgen 1996), differences shown on the flow duration curves between Existing Conditions and the alternatives that are lower than the bankfull discharge would have

minimal effects on channel morphology. At Hot Sulphur Springs, the 2-year peak discharge was estimated to be 923 cfs under Existing Conditions. Under Existing Conditions, this flow would be exceeded about 4 percent of the time (percentage of days during the study period). At the gage near Kremmling, the 2-year peak discharge was estimated to be 2,850 cfs under Existing Conditions. Under Existing Conditions, this flow would be exceeded about 3 percent of the time.

Under all alternatives, the 2-year peak discharge at the Hot Sulphur Springs gage would be exceeded about 1 percent less than under Existing Conditions. The 2-year peak discharge at the gage near Kremmling would also be exceeded 1 percent less than under Existing Conditions. The slight reduction in the percentage of time that the 2-year peak discharge would be exceeded at the two gage sites below the Windy Gap diversion is unlikely to significantly affect stream morphology or change sediment transport or deposition. As still applicable previous studies indicated, the sediment transport rate in the Colorado River far exceeds the sediment supply to the river and no aggradation of the channel is likely with increased diversions (Ward and Eckhardt 1981).

The channel morphology of the Colorado River downstream of Lake Granby is influenced by spills from the lake. Channel maintenance flows below Lake Granby were defined as ranging from 70 cfs to 2,125 cfs (ERO and Boyle 2007). The frequency of flows of 70 cfs would decrease by 4 percent or less under all of the alternatives and the average length of flow of 70 cfs or more would increase slightly under the alternatives. The frequency of flows of at least 2,125 cfs would decrease by up to 9 percent under the alternatives, but the duration of such a flow would change by only one day. The differences in channel maintenance flows between Existing Conditions and the alternatives are minor and are not expected to alter channel morphology or sediment movement in the Colorado River below Lake Granby; therefore, the conditions needed to maintain riparian and wetland vegetation should remain the same.

6.8.1.2. Ground Water Influences

The *Water Resource Technical Report* (ERO and Boyle 2007) concludes that the changes in streamflow in the Colorado River and the resulting changes in stream stage are minor with respect to potential effects to adjacent ground water levels. Thus, ground water's contribution in supporting riparian and wetland vegetation along the Colorado River would not be affected by the alternatives under consideration. Under all the alternatives, alluvial areas adjacent to the stream would remain saturated from perennial flows, sideslope runoff, and irrigation return flows even with seasonal reductions in flow and stream stage.

6.8.1.3. Changes in Stream Stage

Studies indicate that riparian and wetland vegetation along streams and creeks can respond to changes in water surface elevation in the stream (Scott et al. 1999, 2000). Stream stage may influence ground water levels in the alluvial aquifer. Along the Mojave River in California Scott et al. (2000) noted that water table declines greater than 4.5 feet caused between 58 percent and 93 percent mortality of Freemont cottonwood. In areas where the water table decline was less than 3.1 feet, cottonwood mortality was between 7 percent and 13 percent. In another study, Scott et al. (1999) noted that over a 3-year period in medium-grained alluvial sands, sustained declines in the water table of

greater than 3.1 feet resulted in 88 percent mortality of plains cottonwood. The study further noted that gradual water declines of about 1.5 feet had no measurable effect on mortality, stem growth, or live crown volume (Scott et al. 1999).

Riparian systems are dynamic. Water surface elevations in streams vary seasonally, daily, and with flood events. Factors such as soil texture, stream slope, incision, impermeable pans, substrates, or structures, and other topographic features influence development of riparian and wetland vegetation and the relationship of stream water surface elevations on vegetation.

Stream stage data for the Colorado River study area were examined to determine the timing and amount of change in the surface elevation of the river. Under all of the alternatives, minimum streamflows on the Colorado River ranging from 90 cfs below Windy Gap Reservoir to 150 cfs below Williams Fork would be maintained.

Changes in monthly stream stage under Existing Conditions compared to each of the alternatives were evaluated at two representative gages in the study area: Colorado River at Hot Sulphur Springs below the Windy Gap diversion, and the Colorado River near Kremmling below the confluence with the Blue River (Figure 18, Figure 21, and Figure 26). Changes in monthly stream stage at these locations during the growing season (April through September) under each of the alternatives was compared to Existing Conditions for average, dry, and wet years (Table 16 and Table 17). Stream stage data below Lake Granby do not accurately reflect flow conditions because of the influence of periodic large spills. Lake Granby spills can vary annually and even daily, resulting in changes in the river stage ranging from about 2 feet to about 7 feet (ERO and Boyle 2007). As discussed previously, spills from Lake Granby and changes to the range in channel maintenance flows likely are more important to stream channel morphology than stream stage. In addition, year-round minimum flow releases below Lake Granby would be maintained for all alternatives.

Colorado River at Hot Sulphur Springs

At the Hot Sulphur Springs gage, there would be no change in average stream stage in April and September for any of the alternatives (Table 16). Under the No Action alternative, average monthly stream stage in May through August would range from 0.03 feet to 0.16 feet below Existing Conditions. For Alternatives 2 through 5, stream stage would range from 0.06 feet to 0.23 feet below Existing Conditions.

In dry years, there would be no change from Existing Conditions in monthly stream stage under any of the alternatives.

Table 16. Colorado River at Hot Sulphur Springs—Comparison of existing conditions to other alternatives (average monthly river stage in feet).

Average Year (1950-1996)						
	Apr	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Exist. Cond.	**0.72**	**1.04**	**2.03**	**1.36**	**0.77**	**0.59**
Alt 1	0.72	1.00	1.94	1.20	0.74	0.58
Alt 2	0.72	0.95	1.80	1.18	0.72	0.58
Alt 3	0.72	0.96	1.85	1.13	0.71	0.58
Alt 4	0.72	0.96	1.85	1.13	0.71	0.58
Alt 5	0.72	0.95	1.83	1.14	0.71	0.58
Change in Stage From Existing Conditions						
Alt 1	0.00	-0.03	-0.10	-0.16	-0.04	0.00
Alt 2	0.00	-0.09	-0.23	-0.19	-0.06	0.00
Alt 3	0.00	-0.08	-0.19	-0.23	-0.07	0.00
Alt 4	0.00	-0.08	-0.19	-0.23	-0.07	0.00
Alt 5	0.00	-0.09	-0.20	-0.23	-0.06	0.00
Percent Change in Stage From Existing Conditions						
Alt 1	-0.1%	-3.3%	-4.9%	-11.8%	-4.8%	-0.3%
Alt 2	-0.3%	-8.5%	-11.3%	-13.7%	-7.4%	-0.5%
Alt 3	-0.3%	-7.7%	-9.3%	-17.0%	-8.5%	-0.4%
Alt 4	-0.3%	-7.7%	-9.2%	-16.9%	-8.5%	-0.4%
Alt 5	-0.4%	-8.9%	-9.9%	-16.6%	-8.2%	-0.4%
Dry Year Average (1954, 1966, 1977, 1981, 1989)						
Exist. Cond.	**0.69**	**0.70**	**0.71**	**0.70**	**0.61**	**0.54**
All Alts	0.69	0.70	0.71	0.70	0.61	0.54
No change in stage between Existing Conditions and all alternatives in dry years.						
Wet Year Average (1957, 1983, 1984, 1986, 1995)						
Exist. Cond.	**0.76**	**1.81**	**3.22**	**2.73**	**1.36**	**0.69**
Alt 1	0.76	1.79	3.16	2.39	1.17	0.69
Alt 2	0.75	1.60	3.11	2.36	1.09	0.69
Alt 3	0.75	1.63	3.10	2.33	1.07	0.68
Alt 4	0.75	1.63	3.10	2.33	1.07	0.68
Alt 5	0.75	1.61	3.10	2.34	1.08	0.68
Change in Stage From Existing Conditions						
Alt 1	0.00	-0.02	-0.06	-0.35	-0.19	0.00
Alt 2	-0.01	-0.21	-0.12	-0.37	-0.28	0.00
Alt 3	-0.01	-0.18	-0.12	-0.41	-0.30	-0.02
Alt 4	-0.01	-0.18	-0.12	-0.40	-0.29	-0.02
Alt 5	-0.01	-0.20	-0.12	-0.40	-0.28	-0.02
Percent Change in Stage From Existing Conditions						
Alt 1	-0.1%	-1.3%	-1.9%	-12.7%	-14.0%	-0.3%
Alt 2	-1.1%	-11.5%	-3.6%	-13.7%	-20.2%	-0.3%
Alt 3	-1.0%	-10.2%	-3.7%	-14.8%	-21.7%	-2.4%
Alt 4	-1.0%	-10.2%	-3.7%	-14.8%	-21.6%	-2.3%
Alt 5	-1.0%	-11.1%	-3.8%	-14.5%	-20.7%	-2.3%

Alt 1 = No Action; Alt 2 = Chimney Hollow w/Pre-Positioning; Alt 3 = Chimney Hollow w/Jasper East; Alt 4 = Chimney Hollow w/Rockwell Creek; Alt 5 = Dry Creek w/Rockwell Creek.

Table 17. Colorado River Near Kremmling—Comparison of existing conditions to other alternatives (average monthly river stage in feet).

Average Year (1950-1996)						
	Apr	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Exist. Cond.	**4.68**	**6.01**	**8.67**	**7.22**	**5.66**	**5.32**
Alt 1	4.68	5.97	8.55	7.06	5.62	5.30
Alt 2	4.68	5.91	8.39	7.03	5.60	5.30
Alt 3	4.68	5.92	8.44	6.98	5.59	5.30
Alt 4	4.68	5.92	8.44	6.98	5.59	5.30
Alt 5	4.68	5.90	8.43	6.99	5.59	5.30
Change in Stage From Existing Conditions						
Alt 1	0.00	-0.04	-0.12	-0.17	-0.04	-0.02
Alt 2	0.00	-0.10	-0.28	-0.20	-0.06	-0.03
Alt 3	0.00	-0.09	-0.23	-0.25	-0.07	-0.02
Alt 4	0.00	-0.09	-0.23	-0.24	-0.07	-0.02
Alt 5	0.00	-0.11	-0.24	-0.24	-0.07	-0.02
Percent Change in Stage From Existing Conditions						
Alt 1	0.0%	-0.7%	-1.4%	-2.3%	-0.7%	-0.4%
Alt 2	-0.1%	-1.7%	-3.2%	-2.7%	-1.1%	-0.5%
Alt 3	-0.1%	-1.6%	-2.6%	-3.4%	-1.3%	-0.4%
Alt 4	-0.1%	-1.6%	-2.6%	-3.4%	-1.3%	-0.4%
Alt 5	-0.1%	-1.8%	-2.8%	-3.3%	-1.2%	-0.4%
Dry Year Average (1954, 1966, 1977, 1981, 1989)						
Exist. Cond.	**4.49**	**4.01**	**4.17**	**5.31**	**5.39**	**5.19**
All Alts	4.49	4.01	4.17	5.31	5.39	5.19
No change in stage between Existing Conditions and all alternatives in dry years.						
Wet Year Average (1957, 1983, 1984, 1986, 1995)						
Exist. Cond.	**5.03**	**8.26**	**12.17**	**11.20**	**7.25**	**5.46**
Alt 1	5.03	8.23	12.08	10.81	7.03	5.46
Alt 2	5.02	8.02	12.01	10.79	6.93	5.46
Alt 3	5.02	8.04	12.01	10.76	6.91	5.44
Alt 4	5.02	8.04	12.01	10.76	6.91	5.44
Alt 5	5.02	8.02	12.00	10.76	6.93	5.44
Change in Stage From Existing Conditions						
Alt 1	0.00	-0.03	-0.08	-0.39	-0.22	0.00
Alt 2	-0.01	-0.24	-0.16	-0.42	-0.31	0.00
Alt 3	-0.01	-0.22	-0.16	-0.45	-0.33	-0.02
Alt 4	-0.01	-0.22	-0.16	-0.45	-0.33	-0.02
Alt 5	-0.01	-0.23	-0.16	-0.44	-0.32	-0.02
Percent Change in Stage From Existing Conditions						
Alt 1	0.0%	-0.3%	-0.7%	-3.5%	-3.0%	0.0%
Alt 2	-0.2%	-2.9%	-1.3%	-3.7%	-4.3%	-0.1%
Alt 3	-0.2%	-2.6%	-1.3%	-4.0%	-4.6%	-0.3%
Alt 4	-0.2%	-2.6%	-1.3%	-4.0%	-4.6%	-0.3%
Alt 5	-0.2%	-2.8%	-1.4%	-3.9%	-4.4%	-0.3%

Alt 1 = No Action; Alt 2 = Chimney Hollow w/Pre-Positioning; Alt 3 = Chimney Hollow w/Jasper East; Alt 4 = Chimney Hollow w/Rockwell Creek; Alt 5 = Dry Creek w/Rockwell Creek.

The largest differences in stream stage would occur in wet years. Under No Action, average monthly stream stage in wet years would range from about 0.02 feet to 0.35 feet lower than Existing Conditions. Under Alternatives 2 through 5, average monthly stream stage in wet years would range from about 0.01 feet to 0.41 feet lower than Existing Conditions.

Colorado River near Kremmling

At the Kremmling gage, there would be no change in average stream stage in April for any of the alternatives (Table 17). Under the No Action alternative, average monthly stream stage in May through August would range from 0.02 feet to 0.17 feet lower than Existing Conditions. For Alternatives 2 through 5, stream stage would range from 0.02 feet to 0.28 feet lower than Existing Conditions.

In dry years, there would be no change from Existing Conditions in monthly stream stage under any of the alternatives.

The largest differences in stream stage occur in wet years. Under No Action, average monthly stream stage in wet years would range from about 0.03 feet to 0.39 feet lower than Existing Conditions. Under Alternatives 2 through 5, mean monthly stream stage in wet years would range from about 0.01 feet to 0.45 feet lower than Existing Conditions, or less than a 4 percent decrease in stage.

Summary of Stream Stage Changes

Vegetation adjacent to the stream would continue to be supported by streamflow, ground water discharge, and irrigation return flows under each of the alternatives. There would be no change in average monthly stream stage for any of the alternatives during dry years, when riparian and wetland vegetation is more susceptible to drought. In wet years, the stage of the Colorado River would be nearly twice as high as during average years for Existing Conditions as well as all of the alternatives during the growing season. Thus, supporting hydrology for riparian wetland vegetation would not be a limiting factor in wet years.

Based on the studies discussed in Section 6.7.3.3, none of the projected changes in stream stage modeled under any of the alternatives would be of a magnitude or duration likely to significantly affect riparian vegetation. Decreases in Colorado River monthly average stream stage of less than 0.28 feet at both the Hot Sulphur Springs gage below the Windy Gap diversion and near Kremmling for all of the alternatives are unlikely to measurably affect the existing distribution and composition of riparian and wetland vegetation present.

6.8.1.4. Summary of Effects to Riparian and Wetland Vegetation in the Colorado River Study Area

The Water Resource Technical Report (ERO and Boyle 2007) concluded that minor changes in channel maintenance flows and streamflows above bankfull are not expected to alter channel morphology or sediment movement in the Colorado River for any of the alternatives. Similarly, expected changes in stream stage are unlikely to affect ground water levels in the alluvium bordering the Colorado River by more than a few inches. Most of the Colorado River in the study area is a gaining stream; thus, ground water contributions likely play an important role in supporting riparian and wetland vegetation

in the study area. The projected changes in stream stage are generally small and are unlikely to affect riparian and wetland vegetation along the Colorado River, particularly considering the contribution of other sources of water, such as irrigation water and ground water. Also, the largest changes in stream stage predicted under the alternatives occur during wet years, when available water is not a liming factor for streamside vegetation. Based on the conclusions of the stream morphology study, the ground water study, and examinations of changes in the channel maintenance discharges, flow duration, changes in stream stage during the growing season, and examination of riparian areas from field observations and aerial photography, it does not appear that the alternatives would result in a measurable adverse effect to riparian and wetland vegetation in the Colorado River study area.

6.8.2. Effects to Riparian Areas and Wetlands on Willow Creek

The gage on Willow Creek in the study area is in a flume, and although it provides estimates of flow, the flume is not representative of the stream channel, and does not provide an accurate estimate of stream stage (ERO and Boyle 2007); therefore, stream stage data were not used to evaluate potential effects to riparian and wetland vegetation on Willow Creek. The Water Resource Technical Report concluded that the 2-year peak discharge would decrease by less than 1 percent between Existing Conditions and all of the alternatives. It is unlikely that there would be a significant affect to stream morphology or change in sediment transport or deposition. In addition, projected changes in streamflow in Willow Creek would not have a measurable effect to ground water levels for any of the alternatives. Therefore, it is unlikely that riparian vegetation along Willow Creek, which is supported by irrigation return flows and ground water, would be adversely affected by the minor changes in streamflow.

6.8.3. Effects to Riparian Areas and Wetlands on East Slope Streams

Changes in streamflows would occur on North St. Vrain Creek and St. Vrain Creek under the No Action alternative from enlargement and re-operation of Ralph Price Reservoir. The changes are unlikely to alter the morphology of the stream segments or affect sediment movement (ERO and Boyle 2007). Up to a 25 percent decrease in streamflow on North St. Vrain Creek between Ralph Price Reservoir and Longmont Reservoir would occur during July under No Action, but there would be less than a 1 percent change in streamflow during the peak runoff period in June. These changes, plus mostly increased flows in other months, are not expected to affect the riparian and wetland vegetation found primarily along the banks of the stream. Average monthly streamflow in the St. Vrain below Longmont Reservoir would decrease less than 5 percent during the growing season, and St. Vrain Creek above the St. Vrain Feeder Canal would decrease less than 2 percent. These small changes in flow are unlikely to measurably affect riparian and wetland vegetation.

Increases in Big Thompson River average monthly stream stage below Lake Estes to the Hansen Feeder Canal of up to 0.04 feet under the Proposed Action and less than 0.02 feet for the other alternatives are unlikely to affect channel morphology or hydrologic conditions supporting riparian and wetland vegetation.

The predicted streamflow increases for the East Slope stream segments that receive Windy Gap return flows (Big Dry Creek, Coal Creek, St. Vrain Creek, and the Big Thompson River) are unlikely to substantially alter stream morphology, sediment movement or conditions for riparian growth because the increased flows would be small compared to the spring and early summer flows that these channels have the capacity for. In addition, streams on the East Slope have not experienced natural streamflow conditions for more than 100 years, and are not in equilibrium with respect to channel forming and channel moving processes, erosion, or sediment loading, movement, and deposition. Given the magnitude of the average monthly flow increases (less than 9 cfs), it would be difficult to measurably differentiate changes to riparian growth due to changes in Participants' WWTP return flows from the many other ongoing actions influencing East Slope streamflow conditions (ERO and Boyle 2007).

7.0 CUMULATIVE EFFECTS

Cumulative effects are those resulting from the incremental effect of an alternative when added to other past, present, and reasonably foreseeable future actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a time period.

Several reasonably foreseeable actions are anticipated to occur in the future regardless of the implementation of any of the WGFP action alternatives or the No Action alternative. Reasonably foreseeable actions were divided into water-based actions that affect portions of the Colorado River where Windy Gap diversions would occur and land-based actions that include ground disturbances or other activities near potential WGFP facilities. Water- and land-based reasonably foreseeable actions are defined below.

7.1. Water-Based Reasonably Foreseeable Actions

- **Moffat Collection System Project**. This project is currently proposed by Denver Water to develop 18,000 AF per year of new, annual firm yield to the Moffat Treatment Plant to meet future raw water demands on the Eastern Slope. This project is anticipated to result in additional diversions from the upper Fraser River Basin, upstream of the Windy Gap diversion on the Colorado River.
- **Urban Growth in Grand and Summit Counties**. The population of Grand and Summit Counties is expected to grow substantially in the future, which would increase water use and wastewater discharges. Future water use in Grand County would primarily occur in the Fraser River Basin upstream of the Windy Gap diversion; future water use in Summit County would occur primarily in the Blue River Basin, a tributary to the Colorado River downstream of the Windy Gap diversion.
- **Williams Fork Reservoir Releases**. Denver Water's agreement to release 5,412 AF of water annually from Williams Fork Reservoir to satisfy East Slope contributions to the Recovery Program for endangered fish species in the Colorado River expires in 2009. Denver does not plan on continuing these releases past 2009. It assumed that the 5,412 AF of water would come from

sources downstream of the Colorado-Blue River confluence, although the location of future releases for the Recovery Program is unknown.

- **Wolford Mountain Reservoir Releases**. The Colorado River District's agreement to release 5,412 AF of water annually from Wolford Mountain Reservoir to satisfy West Slope contributions to the Recovery Program for endangered fish species in the Colorado River expires in 2010. The River District does not plan on continuing these releases past 2010. It is assumed that the 5,412 AF of water would come from sources downstream of the Colorado-Blue River confluence, although the location of future releases for the Recovery Program is unknown.
- **Big Lake Ditch**. Denver Water currently has an agreement with Taussig Ranch Inc. that curtails Big Lake Ditch diversions if Denver Water needs the water. The conditions under which Denver Water can request that Taussig not divert are related to storage projections in Dillon and Williams Fork reservoirs. This allows Denver Water to divert additional water to storage in Williams Fork Reservoir when in priority. This agreement expires in 2013 and Denver Water does not plan on renewing the agreement. As a result, in the future, Big Lake Ditch water right diversions to the Reeder Creek basin would be abandoned, which would allow Denver Water to capture additional water from the Williams Fork and store the water in Williams Fork Reservoir during all years that their Williams Fork Reservoir water rights are in priority.
- **Shoshone Call Reduction**. Denver Water is negotiating an agreement with Excel Energy to reduce the Shoshone Call between March 14 and May 20 in dry years under certain conditions. Triggers for invoking the call reduction include Denver Water Board predictions of July 1 storage at or below 80 percent, and March 1 NRCS runoff forecast at Kremmling or Dotsero at or below 85 percent of average. Denver Water would make available 15 percent of the "net water" stored or diverted for Excel Energy and 10 percent of the "net water" stored or diverted to West Slope entities. Net water is defined as water stored less water subsequently spilled after filling. The agreement would be signed at the end of March, but would not be reviewed by the Public Utility Commission until September 2006.

7.2. Land-Based Reasonably Foreseeable Actions

- **Land Development**. A variety of new land developments are expected to occur in the vicinity of the potential reservoir sites in Larimer, Grand, and Boulder counties. This includes residential and commercial developments on the West Slope; on the East Slope, this includes primarily residential development.
- **Larimer County Open Space**. Larimer County Parks and Open Lands acquired about 1,850 acres of land adjacent to the proposed Chimney Hollow Reservoir site. Laramie County intends to manage this property for recreation use regardless of whether Chimney Hollow Reservoir is constructed.
- **Urban Growth in the Northern Front Range**. Continued population growth and development is expected to occur in the Northern Front Range, Colorado communities served by many of the Firming Project Participants.

7.3. Methods for Evaluating Cumulative Effects to Vegetation Resources

The cumulative effects assessment evaluated the potential effects to vegetation and wetlands from land- and water-based reasonably foreseeable actions. Land-based reasonably foreseeable actions include actions potentially occurring in the basins where alternative reservoir facilities are located. The development of Larimer County Open Space adjacent to Chimney Reservoir site and a residential development near Jasper East were the only reasonably foreseeable land-based actions identified with potential cumulative effects. All of the reasonably foreseeable water based actions that affect hydrologic resources were evaluated for potential cumulative effects to riparian and wetland vegetation in the same manner as direct effects, as discussed in Section 6.1.4.

7.3.1. Alternative 1—No Action

Vegetation communities near Ralph Price Reservoir have been affected by the original reservoir construction, which inundated about 1.2 miles of North St. Vrain Creek and surrounding lands. Historical effects to vegetation likely included a loss of ponderosa pine and Douglas-fir forest similar to existing lands surrounding the reservoir and riparian wetlands along the stream. Reservoir management and operation have had a limited effect on existing vegetation resources although existing recreation use of the reservoir has resulted in minor vegetation disturbance from trails and shoreline fishing. No reasonably foreseeable land development activities near the reservoir have been identified; thus, there would be no incremental cumulative effects to vegetation, wetlands, or plant species of concern that add to the effects of enlarging Ralph Price Reservoir.

7.3.2. Alternative 2—Chimney Hollow Reservoir (90,000 AF) (Proposed Action)

Vegetation resources at the Chimney Hollow Reservoir site and surrounding lands have been at least partially affected by historical livestock operations and nearby land development including construction of Carter Lake, Flatiron Reservoir, and other C-BT facilities, Bureau of Reclamation offices, rural residential development, and roads. The future planned management of the Chimney Hollow Reservoir site as part of Larimer County's adjacent Chimney Hollow Open Space includes trail development and public access. There would be cumulative loss of vegetation from construction of about 10 miles of trail in addition to the vegetation disturbance and loss from construction of Chimney Hollow Reservoir and related facilities. There is potential for a cumulative impact to CNHP-tracked plant communities or possibly wetlands with trail construction; however, trails can typically be located to avoid sensitive areas. Open space designation and management by Larimer County would protect the area from future development, which would be beneficial to vegetation communities.

7.3.3. Alternative 3—Chimney Hollow (70,000 AF) and Jasper East (20,000 AF)

The cumulative effect to vegetation, wetlands, and plant species of concern at Chimney Hollow Reservoir under this alternative would be the same as Alternative 2.

The quality of the existing vegetation at the Jasper East Reservoir site has been influenced by several disturbances and activities in the area including irrigation and mowing of pasture lands; construction of the Willow Creek Canal, pump station, and forebay; and the presence of County Road 40, which bisects the property. Irrigation practices at the Jasper East Reservoir site have helped establish and support wetland vegetation. Nearby losses or changes in vegetation and wetlands have occurred from construction of Willow Creek Reservoir and residential and commercial development.

Reasonably foreseeable future development in the Jasper East basin includes about 980 acres of planned residential development at the C-Lazy-U Preserve located just north of the reservoir site (Figure 17). The cumulative effect to vegetation from construction of an approximately 485-acre Jasper East Reservoir, including the dam and spillway and the C-Lazy-U development could affect a total of about 1,465 acres of vegetation. However, future land developments at C-Lazy-U would impact a relatively small portion of the site based on planned low-density housing and designation of common open space. Much of C-Lazy-U land is currently used for hay production and pasture.

Future development of C-Lazy-U could affect habitat for threatened and endangered plant species (although no federally listed species have been documented in the vicinity), but construction of Jasper East Reservoir would not add to this potential impact because there would be no effect to federally listed threatened or endangered species from reservoir construction. The loss of sagebrush habitat at C-Lazy-U could result in a cumulative impact to habitat for Middle Park penstemon, a CNHP species that is considered vulnerable, although it was common at Jasper East. The future loss or disturbance of wetlands or waters at C-Lazy-U is not known. Any future losses to wetlands and other waters associated with future development may require permitting and mitigation.

7.3.4. Alternative 4—Chimney Hollow (70,000 AF) and Rockwell/Mueller Creek (20,000 AF)

The cumulative effect to vegetation, wetlands, and plant species of concern at Chimney Hollow Reservoir under this alternative would be the same as Alternative 3.

The Rockwell/Mueller Creek Reservoir site is mostly undeveloped. Vegetation at the reservoir site has been affected by past development and activity in the area, including low density residential housing on the reservoir site and surrounding lands, property owner access roads, and adjacent county roads. Vegetation composition on the property is currently affected by livestock grazing.

No reasonably foreseeable land development activities in the reservoir basin have been identified; thus, there would be no incremental cumulative effects to vegetation, wetlands, or plant species of concern that add to the effects of constructing.

7.3.5. Alternative 5—Dry Creek (60,000 AF) and Rockwell/Mueller Creek (30,000 AF)

The Dry Creek Reservoir site is mostly undeveloped land with a few scattered homes. A portion of Larimer County Open Space extends along the west side of the reservoir site. Possibly trail construction on Larimer County Open Space would result in a minor incremental cumulative effect to vegetation resources (Figure 16).

There would be no cumulative effect to vegetation, wetlands, and plant species of concern from construction of a 30,000 AF Rockwell/Mueller Creek Reservoir, as noted for Alternative 4.

7.4. Cumulative Effects to Riparian Areas and Wetlands

Potential cumulative effects to riparian and wetland resources were evaluated in the same manner as direct effects—using the results of hydrology modeling and potential effects to stream morphology, ground water, streamflow, and reservoir elevations. Additional detail on the cumulative changes to water resources is found in the Water Resources Technical Report (ERO and Boyle 2007).

The cumulative effects hydrology model output for the No Action alternative includes the addition of reasonably foreseeable actions as a basis for comparison with the action alternatives in the future. Because of the similarity in the effects of Alternatives 3, 4, and 5, which each include a combination of East Slope and West Slope reservoirs, the cumulative effects analysis used the results of Alternative 5 (Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir) as representative of these three alternatives. Thus, the potential effect on riparian resources for No Action, the Proposed Action, and Alternative 5 were compared to Existing Conditions.

7.4.1. West Slope Streams and Reservoirs

Potential effects to riparian and wetland areas were evaluated for the Colorado River and Willow Creek and Lake Granby on the West Slope. There would be no hydrologic changes to Grand Lake, Shadow Mountain Lake, or Willow Creek Reservoir.

7.4.1.1. Lake Granby

The water surface elevation in Lake Granby would be lower throughout the year, including the growing season, for all of the alternatives compared to Existing Conditions. The Proposed Action would result in average monthly Lake Granby elevations about 6 to 9 feet lower than Existing Conditions from May to August or about 3 to 5 feet lower than No Action. Alternative 5 would result in lake levels about 4 to 5 feet lower than Existing Conditions. In wet years, the change in average monthly water levels would be slightly less, and in dry years they would be slightly greater for all alternatives. Historically, Lake Granby water levels have fluctuated considerably (nearly 90 feet) as part of reservoir operations and variations in runoff. The vegetation types bordering Lake Granby include upland and riparian species not dependent on lake levels. Lower water levels in Lake Granby are unlikely to substantially affect riparian vegetation for any of the alternatives because reservoir fluctuations would fall within the historical operations of the reservoir and vegetation bordering the lake is supported by multiple water sources.

7.4.1.2. Colorado River

Projected future actions along with WGFP diversions would change the timing and amount of flow in the Colorado River. Many of the morphologic characteristics of a channel are formed when a stream flows at its bankfull discharge (1-½ to 2-year peak flow) (Rosgen 1996). The frequency of flows exceeding the 2-year peak discharge would decrease by no more than 2 percent from Existing Conditions for all the alternatives at Hot Sulphur Springs and near Kremmling. Modeled Colorado River flows below Lake Granby and at Hot Sulphur Springs for all of the alternatives indicate changes in the

magnitude, timing, and frequency of channel maintenance flows from Existing Conditions (ERO and Boyle 2007), but none of the changes are of a magnitude sufficient to measurably alter channel morphology or sediment movement. Therefore, riparian and wetland resources are unlikely to be adversely affected because there would be no substantial change in channel capacity, scouring flows, and other channel forming processes that maintain a suitable substrate for vegetation.

Changes in stream stage and alluvial ground water levels also were examined along the Colorado River. At Hot Sulphur Springs below the Windy Gap diversion, average monthly stream stage would decrease by less than 0.35 feet for all of the alternatives. There would be negligible changes in dry years and up to 0.5 feet decrease in stage during wet years. Average monthly stream stage on the Colorado River below the Blue River confluence would decrease by up to about 1 foot for the Proposed Action and Alternative 5 and about 0.85 foot under No Action. These changes would be about a 12 percent decrease from existing river stage. Projected changes in stream stage would not substantially alter alluvial ground water levels (ERO and Boyle 2007) and is unlikely to measurably affect the distribution and composition of riparian and wetland vegetation along the Colorado River. Riparian vegetation would continue to be supported by various hydrologic sources, including streamflow, ground water, and irrigation return flows. The larger changes in stream stage (a decrease of up to a foot in average years in June and July) near the top of Gore Canyon occur where the channel and riparian vegetation begin to narrow, thus potential effects to riparian and wetland vegetation are unlikely.

7.4.1.3. Willow Creek

Projected changes in Willow Creek streamflow indicate a 1 percent decrease in the frequency of 2-year peak discharges for all the alternatives (ERO and Boyle 2007), which is unlikely to affect stream morphology and conditions for riparian and wetland growth and establishment. Stream stage for Willow Creek is not available, but projected changes in streamflow, primarily in June during peak runoff of less than 30 cfs would not measurably affect ground water levels adjacent to the creek. Therefore, it is unlikely that riparian and wetland vegetation on Willow Creek supported by irrigation return flows, ground water, and streamflow would be affected by changes in streamflow.

7.4.2. East Slope Streams and Reservoirs

Effects to riparian and wetland vegetation were evaluated for the Big Thompson River, St. Vrain Creek, and several smaller streams that would receive additional Windy Gap return flows. Changes in flow in North St. Vrain Creek and the portion of St. Vrain Creek above Lyons were evaluated for the No Action alternative. Potential effects at Carter Lake and Horsetooth Reservoir also were evaluated.

7.4.2.1. Carter Lake and Horsetooth Reservoir

Carter Lake average monthly water surface elevations for all of the alternatives would decrease less than 1 foot. There would be minimal change in dry years and less than a 2-foot decrease in wet years. Horsetooth Reservoir average monthly water surface elevations would not change from Existing Conditions under the No Action alternative, but would decrease up to 6 feet during the growing season under the Proposed Action. Under Alternative 5, Horsetooth average monthly water levels would decrease less than 2

feet. Dry year decreases would be slightly greater for the Proposed Action and Alternative 5 and wet year effects slightly less. The changes in Carter Lake and Horsetooth Reservoir water levels are within the historical range of operation and the vegetation types bordering reservoirs includes primarily upland species not dependent on lake levels. Lower water levels in these reservoirs under any of the alternatives are unlikely to substantially affect the limited shoreline riparian and wetland vegetation present.

7.4.2.2. East Slope Streams

The change in East Slope streamflow, including increased flows in the Big Thompson River between Lake Estes and the Hansen Feeder Canal, and below WWTP discharge points for WGFP Participants on the Big Thompson River, St. Vrain Creek, Coal Creek, and Big Dry Creek would be less than or equal to the amounts discussed for direct effects for all of the alternatives. This is because with reasonably foreseeable actions in place, Windy Gap deliveries to the East Slope would be less. The same is true for the No Action alternative, which would result in less water exchanged to Ralph Price Reservoir and less or equal changes in North St. Vrain Creek and St. Vrain Creek streamflow than the direct effects assessment. As discussed in Section 6.7.5, these changes in streamflow are unlikely to measurably affect stream morphology, ground water levels adjacent to streams, or hydrologic support for riparian and wetland vegetation.

8.0 BEST MANAGEMENT PRACTICES

- Topsoil should be salvaged, stockpiled, and replaced on-site, except in areas of heavy weed infestation.
- A revegetation plan outlining the use of native seed, shrubs, and trees should be developed for all temporarily impacted areas.
- Permanent wetland impacts should be replaced as required by the Corps. Temporarily impacted wetlands should be replaced in situ.
- The revegetation plan should include a program for control of noxious weeds during construction and revegetation.

If the Rockwell/Mueller Creek Reservoir is selected for development, additional field surveys would be necessary including—

- Wetland delineation
- Vegetation community mapping
- Threatened, endangered, and species of concern surveys

Additional wetland delineation and threatened, endangered, and species of concern surveys also should be conducted if Ralph Price Reservoir is enlarged.

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APPENDIX A
SCIENTIFIC NAMES OF PLANT SPECIES

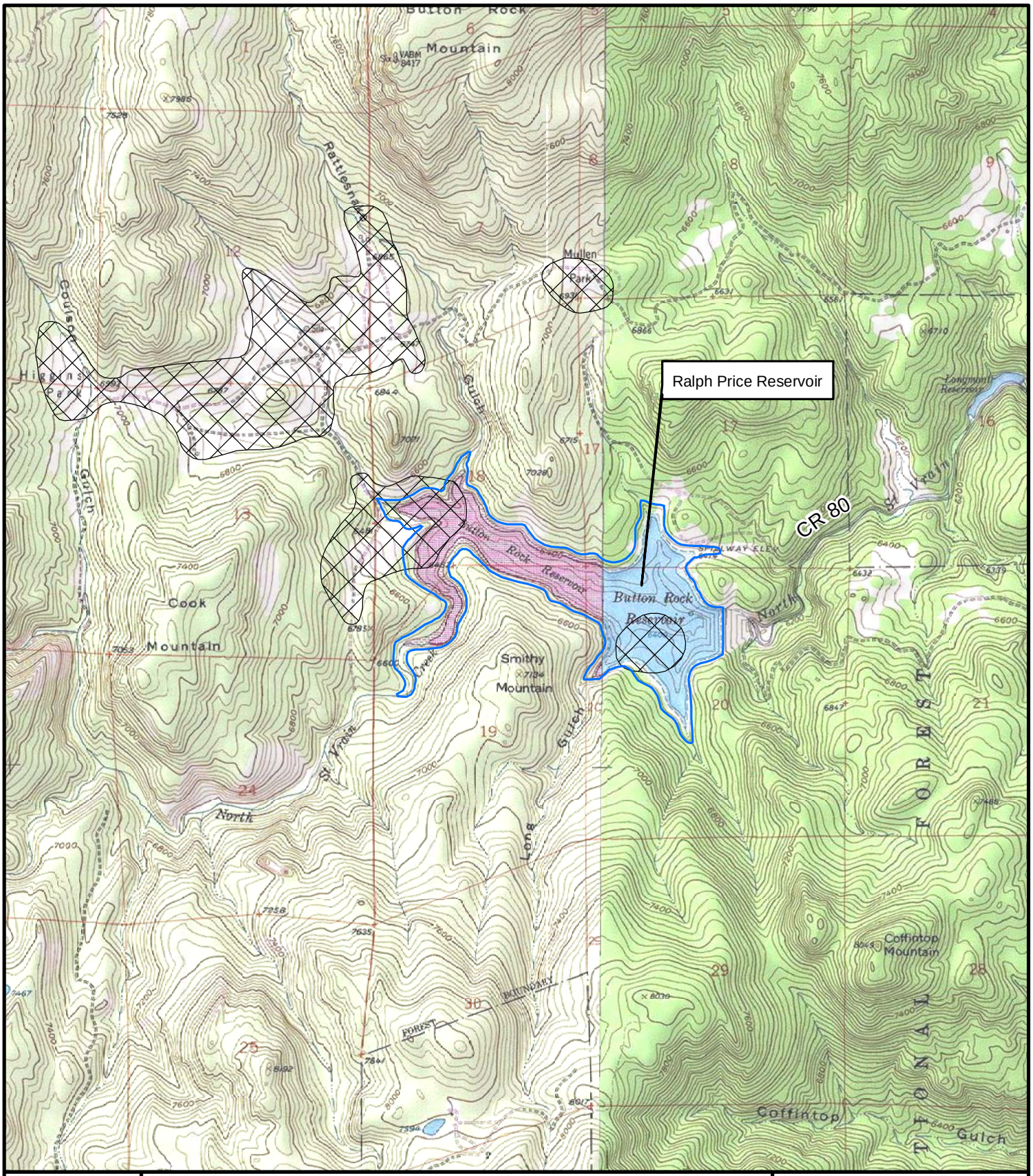
alpine aster (*Aster alpinus* var. *vierhapperi*)
aspen (*Populus tremuloides*)
asters (*Aster* spp.)
Baltic rush (*Juncus balticus*)
beaked sedge (*Carex utriculata*)
bedstraw (*Galium triflorum*)
Bell's twinpod (*Physaria bellii)*
big bluestem (*Andropogon gerardii)*
big sagebrush (A*rtemisia tridentata* ssp. *Wyomingensis*)
bitterbrush (*Purshia tridentata*)
bitteroot (*Lewisia rediviva*)
black spleenwort (*Asplenium adiantum-nigrum)*
blue grama (*Bouteloua gracilis)*
bluebells (*Mertensia ciliata*)
bluebunch wheatgrass (*Pseudoroegneria spicata*)
blue-eyed grass (*Sisyrinchium idahoense*)
bluegrass, mutton-grass (*Poa fendleriana*)
bluejoint reedgrass (*Calamagrostis canadensis*)
Bodin milkvetch (*Astragalus bodinii*)
bottlebrush squirreltail (*Sitanion hystrix*)
box-elder (*Acer negundo)*
bristle-stalk sedge (*Carex leptalea*)
broad-leaved twayblade (*Listera convallarioides)*
buffaloberry (*Shepherdia canadensis*)
bulrush cattail wetlands (*Schoenoplectus acutus-Typha latifolia (Schoenoplectus tabernaemontani*))
buttercup (*Ranunculus* spp.)
Canada bluegrass (*Poa compressa)*
Canada thistle (*Cirsium arvense)*
Canada wildrye (*Elymus canadensis*)
cattail marsh (*Typha latifolia*)
cattails (*Typha latifolia*)
cheatgrass (*Anisantha tectorum)*
cheatgrass (*Bromus tectorum*)
chokecherry (*Padus virginiana*)
clawless draba (*Draba exunguiculata)*
clover (*Trifolium pratense*)
clustered field sedge (*Carex praegracilis*)
clustered lady's slipper (*Cypripedium fasciculatum*)
Colorado butterfly plant (*Gaura neomexicana coloradensis*)
Colorado columbine (*Aquilegia coerulea*)
common gooseberry (*Ribes communis*)
common harebell (*Campanula rotundifolia*)

common juniper (*Juniperus communis*)
common mullein (*Verbascum thapsus*)
crack willow (*Salix fragilis)*
crested wheatgrass (*Agropyron cristatum*)
currant (*Ribes lacustre)*
currant (*Ribes* spp.)
dandelion (*Taraxacum officinale*)
dog parsley (*Aletes nuttallii*)
Douglas-fir (*Pseudotsuga menziesii*)
dropseed (*Sporobolus* spp.)
elk sedge (*Carex geyeri*)
emergent wetland/marsh (*Schoenoplectus maritimus*)
fescues (*Festuca* spp.)
foothills ponderosa pine/spike fescue savannas (*Pinus ponderosa/Leucopoa kingii*)
forked three-awn (*Aristida basiramea*)
fringed sage (*Artemesia frigida)*
gay feather (*Liatris ligulistylis)*
goldenrod (*Solidago* spp.)
Gray's peak whitlow-grass (*Draba grayana*)
green gentian (*Frasera speciosa*)
grouse whortleberry (*Vaccinium scoparium*)
harebells (*Campanula rotundifolia*)
Harrington beardtongue (*Penstemon harringtonii*)
hawkweed (*Hieracium fendleri*)
heartleaf arnica (*Arnica cordifolia*)
Ice grass (*Phippsia algida)*
Idaho fescue (*Festuca idahoensis*)
Indian paintbrush (*Castilleja flava*)
Indian ricegrass (*Achnatherum hymenoides)*
Jacob's ladder (*Polemonium foliosissimum*)
junegrass (*Koeleria cristata*)
Kentucky bluegrass (*Poa pratensis*)
kinnikinnik (*Arctostaphylos uva-ursi*)
kochia *(Kochia scoparium)*
Kotzebue's grass-of-parnassus (*Parnassia kotzebuei*)
lanceleaf cottonwood (*Populus* x. *acuminata*)
lancepod whitlowgrass (*Draba lonchocarpa* var. *lonchocarpa*)
larch-leaf beardtongue *(Penstemon laricifolius ssp. exilifolius*)
Larimer aletes (*Aletes humilis*)
lavender hyssop (*Agastache foeniculum)*
least moonwort (*Botrychium simplex*)
little bluestem (*Schizachyrium scoparium*)
locoweed (*Oxytropis* spp.)
lodgepole pine (*Pinus contorta*)
lupine (*Lupinus argentea*)
mariposa lily (*Calochortus nuttallii*)

meadow foxtail (*Alopecurus pratensis*)
Middle Park penstemon (*Penstemon cyathophorus*)
milkvetch (*Astragalus hallii*)
Mingan's moonwort (*Botrychium minganense*)
moonwort (*Botrychium lineare)*
mountain bladder fern (*Cystopteris montana*)
mountain brome (*Bromus marginatus*)
mountain mahogany – three-leaf sumac/big bluestem shrublands (*Cercocarpus montanus-Rhus trilobata/Andropogon gerardii*)
mountain mahogany (*Cercocarpus montanus)*
mountain mahogany/Mountain muhly shrublands (*Cercocarpus montanus/Muhlenbergia montana*)
mountain mahogany/Scribners needlegrass shrublands (*Cercocarpus montanus/Stipa scribneri*)
mountain muhly (*Muhlenbergia richardsonis*)
mountain muhly needle-and-thread grass grasslands (*Muhlenbergia montana - Stipa comata*)
mountain wormwood (*Artemisia ludoviciana*)
mud sedge (*Carex limosa*)
mullein (*Verbascum thapsis)*
musk thistle (*Carduus nutans)*
nagoon berry (*Rubus arcticus* ssp. *acaulis*)
narrowleaf cottonwood (*Populus angustifolia*)
narrowleaf cottonwood/Common chokecherry woodland (*Populus angustifolia/Prunus virginiana*)
narrowleaf cottonwood / Snowberry montane riparian forest (*Populus angustifolia/Symphoricarpos albus*)
narrowleaf cottonwood/ sandbar willow forest (*Populus angustifolia/Salix exigua*)
narrowleaf cottonwood/thin-leaf alder woodlands (*Populus angustifolia/Alnus incana*)
Nebraska sedge (*Carex nebrascensis*)
needle-and-thread grass (*Stipa comata*)
needle-and-thread grass (*Heterostipa comata*)
needlegrasses (*Stipa* ssp.)
needle-and-thread grass blue grama grasslands (*Stipa comata – Bouteloua gracilis*)
needlegrass species (*Nasella viridula, Heterostipa neomexicana,* and *H. comata)*
Nelson needlegrass (*Stipa nelsonii*)
northern twayblade (*Listera borealis*)
Northwest cinquefoil (*Potentilla gracilis*)
Oregon grape (*Mahonia repens*)
osterhout milkvetch (*Astragalus osterhoutii*)
owl clover (*Orthocarpus tolmei*)
paintbrush (*Castilleja miniata*)
paintbrushes (*Castilleja* ssp.)
pale moonwort (*Botrychium pallidum)*
peachleaf willow (*Salix amygdaloides*)
Peck's sedge (*Carex peckii*)

penland beardtongue (*Penstemon penlandii*)
phlox (*Phlox muscoides*)
pinegrass (*Calamagrostis rubescens*)
plains cottonwood Riparian forest (*Populus deltoides* ssp. *monilifera – Salix amygdaloides/Salix exigua*)
plains cottonwoods (*Populus deltoides* ssp. *monilifera*)
planeleaf, stapleaf, and Geyer's willow (*Salix planifolia*, *S. lutea*, and *S. geyeriana*)
ponderosa pine (*Pinus ponderosa*)
ponderosa pine/Mountain mahogany/big bluestem woodlands (*Pinus ponderosa/Cercocarpus montanus/Andropogon gerardii*)
prairie dropseed (*Sporobolus cryptandrus*)
prairie junegrass *(Koeleria macrantha*)
prairie violet (*Viola pedatifida*)
prickly pear cactus (*Opuntia polyacantha*)
purple cliff-brake (*Pellaea atropurpurea*)
purple ladies' slipper (*Cypripedium fasciculatum*)
pussy-toes (*Antennaria* spp.)
rabbit ears gilia (*Ipomopsis aggregata* ssp. *weberi*)
rattlesnake fern (*Botrypus virginianus* ssp. *europaeus*)
redtop (*Agrostis alba*)
redtop (*Agrostis stolonifera*)
reflected moonwort (*Botrychium echo*)
Rocky Mountain cinquefoil (*Potentillarupincola*)
Rocky Mountain columbine (*Aquilegia saximontana*)
Rocky Mountain penstemon (*Penstemon strictus*)
Rocky Mountain sedge (*Carex saximontana*)
rose (*Rosa* ssp.)
roundleaf sundew (*Drosera rotundifolia*)
sagebrush (*Artemisia tridentata*)
sandbar willow (*Salix exigua)*
Sandberg bluegrass (*Poa secunda*)
Say's rose (*Rosa sayi*)
scarlet gilia (*Ipomopsis aggregata*)
sedge (*Carex stenoptila*)
short-beaked sedge (*Carex simulata*)
shrubby cinquefoil (*Pentaphylloides floribunda*)
sideoats grama (*Bouteloua curtipendula)*
big bluestem (*Andropogon gerardii)*
skunkbush (*Rhus trilobata)*
slender cottongrass (*Eriophorum gracile*)
slender rock brake (*Cryptogramma stelleri*)
slender wheatgrass (*Elymus trachycaulus*)
small-winged sedge (*Carex microptera*)
smooth brome *(Bromus inermis*)
snakeweed (*Gutierrezia sarothrae*)
snowberry (*Symphoricarpos albus*)

snowberry *(Symphoricarpos occidentalis*)
softstem bulrush (*Scirpus tabernaemontani*)
spike trisetum (*Trisetum spicatum*)
spiny aster (*Machaeranthera* spp.)
spreading wood fern (*Dryopteris expansa*)
strap-style gayfeather (*Liatris ligulistylis*)
strawberry (*Fragaria vesca*)
sulphur flower (*Eriogonum umbellatum*)
sweetflag (*Acorus calamus*)
switchgrass (*Panicum virgatum*)
thick-leaf whitlow-grass (*Draba crassa*)
thinleaf alder/mesic graminoid shrublands (Montane riparian shrubland) (*Alnus Incana/Mesic Graminoids*)
Thurber's fescue (*Festuca thurberi*)
Timothy (*Phleum pratense*)
tufted hairgrass *(Deschampsia caespitosa*)
Ute ladies'-tresses orchid (*Spiranthes diluvialis*)
Vasey bulrush (*Juncus vaseyi*)
water sedge (*Carex aquatilis*)
Watson penstemon (*Penstemon watsonii*)
Weber's monkeyflower (*Mimulus gemmiparus*)
weed cheatgrass (*Anisantha tectorum)*
western wheatgrass (*Pascopyrum smithii*)
wild grapes (*Vitas riparia*)
wild plum (*Prunus americana*)
willowherb (*Epilobium ciliatum*)
Wood's rose (*Rosa woodsii*)
yarrow (*Achillea lanulosa*)
yellow sweetclover (*Melilotus officinalis*)
yucca (*Yucca glauca*)



Ralph Price Reservoir Enlargement

Potential Borrow Areas

0 1,300 2,600 Feet

1 Inch = 2600 Feet

N

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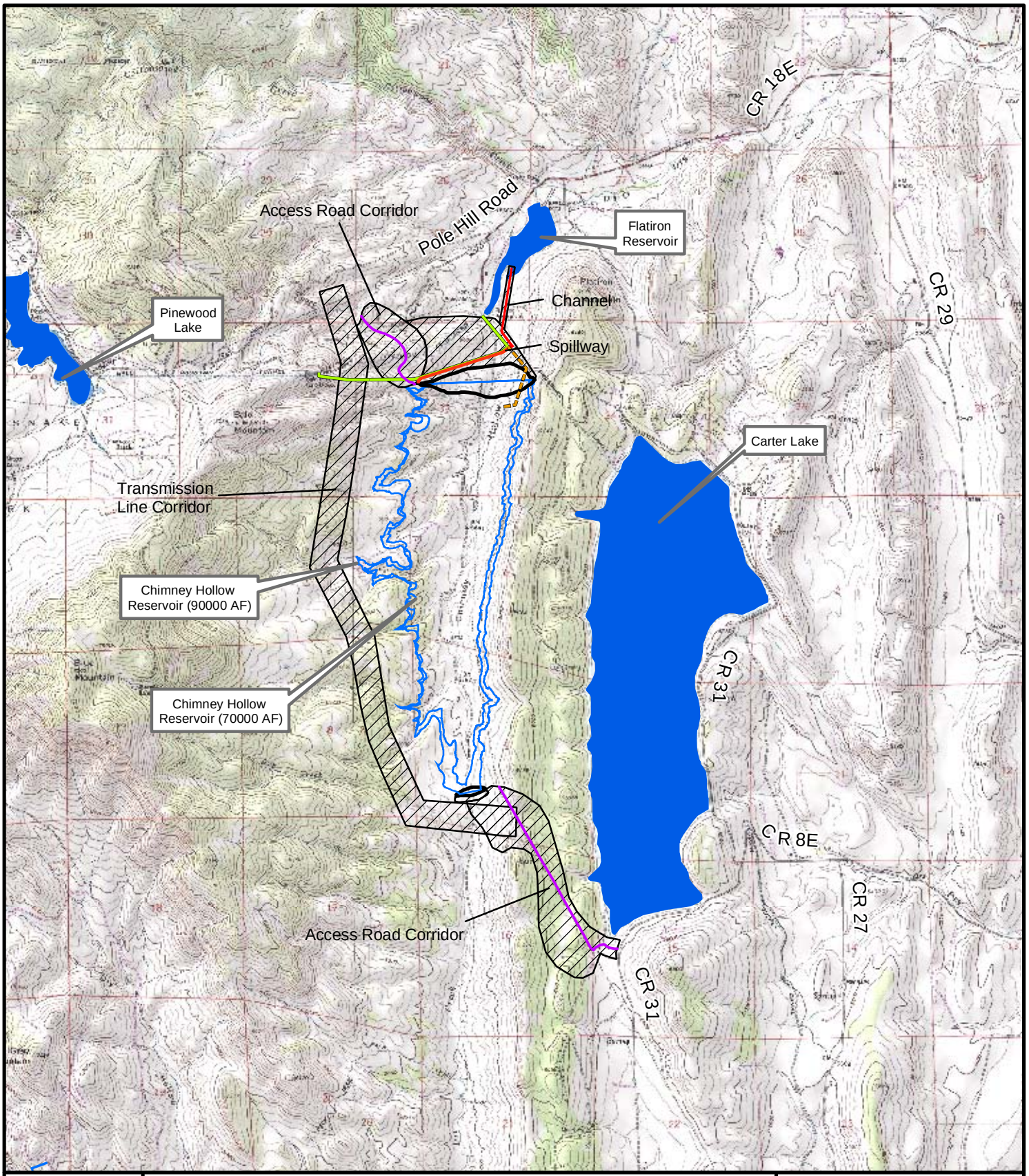
Figure 1
Ralph Price Reservoir Site

Prepared for: Windy Gap Firming Project
File: Ralph_Price_Reservoir_Site_Map.mxd
Date: July 2006



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New or Improved Access Road
Inlet - Outlet
Spillway/Channel
Pipeline
Potential Area of Disturbance
Reservoir
Dam

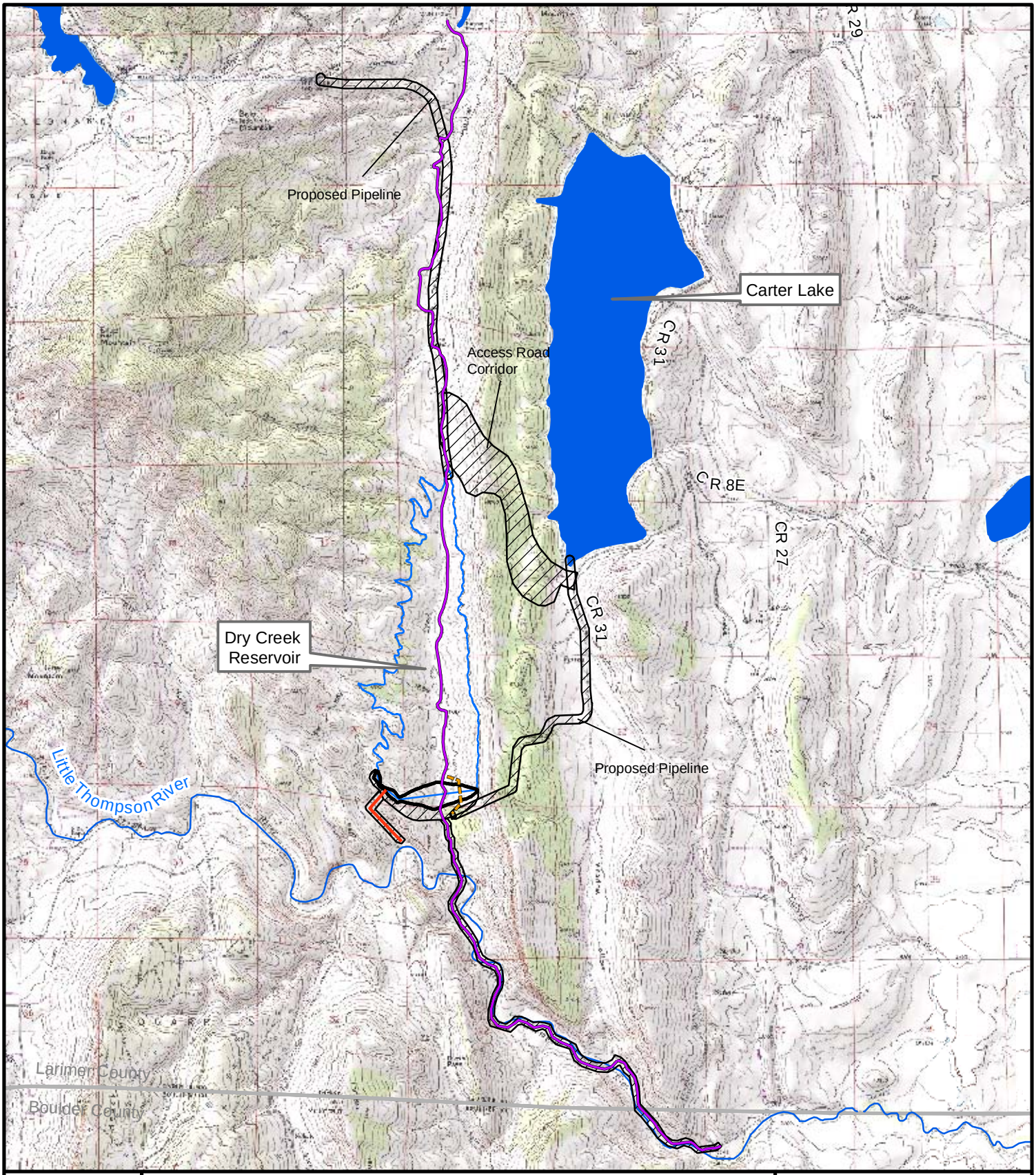
0 2,000 4,000 Feet

1 Inch = 4,000 Feet

N

Figure 2
Chimney Hollow Reservoir Site

Prepared for: Windy Gap Firming Project
File: Chimney_Hollow_Site_Map.mxd
Date: July 2006



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New or Improved Access Road
Inlet - Outlet
Spillway
Potentail Area of Disturbance
Reservoir
Dam
County Boundary

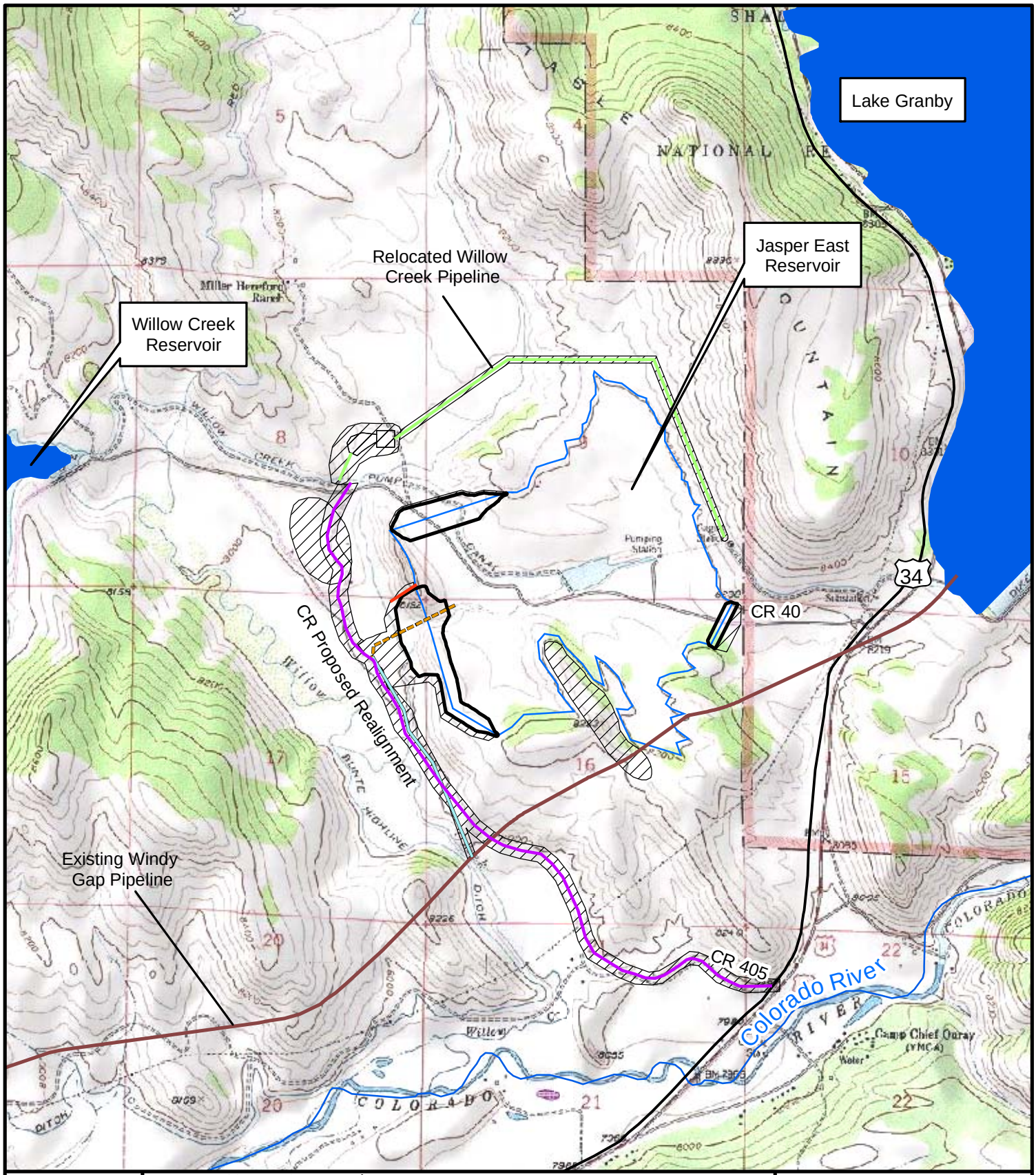
0 2,300 4,600 Feet

1 Inch = 4,600 Feet

N

Figure 3
Dry Creek Reservoir Site

Prepared for: Windy Gap Firming Project
File: Dry_Creek_Site_Map.mxd
Date: July 2006



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New or Improved Access Road
New Pipeline
Inlet - Outlet
Spillway
Potential Area of Disturbance
Reservoir
Dam

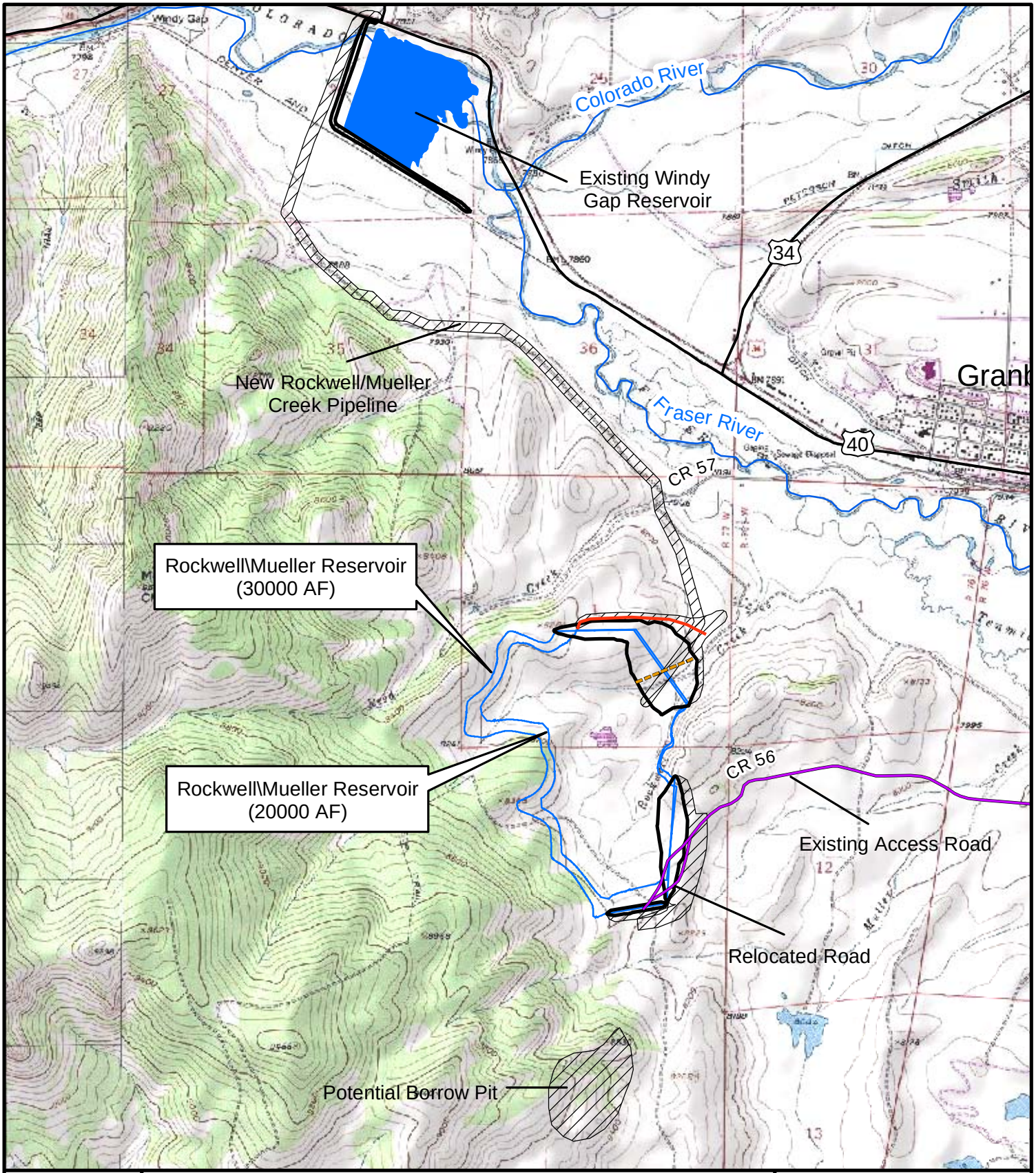
0 1,100 2,200 Feet

1 Inch = 2,200 Feet

N

Figure 4
Jasper East Reservoir Site

Prepared for: Windy Gap Firming Project
File: Jasper_East_Wetland_Study_Area.mxd
Date: July 2006



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New or Improved Access Road
Inlet - Outlet
Spillway
Potential Area of Disturbance
Reservoir
Dam

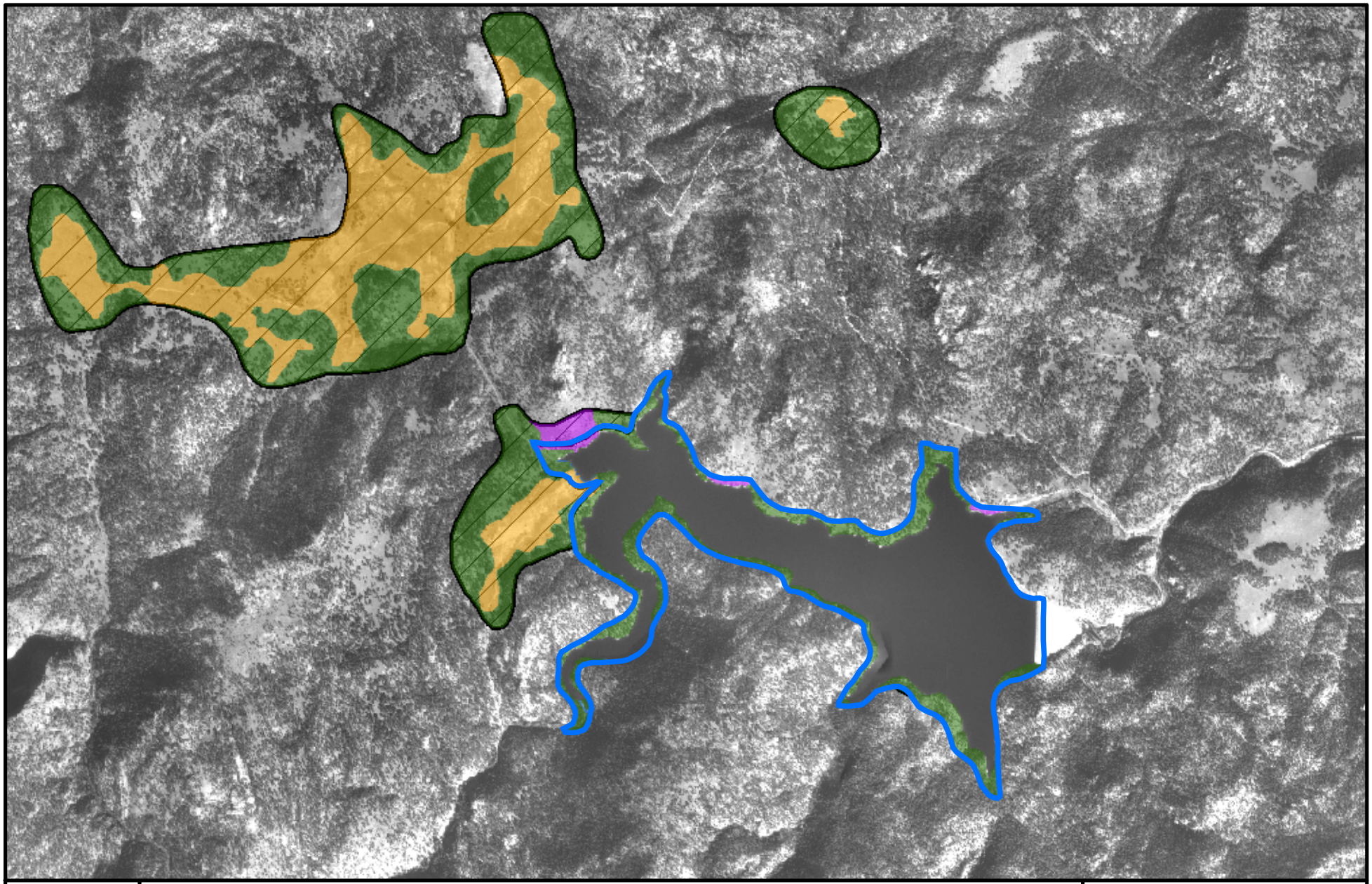
0 1,300 2,600 Feet

1 Inch = 2,600 Feet

N

Figure 5
Rockwell/Mueller Creek Reservoir Site

Prepared for: Windy Gap Firming Project
File: Rockwell_Site_Map.mxd
Date: July 2006



Vegetation Cover Types

- Upland Native Forest
- Upland Native Grasslands
- Upland Native Shrublands

Structures

- Ralph Price Reservoir Enlargement
- Potential Borrow Area

0 900 1,800 Feet

1 Inch = 1,800 Feet

N

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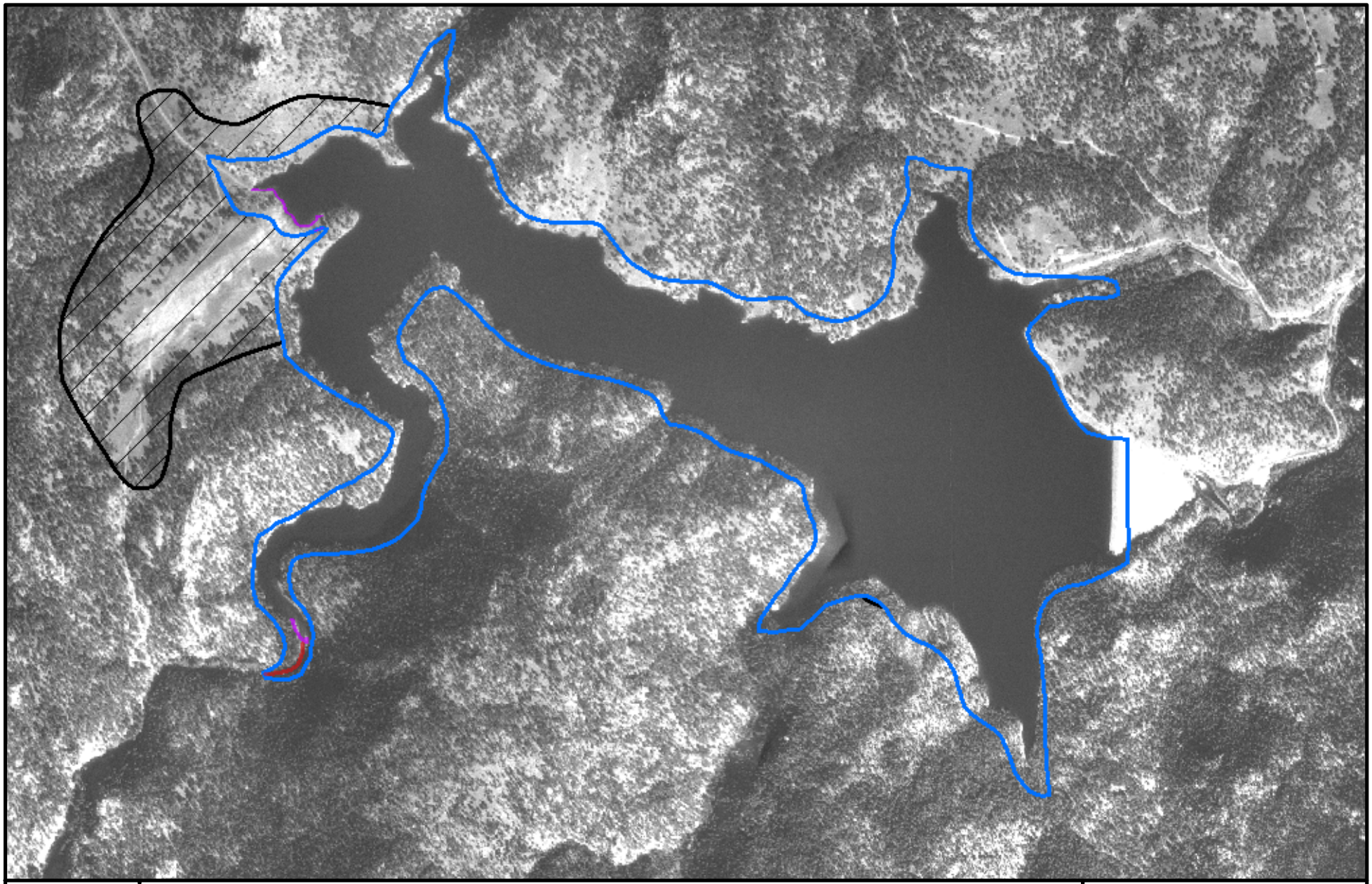
Figure 6
Ralph Price Study Area
Vegetation Cover Types

Prepared for: Windy Gap Firming Project
File: Ralph_Price_Reservoir_Vegetation8x11.mxd
Date: July 2006



Wetland Cover Types

- Waters
- Wetland

Structures

- Ralph Price Reservoir
- Potential Borrow Area

0 500 1,000 Feet

1 Inch = 1,000 Feet

N

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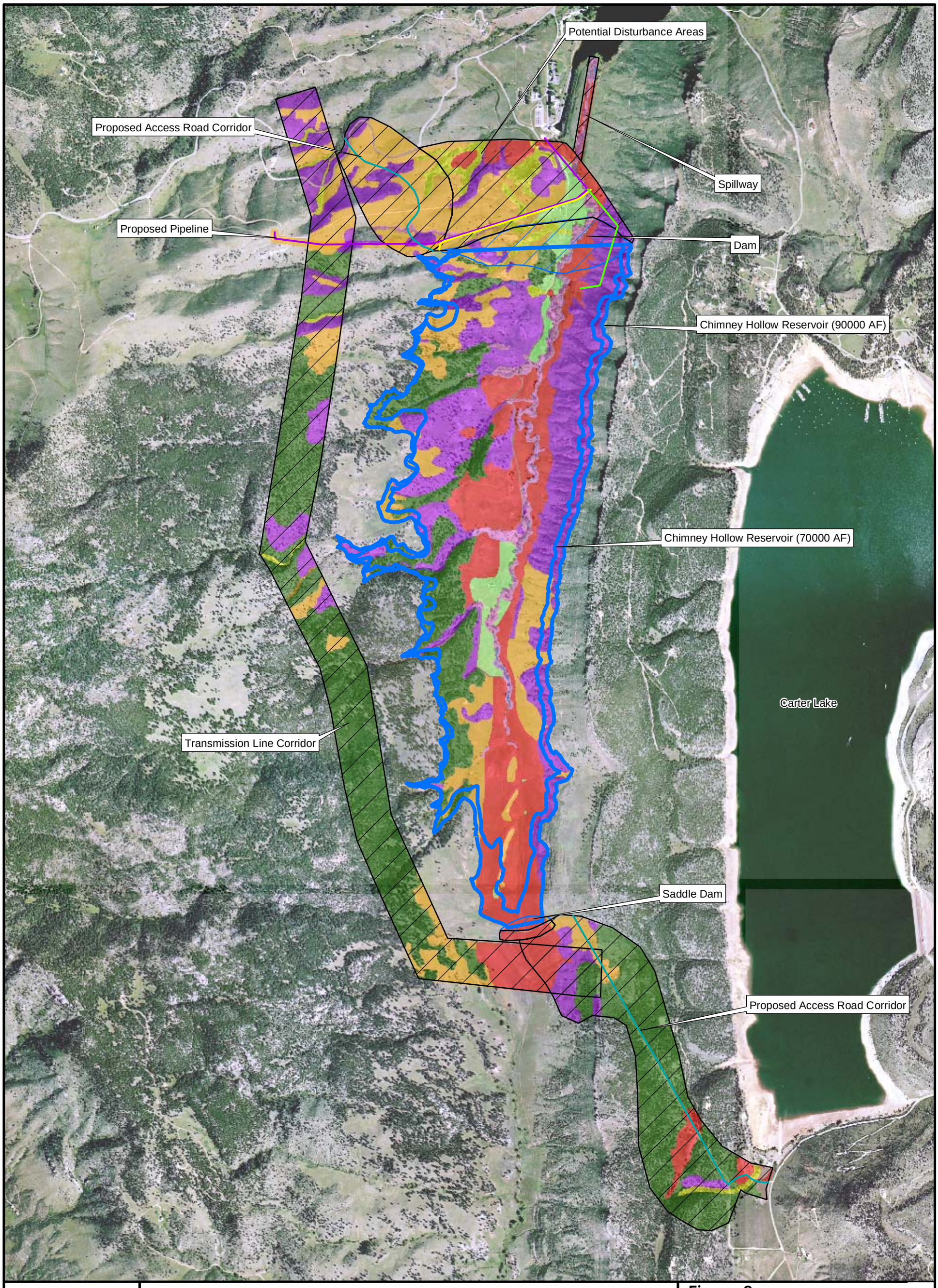
Figure 7
Ralph Price Reservoir Wetlands and Waters

Prepared for: Windy Gap Firming Project
File: Ralph_Price_Reservoir_Wetland8x11.mxd
Date: July 2006



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Vegetation Cover Types
- Disturbed
- Mesic Native Woodlands
- Upland Introduced Grasslands
- Mixed Mesic Grasslands
- Mesic Native Shrublands
- Upland Native Shrublands
- Upland Native Grasslands
- Upland Native Forest

Structures
- Access Road
- Chimney Hollow Pipeline
- Inlet - Outlet
- Spillway
- Potential Disturbance Area
- Chimney Hollow Dam
- Chimney Hollow Reservoir

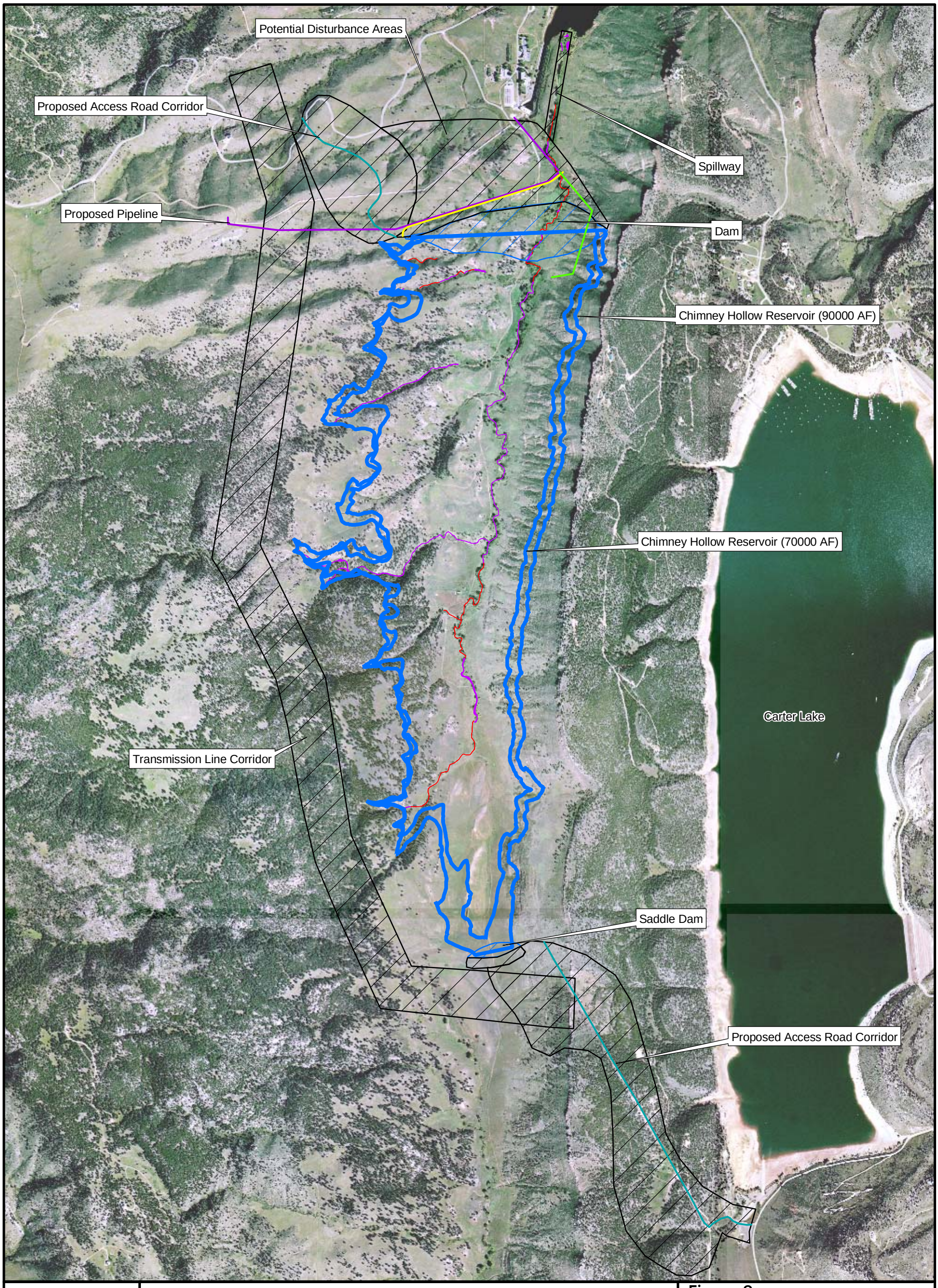
0 850 1,700 Feet

1 Inch = 1,700 Feet

N

Figure 8
Chimney Hollow Study Area
Vegetation Cover Types

Prepared for: Windy Gap Firming Project
File: W/Chimney_Hollow_Vegetation11x17.mxd
Date: July 2006



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Wetland Cover Types
- Waters
- Wetland

Structures
- Access Road
- Chimney Hollow Pipeline
- Inlet - Outlet
- Spillway
- Potential Disturbance Area
- Chimney Hollow Dam
- Chimney Hollow Reservoir

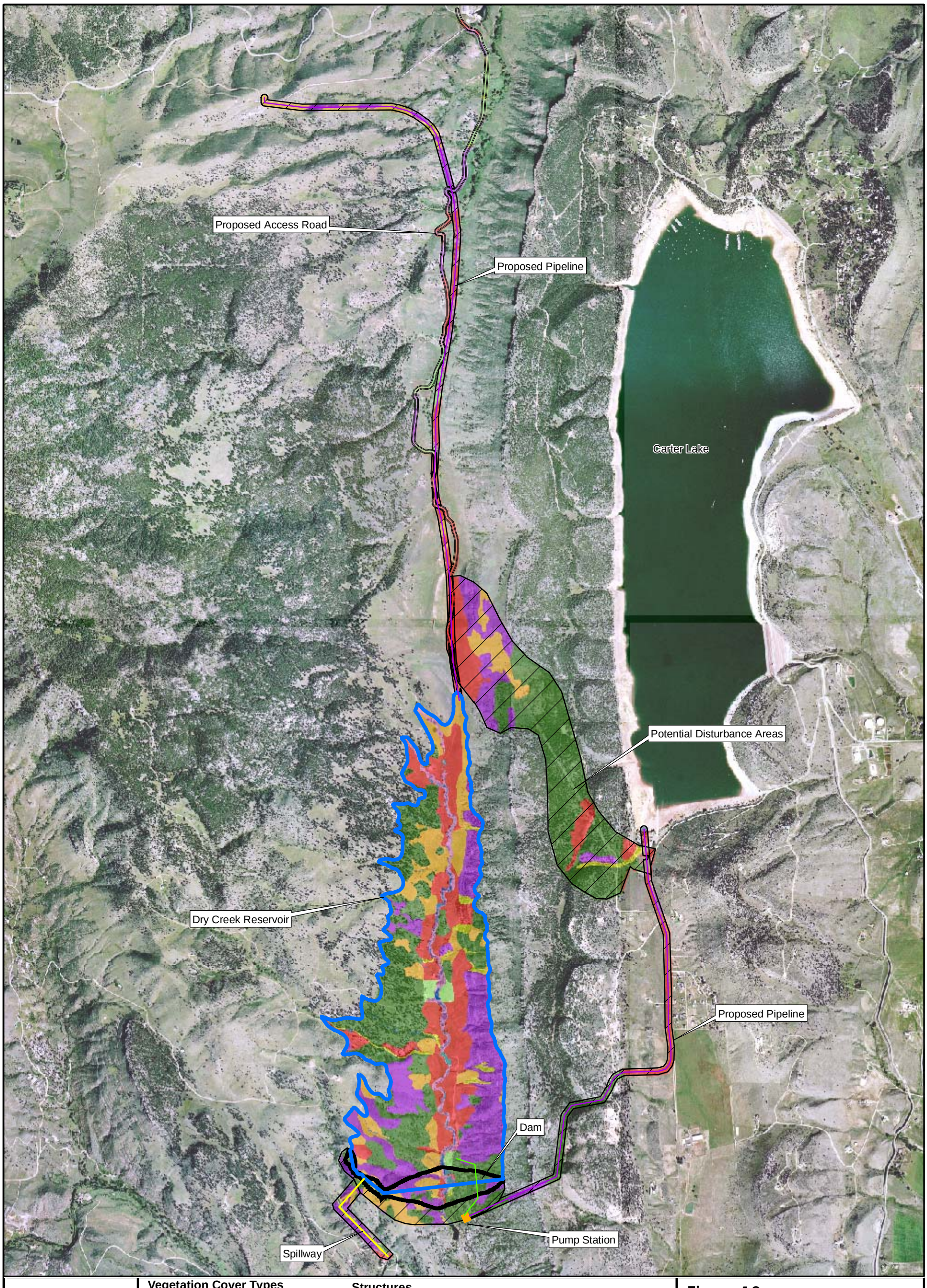
0 800 1,600 Feet

1 Inch = 1,600 Feet

N

Figure 9
Chimney Hollow Reservoir Wetlands and Waters

Prepared for: Windy Gap Firming Project
File: W/Chimney_Hollow_wetland11x17.mxd
Date: April 2006



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Vegetation Cover Types
- Disturbed
- Mesic Native Woodlands
- Upland Introduced Grasslands
- Mixed Mesic Grasslands
- Mesic Native Shrublands
- Upland Native Shrublands
- Upland Native Grasslands
- Upland Native Forest

Structures
- Access Road
- Dry Creek Pipeline
- Inlet - Outlet
- Spillway
- Potential Disturbance Area
- Dry Creek Dam
- Dry Creek Reservoir

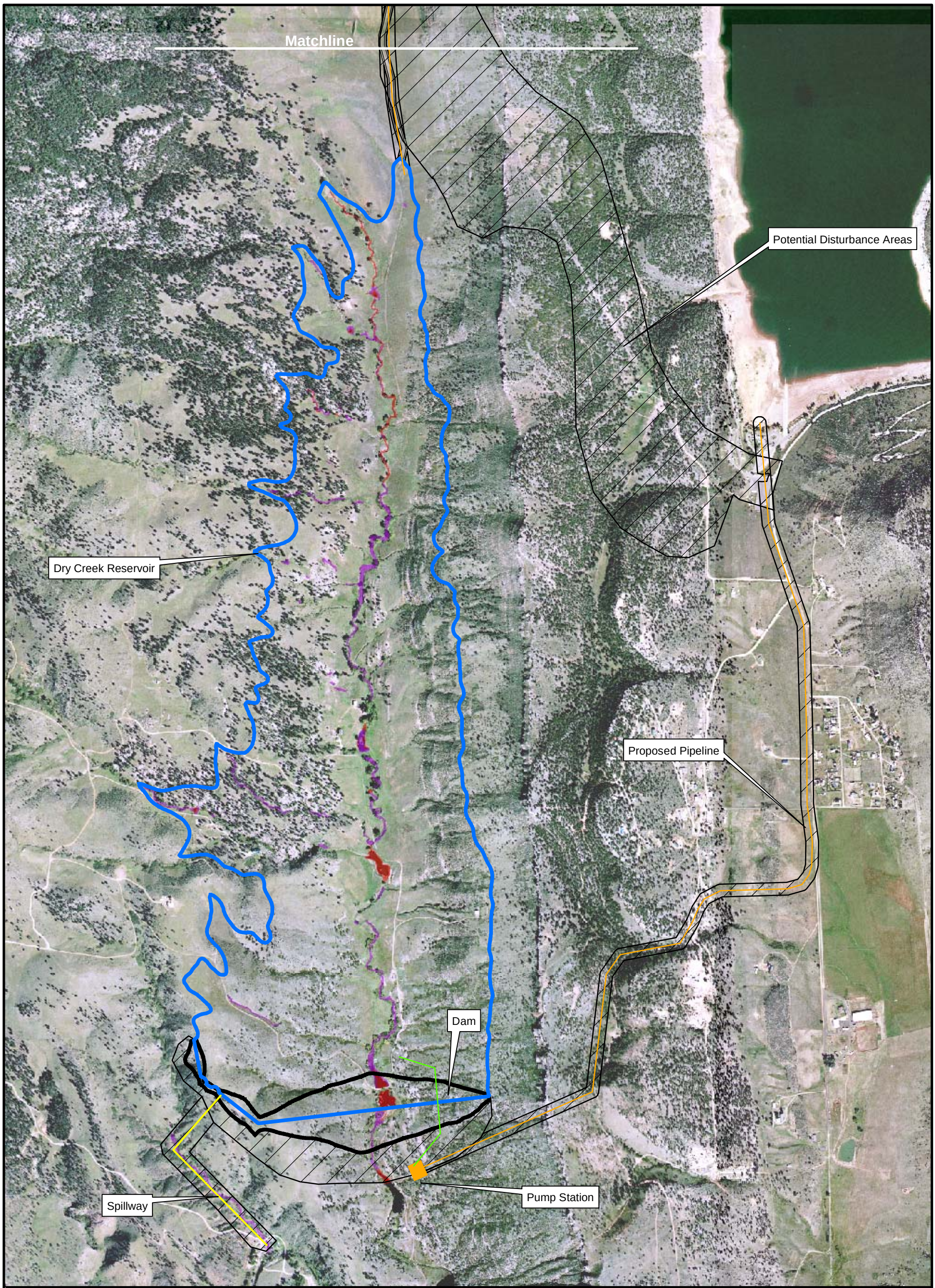
0 1,050 2,100 Feet

1 Inch = 2100 Feet

N

Figure 10
Dry Creek Study Area
Vegetation Cover Types

Prepared for: Windy Gap Firming Project
File: W/DryCreek_vegetation11x17.mxd
Date: July 2006



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Wetland Cover Types
- Waters
- Wetland

Structures
- Access Road
- Dry Creek Pipeline
- Inlet - Outlet
- Spillway
- Potential Disturbance Area
- Dry Creek Dam
- Dry Creek Reservoir

0 550 1,100 Feet

1 Inch = 1,100 Feet

N

Figure 11a
Dry Creek Reservoir
Wetlands and Waters

Prepared for: Windy Gap Firming Project
File: W/DryCreek_wetland11x17_1a.mxd
Date: April 2006

Proposed Access Road

Proposed Pipeline

Potential Disturbance Areas

Matchline

Cart

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Wetland Cover Types
- Waters
- Wetland

Structures
- Access Road
- Dry Creek Pipeline
- Inlet - Outlet
- Spillway
- Potential Disturbance Area
- Dry Creek Dam
- Dry Creek Reservoir

0 550 1,100 Feet

1 Inch = 1,100 Feet

N

Figure 11b
Dry Creek Reservoir
Wetlands and Waters

Prepared for: Windy Gap Firming Project
File: W/DryCreek_wetland11x17_1b.mxd
Date: April 2006

Relocated Willow Creek Canal

Proposed WC Pump Station and Forebay

Dams

Spillway

Filter Borrow

Proposed Pipeline

Potentail Disturbance Areas

Rock Borrow

Existing WG Pipeline

Pump Station

Proposed Access Road

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Vegetation Cover Types

- Disturbed
- Mesic Native Woodlands
- Upland Introduced Grasslands
- Mixed Mesic Grasslands
- Mesic Native Shrublands
- Upland Native Shrublands
- Upland Native Grasslands
- Upland Native Forest
- Wetland
- Ditch

Structures

- Access Road
- Jasper East Pipeline
- Inlet - Outlet
- Spillway
- Irrigation Ditch
- WC Pipeline
- Existing Windy Gap Pipeline
- Potential Disturbance Areas
- Jasper East Dam
- Jasper East Reservoir
- Borrow Area

0 425 850 Feet

1 Inch = 850 Feet

N

Figure 12
Jasper East Study Area
Vegetation Cover Types

Prepared for: Windy Gap Firming Project
File: W/Jaspereast_vegetation11x17.mxd
Date: July 2006
Aerial Photo - 1990

Relocated Willow Creek Canal

WC Pump Station

Dams

Spillway

Filter Borrow

Proposed Pipeline

Potentail Disturbance Areas

Rock Borrow

Existing WG Pipeline

Pump Station

Proposed Access Road

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Wetland Cover Types

- Wetland
- Wetland Potentially Supported by Flood Irrigation
- Up to 50% of this Wetland is Potentially Supported by Irrigation
- Ditch/Forebay
- Waters

Structures

- Access Road
- Jasper East Pipeline
- Inlet - Outlet
- Spillway
- Irrigation Ditch
- WC Pipeline
- Existing Windy Gap Pipeline
- Potential Disturbance Areas
- Jasper East Dam
- Jasper East Reservoir
- Borrow Area

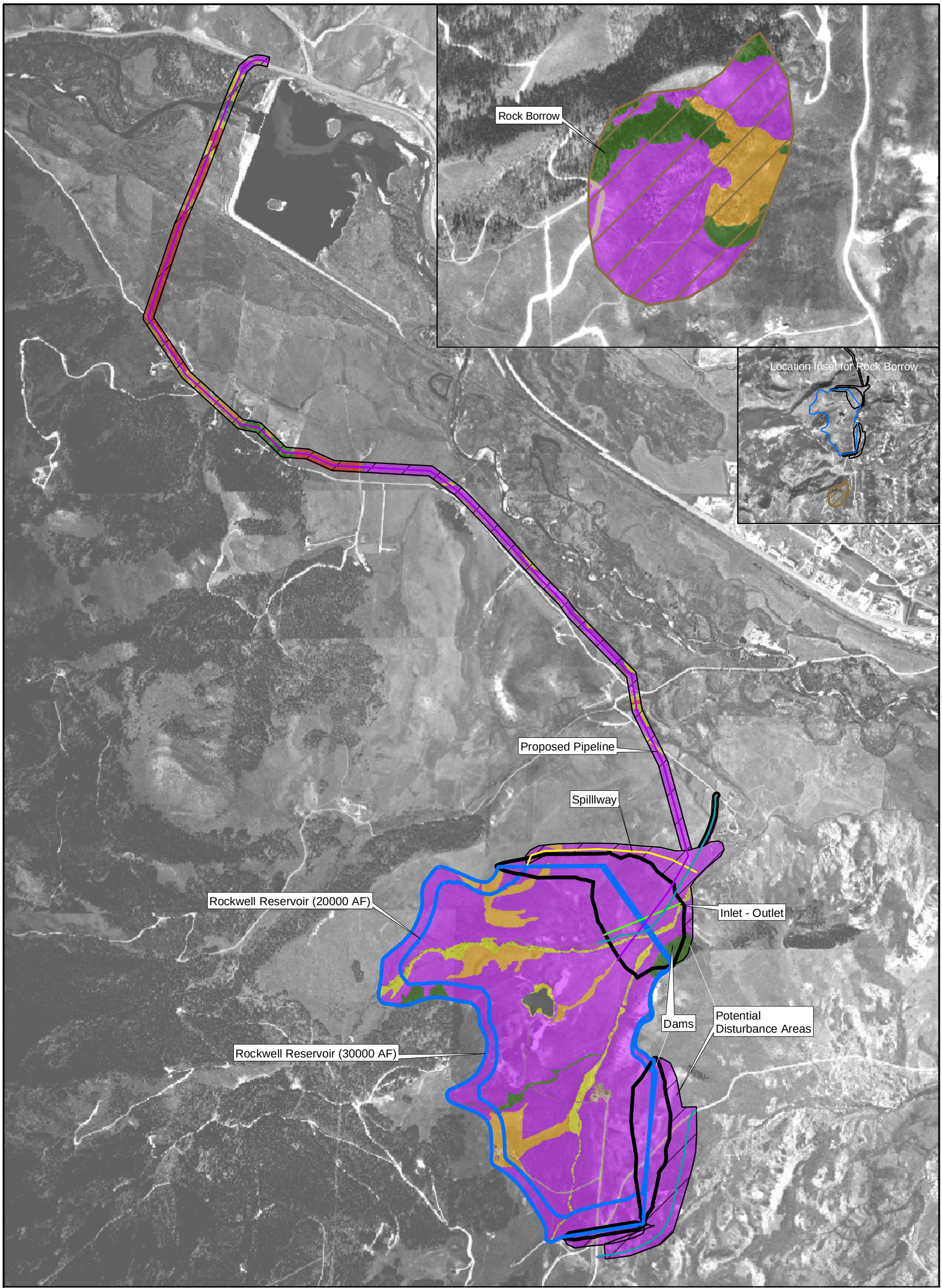
0 425 850 Feet

1 Inch = 850 Feet

N

Figure 13
Jasper East Reservoir Wetlands and Waters

Prepared for: Windy Gap Firming Project
File: W/Jaspereast_wetland11x17.mxd
Date: April 2006
Aerial Photo - 1990



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Vegetation Cover Types
- Disturbed
- Mixed Mesic Grasslands
- Upland Native Forest
- Upland Mixed Grasslands
- Mesic Native Shrublands
- Upland Native Shrublands

Structures
- Access Road
- Rockwell Pipeline
- Inlet - Outlet
- Spillway
- Windy Gap Pipeline
- Potential Disturbance Areas
- Rockwell Dam
- Rockwell Reservoir
- Borrow Area

0 700 1,400 Feet

1 Inch = 1,400 Feet

N

Figure 14
Rockwell/Mueller Study Area
Vegetation Cover Types

Prepared for: Windy Gap Firming Project
File: W/Rockwell_vegetation11x17.mxd
Date: July 2006

Rock Borrow

Matchline

Location Inset for Rock Borrow

Proposed Pipeline

Spilllway

Rockwell Reservoir (20000 AF)

Inlet - Outlet

Dams

Potential Disturbance Areas

Rockwell Reservoir (30000 AF)

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Wetland Cover Types
- Waters
- Wetland/Mesic Native Shrub
- Ditch
- Open Water

Structures
- Access Road
- Rockwell Pipeline
- Inlet - Outlet
- Spillway
- Windy Gap Pipeline
- Potential Disturbance Areas
- Rockwell Dam
- Rockwell Reservoir
- Borrow Area

0 450 900 Feet

1 Inch = 900 Feet

N

Figure 15a
Rockwell/Mueller Reservoir Wetlands and Waters

Prepared for: Windy Gap Firming Project
File: W/Rockwell_wetland11x17.mxd
Date: July 2006

Windy Gap Pump Station

Windy Gap Reservoir

Windy Gap Dam

Proposed Pipeline

Matchline

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Wetland Cover Types
- Waters
- Wetland/Mesic Native Shrub
- Ditch
- Open Water

Structures
- Rockwell Pipeline
- Windy Gap Pipeline
- Potential Disturbance Areas
- Windy Gap Dam
- Windy Gap Reservoir
- Windy Gap Pump Station

*Not all of the pipeline corridor would be disturbed.

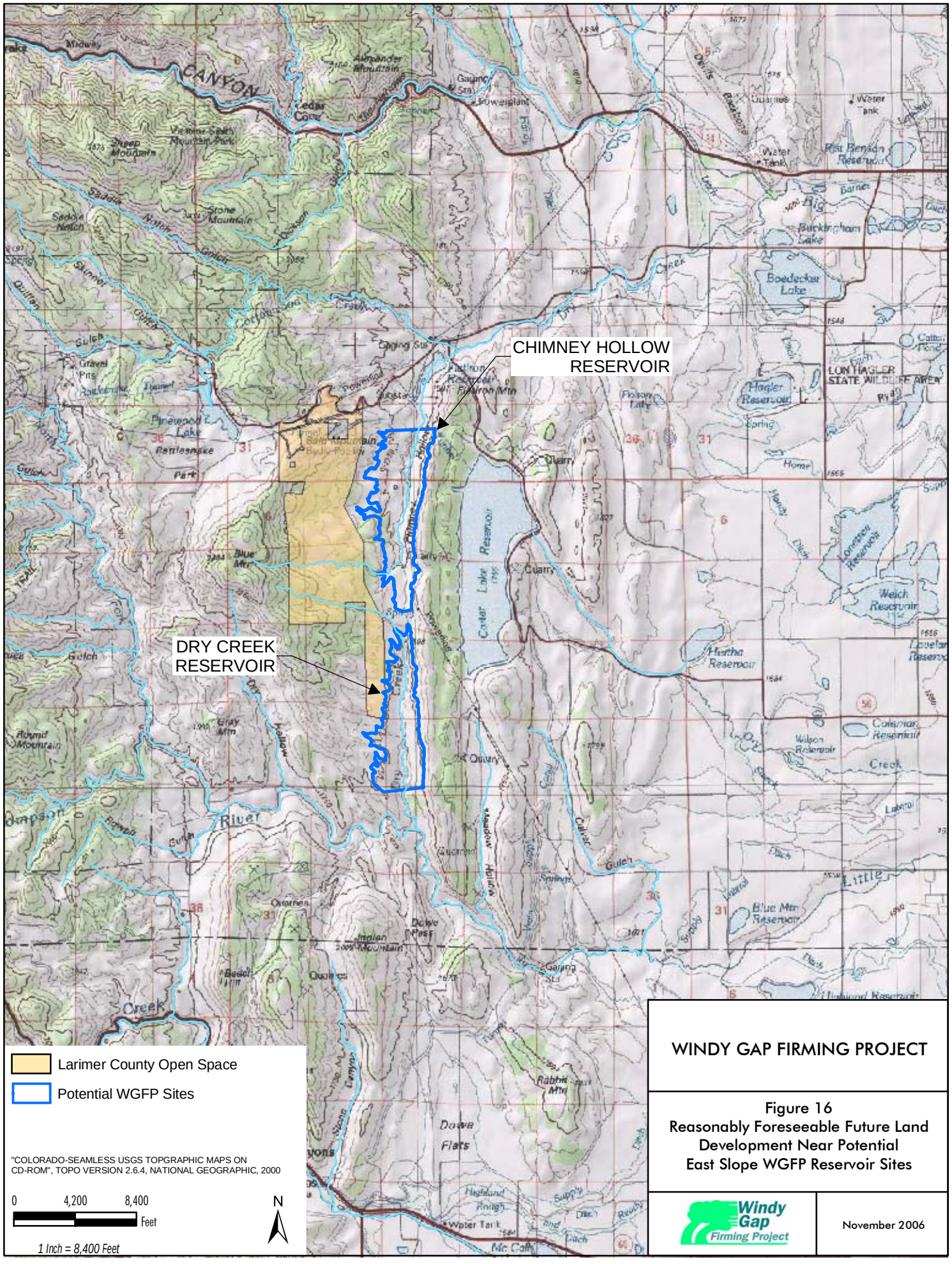
0 450 900 Feet

1 Inch = 900 Feet

N

Figure 15b
Rockwell/Mueller Reservoir Wetlands and Waters

Prepared for: Windy Gap Firming Project
File: W/Rockwell_wetland11x17.mxd
Date: April 2006

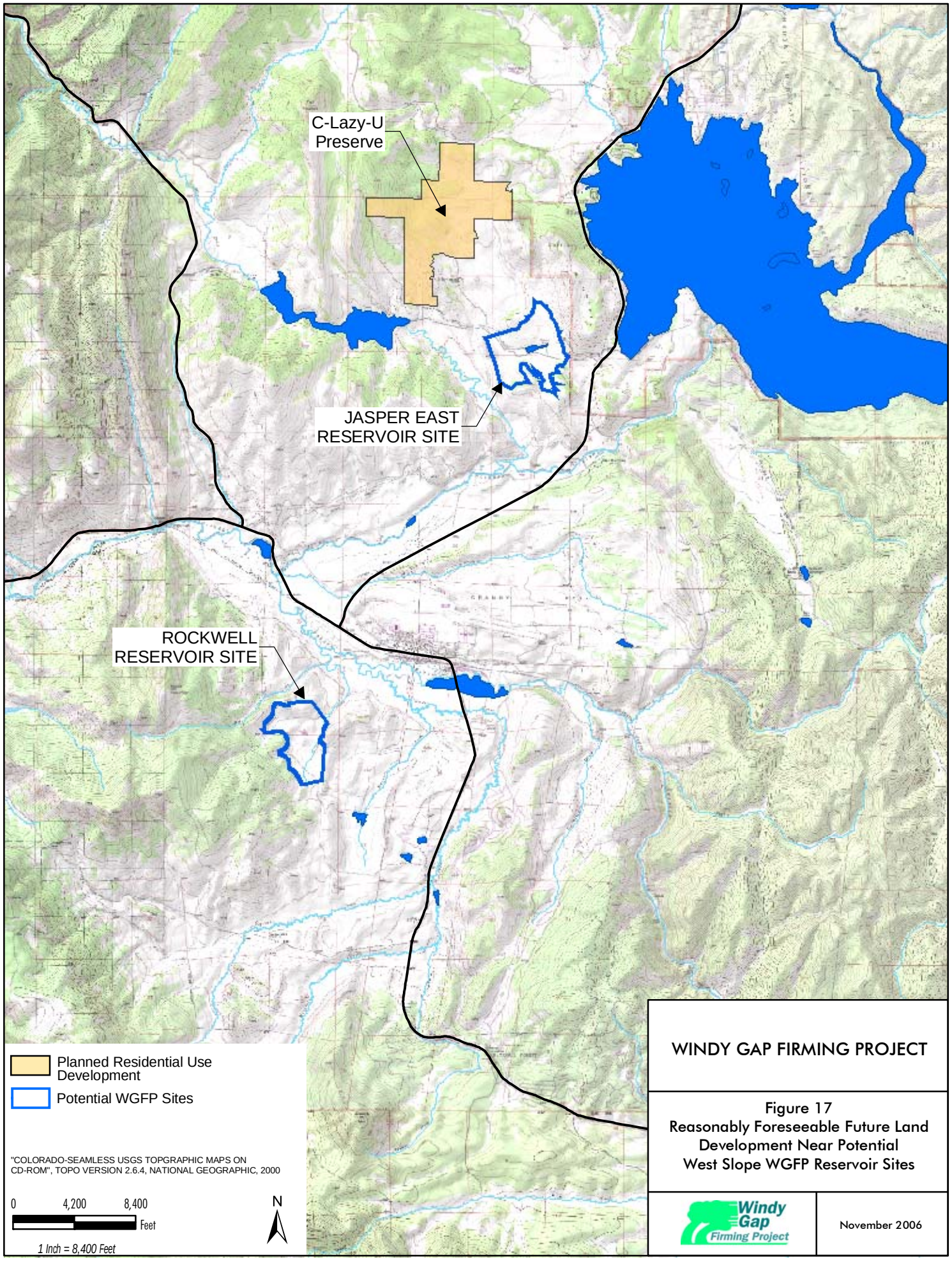


WINDY GAP FIRMING PROJECT

Figure 16
Reasonably Foreseeable Future Land Development Near Potential East Slope WGFP Reservoir Sites

Windy Gap Firming Project

November 2006



WINDY GAP FIRMING PROJECT

Figure 17
Reasonably Foreseeable Future Land Development Near Potential West Slope WGFP Reservoir Sites

Windy Gap Firming Project

November 2006

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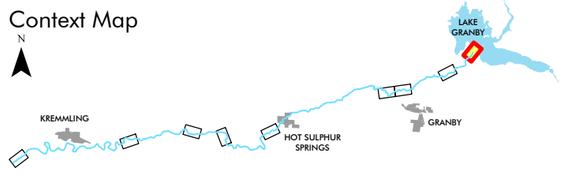
Aerial Photograph: 1974 APFO

Context Map



1 Inch = 400 Feet

Figure 18a
Colorado River
Lake Grandby Outlet
1972 - 1974 Historical Imagery

Prepared for: Windy Gap Firming Project
File: 2390-Map1.mxd
Date: August

Note larger (more mature) trees than 1970 photo (18a)

COLORADO RIVER BELOW LAKE GRANBY, CO.
Gauge No. 9019000

Note more riparian tree and shrub cover than 1970 photo (18a)

Note increase in riparian vegetation, but apparently a decrease in tree cover

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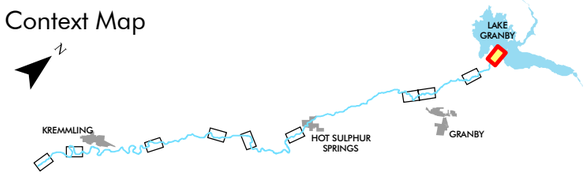
Aerial Photograph: 2005 USGS

Context Map



1 Inch = 400 Feet

Figure 18b
Colorado River, Lake Granby Outlet, 2005 Imagery

Prepared for: Windy Gap Firming Project
File: 2390-VEG_CORiver_2005_mapbook.mxd(JP)
Date: July 2006

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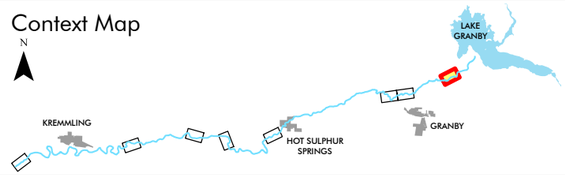
Aerial Photograph: 1974 APFO

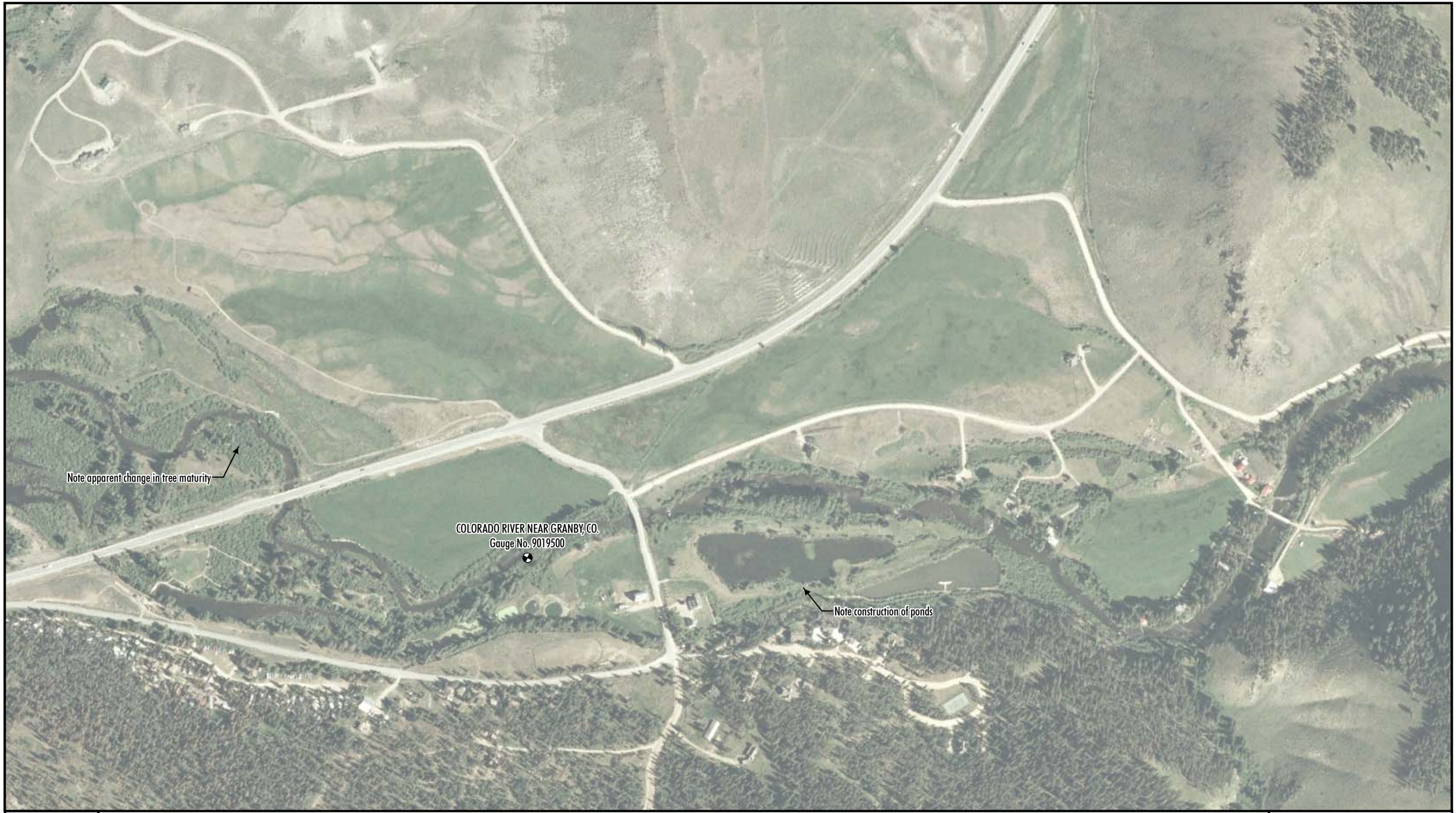
Context Map



1 Inch = 400 Feet

Figure 19a
Colorado River Below Lake Granby
1972 - 1974 Historic Imagery

Prepared for: Windy Gap Firming Project
File: 2390-Map3.mxd
Date: August 2006



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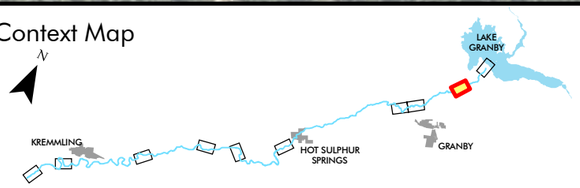
Aerial Photograph: 2005 USGS

Context Map



1 Inch = 400 Feet

Figure 19b
Colorado River below Lake Granby, 2005 Imagery

Prepared for: Windy Gap Firming Project
File: 2390-VEG_CORiver_2005_mapbook.mxd(JP)
Date: July 2006

Ditch

Irrigated hay meadows
Note influence of flood irrigation

Ditch

Ditch

Ditch

Note influence of flood irrigation

Irrigated hay meadows
Note influence of flood irrigation

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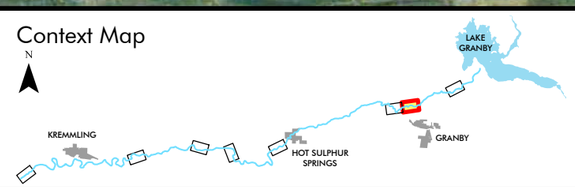
Aerial Photograph: 1974 APFO

Context Map



1 Inch = 400 Feet

Figure 20a
Colorado River Near Granby
1972 - 1974 Historic Imagery

Prepared for: Windy Gap Firming Project
File: 2390-Map6.mxd
Date: August 2006

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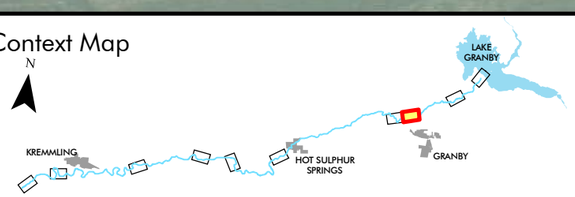
Aerial Photograph: 2005 USGS

Context Map



1 Inch = 400 Feet

Figure 20b
Colorado River near Granby, 2005 Imagery

Prepared for: Windy Gap Firming Project
File: 2390-VEG_CORiver_2005_mapbook.mxd(JP)
Date: July 2006

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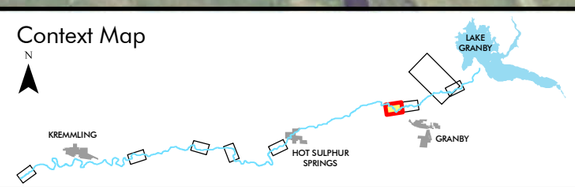
Aerial Photograph: 1974 APFO

Context Map



1 Inch = 400 Feet

Figure 21a
Colorado River at
Windy Gap Reservoir
1972 - 1974 Historic Imagery

Prepared for: Windy Gap Firming Project
File: 2390-Map7.mxd
Date: August 2006

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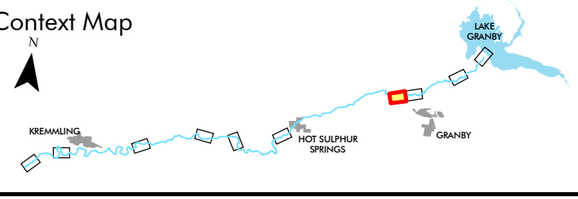
Aerial Photograph: 2005 USGS

Context Map



1 Inch = 400 Feet

Figure 21b
Colorado River at Windy Gap Reservoir, 2005 Imagery

Prepared for: Windy Gap Firming Project
File: 2390-VEG_CORiver_2005_mapbook.mxd(JP)
Date: July 2006

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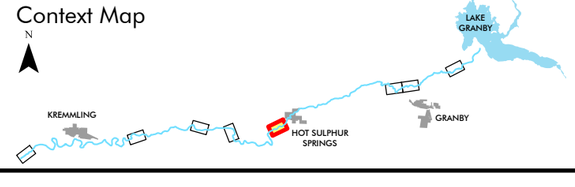
Aerial Photograph: 1972 APFO

Context Map



1 Inch = 400 Feet

Figure 22a
Colorado River in Beyer's Canyon 1972 - 1974 Historic Imagery

Prepared for: Windy Gap Firming Project
File: 2390-Map15.mxd
Date: August 2006

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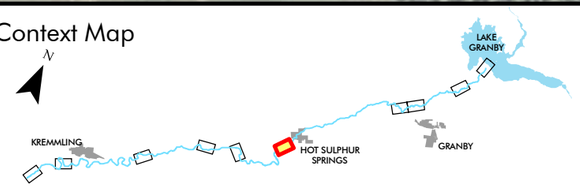
Aerial Photograph: 2005 USGS

Context Map



1 Inch = 400 Feet

Figure 22b
Colorado River in Beyer's Canyon, 2005 Imagery

Prepared for: Windy Gap Firming Project
File: 2390-VEG_CORiver_2005_mapbook.mxd(JP)
Date: July 2006

Note influence of flood irrigation.
In many cases, flood irrigated areas
appear wetter than the areas adjacent
to the streams.

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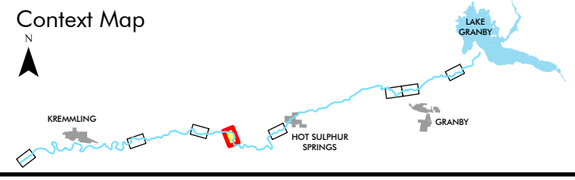
Aerial Photograph: 1972 APFO

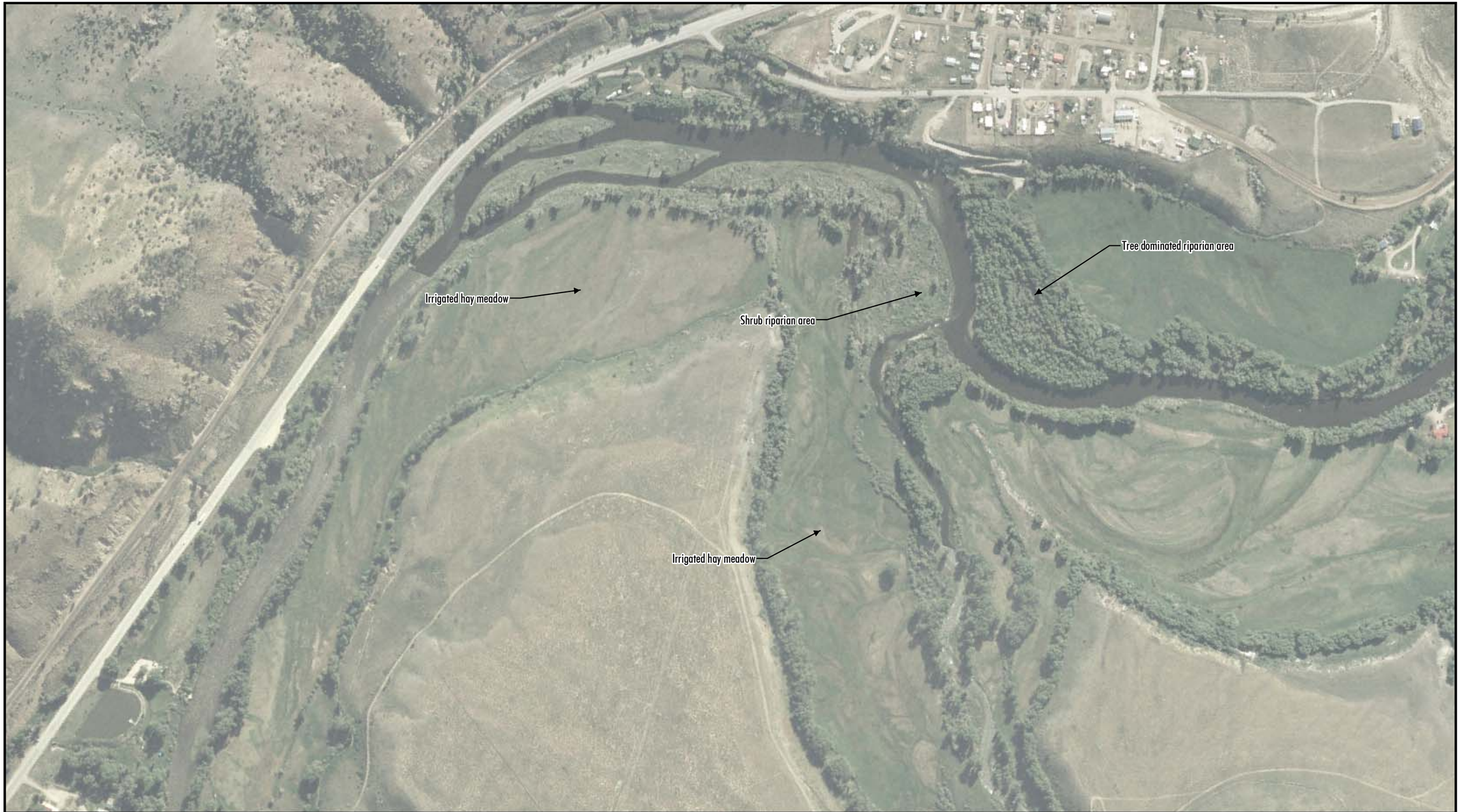
Context Map



1 Inch = 400 Feet

Figure 23a
Colorado River
Below Beyer's Canyon
1972 - 1974 Historic Imagery

Prepared for: Windy Gap Firming Project
File: 2390-Map19.mxd
Date: August 2006



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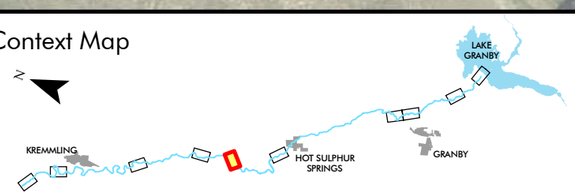
Aerial Photograph: 2005 USGS

Context Map



1 Inch = 400 Feet

Figure 23b
Colorado River below Beyer's Canyon, 2005 Imagery

Prepared for: Windy Gap Firming Project
File: 2390-VEG_CORiver_2005_mapbook.mxd(JP)
Date: July 2006

Note influence of flood
irrigation and tributary stream.

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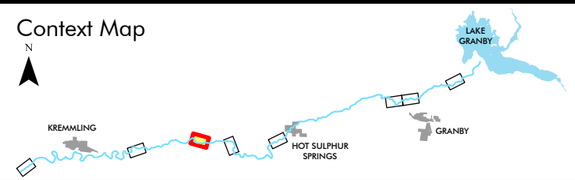
Aerial Photograph: 1972 APFO

Context Map



1 Inch = 400 Feet

Figure 24a
Colorado River Near Parshall
1972 - 1974 Historic Imagery

Prepared for: Windy Gap Firming Project
File: 2390-Map21.mxd
Date: August 2006

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Aerial Photograph: 2005 USGS

Context Map

1 Inch = 400 Feet

Figure 24b
Colorado River near Parshall, 2005 Imagery

Prepared for: Windy Gap Firming Project
File: 2390-VEG_CORiver_2005_mapbook.mxd(JP)
Date: July 2006

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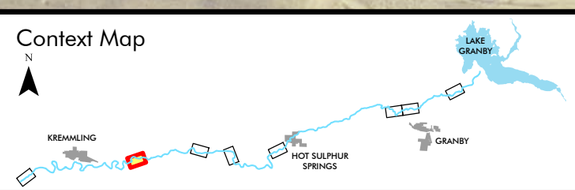
Aerial Photograph: 1972 APFO

Context Map



1 Inch = 400 Feet

Figure 25a
Colorado River
Above Kremmling
1972 - 1974 Historic Imagery

Prepared for: Windy Gap Firming Project
File: 2390-Map25.mxd
Date: August 2006

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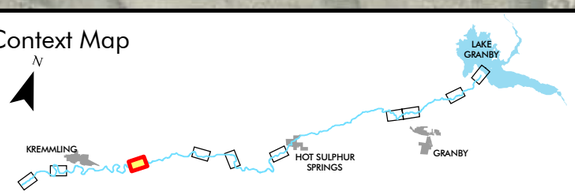
Aerial Photograph: 2005 USGS

Context Map



1 Inch = 400 Feet

Figure 25b
Colorado River above Kremmling, 2005 Imagery

Prepared for: Windy Gap Firming Project
File: 2390-VEG_CORiver_2005_mapbook.mxd(JP)
Date: July 2006

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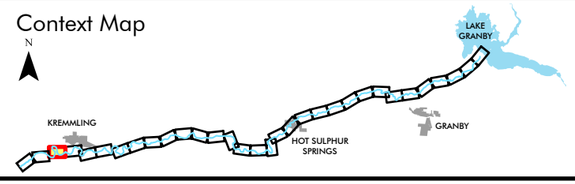
Colorado River - 1972 - 1974 Historic Imagery

Aerial Photograph: 1974 APFO

Context Map



1 Inch = 400 Feet

Figure 26a
Colorado River
Downstream of Kremmling
1972 - 1974 Historical Imagery

Prepared for: Windy Gap Firming Project

File: 2390-Map30.mxd

Date: August 2006

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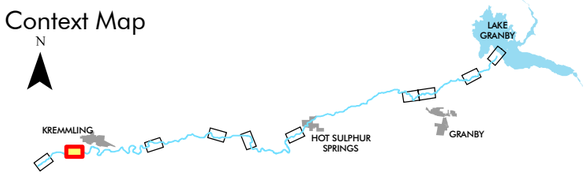
Aerial Photograph: 2005 USGS

Context Map



1 Inch = 400 Feet

Figure 26b
Colorado River below Kremmling, 2005 Imagery

Prepared for: Windy Gap Firming Project
File: 2390-VEG_CORiver_2005_mapbook.mxd(JP)
Date: July 2006

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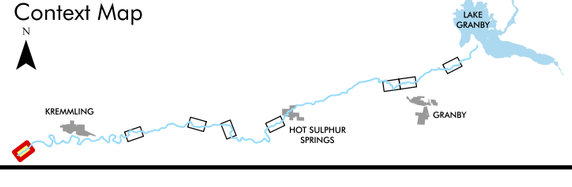
Aerial Photograph: 1972 APFO

Context Map



1 Inch = 400 Feet

Figure 27a
Colorado River at top of Gore Canyon, 1972-1974 Historic Imagery

Prepared for: Windy Gap Firming Project
File: 2390-Map32.mxd
Date: August 2006

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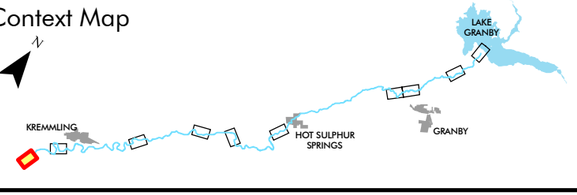
Aerial Photograph: 2005 USGS

Context Map



1 Inch = 400 Feet

Figure 27b
Colorado River at top of Gore Canyon, 2005 Imagery

Prepared for: Windy Gap Firming Project
File: 2390-VEG_CORiver_2005_mapbook.mxd(JP)
Date: July 2006

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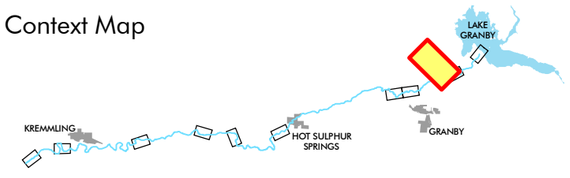
Aerial Photograph: 2005 USGS

Context Map



1 Inch = 1,000 Feet

Figure 28
Willow Creek, Colorado River
2005 Imagery

Prepared for: Windy Gap Firming Project
File: 2390-Willow Creek_fig27.mxd(JP)
Date: May 2006