TABLES

FIGURES

Chapter 2. Proposed Action and Alternatives

This chapter describes the alternatives considered to deliver a firm annual yield of about 30,000 AF from the existing Windy Gap Project and provide 3,000 AF of storage for MPWCD. Five alternatives, including a no action alternative, were selected for detailed analysis in the EIS. All action alternatives include development of 90,000 AF of new storage in either a single reservoir on the East Slope or a combination of East and West Slope reservoirs. The reservoir alternatives included in the EIS are:

1. No Action — Project Participants would maximize delivery of Windy Gap water within the capacity of existing facilities under the existing contractual arrangement between Reclamation and the Subdistrict without any new Reclamation action or new C-BT connections. In addition, the City of Longmont would evaluate the enlargement of Ralph Price Reservoir for storage of its Windy Gap water.
2. Proposed Action — Chimney Hollow Reservoir (90,000 AF) with prepositioning (allowing storage of C-BT water in Chimney Hollow Reservoir)
3. Chimney Hollow Reservoir (70,000 AF) and Jasper East Reservoir (20,000 AF)
4. Chimney Hollow Reservoir (70,000 AF) and Rockwell/Mueller Creek Reservoir (20,000 AF)
5. Dry Creek Reservoir (60,000 AF) and Rockwell/Mueller Creek Reservoir (30,000 AF)

Chimney Hollow Reservoir Site

The Municipal Subdistrict's Proposal is to construct a new 90,000 AF Chimney Hollow Reservoir on the East Slope near Carter Lake and to allow the storage of C-BT Project water in the new reservoir to improve Windy Gap yield.

This chapter discusses the alternative selection process and the key components of each alternative, including the facilities, operation plan, and cost. Section 2.8 describes the identification of reasonably foreseeable actions used in the cumulative effects evaluation. Table 2-5 is a summary comparison of alternative features and resource effects. Table 2-6 and Table 2-7 provide a summary of comparison of direct and cumulative resource impacts of the alternatives.

2.1 Alternative Selection Process

The goal of the alternative selection process was to identify a reasonable range of alternatives to meet the purpose and need of the proposed WGFP. NEPA regulations do not specify the number of alternatives that need to be considered in the EIS, but indicate that a reasonable range of alternatives should be evaluated. The Council on Environmental Quality (CEQ) defines reasonable alternatives as "those that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant" (CEQ 1986). CEQ regulations also require that all reasonable alternatives, including no action, are rigorously explored and objectively evaluated and that the reasons for eliminating alternatives are discussed (40 CFR 150.14).

In addition to satisfying NEPA requirements, projects subject to permitting by the U.S. Army Corps of Engineers under the Clean Water Act also must comply with Section 404(b)(1) Guidelines (40 CFR, Part 230) for discharge of dredge and fill material into waters of the U.S. These Guidelines specify "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences" (Section 230.10(a)). An alternative is considered practicable if "it is capable of being done after taking into consideration cost, existing technology, and logistics in the light of overall project purposes" (Section 230.10(a)(2)). Practicable alternatives under the Guidelines assume that "alternatives that do not involve special aquatic sites are available, unless clearly demonstrated otherwise" (Section 230.3(q)). Guidelines also assume that "all practicable alternatives to the proposed discharge which do not involve a discharge into a special aquatic site are presumed to have less adverse impact on the aquatic ecosystem, unless clearly demonstrated otherwise" (Section 230.10(a)(3)).

The alternatives analysis required for Section 404(b)(1) can be conducted either as a separate analysis for 404 permitting or incorporated into the NEPA process. Reclamation and the Corps have agreed that an integrated approach for the alternatives analysis is appropriate to satisfy NEPA and 404(b)(1) requirements. Integration of both NEPA and 404(b)(1) Guidelines ensures that the alternatives selected for evaluation in the EIS are both reasonable and practical.

2.1.1 Development of Alternatives

The development of potential alternatives for firming the yield of the Windy Gap Project began with a study conducted by the Subdistrict. The results of this study were documented in an Alternative Plan Formulation Report (APFR) (Boyle and EDAW 2003). The APFR identified several categories of alternatives, including new reservoir sites, enlargement or re-regulation of existing reservoirs, development of ground water storage, and re-regulation of existing reservoirs. In addition, nonstructural measures that did not require new infrastructure were evaluated. Hydrologic modeling results conducted for the APFR and subsequent analyses for the EIS indicate that to meet the Project Participant's goal of a reliable annual firm yield of about 30,000 AF would require around 90,000 AF of new storage. The storage goal includes 3,000 AF of new storage for MPWCD to improve the firm yield of their Windy Gap water.

The APFR began with a broad range of potential project elements followed by successive phases of screening and evaluation to identify potentially feasible alternatives. A total of 171 different project elements with individual storage features were evaluated. The analysis resulted in the identification of seven possible alternatives that were presented during the public and agency scoping meetings held in the fall of 2003. The seven identified alternatives were:

- Chimney Hollow Reservoir
- Little Thompson Reservoir
- Cactus Hill Reservoir
- Chimney Hollow Reservoir and Jasper North A Reservoir
- Jasper North Reservoir and Rawhide Reservoir
- Jasper North Reservoir and Chimney Hollow Reservoir
- Chimney Hollow and Rawhide Reservoir

Reclamation and the Corps reviewed the results of the APFR to determine the adequacy of the preliminary identification of potential alternatives and the analyses that were conducted to select alternatives. Both agencies concurred that the APFR provided an excellent compilation of data and alternatives analysis. However, further refinement of the alternative screening and selection process was needed to address the requirements of the 404(b)(1) Guidelines. To comply with 404(b)(1) Guidelines, Reclamation, in concert with the Corps, reevaluated

all of the alternatives identified in the APFR, as well as several new alternatives identified following completion of the APFR and scoping.

2.1.2 Alternative Screening

Alternatives were screened using Clean Water Act Section 404(b)(1) criteria:
- Purpose and Need
- Logistics
- Technology
- Environmental Consequences

Three successive levels of screening were applied to the range of potential alternatives to narrow the list of alternatives for consideration in the EIS. Section 404(b)(1) Guidelines were used as the primary screening tool for the evaluation of alternatives. These Guidelines include five categories of screening criteria—purpose and need, logistics, technology, environmental consequences, and the costs to construct the project (40 CFR 230.10). Cost was not used to screen potential WGFP alternatives because it did not adequately differentiate alternatives. Additional detail on the screening and evaluation of alternatives is found in the Windy Gap Firming Project Alternatives Report (ERO 2005).

2.1.2.1 Level 1 Alternative Screening

The initial Level 1 screening of alternatives considered four categories of 404(b)(1) criteria — purpose and need, logistics, technical, and environmental. These categories are described below.

Purpose and Need Screening Criteria

Alternatives that clearly would not meet or reasonably contribute to meeting the Participants' water supply requirements were eliminated from further consideration, with the exception of the No Action Alternative, which is required by NEPA. This criterion did not eliminate potential reservoir storage alternatives, but did eliminate other types of alternatives. The ability to meet the project purpose and need, including yield requirements, was used again to evaluate alternatives in Level 3 screening.

Logistical Screening Criteria

Logistical screening criteria included land use and the size and number of reservoirs.

Land Use. Potential alternatives were eliminated based on incompatibility with existing land use. Types of incompatible land use included designated Wild and Scenic or Recreational rivers, Wilderness Areas, Superfund sites, sites that require relocation of an Interstate Highway, and sites that would require Congressional Action and adversely affect existing Reclamation projects.

Size and Number of Reservoirs. A minimum reservoir size and maximum number of reservoirs criterion were used to screen out small reservoirs and to limit the environmental effects associated with multiple reservoir sites. In addition, yield and operational considerations affected the size and number of reservoirs that can practicably be used to meet the project purpose and need.

Based on yield calculations and Participant water storage requests, about 90,000 AF of storage is needed to meet the project purpose and need. Because of the capacity limitation in conveying water from the West Slope to the East Slope via the Adams Tunnel, new storage is needed on the East Slope so that water is readily available for delivery to East Slope Participants. Having a portion of the needed storage on the West Slope would allow Windy Gap diversions to be stored immediately without the potential for spilling from Granby Reservoir if the Adams Tunnel is delivering C-BT water at capacity or is otherwise unavailable. However, too much storage on the West Slope may reduce the reliability of the Firming Project because of the dependence on the operation of the Adams Tunnel and other facilities to convey water to East Slope Participants.

Potential reservoir sites were screened using two different size criteria for East and West Slope reservoirs. Hydrologic modeling indicates that at least 20,000 AF of storage is needed on the West Slope to provide sufficient yield when combined with an East Slope reservoir. Thus, reservoir sites with less than 20,000 AF of storage on the West Slope were eliminated from further consideration. A stand-alone East Slope reservoir site would need to have a storage capacity of about 90,000 AF to meet project needs. If 20,000 AF of storage is available on the West Slope, then about 70,000 AF of East Slope storage is required. West Slope storage greater

than 20,000 AF would reduce East Slope storage requirements. A minimum reservoir size of 30,000 AF on the East Slope was considered reasonable for the purpose of selecting reservoir sites for consideration because at least twice this amount of storage (60,000 AF) would be needed on the East Slope based on the available West Slope storage options.

A single large reservoir would typically have less total disturbance than two smaller reservoirs with combined equivalent volume. The incremental environmental effects associated with multiple reservoir sites are likely greater than if the disturbance is concentrated at fewer locations. Multiple reservoirs also require the construction of additional pipelines, pumping stations, and other conveyance structures that increase environmental disturbance and reduce the operational efficiency. Multiple small reservoir sites typically have greater surface area and greater evaporation rates than larger deeper reservoirs. Thus, large deep reservoirs conserve water resources by reducing evaporation losses compared to multiple smaller reservoirs. In consideration of the potential environmental impacts, operational inefficiencies, evaporative water loss associated with multiple reservoir sites, and conveyance and energy requirements, alternative configurations were limited to no more than two reservoir sites on the East Slope.

Technical Screening Criteria

Constructability and safety factors eliminated reservoir sites near or on mine sites.

Environmental Screening Criteria

Environmental screening criteria included an evaluation of potential effects to wetlands and perennial streams.

Wetlands. Potential reservoir sites were eliminated from consideration if they contained more than 25 acres of wetlands or if fens (a special category of wetlands) were known to be present. Wetland determinations were based on National Wetland Inventory (NWI) mapping by the U.S. Fish and Wildlife Service or field investigations.

Perennial Streams. Perennial streams provide year-round flows and often support aquatic ecosystems. Potential reservoir sites located on perennial streams were eliminated from consideration to avoid potential impacts to flowing streams and the associated aquatic life and habitat. Perennial streams were identified based on the presence of a solid blue line on U.S. Geological Survey Quadrangle Maps (scale = 1:24,000). Thus, potential reservoir sites were limited to ephemeral or intermittent streams. Existing reservoirs located on perennial streams were an exception to this criterion because these streams have already been impacted.

Alternatives Considered in Level 1 Screening:

The following sections provide a brief discussion of the alternatives remaining following Level 1 screening and the rationale for eliminating those alternatives that were screened out.

Alternatives that did not meet Level 1 screening criteria were eliminated from further consideration.

New Reservoirs. A total of 124 potential new reservoir sites identified for analysis were eliminated by the Level 1 screening criteria. Thirteen new reservoirs were carried forward for further analysis in Level 2, including ten East Slope reservoir sites and three West Slope reservoir sites (Table 2-1).

Enlarge Existing Reservoirs. Application of the Level 1 screening criteria eliminated the potential enlargements of 26 existing reservoirs. The enlargement of three East Slope reservoirs was carried forward for further screening in Level 2 (Table 2-1).

Aquifer Storage. Bedrock and alluvial aquifers were considered as possible storage options, but were eliminated because of the limited storage capacity and uncertainty in providing long-term storage. Aquifer storage would not provide sufficient storage potential for meeting the project purpose and need.

Table 2-1. Reservoir alternatives remaining following Level 1 screening.

Reservoir Site	River Basin
New Reservoirs—East Slope	
Glade	Cache la Poudre
Cactus Hill	Cache la Poudre
Rawhide North	Cache la Poudre
Dowe Flats	St. Vrain
Stone Canyon	St. Vrain
Chimney Hollow	Big Thompson
Meadow Hollow	Big Thompson
Sprenger Ranch	Big Thompson
Dry Creek	Big Thompson
Wildcat	Big Thompson
New Reservoirs—West Slope	
Jasper East	Colorado
Rockwell/Mueller Creek	Colorado
Mt. Chauncey South	Colorado
Enlarge Existing Reservoirs—East Slope	
Halligan	Cache la Poudre
Seaman	Cache la Poudre
Hertha	Big Thompson

Re-regulation of Existing Reservoirs. This alternative was evaluated to determine if sufficient additional storage space could be made available within existing non-C-BT reservoirs to store Windy Gap water. Re-regulation of existing reservoirs was eliminated as a potential alternative because existing reservoirs are already being operated in an effort to maximize yield; therefore, their operation potential and amount of storage available is minimal. Storage in existing reservoirs is typically fully committed to firm other water supplies and is generally not available when Windy Gap water is diverted. Therefore, re-regulation of existing reservoirs would not meet the project purpose and need and additional storage is necessary for Windy Gap water.

Nonstructural Alternatives. Nonstructural measures primarily involve modification to existing operations without significant new structural features. Nonstructural alternatives were evaluated primarily on their ability to firm Windy Gap Project water supplies as defined by the project purpose and need, as well as logistical considerations.

Most nonstructural measures, involve use or integration of the WGFP with the C-BT Project, and included:

- Unlimited and limited borrowing from C-BT
- Modified borrowing of C-BT water
- Buying C-BT storage
- Interruptible supply contracts
- Purchase/leaseback contracts or dry year options on C-BT units
- Prepositioning

All nonstructural measures, except prepositioning, were eliminated from further consideration for one or more reasons including conflicts with C-BT operations, adverse impacts on water deliveries to C-BT unit holders, and the inability to firm Windy Gap water. Prepositioning is a method of operation in which C-BT water is prepositioned or stored in advance in an East Slope reservoir, such as Chimney Hollow. Space created in Granby Reservoir by prepositioning would be filled with Windy Gap water, which would then be exchanged for C-BT water stored in Chimney Hollow. This arrangement ensures temporary space in Granby Reservoir to 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 ensure that total allowable C-BT storage would not change and that C-BT and Windy Gap water rights would not be expanded, the C-BT Project would stop diverting water from the Colorado River for storage in Granby Reservoir when total C-BT contents in Granby and Chimney Hollow reservoirs reach the volumetric limit of 539,758 AF (elevation 8,280 feet), which is the physical capacity of Granby Reservoir. This would prevent expansion of C-BT Project diversions because it imposes the same constraint as if C-BT water was stored in Granby Reservoir, as opposed to a portion being stored in Chimney Hollow Reservoir. Prepositioning is a component of the Proposed Action.

Integration with Denver Water's Moffat Collection System was another nonstructural alternative eliminated from consideration. This alternative is primarily a method of conveyance and does not address storage requirements or provide the firm yield identified in the purpose and need. There is insufficient capacity in South Boulder Creek to convey Windy Gap water and Denver's Moffat system water, in addition water right and environmental issues limit the practicality of this alternative.

Other Alternatives. Additional alternatives were identified during scoping, but were eliminated for the reasons noted below.

Around-the-horn delivery. This proposal involved leaving water in the Fraser River that would normally be delivered to Broomfield through Denver's Moffat System. This water could then be diverted at Windy Gap Reservoir and delivered to Broomfield through the Windy Gap/C-BT system. This conveyance option was suggested as a method to improve Fraser River flows and offset effects of possible additional Denver Water diversions from the Fraser System. This alternative does not contribute to meeting the purpose and need of the Firming Project or offset any effects of the WGFP and would exceed the capacity of East Slope delivery infrastructure to deliver the water to Broomfield.

South Platte River storage and exchange for C-BT water. This alternative included the development of storage on the South Platte River to capture Windy Gap water for reuse and exchange upstream for C-BT water. This alternative was eliminated because most Participants have commitments or plans for reuse of Windy Gap water, and any reuse of Windy Gap water depends on the reliable delivery of the first use of the water. This alternative does not meet the purpose and need of firming Windy Gap water, but rather provides a potential mechanism to capture and reuse Windy Gap water and perhaps other reusable water.

Interruptible supply contracts. These types of contracts are used to provide water in dry years, but do not provide a long-term reliable supply of water to meet the purpose and need of the proposed Firming Project.

Storage in Horsetooth Reservoir. Dedicating storage space in Horsetooth Reservoir for Windy Gap firming would reduce the storage and yield for the C-BT Project and injure C-BT unit holders. A change in the purpose of the C-BT Project would require Congressional action. This alternative was eliminated from consideration because it would adversely affect C-BT unit holders contrary to Reclamation obligations associated with the establishment of the C-BT Project authorized by Congress.

Water conservation. Water conservation measures play an important role in reducing demand and extending supplies for each of the Project Participants. Participants have implemented a variety of conservation measures over the past 15 years, which has substantially reduced water use. Additional incremental improvements in water conservation in the future are expected to contribute to meeting Participants' future water needs, but conservation alone does not meet all of the projected water supply requirements or eliminate the need for firming existing Windy Gap Project water supplies. Past conservation is included in the demand projections in Chapter 1. Future

water use projections are based on average water use during the 1998–2003 period, including significantly reduced water use in the drought of 2002-2003, which resulted in conservatively low per capita water use. Conservation measures will continue to reduce demand and conserve available supplies in the future, but they do not provide an immediate source of water to meet near-term demand projections.

Joint West Slope storage project. This alternative included locating a reservoir site in the Fraser River basin that could be jointly used for storing Windy Gap water and water for West Slope use. To store Windy Gap water in the upper Fraser River basin would require either a pipeline from the existing Windy Gap diversion site on the Colorado River or a change in the point of diversion. Because a suitable location for a Fraser Valley reservoir has not been identified and the logistical constraints, legal requirements associated with delivery of Windy Gap water to a Fraser Valley reservoir, as well as the uncertainties associated with the timing of construction of a Fraser Valley reservoir, this alternative was eliminated from consideration.

2.1.2.2 Level 2 Alternative Screening

Level 2 screening selected alternatives with the least impact to wetlands.

Level 2 screening was based on storage options that would have the least potential effect on wetlands, which are part of the 404(b)(1) evaluation process. The five reservoir sites with the least wetland impact for each of the three storage categories—new reservoirs (East and West Slope) and reservoir enlargement—were selected for further evaluation. Level 2 screening eliminated five new East Slope reservoir sites. All three potential new West Slope reservoirs sites and three East Slope reservoir enlargements were retained for further consideration. Reservoir sites with the least wetland impact are indicated by shading in Table 2-2. These sites were carried forward for further evaluation in Level 3 alternative screening.

Table 2-2. Level 2 alternative screening.

Reservoir Site[1]	Reservoir Size (AF)	Wetlands (acres)
New Reservoirs—East Slope		
Glade	61,000 – 303,000	6-40
Cactus Hill	104,071	14
Rawhide North	43,100	1
Dowe Flats	55,000 – 119,000	18
Stone Canyon	31,800	0
Chimney Hollow	60,000 – 110,000	2
Meadow Hollow	60,000	6
Sprenger Ranch	92,700	1
Dry Creek	21,000 – 62,300	3–6
Wildcat	60,000	13
New Reservoirs—West Slope		
Jasper East	21,800	19
Rockwell/Mueller Creek	20,000 – 30,000	3–18
Mt. Chauncey South	23,500	7
Enlarge Existing Reservoirs—East Slope		
Halligan	35,300 – 62,900	18
Seaman	3,200 – 38,000	18
Hertha	74,300	1

[1]Shaded reservoir sites had the least impact on wetlands and were evaluated in Level 3 Screening.

2.1.2.3 Level 3 Alternative Screening

Level 3 screening examined remaining alternatives in more detail based on their ability to meet the purpose and need of the proposed project, along with consideration of additional logistical and environmental factors.

The third level of alternatives analysis evaluated the 11 remaining reservoir alternatives based on their ability to meet the purpose and need of the proposed project, along with consideration of additional logistical and environmental factors. Reservoir sites evaluated in Level 3 are shown in Figure 2-1. Prepositioning was also evaluated to determine its potential for improving yield and meeting the project purpose and need. A discussion of each of the remaining alternatives and the rationale for inclusion or exclusion in the EIS follows.

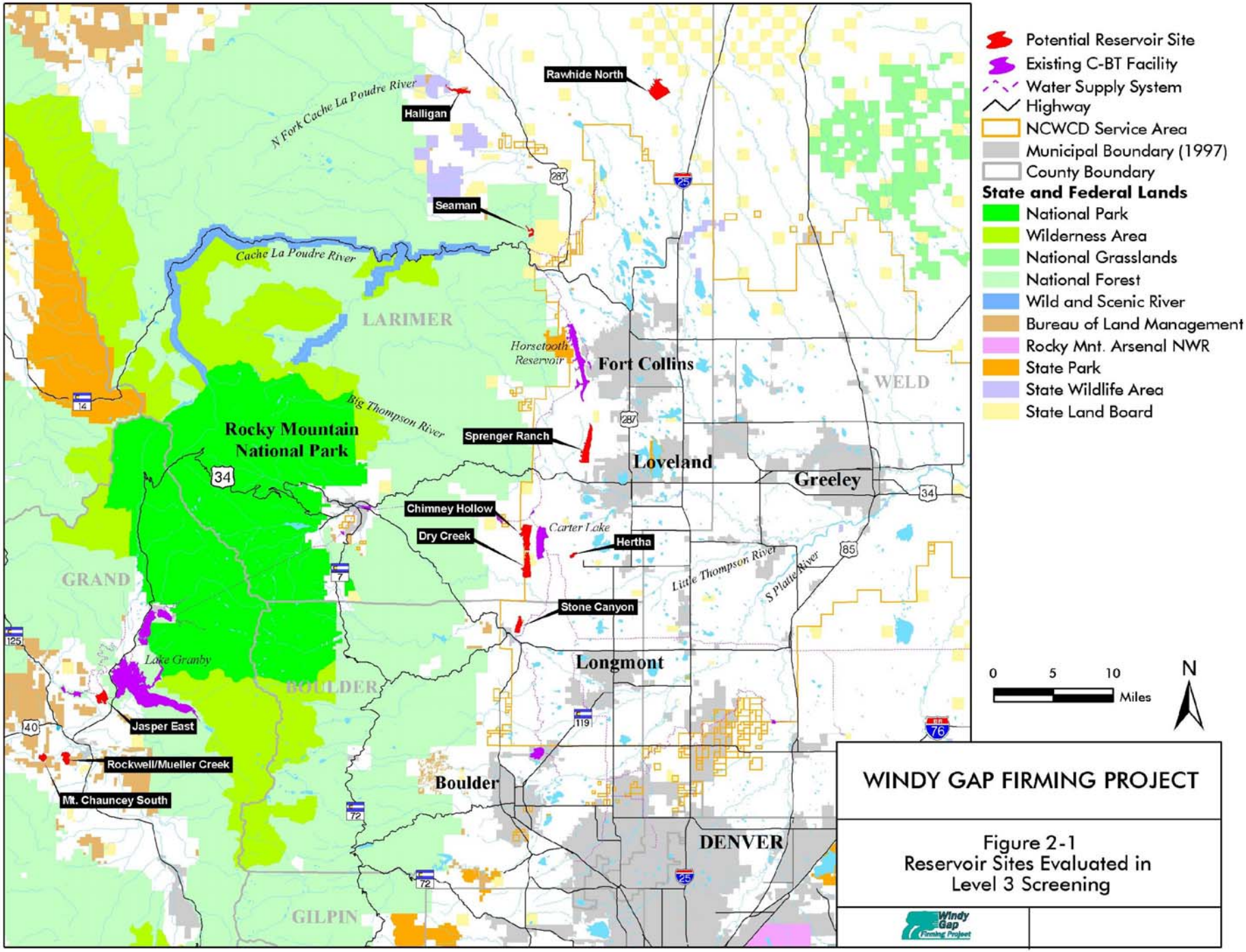
Alternatives Evaluated in Level 3 Screening:

Rawhide North. This potential 43,000 AF reservoir site is located about 20 miles north of Fort Collins. Although located near the Platte River Power Authority, it would be over 35 miles from other East Slope Participants. This alternative was eliminated from further consideration for several reasons: the yield would be low because of the evaporation loss from a shallow reservoir; there would be logistical constraints and inefficiency associated with water conveyance north to the reservoir and then back south to other Participants; and the environmental effects associated with construction of extensive conveyance, along with the need to build at least one additional East Slope reservoir. In addition, there would be additional environmental effects from the greater water diversions that would be needed to make up for higher evaporation losses. Because of the inability of the Rawhide North Reservoir site to effectively contribute to meeting the firm yield requirements of the project purpose and need and other logistical and environmental impacts, this alternative was eliminated.

Stone Canyon. The Stone Canyon reservoir site is about 1 mile northeast of the Town of Lyons. With a maximum storage capacity of about 32,000 AF, it would need to be combined with at least one additional East Slope reservoir to meet total storage requirements. This site was occupied by nine homes in 2005 and about 80 acres of two Boulder County open space properties—Indian Mountain, an archeologically sensitive area and Natural Landmark; and Rabbit Mountain-Dowe Flats, which contains land restricted in perpetuity for use by American Indians. Boulder County has indicated that it is not willing to sell the open space property or have it used for a reservoir (Koopman 2004).

The Stone Canyon reservoir site was eliminated from further consideration because of the numerous conflicting land uses and the natural and cultural resource values associated with these lands. While the Subdistrict may have the authority to condemn property for reservoir construction, placement of a reservoir on this location would potentially require condemnation of county open space and other private property. Consultation with the United Tribes of Colorado on the impact to Traditional Cultural Property committed to ceremonial and educational uses in perpetuity by multiple tribes would need to be conducted. These conflicting land uses would likely substantially increase the time required to complete the project and Participants have a near term need for the water. In addition, a second East Slope reservoir would need to be combined with the Stone Canyon Reservoir to meet project storage requirements, and the environmental effects from two East Slope reservoirs are likely to be greater than alternatives with a single East Slope reservoir.

Chimney Hollow. The Chimney Hollow reservoir site is in a hogback valley just west of Carter Lake and about 8 miles southwest of the City of Loveland. The reservoir site has potential storage capacity of 40,000 to 110,000 AF and could serve as a stand-alone facility. At sizes less than 90,000 AF, it would need to be combined with another East or West Slope reservoir. This reservoir site was proposed to Reclamation by the Subdistrict and is also included as a 70,000 AF Reservoir in Alternatives 3 and 4.


Potential Reservoir Site
Existing C-BT Facility
Water Supply System
Highway
NCWCD Service Area
Municipal Boundary (1997)
County Boundary
State and Federal Lands
National Park
Wilderness Area
National Grasslands
National Forest
Wild and Scenic River
Bureau of Land Management
Rocky Mnt. Arsenal NWR
State Park
State Wildlife Area
State Land Board
Rawhide North
Halligan
Seaman
Sprenger Ranch
Chimney Hollow
Dry Creek
Hertha
Stone Canyon
Jasper East
Rockwell/Mueller Creek
Mt. Chauncey South
N Fork Cache La Poudre River
Cache La Poudre River
Horsetooth Reservoir
Big Thompson River
Carter Lake
Little Thompson River
S Platte River
Lake Granby
Rocky Mountain National Park
Fort Collins
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WINDY GAP FIRMING PROJECT
Figure 2-1
Reservoir Sites Evaluated in
Level 3 Screening

Sprenger Ranch. The Sprenger Ranch reservoir site (92,700 AF) is about 5 miles west of the City of Loveland. The reservoir site was occupied by about 15 residences in 2005, and overlaps portions of two Larimer County Open Space parcels—Rimrock and Devils Backbone. The Rimrock Open Space was established because of its aesthetic and ecological values, portions of which include a highly significant Colorado Natural Heritage Conservation Site (Larimer County 2001). The Devils Backbone Open Space supports imperiled foothills plant communities, and likely supports imperiled butterfly species that have been documented nearby within similar habitat (Larimer County 2004). Larimer County has indicated that it would not be willing to sell or enter into an agreement that would permit construction of a dam and reservoir that would impact county open space (Buffington 2004).

The Sprenger Ranch reservoir site was eliminated from further consideration because of the environmental values present and the conflict with existing land uses. Similar to the Stone Canyon site, it is likely that condemnation proceedings would be required to obtain Larimer County Open Space and possibly other private land for construction of a reservoir at this location. Extended legal proceedings are likely to substantially increase the time required to construct a reservoir at this location and the Participants have a near term need.

Dry Creek. The Dry Creek reservoir site is southeast of Carter Lake and due south of the Chimney Hollow reservoir site. The Dry Creek reservoir site is on private and state-owned land and would affect three residences. A reservoir at this location could be constructed to a size ranging from 21,000 AF to about 62,000 AF. To meet the firm yield requirement for the Firming Project, this reservoir would need to be combined with an additional East or West Slope reservoir. This potential reservoir site was selected for additional evaluation in the EIS in Alternative 5 and is described in Section 2.7.

Halligan Reservoir. Halligan Reservoir is an existing 6,400 acre-foot reservoir located about 23 miles northwest of Fort Collins on the North Fork of the Cache la Poudre River. The cities of Fort Collins and Greeley, and others are currently evaluating the potential to enlarge this reservoir. The City of Fort Collins has indicated that the full expansion capacity of an enlarged Halligan is fully allocated (Janonis 2004). As such, capacity is not sufficient for storage of Windy Gap water in this facility. The practicality of delivering and storing Windy Gap water at a reservoir site almost 40 miles from Carter Lake, where Windy Gap water is currently delivered, also would involve numerous logistical issues including the need for extensive pipeline construction and pumping facilities with high energy requirements, in addition to the environmental effects associated with water conveyance facilities. For these reasons, enlargement of Halligan Reservoir was eliminated from further consideration for Windy Gap Firming storage.

Seaman Reservoir. Seaman Reservoir is an existing reservoir located on the North Fork of the Cache la Poudre River downstream from Halligan Reservoir and about 10 miles northwest of Fort Collins. The City of Greeley and others are currently evaluating the potential for enlarging this reservoir to meet a portion of their future water storage needs. The North Fork of the Poudre River currently contains critical habitat for the threatened Preble's meadow jumping mouse. The City of Greeley and others have fully subscribed all of the available capacity of an enlarged Seaman Reservoir (Koch 2004). Similar to the Halligan Reservoir enlargement, there are also substantial logistical difficulties and environmental concerns in conveying water to Seaman Reservoir and then delivering water south to Participants. Potential effects to wetlands and a perennial stream are also higher compared to other new East Slope reservoir locations. For these reasons, consideration of Seaman Reservoir was eliminated from further evaluation.

Hertha Reservoir. The existing Hertha Reservoir site is about 6 miles southwest of the City of Loveland and about 2 miles east of Carter Lake Reservoir. Expansion of Hertha Reservoir to about 74,000 AF of storage capacity is possible with construction of about 2 miles of dam that would encircle and enlarge the existing reservoir. This small reservoir currently serves the Handy Ditch Company. The Hertha Reservoir site also contains Rainbow Lake Estates, a residential subdivision containing at least 32 completed homes with an assessed individual value of $300,000 to $500,000, plus 39 additional lots for sale or homes under construction as of 2005.

In order to acquire the right to use and enlarge Hertha Reservoir, the Subdistrict would have to condemn the land at the reservoir site and most likely some interest in the water rights associated with the existing reservoir because

reservoir enlargement would likely interfere with those water rights. Several government entities own shares in the Handy Ditch Company, and thus own an interest in the water rights associated with the Hertha Reservoir. The Hertha Reservoir site was eliminated from further consideration because of the conflicting land uses and the amount of time it would likely take to acquire both the property and the water rights.

Jasper East. The Jasper East reservoir site is between Willow Creek Reservoir and Granby Reservoir in Grand County. This potential reservoir site has a storage capacity of up to about 22,000 AF. The site is located in an area of irrigated pastureland. Reservoir construction at this site would require relocating County Road 40 and the Willow Creek Pump Station and a portion of the Willow Creek Canal, which are features of the C-BT Project. No homes are presently on this site. A potential reservoir at this site would need to be paired with additional East Slope storage. The Jasper East reservoir site was selected as a potential alternative in combination with Chimney Hollow Reservoir and is discussed for Alternative 3.

Rockwell/Mueller Creek. The Rockwell/Mueller Creek Reservoir site (Rockwell) is about 2 miles southwest of the Town of Granby on the West Slope. This reservoir site has up to 35,000 AF of storage capacity. Current land use includes pastureland and four residences. A pipeline and pump station would be required to deliver water to Rockwell Reservoir and back to Windy Gap Reservoir. This reservoir site, in combination with either Chimney Hollow Reservoir or Dry Creek Reservoir, was included in Alternatives 4 and 5, as discussed in Section 2.6 and Section 2.7.

Mt. Chauncey South. The Mt. Chauncey South potential reservoir site is at the headwater of Reed Creek about 4 miles southwest of the Town of Granby. This reservoir is located at an elevation of about 9,200 feet and is about 3 miles south of Windy Gap Reservoir. Construction of a reservoir at this elevation introduces several operating inefficiencies compared to lower elevation West Slope sites including 1,400 feet of pumping lift and the need for a bi-directional conveyance facility from Windy Gap Reservoir. Energy requirements for operation would be higher than either the Rockwell Reservoir or Jasper East Reservoir sites, which are located at elevations similar to Granby Reservoir. New roads, dam construction and pipeline installation in steep terrain would require substantial disturbance to native vegetation communities. Based on NWI mapping, the impact to wetlands could be greater than Rockwell Reservoir. While wetland effects may be less than the Jasper East reservoir site, the Jasper East wetlands appear to be supported primarily by irrigated pasturelands and ditch leakage. The Mt. Chauncey South reservoir site is also in potential habitat for the federally listed threatened lynx (CDOW 2005a).

This site was eliminated from further consideration because of the substantial operational inefficiency of locating a reservoir at this elevation, the high energy requirements needed for pumping, the environmental disturbance associated with construction of facilities in primarily undisturbed and steep terrain, and the presence of potential lynx habitat. The Mt. Chauncey South reservoir site does not provide any logistical or environmental advantages over the Jasper East or Rockwell reservoir sites.

Prepositioning. Hydrologic modeling was used to determine whether prepositioning would improve yield when used with a stand-alone 90,000 AF Chimney Hollow Reservoir. Results indicate that prepositioning improves project yield, and that without prepositioning, total project yield is reduced by about 15 percent. The reduction in firm yield for individual Participants would range from 0 to 30 percent depending on the number of Windy Gap units they own, demand, and requested storage for Chimney Hollow Reservoir. Without prepositioning, all Windy Gap diversions must either be stored in Granby Reservoir or delivered directly through the Adams and Olympus Tunnels into Chimney Hollow if Granby Reservoir is full. The WGFP is particularly reliant on available capacity in the Adams and Olympus Tunnels in wet years when Granby Reservoir typically fills. Without prepositioning, yield is substantially reduced because a lack of available space in the tunnels would reduce Windy Gap diversions in wet years.

Chimney Hollow Reservoir without prepositioning was eliminated as an alternative because of the substantial reduction in yield and because it would not provide adequate yield to meet the water needs for all of the Participants. Prepositioning is a component of the Proposed Action in combination with Chimney Hollow Reservoir as discussed in Section 2.4.

2.1.2.4 Alternatives Selected for NEPA Analysis

Based on the screening and evaluation of potential alternatives, four reservoir sites appear feasible to meet the purpose and need for the proposed WGFP. Potential reservoir sites include Jasper East and Rockwell on the West Slope (Figure 2-2) and Chimney Hollow and Dry Creek on the East Slope (Figure 2-3).

The Chimney Hollow Reservoir site has the capacity to meet total storage requirements of 90,000 AF. The other reservoir sites would need to be used in combination to provide adequate storage. A smaller Chimney Hollow could be combined with either of the two potential West Slope reservoirs.

The Dry Creek reservoir site, which has a maximum storage capacity of about 60,000 AF, could be combined with a 30,000 AF Rockwell Reservoir on the West Slope to provide 90,000 AF of storage. A Dry Creek and Jasper East combination is not feasible because Jasper East storage capacity is limited to about 22,000 AF.

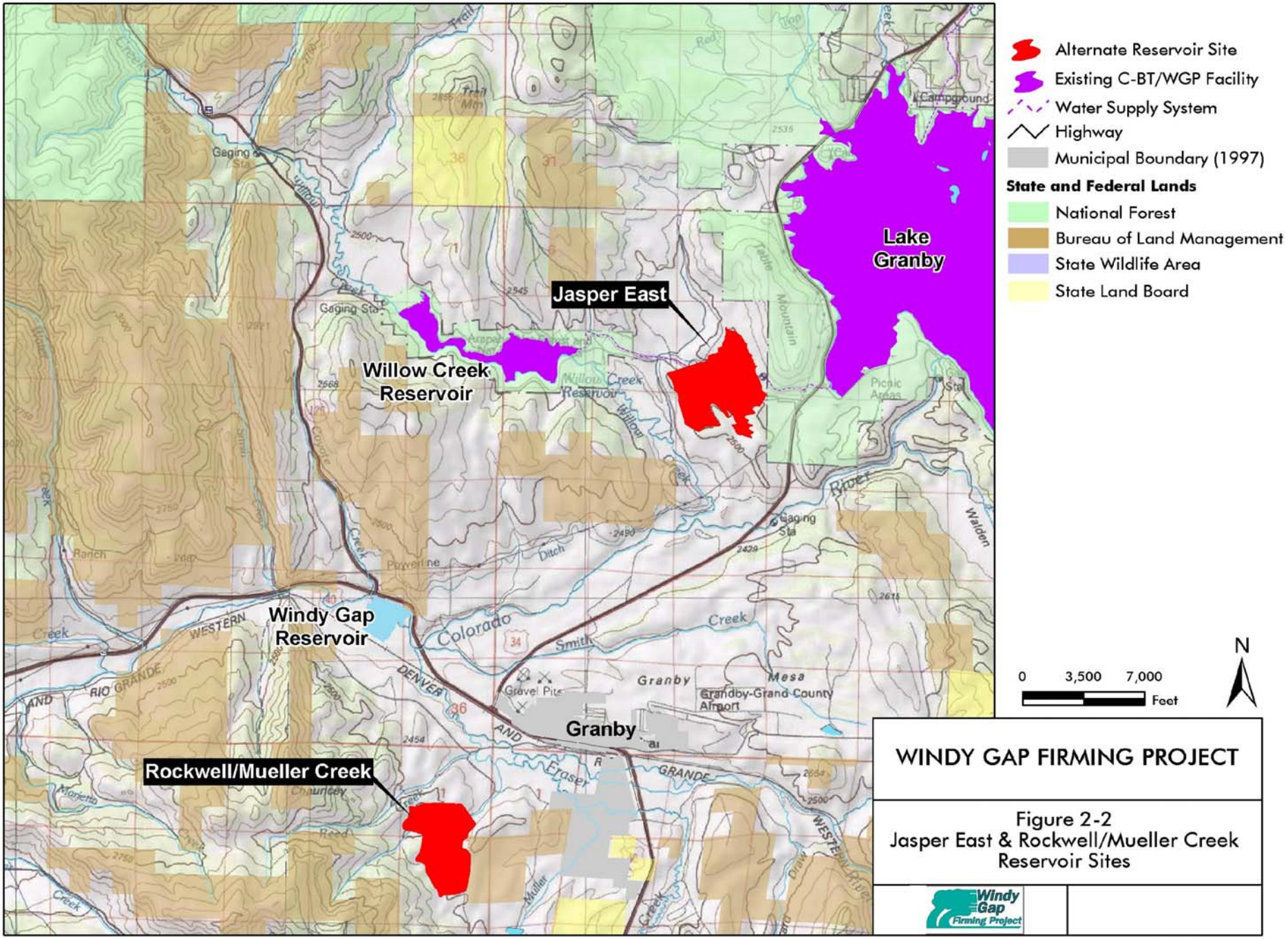
The alternatives analysis concluded that the following reservoirs, individually or in combination, provide a reasonable range of alternatives for meeting the project purpose and need, satisfying technical/logistic considerations, while minimizing environmental effects and should be considered for additional evaluation in the EIS.

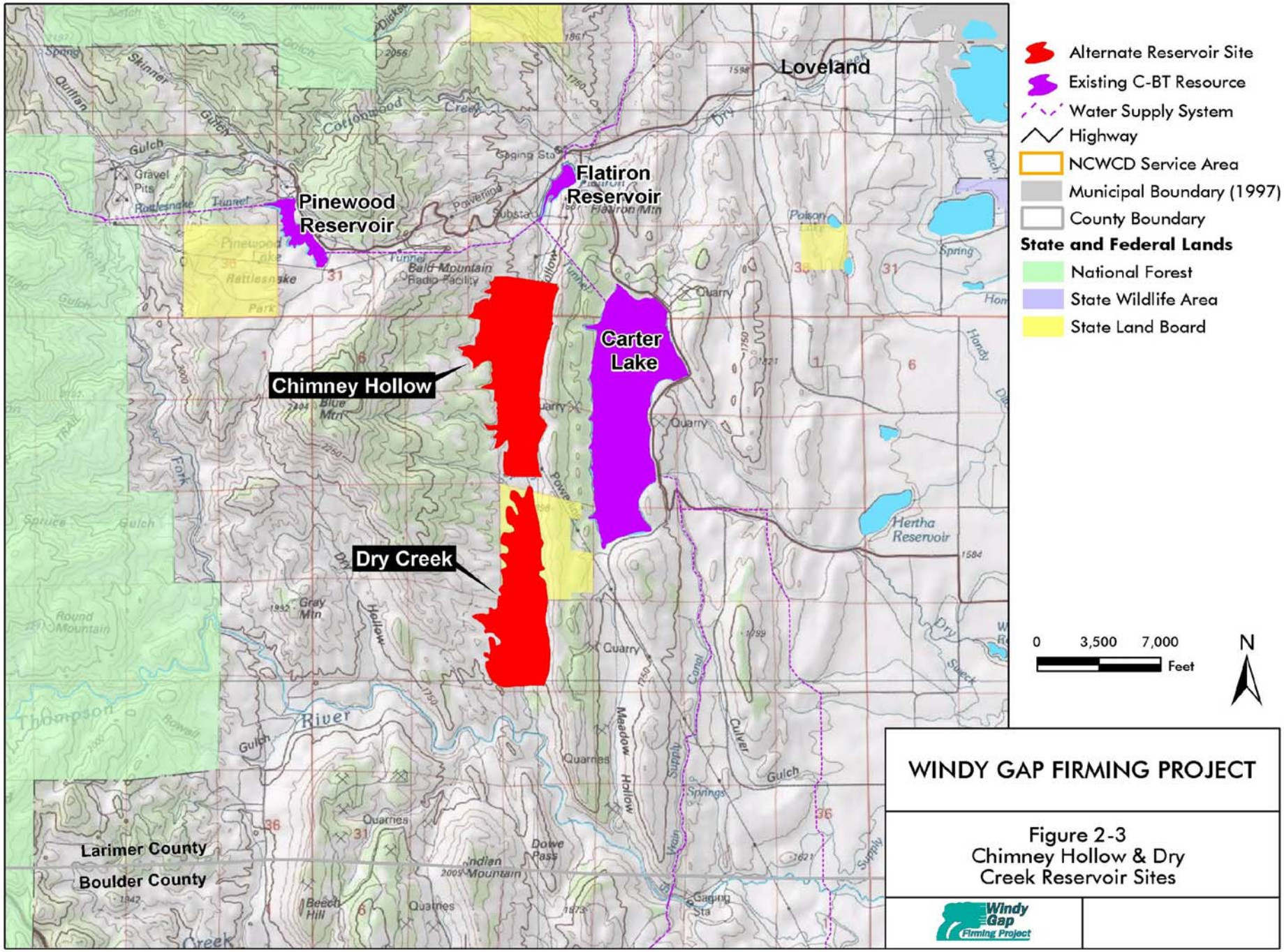
- Chimney Hollow Reservoir (90,000 AF) with prepositioning
- Chimney Hollow Reservoir (70,000 AF) and Jasper East Reservoir (20,000 AF)
- Chimney Hollow Reservoir (70,000 AF) and Rockwell/Mueller Creek Reservoir (20,000 AF)
- Dry Creek Reservoir (60,000 AF) and Rockwell/Mueller Creek Reservoir (30,000 AF)

The Subdistrict's proposal is to construct a 90,000 AF Chimney Hollow Reservoir using prepositioning to improve yield. The following sections describe the components and operational characteristics of the No Action Alternative and four action alternatives. Chapter 3 provides information on the estimated yield and the potential environmental consequences for each alternative.

2.2 Alternative 1—No Action Alternative

NEPA regulations require analysis of a no action alternative (CEQ Guidelines 1502.14). No action does not necessarily require continuation of current conditions or the status quo, but rather a reasonable projection of future conditions or actions if none of the action alternatives are implemented. No action, in the context of this EIS, means that Reclamation would not take action to enter into contracts and agreements that would allow the Subdistrict to implement the WGFP. No action from Reclamation's perspective is what is reasonably likely to occur with continuation of the existing contractual arrangement between Reclamation and the Subdistrict for the delivery of Windy Gap water through the C-BT system without a new or amended contract for additional connection of new Windy Gap Firming infrastructure to C-BT facilities. The No Action Alternative is described below and was analyzed along with the action alternatives to provide a basis for comparison.


Alternate Reservoir Site
Existing C-BT/WGP Facility
Water Supply System
Highway
Municipal Boundary (1997)
State and Federal Lands
National Forest
Bureau of Land Management
State Wildlife Area
State Land Board
Lake Granby
Jasper East
Willow Creek Reservoir
Windy Gap Reservoir
Rockwell/Mueller Creek
Granby
Granby-Grand County Airport
Gravel Pits
Campground
Picnic Areas
Gaging Sta
Powerline
Ditch
Colorado River
Fraser River
Willow Creek
Walden
Granby
Mesa
Smith
Creek
WESTERN
DENVER
RIO GRANDE
AND
GRANDE
Marietta
Chauncey
Reed
Muller
Taylor Mountain
Trail Mtn
0
3,500
7,000
Feet
N
WINDY GAP FIRMING PROJECT
Figure 2-2
Jasper East & Rockwell/Mueller Creek
Reservoir Sites
Windy Gap Firming Project


Alternate Reservoir Site
Existing C-BT Resource
Water Supply System
Highway
NCWCD Service Area
Municipal Boundary (1997)
County Boundary
State and Federal Lands
National Forest
State Wildlife Area
State Land Board
Loveland
Flatiron Reservoir
Pinewood Reservoir
Carter Lake
Chimney Hollow
Dry Creek
Hertha Reservoir
Larimer County
Boulder County
0 3,500 7,000
Feet
N
WINDY GAP FIRMING PROJECT
Figure 2-3
Chimney Hollow & Dry Creek Reservoir Sites
Windy Gap Firming Project

2.2.1 Current Windy Gap Project Operations

The current Windy Gap Project has been in operation since 1985. Windy Gap Project water is diverted from the Colorado River just downstream of the confluence of the Colorado and Fraser Rivers at Windy Gap Reservoir (Figure 1-3). Once collected, it is pumped to Granby Reservoir for storage and is conveyed to the East Slope via the Adams Tunnel to Carter Lake, another C-BT reservoir. Granby Reservoir is the only long-term storage facility for Windy Gap water prior to delivery to Windy Gap Participants. Carter Lake and Horsetooth Reservoir provide only short-term conveyance of Windy Gap water. From Carter Lake, Windy Gap water is distributed using conveyance through C-BT facilities including the Hansen Feeder Canal and Horsetooth Reservoir for Project Participants to the north, and the St. Vrain Supply Canal, Boulder Feeder Canal, and Boulder Creek Supply Canal for Participants to the south. In addition, the Southern Water Supply Pipeline out of Carter Lake provides delivery to six Project Participants to the south. No Windy Gap water is stored in East Slope C-BT storage reservoirs. Storage capacity of Windy Gap water for most Project Participants once delivery is taken is limited; therefore, most Participants typically only order delivery of Windy Gap water from Granby Reservoir as needed.

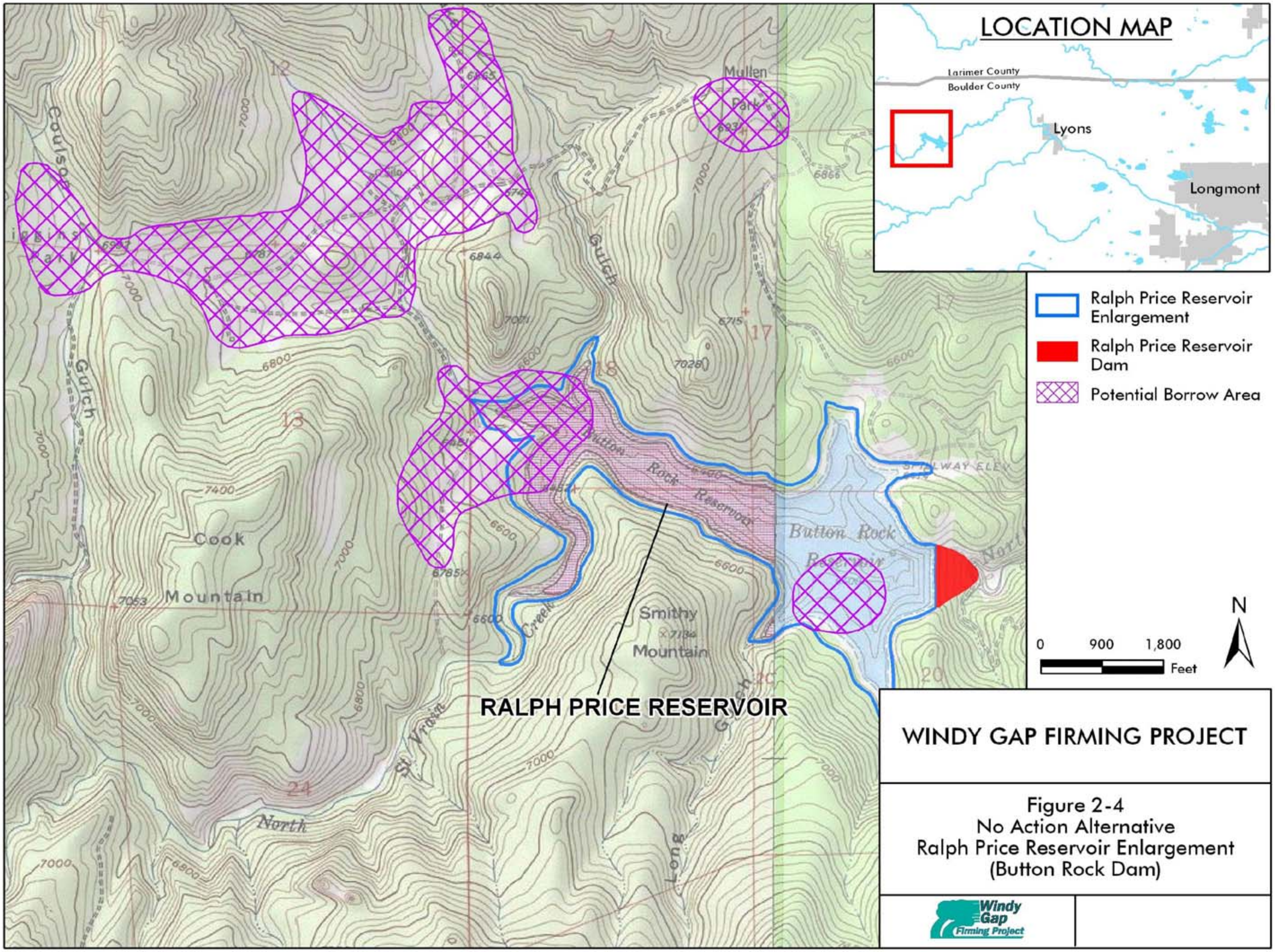
The current Windy Gap Project, according to the terms outlined in the *1985 Supplement to the 1980 Agreement Concerning the Windy Gap Project and Azure Reservoir and Power Project*, requires the Municipal Subdistrict, Northern Colorado Water Conservancy District to dedicate and set aside annually, but non-cumulatively, at no cost to MPWCD, the first 3,000 AF of water in Granby Reservoir that is produced each water year from Windy Gap water supplies. This water is for beneficial use without waste, either directly or by exchange or substitution, in the MPWCD. The direct beneficial uses do not include instream uses or industrial uses. In the event of a Granby Reservoir spill, MPWCD's Windy Gap water stored in the reservoir is the last of any Windy Gap water to be spilled. MPWCD's Windy Gap water stored in Granby Reservoir cannot be carried over to the next year.

2.2.2 Participant Operations under the No Action Alternative

If Reclamation does not approve a contract to connect new WGFP facilities to C-BT facilities as required for the action alternatives, Project Participants in the near term would maximize delivery of Windy Gap water according to their demand, water rights, availability of storage in Granby Reservoir, and existing Adams Tunnel conveyance constraints. The City of Longmont is the only Participant that currently has an option to develop storage independently if the WGFP is not implemented. Most 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. However, no specific reservoir sites have been identified by Participants other than the City of Longmont.

Those 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 between Reclamation and the Municipal Subdistrict, Northern Colorado Water Conservancy District. 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, 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 implemented.

The City of Longmont indicates that it would develop storage facilities for Windy Gap water independently, if the Firming Project is not approved and completed. The City 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 the City. The enlargement of Ralph Price Reservoir by 13,000 AF would be the City's preferred option because Union Reservoir would not have sufficient capacity for Windy Gap water and other planned sources of water that could be stored. Also, conveyance and distribution would be more efficient from the higher elevation Ralph Price Reservoir (Figure 2-4). Additional description of the infrastructure and operation of Ralph Price Reservoir is included in Section 2.2.2.1.


LOCATION MAP
Larimer County
Boulder County
Lyons
Longmont
Ralph Price Reservoir Enlargement
Ralph Price Reservoir Dam
Potential Borrow Area
N
0
900
1,800
Feet
RALPH PRICE RESERVOIR
Button Rock Reservoir
Mullen Park
Gulch
Cook Mountain
Smithy Mountain
St Vrain
North
Creek
Long
Coulson
Spillway Elev
7000
6800
6600
7400
6844
6715
7028
7053
7134
6785
12
13
17
18
20
24
Windy Gap Firming Project

WINDY GAP FIRMING PROJECT

Figure 2-4
No Action Alternative
Ralph Price Reservoir Enlargement
(Button Rock Dam)

MPWCD would continue to use Windy Gap water when available 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 Granby Reservoir each year if Windy Gap water can be diverted and storage space is available.

Hydrologic modeling of the No Action Alternative was used to estimate the amount of Colorado River diversions, storage requirements, and yield for Project Participants based on the near-term maximization of Windy Gap deliveries with the addition of storage in an enlarged Ralph Price Reservoir by the City of Longmont. The following assumptions also were used in the analysis:

- There would be no change in the existing Windy Gap or C-BT facilities for the conveyance or storage of Windy Gap water.
- East Slope Participants would continue to divert and take Windy Gap water from existing Participant delivery points, subject to existing conveyance limitations in delivering water from Granby Reservoir to the East Slope via the Adams Tunnel and existing East Slope C-BT conveyance facilities.
- The amount of water diverted from the Colorado River would be subject to existing Windy Gap water rights.
- WGFP Participants would adhere to conditions in the 1981 Record of Decision and associated agreements that limit or place conditions on the timing or amount of water that can be pumped by the Windy Gap Project.
- Project Participant demand for Windy Gap water would be the same as identified in the Windy Gap Firming Project Purpose and Need Report as discussed in Chapter 1 and described in Section 3.5.2.10.

Under No Action, most Participants are expected to develop their own storage options for their Windy Gap water. The types of storage that might be used for Windy Gap water include gravel pits, new reservoirs, enlargement of existing reservoirs, or options not yet identified. The construction of multiple new storage facilities also would require additional infrastructure to convey, pump, and distribute water outside of the C-BT system. The amount of water that could be delivered to new reservoirs would still be limited by the terms of the existing Carriage Contract. Because most Participants have not identified specific facilities to store Windy Gap water independently, the physical disturbance and associated resource effects, as well as the hydrologic consequences of future storage are unknown.

Under the No Action Alternative, Reclamation would not approve the connection of new WGFP facilities to C-BT facilities. The Subdistrict would maximize the delivery of Windy Gap water to participants under existing agreements between Reclamation and the Subdistrict. Participants would seek to maximize their delivery of Windy Gap water using existing facilities. In addition, the City of Longmont would enlarge Ralph Price Reservoir to firm its Windy Gap water. The City of Lafayette would not participate in the Windy Gap Project.

Continued operation and delivery of Windy Gap Project water to Participants would not require NEPA compliance or a permit from the Corps, but the enlargement of Ralph Price Reservoir is likely to result in a discharge to a regulated water of the U.S., which is subject to Corps permitting requirements and other NEPA compliance. Other future projects by the Participants to develop additional storage could likewise be subject to Corps' jurisdiction and NEPA compliance. Because a no action alternative that completely avoids Corps' jurisdiction has not been identified, the Corps' No Action Alternative is assumed to be the same as Reclamation's.

2.2.2.1 Infrastructure and Operations for Ralph Price Reservoir Enlargement

Detailed design studies for the enlargement of Ralph Price Reservoir have not been conducted. As a result, specific information on the construction, material requirements, scheduling, and detailed cost is not available. The following provides a description of the estimated requirements for the enlargement of Ralph Price Reservoir and its operation.

Dam and Spillway. The existing 16,000 AF Ralph Price Reservoir would be enlarged to about 29,000 AF to provide 13,000 AF of additional storage. The existing Button Rock dam would be raised 50 feet, from a current normal high water elevation of 6,400 feet to 6,450 feet. The surface area of the reservoir would increase from about 227 acres to 304 acres. Based on preliminary studies, an earth and rockfill dam would probably be used to raise the existing dam (Woodward-Clyde 1987). An enlarged spillway would be required and possibly some modifications to the existing inlet and outlet works.

Ralph Price Reservoir

Conveyance and Operation. No new conveyance infrastructure would be needed to deliver water to the enlarged Ralph Price Reservoir or from the reservoir to the City of Longmont. Windy Gap water delivered from the West Slope through existing C-BT facilities would be released to St. Vrain Creek via the St. Vrain Supply Canal and exchanged up to the enlarged Ralph Price Reservoir by capturing an equivalent amount of water from North St. Vrain Creek in the reservoir. Water released from Ralph Price Reservoir would flow about 2 miles downstream in North St. Vrain Creek and would then be diverted at the existing Longmont Dam diversion structure for delivery to City water treatment plants using existing infrastructure.

Access, Borrow Areas, and Power. Existing Boulder County Road 80 and City roads would provide access to the dam and reservoir for construction. Several potential borrow area sources for dam enlargement were identified in the Woodward-Clyde study (Figure 2-4). The amount, type, and source of borrow material would depend on final dam design. Access to most borrow areas would require temporarily draining the reservoir. Existing power lines to the reservoir would provide power during construction and operation of the enlarged reservoir.

Construction Program. Raising Button Rock dam would require draining the reservoir and establishing staging areas. The work force needed to raise the dam and rebuild a spillway is estimated to average 50 people, peaking at about 100 people at the height of construction (Boyle Engineering 2005d).

Cost and Schedule. Preliminary cost estimates for raising Button Rock Dam were made during a feasibility study in 1987 (Woodward-Clyde 1987). Based on this information, the estimated cost of raising the dam 50 feet is about $31 million in 2003 dollars. Construction of the reservoir enlargement and other improvements would take about two years.

Public Access and Recreation. Ralph Price Reservoir is currently part of the Button Rock Preserve, which provides fishing, hiking, and wildlife viewing opportunities. Similar activities would be maintained following reservoir enlargement, although public access would be restricted during construction.

2.3 Activities Common to All Action Alternatives

Each of the Project Participants has requested a defined amount of storage in the proposed Firming Project. The amount of storage requested was based on the number of Windy Gap units that each Participant owns or intends to acquire, the projected yield or firm delivery, and the cost of storage. All action alternatives include 3,000 AF of storage for the MPWCD.

Sections 2.4 through 2.7 provide a description of the infrastructure, operations plan, construction program, public access, and recreation potential for each of the action alternatives. Additional detailed description on the project components is found in the Windy Gap EIS Alternatives Description Report (Boyle 2005b).

A number of the construction-related features are similar for the action alternatives. Unless noted otherwise, all pipelines would be buried. A permanent easement of about 50 to 80 feet and an additional temporary easement of 100 feet would be needed during pipeline construction. Following construction, areas temporarily disturbed during pipeline construction would be reclaimed and revegetated with native species, or with existing species in agricultural areas. Borrow areas outside of the area of inundation, staging areas, and other areas of temporary disturbance needed for construction would likewise be revegetated.

Blasting would be necessary at all of the reservoir sites to: 1) obtain a suitable foundation for the dam prior to placement of the embankment materials; 2) produce suitable rock for the upstream and downstream slopes of the dam from the borrow areas; and 3) construct water conveyance facilities, temporary or permanent access roads, and other project features. Blasting activities could take place throughout the construction period depending on the contractor's plans for producing and stockpiling rock for use in the dam.

2.4 Alternative 2—Chimney Hollow Reservoir (Proposed Action)

Construction of a 90,000 AF Chimney Hollow Reservoir, along with the ability to store or preposition C-BT water in the new reservoir is Reclamation's Proposed Action. Water would be conveyed to Chimney Hollow Reservoir via a new pipeline connection to existing East Slope C-BT facilities. Connections between Chimney Hollow Reservoir and Carter Lake would allow delivery of water to Participants using existing infrastructure.

The Chimney Hollow Reservoir site is in Larimer County about 8 miles southwest of the Loveland, Colorado and ½ mile west of Carter Lake (Figure 2-5). The reservoir would be built in a hogback valley along an intermittent drainage at an elevation of about 5,600 feet.

Chimney Hollow Reservoir Site

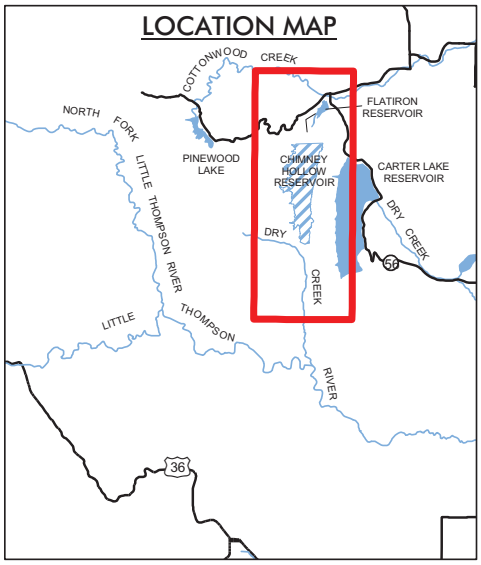
2.4.1 Infrastructure

2.4.1.1 Dam and Spillway

Chimney Hollow Reservoir would require construction of a 346-foot-high dam to impound about 90,000 AF of water. The maximum normal pool elevation would be 5,866 feet. The reservoir at the maximum water surface elevation would inundate about 742 acres. Preliminary design indicates a rockfill dam type would be appropriate, but the specific type of rockfill dam would not be determined until final design. Appurtenances to the dam would include a spillway to convey a peak discharge of about 2,100 cfs. A 36-foot-high saddle dam would be required at the southern end of the reservoir.

2.4.1.2 Conveyance

Water would be conveyed to the East Slope via existing C-BT facilities as far as the upper end of the Flatiron Penstocks (Figure 2-6). Water would be conveyed to Chimney Hollow Reservoir using a new buried penstock pipeline to the pressure conduit between the Bald Mountain Tunnel surge tank and the Flatiron Penstock valve house. Other new conveyance facilities would include pipelines and an energy dissipation facility from the Flatiron Penstocks to the Chimney Hollow inlet/outlet along with connections to the existing Carter Lake pressure conduit. Modifications in the various pipeline connections may be made during final design.



Inlet - Outlet Tunnel

Spillway and Channel

New Pipeline

Potential Disturbance Area

Transmission Line Corridor

Chimney Hollow Reservoir

Dam

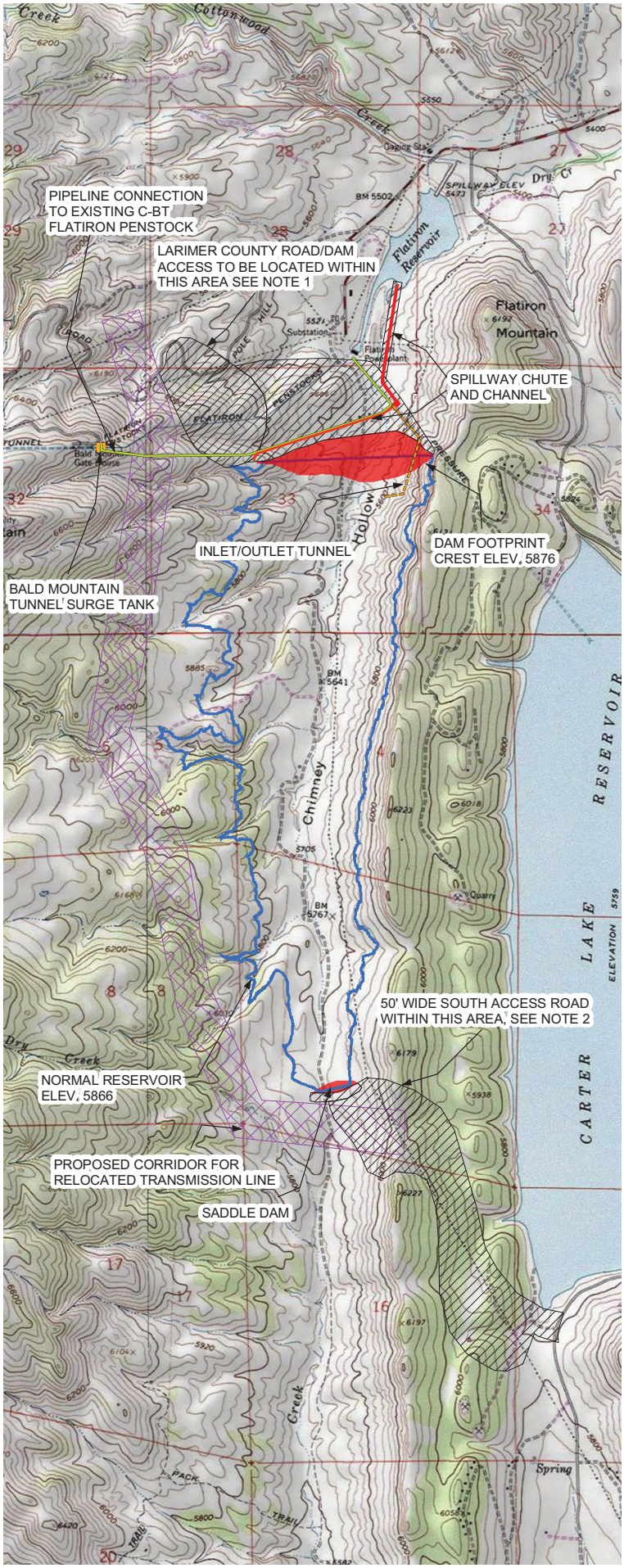
NOTES:

1. FINAL LOCATION OF DAM CREST ACCESS ROAD TO BE DETERMINED THROUGH LARIMER COUNTY PARK PLANNING PROCESS.
2. SOUTH ACCESS ROAD DURING CONSTRUCTION - GATED WITH NO PUBLIC ACCESS FOLLOWING CONSTRUCTION.

0 2,000 4,000 Feet

N

"USGS MAP OF THE CARTER LAKE RESERVOIR QUADRANGLE, BOULDER AND LARIMER COUNTIES, COLORADO"
SITE SPECIFIC TOPOGRAPHY BASED ON AERIAL SURVEY, APRIL 2003

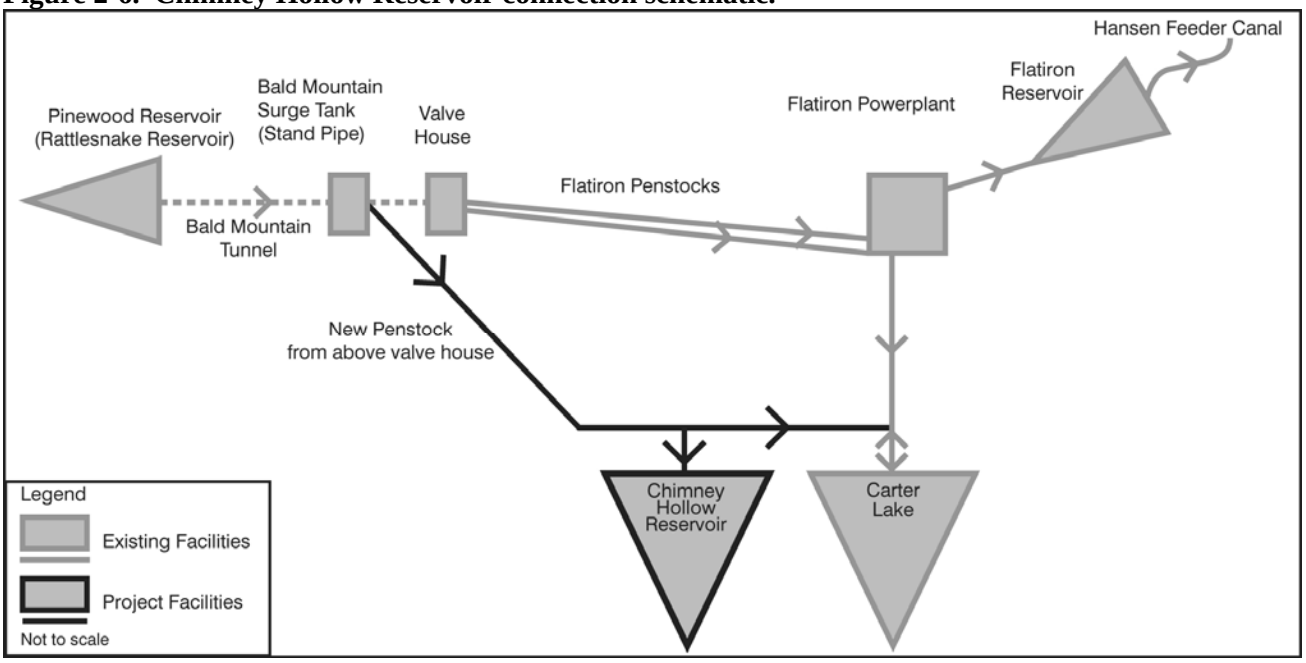


WINDY GAP FIRMING PROJECT

Figure 2-5
Alternative 2, Proposed Action Chimney Hollow Reservoir (90,000 AF)

Windy Gap Firming Project

Figure 2-6. Chimney Hollow Reservoir connection schematic.



2.4.1.3 Access, Borrow Areas, and Power

Primary access to Chimney Hollow Reservoir would be from Pole Hill Road below the dam site. A new permanent access road about 1.5 miles long on the northwest side of the reservoir would provide access for construction, maintenance, and public recreation access after the reservoir is completed. The final road layout would be determined in coordination with Larimer County. Construction access to the saddle dam on the southern end of the reservoir would be located along or near an existing transmission line maintenance road. This road would be closed to public access.

Construction materials for the dams would be taken from borrow areas within the reservoir basin. Two primary borrow sources have been identified: 1) granite bedrock along the west rim of the reservoir for use as rockfill in the dam shell; and 2) fine-grained material in the central part of the reservoir for use as low permeability material in the core of the dam. The need for off-site borrow material would depend on the type of dam constructed and quality of the material from within the reservoir site. Off-site borrow material may be needed for concrete production, or bitumen if an asphaltic core rockfill dam is used. Commercial sources for these materials are available in the region if needed.

Power supply to the reservoir and conveyance facilities would come from the existing facilities associated with the Flatiron Power Plant. A substation may be needed to step down voltage.

2.4.1.4 Transmission Line Relocation

The existing 115-kV transmission line located in Chimney Hollow would need to be relocated to construct the reservoir. The transmission line is owned by Western and was constructed as part of the original C-BT Project. The existing line is constructed on wood H-frame structures and is part of a 27-mile line with terminals at the Estes Powerplant and at the Lyons Substation (Western 2004).

About 3.8 miles of the transmission line would be relocated to the west side of the proposed reservoir. Western, Larimer County, and the Subdistrict identified a 750-foot wide corridor as a suitable location for line relocation. Selection of the line relocation corridor was based on visual simulations used to reduce transmission line visibility, minimize removal of existing trees, and with consideration of planned Larimer County Parks and Open Land trails, and construction accessibility. The specific transmission line location, pole placement, and spacing would be identified by Western during final design. The location of access roads for transmission line installation and maintenance also would be determined during final design. A 100-foot-wide right-of-way across Subdistrict and Larimer County land would be required for the relocated line. The new line would connect with the existing alignment on the north and south ends of the proposed reservoir. Western considered additional re-route alternatives for the transmission line but rejected them from further consideration in the EIS. The basis for rejecting alternative alignments is based on the relative cost and environmental impacts. Reroutes located to the east of the proposed Chimney Hollow Reservoir were rejected because of increased visual impacts to local residents and users of the Larimer County Parks, the difficulty of constructing on steep terrain; increased potential for soil erosion on steep terrain, poor access for maintenance and emergency access, and increased costs for construction and maintenance. Other alignments were considerably longer, impacted more private landowners, and resulted in more visual impacts.

A new pipeline and connection to C-BT facilities on the East Slope would be needed to deliver Windy Gap water to Chimney Hollow Reservoir.

Removal of the existing transmission and relocation of the transmission line would take between 2 and 4 months, depending on weather and other factors. The new section of line would be installed before the old section is removed. Sequencing the action in this way allows the old line to remain in service to serve customer electrical loads during the installation of the relocated section. Electrical service disruption would be minimized. Once the new line is constructed, it would be connected to the system and the old line would be disconnected and removed. Dismantling and removing the old line section would be accomplished by removing the conductor and pulling the old structures out of the ground using cranes. The holes would then be backfilled. The old structures would be removed and disposed of in appropriately licensed landfills, or recycled to landowners or others having a use for them. The new section of line would be constructed with augured foundations. The steel structures may either be placed into the augured holes and then backfilled with concrete or poured foundations made with reinforced concrete to which the structures would be bolted would be used. Concrete would be hauled to the site in trucks. The steel structures would be lifted into place with cranes. Once the structures are in place, the hardware (e.g., conductor supports and insulators) would be attached to the structures. The conductor would then be installed and tensioned. Cleanup of the ROW, erosion control measures, and any required revegetation would be the last step in the installation process. Equipment would consist of pickup trucks, a truck-mounted auger, cement trucks, crane, trucks with conductor spools, and tensioning and pulling equipment. Western uses existing access to the extent possible and typically does not construct access roads unless necessary. Access road requirements would be determined during the design phase.

According to Western's capital improvement plan, the transmission line is scheduled for upgrading to a 230-kV, double circuit line. Thus, the relocated line would be rebuilt with larger structures and conductors for operation at 230-kV. The rebuilt line would use single steel poles up to 110 feet tall. Poles would be placed at intervals varying between 900 feet and 1,200 feet, depending on the terrain. Western would remove trees that could negatively impact the reliable operation of the transmission line (e.g., trees that could grow tall enough to cause arcing between the tree and the conductors or could fall into the conductors or structures). Western would promote the growth of low-growing native plants on the ROW. To minimize the visibility of the transmission line, nonspecular, nonreflective wire would be used. Nonreflective insulators also would be used and possibly Corten steel poles that have a rusted nonreflective surface and dark brown color. Western would design the transmission line in conformance with Suggested Practices for Protection of Raptors on Power lines (APLIC 1994) and Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006 (APLIC 2006). The estimated cost for removal of the existing transmission line and construction of the new line is $4.5 million and would be paid for jointly by the Subdistrict and Western. Western would be responsible for oversight and contracting for the relocation.

Western's proposal for removal of the existing transmission line and its relocation includes several standard construction and mitigation measures listed in Table 2-3.

Table 2-3. Western's standard construction mitigation measures.

Mitigation Action
General
The contractor shall limit the movement of crews and equipment to the ROW, including access routes. The contractor shall limit movement on the ROW to minimize damage to residential yards, grazing land, crops, orchards, and property, and shall avoid damage to property.
The contractor shall coordinate with the landowners to avoid impacting the normal function of irrigation devices during project construction and operation.
When weather and ground conditions permit, obliterate all construction-caused deep ruts that are hazardous to farming operations and to movement of equipment. Such ruts shall be leveled, filled and graded, or otherwise eliminated in an approved manner. Ruts, scars, and compacted soils in hay meadows, alfalfa fields, pastures, and cultivated productive lands shall have the soil loosened and leveled by scarifying, harrowing, disking, or other approved methods. Damage to ditches, tile drains, terraces, roads, and other features of the land shall be corrected. At the end of each construction season and before final acceptance of the work in these agricultural areas, all ruts shall be obliterated, and all trails and areas that are hard-packed as a result of construction operations shall be loosened and leveled. The land and facilities shall be restored as nearly as practicable to the original condition.
Construction trails not required for maintenance access shall be restored to the original contour and made impassable to vehicular traffic. The surfaces of such construction trails shall be scarified as needed to provide a condition that will facilitate natural revegetation, provide for proper drainage, and prevent erosion.
Construction staging areas shall be located and arranged in a manner to preserve trees and vegetation to the maximum practicable extent. On abandonment, all storage and construction materials and debris shall be removed from the site. The area shall be regraded, as required, so that all surfaces drain naturally, blend with the natural terrain, and are left in a condition that will facilitate natural revegetation, provide for proper drainage, and prevent erosion.
Borrow pits shall be excavated so that water will not collect and stand therein. Before being abandoned, the sides of borrow pits shall be brought to stable slopes, with slope intersections shaped to carry the natural contour of adjacent undisturbed terrain into the pit or borrow area, giving a natural appearance. Piles of excess soil or other borrow shall be shaped to provide a natural appearance.
The Contractor shall make all necessary provisions in conformance with safety requirements for maintaining the flow of public traffic and shall conduct his construction operations so as to offer the least possible obstruction and inconvenience to public traffic.
Erosion
Water turnoff bars or small terraces shall be constructed across all ROW trails on hillsides to prevent water erosion and to facilitate natural revegetation on the trails.
Environmental
The contractor and Western shall comply with all applicable federal, state, and local environmental laws, orders, and regulations. Prior to construction, all supervisory construction personnel will be instructed on the protection of cultural and ecological resources.
The contractor shall exercise care to preserve the natural landscape. Construction activities shall be conducted to minimize scarring or defacing of the natural surroundings in the vicinity of the work. Except where clearing is required for permanent works, approved construction roads, or excavation operations, vegetation shall be preserved and shall be protected from damage by the contractor's construction operations and equipment.
Vegetation
On completion of the work, all work areas except access trails shall be scarified or left in a condition that will facilitate natural revegetation (unless reseeding, mulching, or other specific requirements apply), provide for proper drainage, and prevent erosion. All destruction, scarring, damage, or defacing of the landscape resulting from the contractor's operations shall be repaired by the contractor.
Wildlife
Western would design the transmission line in conformance with Suggested Practices for Protection of Raptors on Power lines (APLIC 1994) and Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006 (APLIC 2006).

Mitigation Action
Waste
Construction activities shall be performed by methods that prevent entrance or accidental spillage of solid matter, contaminants, debris, and other objectionable pollutants and wastes into flowing streams or dry water courses, lakes, and underground water sources. Such pollutants and wastes include, but are not restricted to, refuse, garbage, cement, concrete, sanitary waste, industrial waste, oil and other petroleum products, aggregate processing tailings, mineral salts, and thermal pollution.
Burning or burying of waste materials on the ROW or at the construction site will not be allowed. The contractor shall remove all waste materials from the construction area. All materials resulting from the contractor's clearing operations shall be removed from the ROW and disposed of in accordance with applicable regulations.
Water
Dewatering work for structure foundations or earthwork operations adjacent to, or encroaching on, streams or water courses will not be performed without prior notice to appropriate state agencies and compliance with applicable NPDES requirements.
Excavated material or other construction materials shall not be stockpiled or deposited near or on streambanks, lake shorelines, or other water course perimeters where they can be washed away by high water or storm runoff or can in any way encroach upon the actual water source itself.
Waste waters from construction operations shall not enter streams, water courses, or other surface waters without use of such turbidity control methods as settling ponds, gravel-filter entrapment dikes, filter fences, approved flocculating processes that are not harmful to fish, recirculation systems for washing of aggregates, or other approved methods. Any such waste waters discharged into surface waters shall be essentially free of suspended material.
Minimize or avoid activities in riparian areas. Avoid disturbance to riparian vegetation whenever practical.
Air
The contractor shall utilize such practicable methods and devices as are reasonably available to control, prevent, and otherwise minimize atmospheric emissions or discharges of air contaminants.
Equipment and vehicles that show excessive emissions of exhaust gases due to poor engine adjustments, or other inefficient operating conditions, shall not be operated until corrective repairs or adjustments are made.
Electromagnetic Fields
Western will apply necessary mitigation to eliminate problems of induced currents and voltages onto conductive objects sharing a ROW, to the mutual satisfaction of the parties involved. Western will install fence grounds on all fences that cross or are parallel to the proposed line.

2.4.2 Operations

Windy Gap water would be diverted from the existing point of diversion at Windy Gap Reservoir and Pump Plant located below the confluence of the Fraser and Colorado Rivers, near the Town of Granby. The existing Windy Gap pipeline would pump water to Granby Reservoir, which would then be delivered to the East Slope using existing C-BT facilities. Water would be routed to Chimney Hollow Reservoir using the new pipeline connections discussed previously in Section 2.4.1.2. No new West Slope infrastructure is needed to divert or convey water to the East Slope. In addition to storage in Chimney Hollow, Windy Gap water may also be stored in Granby Reservoir when unused capacity is available.

The delivery of Windy Gap water to the East Slope, either for storage or to meet Participant demand depends on several factors including the physical and legal availability of water for diversion, storage space in Granby Reservoir, capacity in the Adams Tunnel, and space in Chimney Hollow Reservoir. Instantaneous delivery of Windy Gap water as allowed by the existing Carriage Contract between Reclamation, the NCWCD, and Municipal Subdistrict, Northern Colorado Water Conservancy District allows Windy Gap water in Granby Reservoir to be immediately delivered out of Carter Lake or Horsetooth Reservoir on the East Slope, with the same amount of water being exchanged with C-BT. Instantaneous deliveries reduce conveyance constraints in the Adams Tunnel or if space is not available in Chimney Hollow to take direct deliveries.

Prepositioning is a method of water operation in which C-BT water is "prepositioned," or stored in advance, in Chimney Hollow Reservoir. By storing C-BT water in Chimney Hollow, additional storage space for Windy Gap water could be made available in Granby Reservoir. As a result, there would be fewer instances when Windy Gap water could not be diverted. Total allowable C-BT storage would not change and the existing C-BT water rights and diversions would not be expanded.

Prepositioning would be used to facilitate delivery of Windy Gap water and increase yield. Prepositioning would involve the use of available Adams Tunnel capacity to deliver C-BT water into Chimney Hollow to occupy storage space that is not occupied by Windy Gap water. Delivery of C-BT water to Chimney Hollow in this manner would maintain Chimney Hollow full most of the time. The delivery of C-BT water from Granby Reservoir into Chimney Hollow would create space for Windy Gap water in Granby Reservoir. When Windy Gap water is diverted into Granby Reservoir, the C-BT water in Chimney Hollow would be exchanged for a like amount of Windy Gap water in Granby Reservoir. The amount of C-BT water delivered to Chimney Hollow in any month generally would coincide with the amount of Windy Gap water released to meet Participant demands, which would range from about 1,000 AF to 3,000 AF per month throughout the year. Prepositioning would not require any additional structural facilities to operate and would not change the storage or yield of C-BT Project water.

Participants would take delivery of Windy Gap water from Chimney Hollow Reservoir via releases through existing C-BT facilities. Deliveries to Participants to the north would be made via the Flatiron Afterbay to the Charles Hansen Feeder Canal. Deliveries to the south would be released from Chimney Hollow to a tie-in with the Carter Lake Pressure Tunnel and then Carter Lake. Windy Gap water would then be released to the St. Vrain Supply Canal and/or the Southern Water Supply Pipeline.

MPWCD's Windy Gap water would be stored in Chimney Hollow Reservoir and exchanged back to the West Slope as needed.

MPWCD would use its Windy Gap water as a source of augmentation water to replace out-of-priority depletions in Grand or Summit county. MPWCD 3,000 AF of water would be stored in Chimney Hollow Reservoir and then exchanged back to Granby Reservoir where releases to the Colorado River would be made to offset depletions. Releases would either directly replace depletions for uses on the Colorado River or replace by exchange if depletions occur in the Willow Creek, Fraser River, or Blue River basins. MPWCD's Windy Gap water is assumed to be evenly delivered from September to March based on the location and types of uses and generally when its contractees require augmentation supplies.

2.4.3 Construction Program

Construction of Chimney Hollow dam and the associated pipeline, roads, and related facilities would take from 3 to 5 years. Construction sequencing includes construction of a new access road, relocation of the transmission line, development of borrow areas, excavation of the dam foundation, and construction of inlet and outlet facilities, spillway, and delivery pipelines. Construction staging areas would include the permanent reservoir pool, an area below the dam, and possibly Reclamation Flatiron facilities.

The work force needed to construct proposed facilities depends on the final design specifications and contractor construction equipment and construction methods. The average workforce based on a 4-year construction schedule and reduced activity during the winter is 235 people. Peak employment is estimated to reach about 500 people.

The majority of the construction material for the dam would be excavated on-site. Truck deliveries for steel, cement, fuel, and other materials would be needed. Average truck deliveries are estimated at five trucks per day, with peak truck traffic of 10 truck deliveries per day. Pipe delivery would add about three additional trucks per day.

2.4.4 Cost

The capital cost for constructing Chimney Hollow Reservoir and facilities would be about $223 million in 2005 dollars.

The estimated total construction cost for Chimney Hollow Reservoir and associated facilities is $223 million in 2005 dollars. This includes about $208 million for the dam, reservoir, and appurtenances and about $15 million for conveyance facilities. In 2008, it was estimated that reservoir construction costs had increased about 17 percent since the 2005 cost estimate to about $261 million. However, the downturn in the national economy in 2009/2010 may have reduced construction costs since 2008. Included in the cost is $4.5 million for relocation of Western's transmission line. Routine operation and maintenance (O&M) activities are estimated to be about $500,000 annually for the reservoir and dam. This is based on an equivalent labor force of four full-time personnel and direct costs for equipment, parts, and contractor services. Annual O&M costs for the conveyance facilities including power costs are estimated to be about $295,000. Power costs would be minimal because deliveries in and out of the reservoir would be by gravity.

2.4.5 Public Access and Recreation

The proposed Chimney Hollow Reservoir site is currently owned by the Subdistrict and is not open to the public. Larimer County Parks and Open Lands own about 1,800 acres of land adjacent to the west side of the reservoir site. Larimer County and the Subdistrict entered into an Intergovernmental Agreement that includes a recreational lease of about 1,600 acres of Subdistrict property to the County at no fee (Larimer County - Municipal Subdistrict 2004). The recreational lease is contingent on construction of Chimney Hollow Reservoir. Larimer County recreation plans for this property include nonmotorized boating (except for small electric motors on watercraft), hiking, biking, and horseback riding. Anticipated recreation features include a parking area, trails, boat dock and ramp, picnic facilities, and vault toilets. About 10 miles of trail would be constructed on both County and Subdistrict land. No overnight camping would be allowed.

Larimer County would be responsible for all development, building, management, and maintenance of recreation facilities. The County also would provide patrol and law enforcement for Subdistrict property. As part of reservoir construction, the Subdistrict would construct a public access road to recreation facilities on the northwest side of the reservoir.

Larimer County Parks and Open Lands would develop and manage recreation at Chimney Hollow Reservoir along with the adjacent County Open Space property.

Larimer County would prepare a recreation management plan for County and Subdistrict property prior to completion of the reservoir. The recreation management plan would be developed with water quality protection as an essential goal. Recreation improvements and general public access would be completed about the same time as the reservoir. Prior to that, Larimer County may conduct tours or allow limited public access to county property.

2.5 Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Alternative 3 is a combination of a 70,000 AF Chimney Hollow Reservoir on the East Slope and a 20,000 AF Jasper East Reservoir on the West Slope. The availability of a new West Slope reservoir would allow water diversions from the existing Windy Gap Reservoir to be routed to either Jasper East or Granby Reservoir. Thus, when Granby Reservoir is full or the Adams Tunnel is at capacity, Windy Gap water could be diverted and stored until there is sufficient capacity to transfer water to Chimney Hollow Reservoir. Prepositioning is not a component of this alternative because it would not be necessary to meet the firm yield target identified in the Purpose and Need statement.

The 70,000 AF Chimney Hollow Reservoir would be at the same location as the 90,000-AF reservoir described in Alternative 2. Under this alternative, Western would remove a section of the existing Estes-Lyons 115-kV Transmission Line and relocate it as described in Section 2.4.1.4. The Jasper East Reservoir site is located in Grand County about 4 miles north of the Town of Granby and 1 mile west of Granby Reservoir. Jasper East Reservoir would be built in undulating terrain along an unnamed intermittent drainage at an elevation of about 8,100 feet.

2.5.1 Infrastructure

2.5.1.1 Dams and Spillway

The configuration for a 70,000 AF Chimney Hollow Reservoir would be the same as the larger reservoir described for Alternative 2; however, the main dam and saddle dams would be smaller. The maximum normal pool elevation would be about 5,838 feet and the area of reservoir inundation would be 627 acres (Figure 2-7). The spillway size would be similar to the 90,000 AF Chimney Hollow Reservoir.

Construction of Jasper East Reservoir would require three separate earthfill dams (Figure 2-8). The 20,000 AF reservoir would have a maximum normal pool elevation of about 8,180 feet and inundate 434 acres. A 5-foot-wide spillway on the largest dam would be routed to the natural drainage.

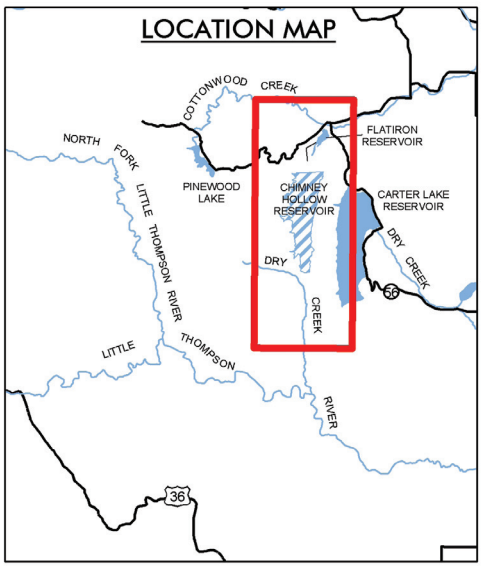
2.5.1.2 Conveyance

Deliveries to and from Jasper East would require a new connection to the existing Windy Gap Pipeline. Diversions at the existing Windy Gap Reservoir would be pumped to Jasper East via a new pipeline off the existing pipeline at a connection less than 1 mile south of the reservoir (Figure 2-9). Water from Jasper East would be delivered to Granby Reservoir using the new pipeline back down to the existing Windy Gap pipeline, where a new booster pump would assist in the delivery to Granby Reservoir. The pump station building would be about 75 feet by 50 feet, with a height of less than 50 feet. The new buried pipeline would be about 10 feet in diameter and 4,800 feet in length.

Jasper East may inundate about 500 feet of the existing Windy Gap pipeline at the south end of the reservoir. Additional survey and analysis during final design would determine if alterations in design are needed.

A new 1-mile pipeline would be needed to connect Jasper East Reservoir to the existing Windy Gap pipeline that delivers water to Granby Reservoir.

Water would be conveyed from the West Slope to Chimney Hollow Reservoir via existing C-BT facilities to the upper end of the existing Flatiron Penstock, where a new buried penstock would deliver water to Chimney Hollow or Carter Lake as described for Alternative 2.



Inlet - Outlet Tunnel

Spillway and Channel

New Pipeline

Potential Disturbance Area

Transmission Line Corridor

Chimney Hollow Reservoir

Dam

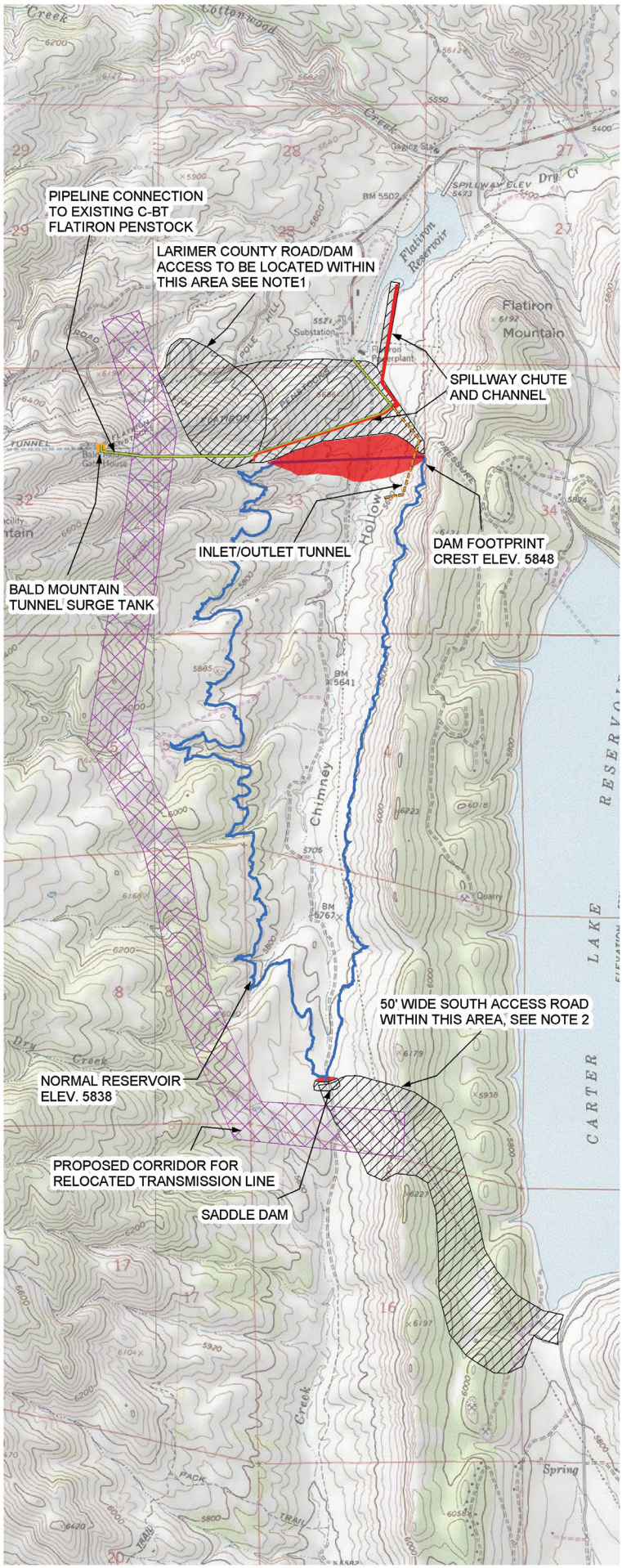
NOTES:

1. FINAL LOCATION OF DAM CREST ACCESS ROAD TO BE DETERMINED THROUGH LARIMER COUNTY PARK PLANNING PROCESS.
2. SOUTH ACCESS ROAD DURING CONSTRUCTION - GATED WITH NO PUBLIC ACCESS FOLLOWING CONSTRUCTION.

0 2,000 4,000 Feet

N

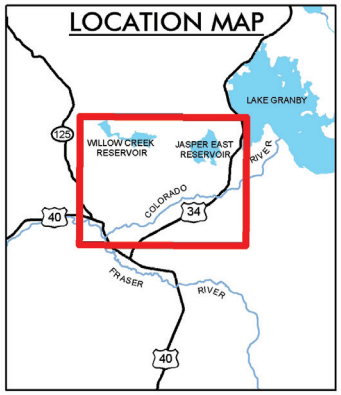
"USGS MAP OF THE CARTER LAKE RESERVOIR QUADRANGLE, BOULDER AND LARIMER COUNTIES, COLORADO"
SITE SPECIFIC TOPOGRAPHY BASED ON AERIAL SURVEY, APRIL 2003



WINDY GAP FIRMING PROJECT

Figure 2-7
Alternative 3 - Chimney Hollow Reservoir (70,000 AF)

Windy Gap Firming Project



- Inlet - Outlet Tunnel
- Spillway and Channel
- New Pipeline
- Willow Creek Pipeline Relocation
- Existing Windy Gap Pipeline
- Potential Disturbance Area
- Borrow Area
- Jasper East Reservoir
- Dam

GEOLOGIC REFERENCE:

"GEOLOGIC MAP OF THE TRAIL MOUNTAIN QUADRANGLE, GRAND COUNTY, COLORADO", MAP GQ-1156, U.S. GEOLOGICAL SURVEY, 1974.

TOPOGRAPHY REFERENCE:
"COLORADO-SEAMLESS USGS TOPOGRAPHIC MAPS ON CD-ROM", TOPO VERSION 2.6.4, NATIONAL GEOGRAPHIC, 2000.

0 2,200 4,400 Feet

N

NORMAL RESERVOIR ELEV. 8200

RELOCATION OF WILLOW CREEK PIPELINE

NEW WILLOW CREEK PUMP STATION AND FOREBAY

SPILLWAY CHUTE

DAM FOOTPRINT (CREST ELEV. 8205)

OUTLET WORKS

LAKE GRANBY

POTENTIAL BORROW OPERATIONS

PIPELINE CORRECTION

LOCATION OF BOOSTER PUMP AND END OF PIPELINE

EXISTING WINDY GAP PIPELINE

IMPROVED COUNTY ROAD FOR SITE ACCESS AND COUNTY ROAD 40 RELOCATION

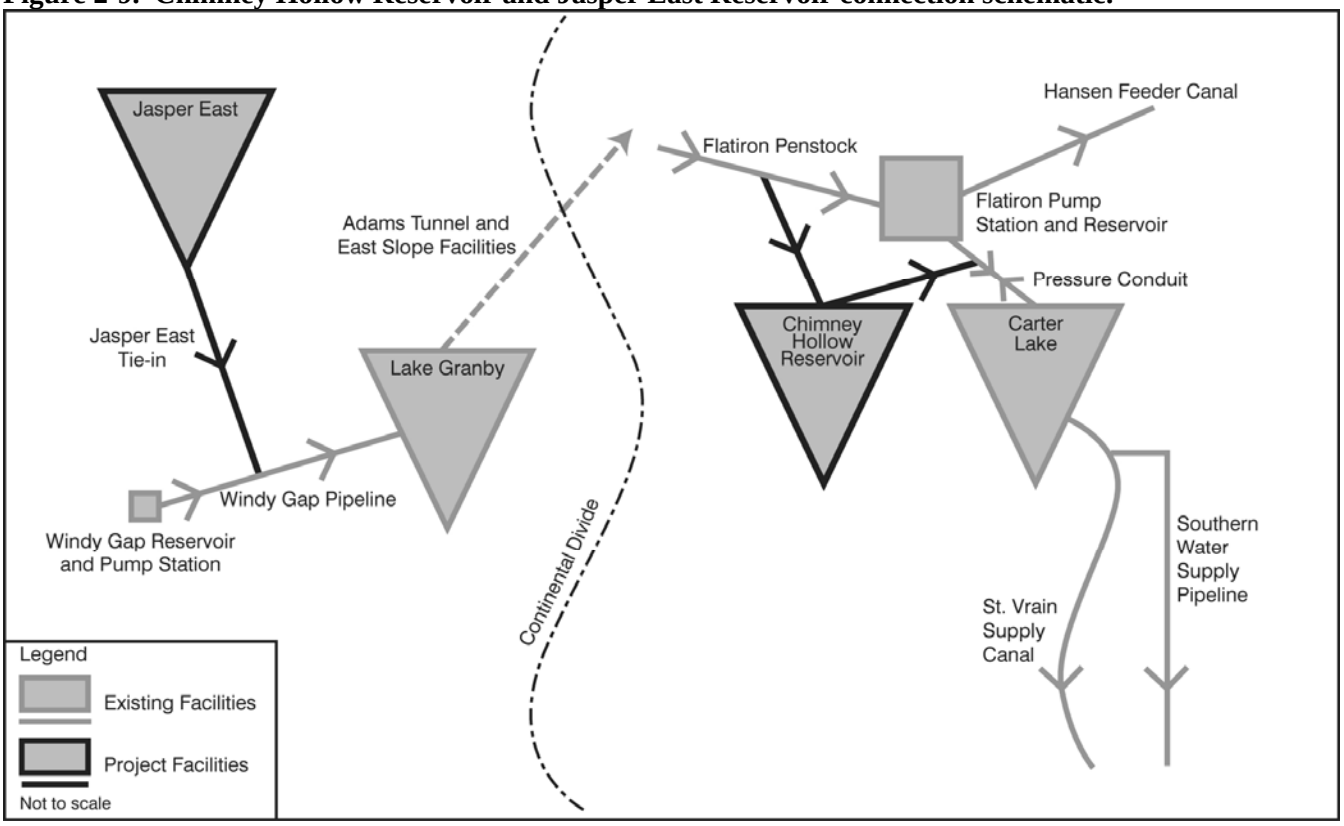
EXISTING WINDY GAP DAM AND RESERVOIR

WINDY GAP FIRMING PROJECT

Figure 2-8
Alternative 3 - Jasper East Reservoir (20,000 AF)

Windy Gap Firming Project

Figure 2-9. Chimney Hollow Reservoir and Jasper East Reservoir connection schematic.



2.5.1.3 Access, Borrow Areas, and Power

Access, borrow areas, and power facilities required for the 70,000 AF Chimney Hollow Reservoir would be the same as Alternative 2.

Initial construction access to the Jasper East Reservoir site would be off County Road 40 from U.S. Highway 34. However, the new reservoir would inundate about 1.2 miles of County Road 40 and require the eventual relocation of the road. A new access road would be constructed using a combination of existing and new roads including, County Road 405 off Highway 34, an unimproved dirt road east of the reservoir, and about 5,600 feet of new road. Access to C-BT facilities, Willow Creek Reservoir Arapaho National Recreation Area, and private lands would be provided during and following reservoir construction.

Jasper East Reservoir Site

The availability of suitable material for the Jasper East dam construction within the project limits is unknown, but it is anticipated that material from overburden deposits could be used. Filter and drain material is available from an existing Willow Creek gravel pit located nearby. Riprap and bedding material is believed to be available from basalt bedrock adjacent to the reservoir.

The power supply to Jasper East Reservoir and Jasper East pump station would use the existing transmission lines present near the site. A substation to reduce the voltage for these facilities would likely be needed.

2.5.1.4 Relocation of Willow Creek Pump Station and Pipeline

Construction of Jasper East Reservoir would require relocation of the Willow Creek Pump Station, forebay, and portions of the canal and pipeline that would be inundated by the new reservoir. The Willow Creek Pump Station and facilities are part of the C-BT Project that conveys water from Willow Creek Reservoir to Granby Reservoir. The preliminary design includes relocation of these facilities to the north of Jasper East Reservoir (Figure 2-8). Materials from the existing pump station would be salvaged as much as possible for the new facility, but a new 50-foot by 75-foot building would need to be constructed. A new 2.5-acre forebay would be constructed and about 8,800 feet of new pipeline and possibly some canal would be constructed to reconnect Willow Creek conveyance facilities. New facilities would have the same capacity as the existing facilities.

2.5.2 Operations

Windy Gap diversions would first be delivered to Chimney Hollow Reservoir, depending on the availability of space in the Adams Tunnel for conveyance to the East Slope. If the Adams Tunnel is full, then diversions would be delivered to Jasper East for storage. Releases to Participants would first be made from Jasper East and then out of Chimney Hollow when necessary. The general goal for filling and emptying the reservoirs is to move Windy Gap water to the East Slope as soon as possible. This can be done physically when space in the Adams Tunnel is available by delivering to Chimney Hollow first and then by releasing from Jasper East. Once Windy Gap water enters Granby Reservoir, it is available for delivery to meet Windy Gap demand out of East Slope C-BT storage in Carter Lake or Horsetooth Reservoir via instantaneous delivery. In addition to storage in Chimney Hollow and Jasper East, Windy Gap water may also be stored in Granby Reservoir when unused capacity is available.

In general, the water levels in Chimney Hollow would fluctuate based on available Windy Gap supplies and Participant water demands. Chimney Hollow would typically be fuller during wet years and drawn down during dry years. Jasper East water levels would fluctuate more than Chimney Hollow because there may be years when all available Windy Gap water is delivered to the East Slope. Jasper East also would tend to be drawn down more quickly within a year than Chimney Hollow because the priority would be to deliver Windy Gap water stored in Jasper East to meet Participant demands or to Chimney Hollow where it is available on the East Slope and deliveries are not constrained by available capacity in the Adams Tunnel.

Deliveries of Windy Gap water to Participants from Chimney Hollow Reservoir through releases to C-BT facilities would be the same as current operations and as described for Alternative 2.

The MPWCD would use its Windy Gap water as a source of augmentation water to replace out-of-priority depletions in Grand or Summit county. MPWCD 3,000 AF of water would be stored in either Chimney Hollow or Jasper East Reservoirs and released to the Colorado River to offset depletions. Releases would either directly replace depletions for uses on the Colorado River or be replaced by exchange if depletions occur in the Willow Creek, Fraser River, or Blue River basins. MPWCD's Windy Gap water is assumed to be evenly delivered from September to March based on the location and types of uses and generally when its contractees require augmentation supplies.

2.5.3 Construction Program

Construction of a 70,000 AF Chimney Hollow Reservoir would be similar to that described for Alternative 2. The smaller dam would not substantially change the size of the work force, construction traffic, and amount of construction material. Construction of the dam and associated facilities is estimated to take from 2.5 to 5 years.

Construction of Jasper East Reservoir also is estimated to take 2.5 to 5 years. Construction sequencing includes the development of staging areas, relocation of the Willow Creek Pumping Station, relocation of County Road 40

followed by development of borrow areas, dam construction, spillways, and pipeline and booster pump installation.

Assuming both reservoir sites are constructed concurrently, an average workforce of about 190 people at Chimney Hollow and an additional 65 people at Jasper East would be needed. Reclamation would need a staff of about 15 people during the relocation of Willow Creek Pump Station facilities. The combined peak workforce for both sites would reach about 570 people.

Most construction materials for the Jasper East dams would be excavated from materials within the reservoir basin or adjacent areas. The amount of concrete needed for spillway and outlet works would not warrant an on-site batch plant; therefore, two to six concrete trucks per day would be needed during construction of these facilities. Including traffic for other supplies, the average truck traffic to the site would be five vehicles per day, peaking at 10 vehicles per day. If pipe is delivered concurrent with dam construction, an additional three trucks per day would travel to the site.

2.5.4 Cost

The estimated cost for construction of a 70,000 AF Chimney Hollow Reservoir and associated facilities is $180 million in 2005 dollars. Included in the cost is $4.5 million for relocation of Western's transmission line. Operation and maintenance costs for the reservoir would be $500,000 annually in addition to $295,000 for O&M of conveyance facilities.

The estimated cost for construction of Jasper East Reservoir and associated facilities is $60 million in 2005 dollars. This includes $31 million for dam construction, $14 million for the pipeline and the booster pump station, and $15 to $21 million for relocating the Willow Creek Pump Station and Canal. Total O&M costs for the reservoir, pipeline, and facilities are estimated at $329,000 annually. About half of this cost is for the incremental increase in power requirements to pump water from Jasper East to Granby Reservoir.

The capital cost for constructing Chimney Hollow Reservoir and Jasper East Reservoir would be about $240 million in 2005 dollars.

The total capital cost for this alternative is about $240 million in 2005 dollars. The total annual O&M cost would be about $1.38 million.

2.5.5 Public Access and Recreation

Public access and recreation at Chimney Hollow Reservoir would be the same as Alternative 2. Larimer County Parks and Open Lands would manage the property and develop the area for nonmotorized boating, hiking, and picnicking.

There are currently no plans for recreation development or public access at the Jasper East Reservoir site. The Subdistrict would not operate or manage recreation facilities, but would consider leasing the area to a government agency or other entity that would take responsibility for developing and managing recreation facilities. It is assumed that an entity would be interested in managing recreation at Jasper East and that uses would be similar to those planned for Chimney Hollow Reservoir. If no recreation management entity is found, the reservoir would be closed to public access.

2.6 Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Alternative 4 is a combination of a 70,000 AF Chimney Hollow Reservoir on the East Slope and a 20,000 AF Rockwell/Mueller Creek Reservoir (Rockwell) on the West Slope. As with the Jasper East Reservoir site, the availability of a new West Slope reservoir would allow water diversions from the existing Windy Gap Reservoir to be routed to either Rockwell or Granby Reservoir. Thus, when Granby Reservoir is full or the Adams Tunnel is at capacity, Windy Gap water would be diverted and stored until there is sufficient capacity to transfer water to Chimney Hollow Reservoir. Prepositioning is not a component of this alternative because it would not be necessary to meet the firm yield target identified in the Purpose and Need statement.

Rockwell/Mueller Creek Reservoir Site

The 70,000 AF Chimney Hollow Reservoir location is identical to that described for Alternative 3. Under this alternative, Western would remove a section of the existing Estes-Lyons 115-kV Transmission Line and relocate it as described in Section 2.4.1.4. The Rockwell Reservoir site is located in Grand County about 1.5 miles southwest of the Town of Granby. Rockwell Reservoir would be built on the intermittent Rockwell Creek and Mueller Creek drainages at an elevation of about 8,100 feet.

2.6.1 Infrastructure

2.6.1.1 Dams and Spillway

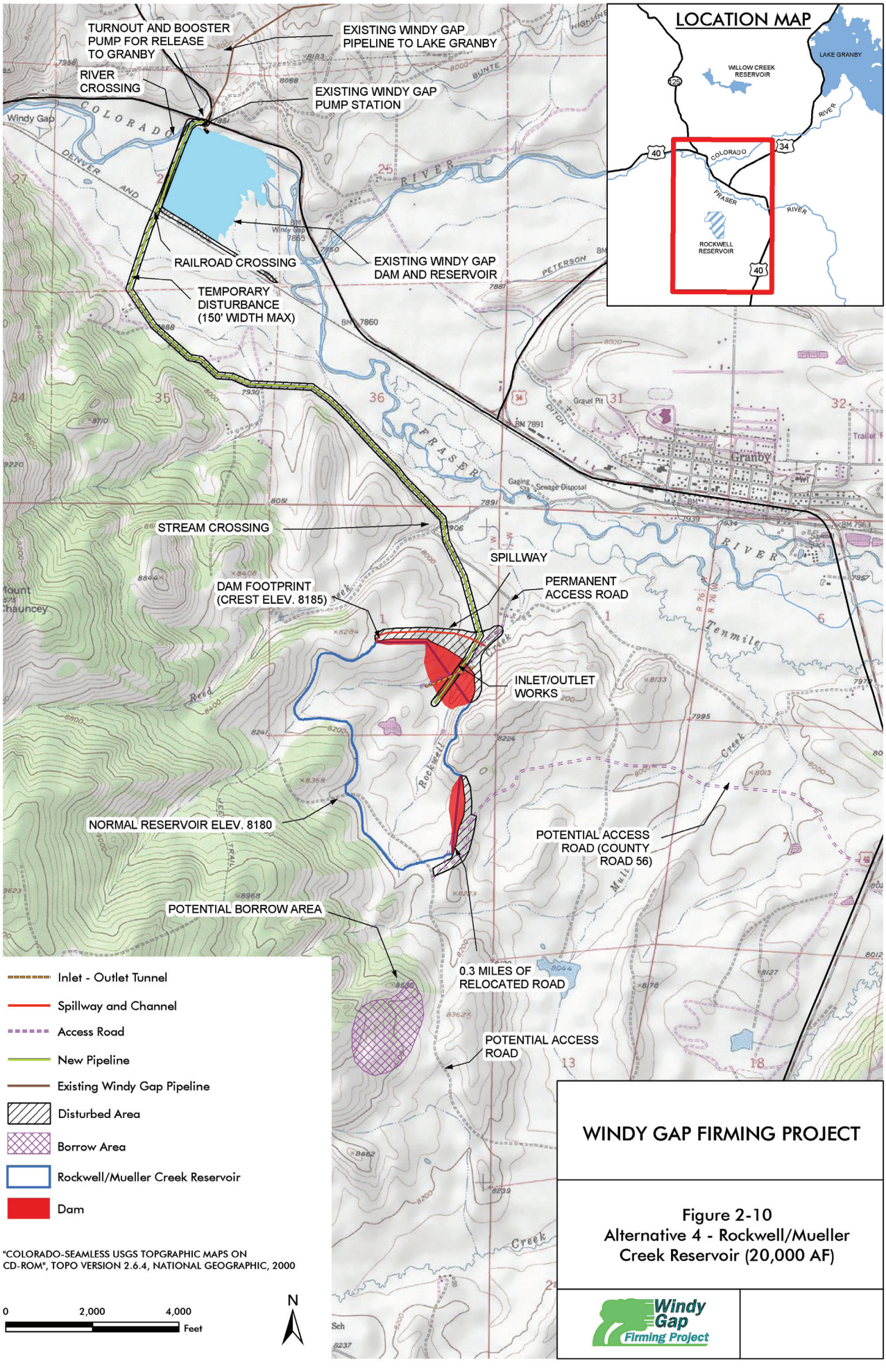
The configuration, dam, and spillway for a 70,000 AF Chimney Hollow Reservoir would be the same as Alternative 3.

Construction of Rockwell Reservoir would require two earthfill dams (Figure 2-10). The main dam would be on Rockwell Creek with a smaller dam on the southeast side of the reservoir. The main dam would have a height of 205 feet and the smaller dam a height of 45 feet. The normal surface area of the 20,000 AF reservoir would inundate 294 acres. Because the reservoir would be located directly above the Town of Granby, it would be considered a high hazard (Class 1) facility as defined by Colorado State Engineer's criteria. This requires a spillway design capable of passing 100 percent of a flood resulting from a probable maximum precipitation event. The spillway design to meet this criterion would be about 10 feet wide and 2,700 feet long.

2.6.1.2 Conveyance

A new 2.2-mile pipeline would be needed to deliver water from the existing Windy Gap Reservoir to Rockwell Reservoir and then back to the existing Windy Gap pipeline.

Deliveries to and from Rockwell Reservoir would require a new connection to the existing Windy Gap Pump Station and Pipeline. Diversions at the existing Windy Gap Reservoir would be pumped using the existing Windy Gap Pump Station to Rockwell Reservoir. Because the water surface elevation of Rockwell is lower than Granby Reservoir, the existing pump facility probably would be adequate (Figure 2-11). Water from Rockwell Reservoir would be delivered to Granby Reservoir using the same pipeline with the addition of a booster pump near Windy Gap Reservoir. The pump station building would be about 75 feet by 50 feet with a height of less than 50 feet. The new buried pipeline would be about 10 feet in diameter and 17,600 feet in length from the Windy Gap Pump Station to the Rockwell Reservoir inlet/outlet works. The pipeline would follow County Road 57 and previously disturbed areas to the extent possible, and would cross the Colorado River immediately downstream of Windy Gap Reservoir.

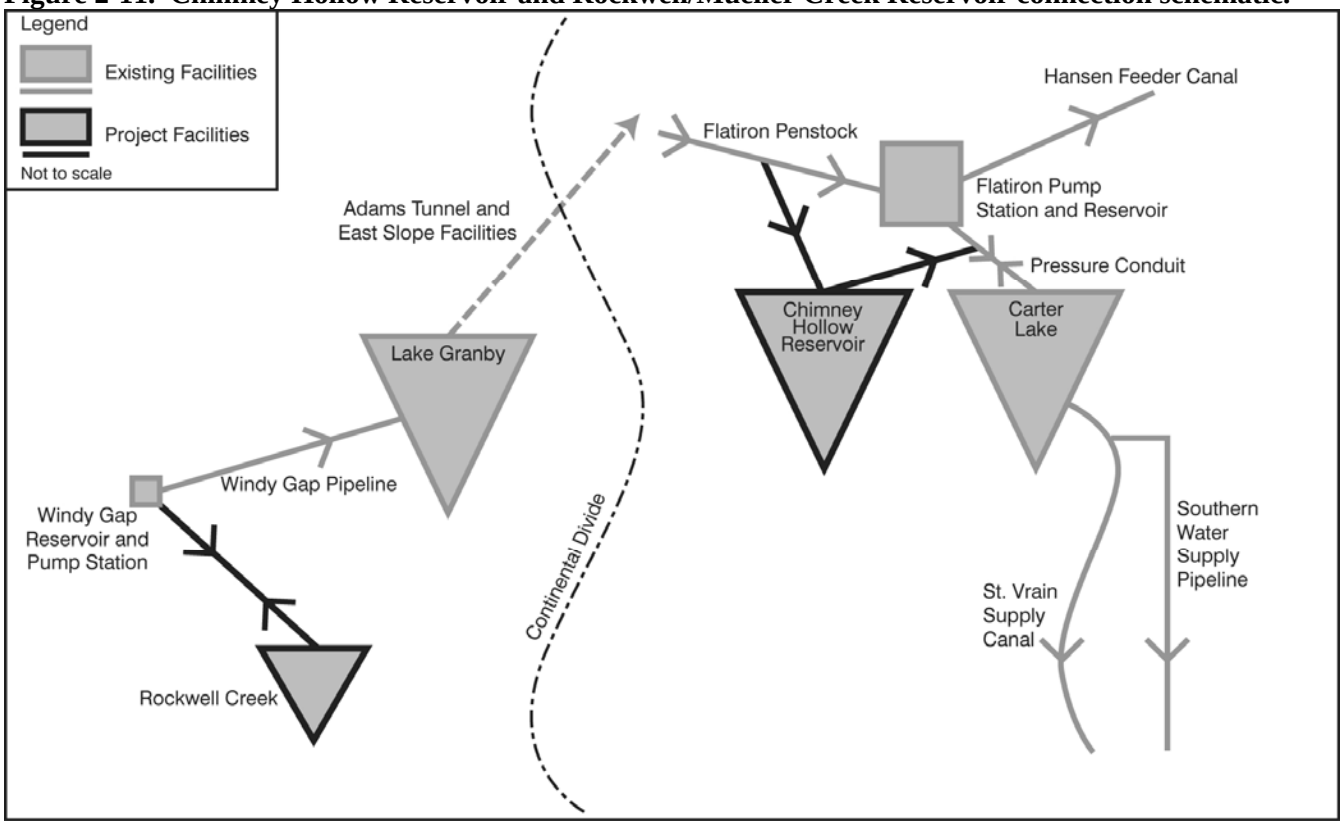


WINDY GAP FIRMING PROJECT

Figure 2-10
Alternative 4 - Rockwell/Mueller Creek Reservoir (20,000 AF)

Windy Gap Firming Project

Figure 2-11. Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir connection schematic.



Water would be conveyed from the West Slope to Chimney Hollow Reservoir via existing C-BT facilities to the upper end of the existing Flatiron Penstock, where a new buried penstock would deliver water to Chimney Hollow or Carter Lake as described for Alternative 2.

2.6.1.3 Access, Borrow Areas, and Power

Access, borrow areas, and power facilities for the 70,000 AF Chimney Hollow Reservoir would be the same as Alternative 3.

Access to the Rockwell Reservoir site would likely be via two gravel roads on the east and north. The north route is accessible via U.S. Highway 40 and County Road 57. The east route along County Road 56 is accessible from U.S. Highway 40. An additional access road option from the south could be used. Improvements to existing roads may be needed to provide adequate access for equipment and trucks during construction.

The availability of suitable material for construction of Rockwell dam within the reservoir footprint is unknown, but it is anticipated that material from overburden deposits and the underlying fine-grain bedrock could be used. If on-site material is not suitable, a potential borrow area is located less than 1 mile to the south. Based on available geologic mapping, filter and drain material may not be available on-site and would probably have to be imported, perhaps from the quarry near Jasper East. Basalt material from this quarry might also be needed to provide riprap and bedding material.

The power supply to Rockwell Reservoir and the new booster pump station would come from the existing transmission line near the Windy Gap Pump Station. A substation to reduce the voltage for these facilities would likely be needed.

2.6.2 Operations

Deliveries to Chimney Hollow would be the same as described for Alternatives 2 and 3. Rockwell Reservoir would be operated the same as described for Jasper East Reservoir in Alternative 3. Windy Gap diversions would first be delivered to Chimney Hollow Reservoir depending on the availability of space in the Adams Tunnel for conveyance to the East Slope. If the Adams Tunnel is full, then diversions would be delivered to Rockwell Reservoir for storage. Releases to Participants would first be made from Rockwell Reservoir and then out of Chimney Hollow Reservoir. The general goal for filling and emptying the reservoirs would be to move Windy Gap water to the East Slope as soon as possible. This can be done physically when space in the Adams Tunnel is available by delivering to Chimney Hollow Reservoir first and then releasing from Rockwell Reservoir. Once Windy Gap water enters Granby Reservoir, it would be available for delivery to a Windy Gap demand out of East Slope C-BT storage in Carter Lake or Horsetooth Reservoir via instantaneous delivery.

In general, water levels in Chimney Hollow would fluctuate based on available Windy Gap supplies and demands. Chimney Hollow would typically be fuller during wet years and drawn down during dry years. Rockwell Reservoir water levels would fluctuate more than Chimney Hollow because there may be years when all available Windy Gap water is delivered to the East Slope. Rockwell Reservoir also would typically be drawn down more quickly within a year than Chimney Hollow because the priority would be to deliver Windy Gap water stored in Rockwell to meet Participant demands or to Chimney Hollow where it is available on the East Slope and deliveries are not constrained by available capacity in the Adams Tunnel.

Deliveries of Windy Gap water to Participants from Chimney Hollow Reservoir through releases to C-BT facilities would be the same as current operations as described for Alternative 2.

The MPWCD would use its Windy Gap water as a source of augmentation water to replace out-of-priority depletions in Grand and Summit counties. MPWCD 3,000 AF of water would be stored either in Chimney Hollow or Rockwell reservoirs and released to the Colorado River (either directly or by exchange) to offset depletions. Releases would either directly replace depletions for uses on the Colorado River or be replaced by exchange if depletions occur in the Willow Creek, Fraser River, or Blue River basins. MPWCD's Windy Gap water is assumed to be evenly delivered from September to March based on the location and types of uses and generally when its contractees require augmentation supplies.

2.6.3 Construction Program

The construction program for a 70,000 AF Chimney Hollow Reservoir would be similar to that described for Alternative 2.

Construction of Rockwell Reservoir is estimated to take from 2.5 to 4.5 years. Construction sequencing includes the development of staging areas and borrow areas, dam construction, spillways, and pipeline and booster pump installation.

Assuming both reservoir sites are constructed concurrently, an average workforce of about 190 people at Chimney Hollow and 76 people at Rockwell Reservoir would be needed. The combined peak workforce for both sites would reach about 585 people.

The majority of the construction materials for the Rockwell dams would be excavated from the reservoir basin or adjacent areas; however, riprap for slope protection on the dam would likely have to come from off-site. The estimated duration of riprap placement is 15 months with an average traffic volume of 13 trucks per day. The amount of concrete needed for spillway and outlet works does not warrant an on-site batch plant; therefore, an average of about 4.5 concrete trucks per day would be needed during placement of concrete. Including traffic for other supplies, the average truck traffic to the site would be about 18 vehicles per day, peaking at as many as 45 vehicles per day during dam construction. Assuming 50 percent of the bedding material needed for pipeline placement comes from off-site locations and that removal of excess excavated material and pipeline deliveries occur concurrently, then about 26 trucks per day would access the project area during this phase of construction.

2.6.4 Cost

The estimated cost for construction of Chimney Hollow Reservoir and associated facilities is $180 million in 2005 dollars. Included in the cost is $4.5 million for relocation of Western's transmission line. Operation and maintenance costs for the reservoir would be $500,000 annually in addition to $295,000 for O&M of conveyance facilities. These costs are the same as Alternative 4.

The capital costs for constructing Chimney Hollow and Rockwell reservoirs would be about $252 million in 2005 dollars.

Construction of Rockwell Reservoir and associated facilities is estimated to cost about $72 million. This includes $37 million for dam construction, $24 million for the pipeline, and $11 million for the booster pump station. Total O&M costs for the reservoir, pipeline, and facilities are estimated at about $935,000 annually. About $207,000 of this cost is for the incremental increase in power requirements above existing pumping costs to pump water from Rockwell Reservoir to Granby Reservoir.

The total estimated capital construction cost for this alternative is about $252 million. Total annual O&M costs would be about $1.73 million.

2.6.5 Public Access and Recreation

Public access and recreation at Chimney Hollow Reservoir would be the same as Alternative 2. Larimer County Parks and Open Lands would lease the property and develop the area for nonmotorized boating, hiking, and picnicking.

There are currently no plans for recreation development or public access at the Rockwell Reservoir site. The Subdistrict would not operate or manage recreation facilities, but would consider leasing the area to a government agency or other entity that would take responsibility for developing and managing recreation facilities. It is assumed that an entity would be interested in managing recreation at Rockwell Reservoir and that uses would be similar to those planned for Chimney Hollow Reservoir. If no recreation management entity is found, the reservoir would be closed to public access.

2.7 Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

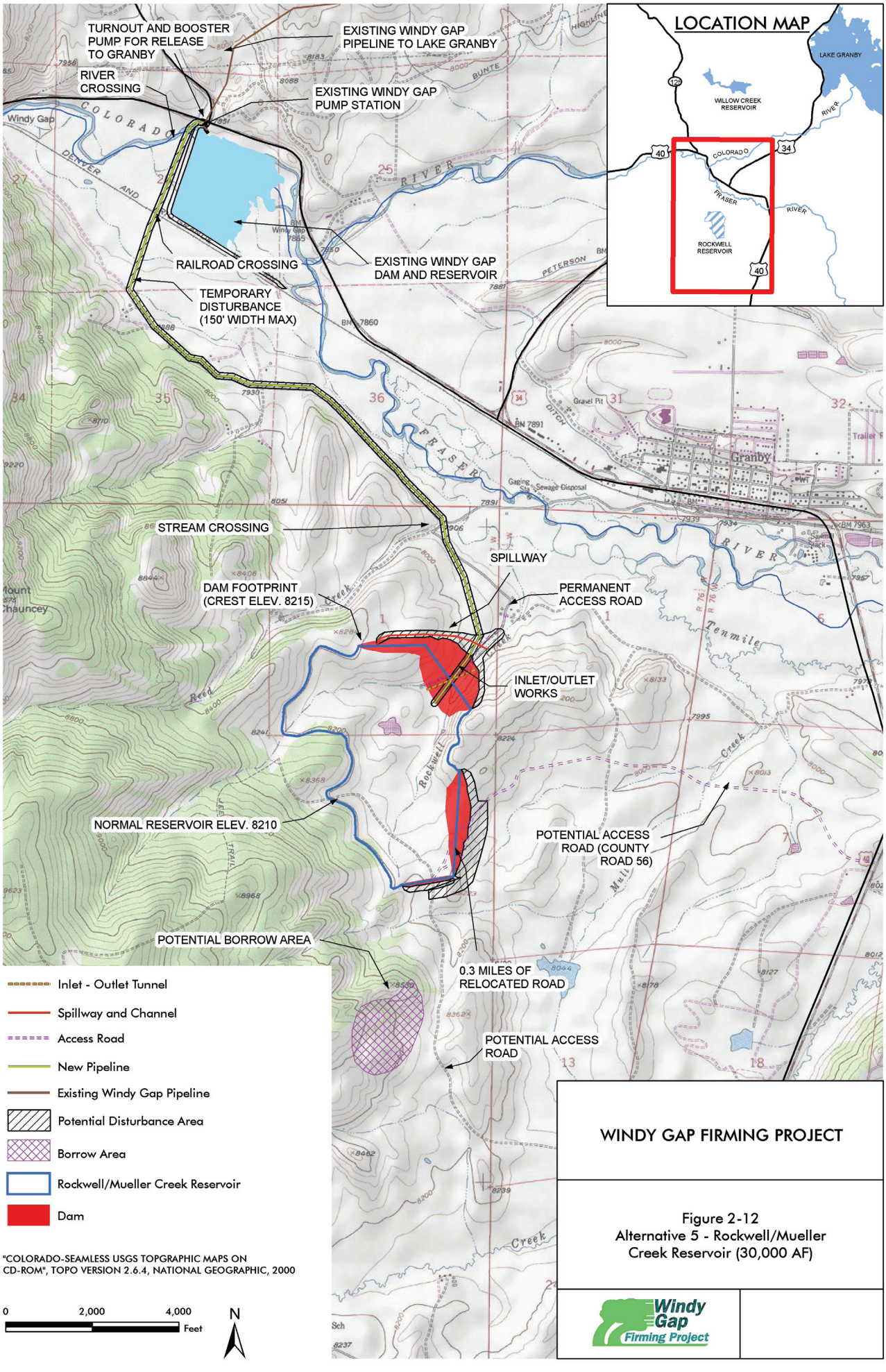
Alternative 5 is a combination of a 60,000 AF Dry Creek Reservoir on the East Slope and a 30,000 AF Rockwell/Mueller Creek Reservoir on the West Slope. As with the Alternatives 3 and 4, the availability of a new West Slope reservoir would allow water diversions from the existing Windy Gap Reservoir to be routed to either Rockwell Reservoir or Granby Reservoir. Thus, when Granby Reservoir is full or the Adams Tunnel is at capacity, Windy Gap water could be diverted and stored until there is sufficient capacity to transfer water to Chimney Hollow Reservoir. Prepositioning is not a component of this alternative because it would not substantially improve yield if a new West Slope reservoir is available.

The 60,000 AF Dry Creek Reservoir site is located in the drainage just south of Chimney Hollow about 12 miles southwest of Loveland, Colorado. The Dry Creek dam would be built on the intermittent Dry Creek drainage, which is a tributary to the Little Thomson River. The reservoir surface would be at an elevation of about 5,800 feet. Rockwell Reservoir is at the same location as described for Alternative 4.

2.7.1 Infrastructure

2.7.1.1 Dams and Spillway

The infrastructure for a 30,000 AF Rockwell Reservoir is the same as the 20,000 AF reservoir described in Alternative 4. The reservoir and dam footprints would be larger than the smaller reservoir size (Figure 2-12). The increased reservoir size would require a third small dam on the south side of the reservoir. The main dam on



WINDY GAP FIRMING PROJECT

Figure 2-12
Alternative 5 - Rockwell/Mueller Creek Reservoir (30,000 AF)

Windy Gap Firming Project

Rockwell Creek would have a height of about 235 feet, the eastern dam would have a height of 80 feet, and the southern dam would have a height of 20 feet. The area of inundation would be about 348 acres. The spillway would be similar to the 20,000 AF reservoir size.

Construction of a 60,000 AF Dry Creek Reservoir would require a single rockfill dam (Figure 2-13). The dam would have a height of 310 feet. The normal surface area of the full reservoir would inundate 589 acres. A 25-foot spillway width with a chute of about 3,000 feet would be needed.

2.7.1.2 Conveyance

Water deliveries to and from Rockwell Reservoir would require a new pipeline and connection to the existing Windy Gap Pump Station and Pipeline as described in Alternative 4 (Figure 2-14).

Dry Creek Reservoir Site

Delivery of Windy Gap water to Dry Creek Reservoir would require a new pipeline originating above the existing penstock valve house and traversing down the ridge to the south of the existing Flatiron Penstocks (as described for Alternative 2), then turning south through Chimney Hollow to the upper end of Dry Creek Reservoir. Releases from Dry Creek Reservoir would be made from the dam outlet and pumped via a new tunnel conduit through the ridge to the east, then flow by a gravity pipeline into the southern end of Carter Lake. Once in Carter Lake, deliveries could be made to St. Vrain Supply Canal or Southern Water Supply Pipeline for Participants to the south. Deliveries to Participants north of Carter Lake would be made by releases to the Carter Lake Pressure Tunnel to Flatiron Reservoir and other C-BT conveyance facilities.

A new 108-inch pipeline from the C-BT connection to Dry Creek Reservoir would be about 18,000 feet in length. A turnout to allow deliveries to the existing Flatiron Reservoir would be about 2,900 feet in length. The Dry Creek Reservoir outlet pipeline to Carter Lake would be about 11,100 feet long and have a diameter of 36 inches.

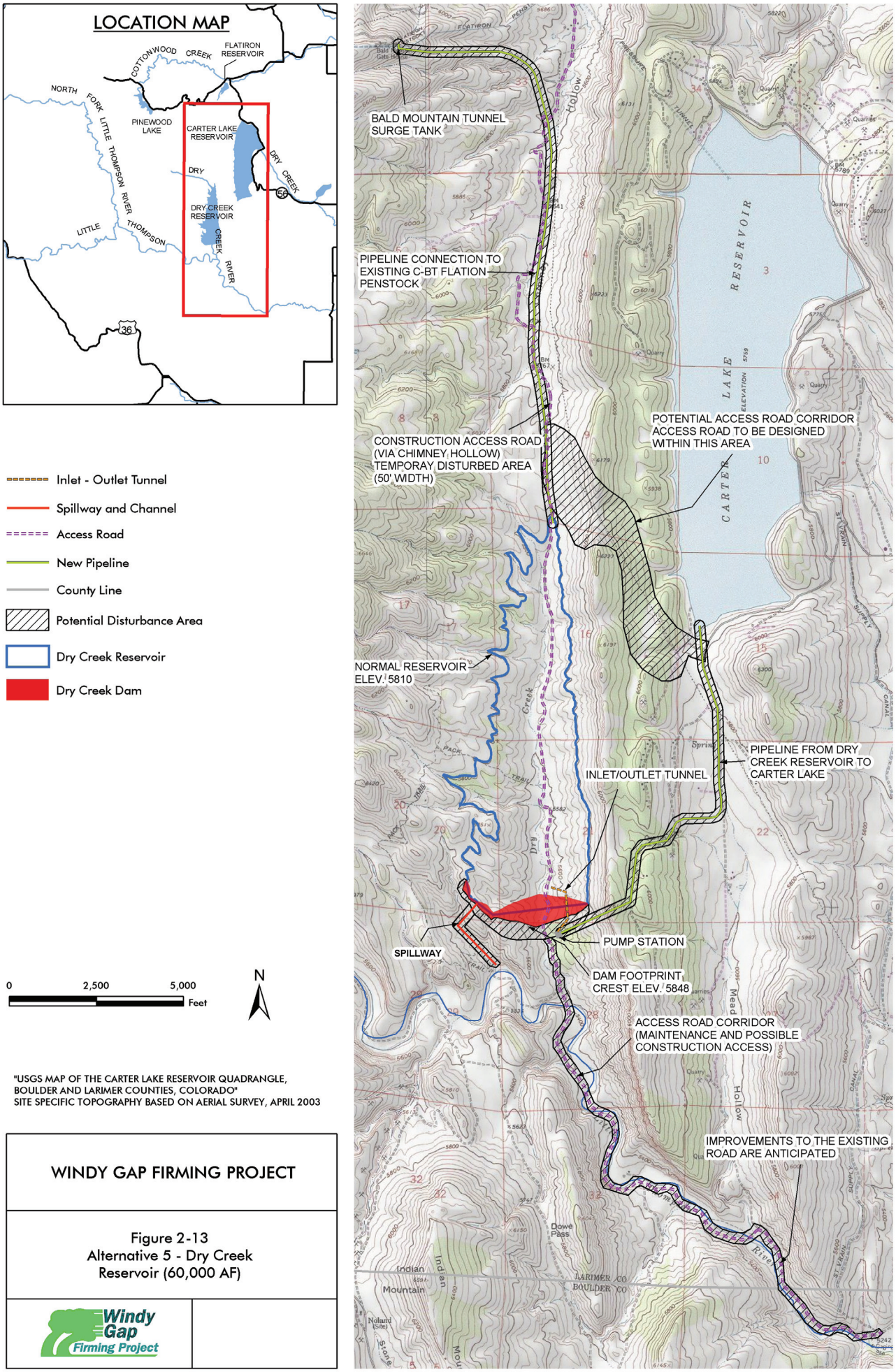
2.7.1.3 Access, Borrow Areas, and Power

Access, borrow areas, and power facilities for the 30,000 AF Rockwell Reservoir would be the same as described for Alternative 4. However, the larger dams and the addition of a third dam would require more borrow material than the 20,000 AF reservoir.

Proposed construction access to the Dry Creek Reservoir site would be from the north through Chimney Hollow. The existing unimproved roads in Chimney Hollow would need to be upgraded. Secondary access options that may need to be considered include use of an existing road along the Little Thompson Valley or across the hogback south of Carter Lake. Construction access roads would need to be improved to a width of 40 feet. Following construction, roads could be reclaimed to some extent, although access would need to be provided for maintenance.

To convey Windy Gap water to Dry Creek Reservoir would require a new 3.4-mile pipeline connection to C-BT facilities. In addition, a new 2.1-mile pipeline would be needed to deliver water from Dry Creek Reservoir to Carter Lake.

The availability of suitable material for construction of the Dry Creek dam within the project limits is unknown, but it is anticipated that fine-grain embankment material and suitable material for rockfill may be present in the valley bottom. Coarse grained sand and gravel material does not appear to be present on-site, but available granitic material could be quarried and crushed, or off-site commercial sources could be used. Granitic bedrock on the west side of the reservoir site could probably be used for riprap.



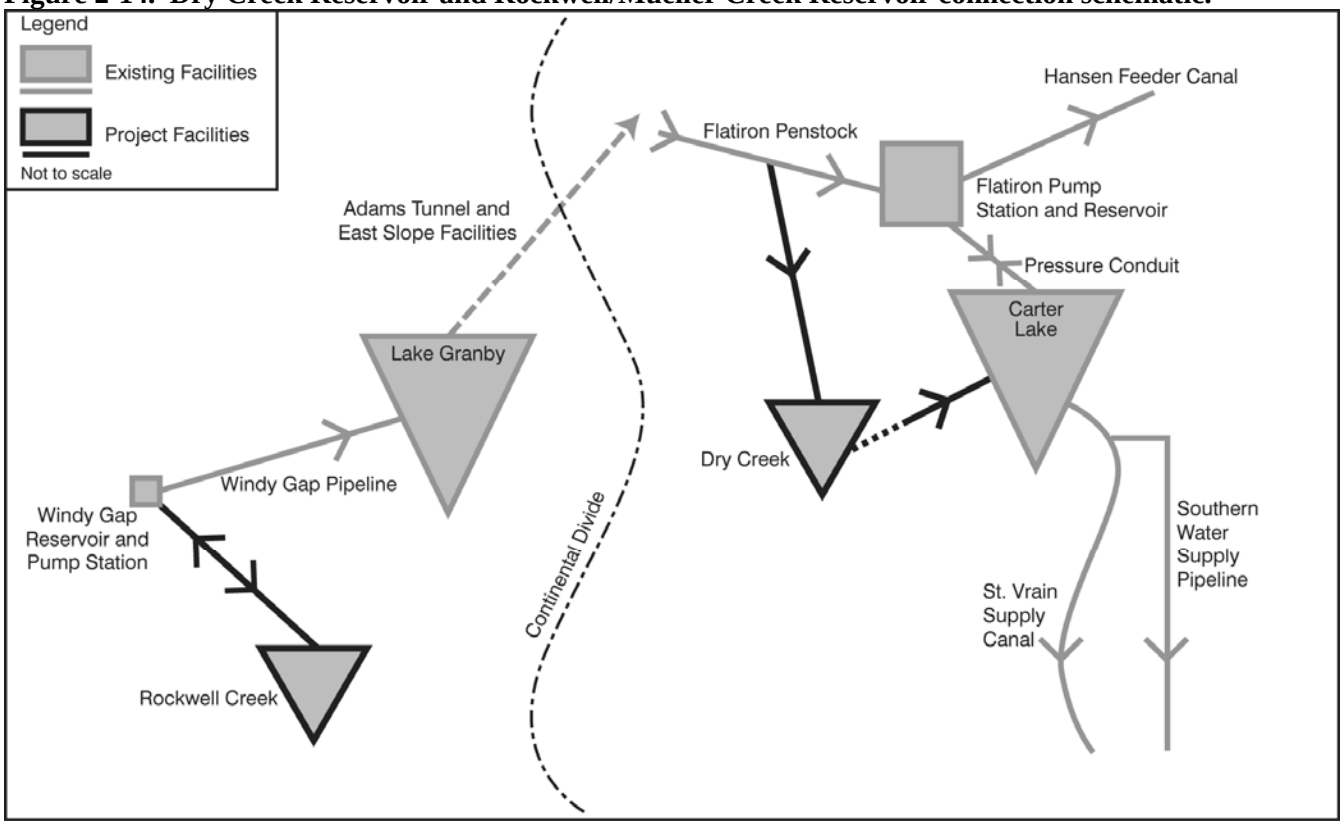
"USGS MAP OF THE CARTER LAKE RESERVOIR QUADRANGLE, BOULDER AND LARIMER COUNTIES, COLORADO"
SITE SPECIFIC TOPOGRAPHY BASED ON AERIAL SURVEY, APRIL 2003

WINDY GAP FIRMING PROJECT

Figure 2-13
Alternative 5 - Dry Creek Reservoir (60,000 AF)

Windy Gap Firming Project

Figure 2-14. Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir connection schematic.



The power supply to Dry Creek Reservoir and conveyance facilities would come from the existing facilities associated with the Flatiron Power Plant. A substation may be needed to step down voltage.

2.7.2 Operations

The operation of Dry Creek and Rockwell reservoirs would be similar to the Chimney Hollow and Rockwell Reservoir combination described in Alternative 4. Deliveries to Rockwell Reservoir would be made using the existing Windy Gap Pump Station and a new bi-directional pipeline. Releases would be made to the pipeline running north, where a turnout would run the water through a booster pump for delivery to Granby Reservoir via the existing Windy Gap Pipeline.

Windy Gap diversions would first be delivered to Dry Creek Reservoir as limited by available capacity in the Adams Tunnel. If the Adams Tunnel is full, then diversions would be delivered to Rockwell Reservoir for storage. The general goal for filling and emptying the reservoirs is to move Windy Gap water to the East Slope as soon as possible. This can be done physically when space in Adams Tunnel is available by delivering to Dry Creek Reservoir first and then releasing from Rockwell Reservoir for delivery to Dry Creek Reservoir. Instantaneous delivery of Windy Gap water to the East Slope also helps to accomplish this goal. Once Windy Gap water enters Granby Reservoir, it is available for delivery to meet Windy Gap demand out of East Slope C-BT storage in Carter Lake or Horsetooth Reservoir via instantaneous delivery.

In general, water levels in Dry Creek Reservoir would fluctuate based on available Windy Gap supplies and demands. Dry Creek Reservoir would typically be fuller during wet years and drawn down during dry years. Rockwell Reservoir water levels would fluctuate more than Dry Creek Reservoir because there may be years when all available Windy Gap water is delivered to the East Slope. Rockwell Reservoir also would tend to be drawn down more quickly within a year than Dry Creek Reservoir because the priority would be to deliver Windy

Gap water stored in Rockwell Reservoir to meet Participant demands or to Dry Creek Reservoir where it is available on the East Slope and deliveries are not constrained by available capacity in the Adams Tunnel.

The MPWCD would use its Windy Gap water as a source of augmentation water to replace out-of-priority depletions in Grand and Summit counties. MPWCD 3,000 AF of water would be stored either in Dry Creek or Rockwell reservoirs and released to the Colorado River (either directly or by exchange) to offset depletions. Releases would either directly replace depletions for uses on the Colorado River or be replaced by exchange if depletions occur in the Willow Creek, Fraser River, or Blue River basins. MPWCD's Windy Gap water is assumed to be evenly delivered from September to March based on the location and types of uses and generally when its contractees require augmentation supplies.

2.7.3 Construction

The construction program for a Rockwell Reservoir would be similar to that described for Alternative 4. The larger dam may require more time to complete but, in general, construction activities would be similar. The size of the workforce and level of construction traffic also would be similar.

Construction of the Dry Creek dam and appurtenances is estimated to take from 2.5 to 4.5 years. Construction sequencing includes the establishment of staging areas, development of borrow areas, and construction of the dam, spillways, and pipelines including the outlet boring to Carter Lake.

Assuming both reservoirs are constructed concurrently, an average workforce of about 210 people at Dry Creek Reservoir and an additional 92 people at Rockwell Reservoir would be needed. The combined peak workforce for both reservoirs would reach about 657 people.

Most construction materials for the Dry Creek dam would be excavated from the reservoir basin. Depending on the type of rockfill dam selected, the cement for a concrete face or bitumen for an asphalt core would be trucked to the site. The average traffic during dam construction is estimated at five vehicles per day with peak deliveries of 10 vehicles per day. An additional three trucks per day would deliver pipe during construction of the pipelines.

2.7.4 Cost

Total capital costs to construct Dry Creek and Rockwell reservoirs would be about $288 million in 2005 dollars.

The estimated cost for construction of Dry Creek Reservoir and associated facilities is about $200 million in 2005 dollars. This includes $157 million for the dam and about $43 million for pipelines and a pumping station. Operation and maintenance costs for the Dry Creek Reservoir and facilities would be $1.3 million annually including $500,000 for the reservoir and $800,000 for the conveyance facilities. Average annual power costs of $314,000 are including in conveyance costs.

The construction of a 30,000 AF Rockwell Reservoir and associated facilities is estimated to cost about $88 million. This includes $53 million for dam construction, $24 million for the pipeline, and $11 million for the booster pump station. Total O&M costs for the reservoir, pipeline, and facilities are estimated at about $935,000 annually. About $207,000 of this cost is for the incremental increase in power requirements above existing pumping costs to pump water from Rockwell Reservoir to Granby Reservoir.

The total capital construction costs for this alternative would be about $288 million. Total annual O&M costs would average $2.24 million.

2.7.5 Public Access and Recreation

Public access and recreation at Dry Creek Reservoir could be similar to Alternative 2. Larimer County Parks and Open Lands may be interested in leasing the property and developing the area for nonmotorized boating, hiking, and picnicking.

There are currently no plans for recreation development or public access at the Rockwell Reservoir or the Dry Creek Reservoir site. The Subdistrict would not operate or manage recreation facilities, but would consider

leasing the area to a government agency or other entity that would take responsibility for developing and managing recreation facilities. It is assumed that an entity would be interested in managing recreation at these reservoirs and that uses would be similar to those planned for Chimney Hollow Reservoir. If no recreation management entity is found, the reservoir would be closed to public access.

2.8 Determination of Reasonably Foreseeable Actions

Several reasonably foreseeable actions are anticipated to occur in the future regardless of the implementation of any of the action alternatives or the no action alternative. Reasonably foreseeable future actions, when combined with past and present actions and the alternatives evaluated in this EIS, may result in cumulative effects. Cumulative effects are discussed in the environmental consequences section for each of the resources evaluated in Chapter 3. This section describes the process for identifying reasonably foreseeable actions, as well as those actions that were not considered reasonably foreseeable or that would not have any overlapping impacts with the WGFP.

Since the completion of the Draft EIS, several new reasonably foreseeable actions were identified. The 10825 Project, which is designed to provide 10,825 AF of water for endangered fish on the Colorado River is currently in the NEPA process and the Proposed Action includes release of 5,412.5 AF from Granby Reservoir. This future action is included in the discussion of reasonably foreseeable actions expected to occur as described below in Section 2.8.2.1. The Municipal Subdistrict and Denver Water each completed Fish and Wildlife Enhancement plans that include measures to improve aquatic habitat in the upper Colorado River basin. These plans were endorsed by the CDPW and the Colorado Water Conservation Board (CWCB) in 2011 and are included in the discussion of reasonably foreseeable actions. Denver Water also developed a Colorado River Cooperative Agreement with stakeholders on the West Slope that includes measures that would benefit streamflow and aquatic life in the upper Colorado River. This agreement is still pending approval by all parties, but components of this agreement with cumulative effects in the project area are included in the discussion of reasonably foreseeable water-based actions. The discussion of reasonably foreseeable effects associated with climate change have been updated in the FEIS to reflect new information and research results regarding potential effects on precipitation, temperature, and streamflow in the project area. In addition, the City of Colorado Springs and Reclamation completed the Green Mountain Reservoir Substitution and Power Interference Agreement in 2009. This project would have very limited impact on Colorado River flows and was dismissed from detailed consideration as described below.

2.8.1 Identifying Reasonably Foreseeable Actions

Potential future actions were identified through public and agency scoping, input from cooperating agencies and local agencies, and available data on known projects or actions under consideration. Actions that meet all of the following criteria were considered reasonably foreseeable and were included in the cumulative effects analysis:

- The action would occur within the same geographic area where effects from the alternative WGFP actions are expected to occur.
- The action would affect the same environmental resources as the WGFP alternatives and measurably contribute to the total resource impact.
- There is reasonable certainty as to the likelihood of the action occurring; the action is not speculative.
- There is sufficient information available to define the action and conduct a meaningful analysis.

2.8.2 Reasonably Foreseeable Actions

The WGFP would result in two primary types of action, one from the diversion and storage of water from the Colorado River and the second from the surface disturbance required for construction of reservoirs and associated facilities. Reasonably foreseeable effects were classified as either water-based or land-based actions that might have effects overlapping those of the WGFP. Those future actions that meet the criteria for being reasonably foreseeable are described below.

2.8.2.1 Water-Based Actions

Denver Water Moffat Collection System Project. The Moffat Collection System Project is currently proposed by Denver Water (Denver) to develop 18,000 AF/year of new annual yield to the Moffat Treatment Plant to meet future raw water demands on the East Slope. This project is anticipated to result in additional diversions, primarily from the upper Fraser River and Williams Fork River basins. Denver's proposed additional Fraser River diversions would be located upstream of the Windy Gap Project diversion site on the Colorado River and would directly affect the availability of water for the WGFP. The Moffat Collection System Project Draft EIS prepared by the Corps was released for public review in 2009. For the purpose of hydrologic modeling for the WGFP, it was assumed that Denver maximizes future diversions from the Fraser River basin. In 2005, Denver provided output from its Platte and Colorado Simulations Model (PACSM) run that includes Denver's total system demand at about 393,000 AF/year, which would be full use of its existing system including the safety factor, plus 18,000 AF of new firm yield generated by the Moffat Collection System Project. Denver's current demand is 285,000 AF/year; therefore, an increase in demand of 108,000 AF/year was considered for the cumulative effects analysis. Following completion of the hydrologic analysis for the WGFP, Denver completed their modeling for the Moffat Collection System Project EIS and considered a total system demand of 363,000 AF/year, which does not include use of the 30,000 AF/year safety factor. Thus, Denver's water use and diversions, primarily from the Blue River and to a lesser degree in the Fraser River and Williams Fork, is overstated in the cumulative effects hydrology used in the WGFP analysis.

Population Growth in Grand and Summit Counties. The population in Grand and Summit counties is expected to more than double over the next 25 years, from a year-round population of about 39,000 in 2005 to about 79,000 in 2030 (ERO and Harvey Economics 2005). Most growth in Grand County is likely to occur in the Fraser River basin upstream of the Windy Gap Project diversion site on the Colorado River. Future increases in water use in Summit County would occur primarily in the Blue River basin, a tributary to the Colorado River downstream of Windy Gap's point of diversion. Increased water use and wastewater discharges are expected to result in changes in streamflow and water quality and contribute to cumulative effects. Urban growth in Grand and Summit counties was based on build-out municipal and industrial demands of 16,168 AF for Grand County and 17,940 AF for Summit County as identified in the *Upper Colorado River Basin Study* (Hydrosphere 2003a). In 2000, water demand in Grand County was about 3,100 AF and in Summit County was about 7,700 AF. A relatively small percentage of the growth in demand in Grand and Summit counties will be consumed and deplete the Colorado River system since a significant portion of the water diverted returns to the river immediately or over the next several months. Of the water used for indoor use, approximately 90 to 95 percent returns to the river. Similarly, a significant portion of the water used for snowmaking returns to the river, whereas, a higher percentage of the water used for irrigation is consumed.

Reduction of Xcel Energy's Shoshone Power Plant Call. Denver Water and Xcel Energy have negotiated an agreement to periodically invoke a relaxation of the junior Shoshone call for hydropower generation on the Colorado River[1]. The agreement to relax the call could result in a one-turbine call of 704 cfs, which would be managed in such a way to avoid a Cameo Call by the Grand Valley Water users[2]. The Shoshone call could be increased above 704 cfs as needed to keep the Cameo water rights satisfied. The Shoshone call relaxation could be invoked if, in March, Denver predicts its total system storage will be at or below 80 percent on July 1 that year, and the March 1 Natural Resources Conservation Service (NRCS) forecast for Colorado River flows at Kremmling or Dotsero are at or below 85 percent of average. The Shoshone call relaxation could be invoked between March 14 and May 20. Denver would make available 15 percent of the "net water" stored or diverted by Denver by virtue of the call relaxation for Xcel Energy. Net water is water stored less water subsequently spilled

[1] The Shoshone Hydro Plant owned by Xcel Energy, is a large senior water right on the Colorado River 8 miles east of Glenwood Springs. At flows less than 1,250 cfs at the power plant, it is the most senior water right on the River and can "call" water from all water rights upstream of the power plant, including the Moffat Tunnel, C-BT Project, Windy Gap, and other water rights.

[2] The Cameo Call refers to a collection of senior water rights owned by five entities near Grand Junction. The water is used primarily for irrigation and power.

after filling. In addition, Denver would make available 10 percent of the net water stored or diverted by Denver by virtue of the call relaxation to West Slope entities. The West Slope beneficiaries and the timing and amount of deliveries are not specified, but would be determined by Denver and the Colorado River Water Conservation District (CRWCD). The term of this agreement is from January 1, 2007 through February 28, 2032.

Changes in Releases from Williams Fork and Wolford Mountain Reservoirs to Meet Flow Recommendations for Endangered Fish. The City and County of Denver, the CWCB and the USFWS have had an agreement to release 5,412.5 AF of water annually from Williams Fork Reservoir to provide flow in the 15-Mile Reach of the Colorado River near Grand Junction as part of the Recovery Program to benefit endangered fish. This agreement was set to expire on July 1, 2009, but was extended until 2012 to complete compliance for the 10825 Project currently being evaluated in a separate NEPA analysis by Reclamation. A similar agreement exists between the CRWCD, CWCB, and the USFWS. This agreement provides a total release of 5,412.5 AF of water annually from Wolford Mountain Reservoir. This contract expired in 2010 and was likewise extended until 2012. When the hydrologic cumulative effects analysis for the WGFP was conducted, the Water User proposal to deliver 10,825 AF to the 15 Mile Reach permanently was in the formative stages with a number of alternatives being considered that delivered water from sources downstream of the Blue River. Therefore, it was assumed that the releases for endangered fish would be made from a reservoir located downstream of Kremmling and outside the study area; however, if the 10825 Project, as currently proposed, is implemented, 5,412.5 AF of water would be delivered annually from Granby Reservoir and 5,412.5 AF would be delivered annually from Ruedi Reservoir. The 10825 Project is described further in the next paragraph and the cumulative effects are discussed in Section 3.5.3.2 of the FEIS.

10825 Project. Water providers on the East Slope and West Slope have committed to permanently supply 10,825 AF of water per year during the late summer months to assist with the recovery of endangered fish in the "15-Mile Reach" of the Colorado River near Grand Junction per the Upper Colorado River Endangered Fish Recovery Program. Previously, the 10825 water was provided on a temporary and interim basis by Denver Water (from Williams Fork Reservoir) and by the CRWCD (from Wolford Mountain Reservoir). Reclamation is currently preparing an environmental assessment to evaluate the proposed project, which includes release of 5,412.5 AF of water from Ruedi Reservoir on the Roaring Fork River and 5,412.5 AF released from Granby Reservoir to the Colorado River (Reclamation 2011a). The Proposed Action would release 5,412.5 AF of water from Granby Reservoir each year during the late summer and fall, on a schedule that would be agreed upon in the spring of each year and an additional 5,412.5 AF would be released from Ruedi Reservoir. The Granby Reservoir releases would be made possible by the dry-up of a portion of the land currently irrigated by the Redtop Valley Ditch. Also, if the schedule of releases from Granby Reservoir are not consistent with needs in the 15-Mile Reach, excess storage capacity in Green Mountain Reservoir may be used to re-time the scheduled releases from Granby Reservoir, as necessary, and to optimize benefits in the 15-Mile Reach. The WGFP hydrologic model reflects that releases of 10,825 AF would no longer be made from Williams Fork (5,412.5) and Wolford Mountain (5,412.5) reservoirs for endangered fish in the 15-Mile Reach. However, the WGFP hydrologic model does not include the 5,412.5 AF from Granby Reservoir since these data were not available in time to incorporate into the FEIS. The Granby Reservoir releases were used in the cumulative effects analysis for stream temperature modeling (Section 3.8.3.1).

Wolford Mountain Reservoir Contract Demand. The CRWCD projects that the demand for contract water out of Wolford Mountain Reservoir will increase in the future. Currently, there is about 8,750 AF/year of available contract water in Wolford Mountain Reservoir (Colorado Springs has a lease for contract water from Wolford Mountain Reservoir that reduces the firm yield of the contract pool from 10,000 to 8,750 AF/year). The CRWCD indicates that the full 8,750 AF/year will likely be contracted for by 2030. In addition, MPWCD has 3,000 AF/year of storage in Wolford Mountain Reservoir, of which 613 AF/year is owed to Denver under the Clinton Reservoir Agreement. The CRWCD indicated that the remaining 2,387 AF/year will likely be contracted for by 2030. Therefore, the total additional future demand for contract water from Wolford Mountain Reservoir is assumed to be 11,137 AF/year by 2030.

Expiration of Denver Water's Contract with Big Lake Ditch in 2013. The Big Lake Ditch is a senior irrigation right in the Williams Fork basin that diverts below Denver's Williams Fork collection system and above Williams Fork Reservoir. Big Lake Ditch diversions are currently delivered for irrigation above Williams Fork Reservoir and for use in the Reeder Creek drainage, which is a tributary of the Colorado River. Return flows associated with irrigation in the Reeder Creek drainage return to the Colorado River between the confluence with the Williams Fork River and the confluence with the Blue River.

In 1963, Denver entered into a contract with Bethel Hereford Ranch Inc., which owned and operated the Big Lake Ditch, whereby Denver purchased the Ranch's water rights. Bethel Hereford was granted a 40-year lease to continue its operation under the condition that the Big Lake Ditch water rights are not called if needed by Denver. The 1963 agreement was superseded by a 1998 agreement, which extended the operation of the Big Lake Ditch through 2013, and provided more detail on the conditions under which Denver would need the water. The 1998 agreement expires November 1, 2013 and Denver does not plan to extend the existing contract. After the contract expires in 2013, the Big Lake Ditch can no longer divert water under the enlargement decree for 111 cfs for irrigation in the Reeder Creek drainage. As a result, future Big Lake Ditch water right diversions to the Reeder Creek basin will be abandoned, which will allow Denver to capture additional water from the Williams Fork and store the water in Williams Fork Reservoir during all years that its Williams Fork Reservoir water rights are in priority.

Colorado Springs Utilities' Green Mountain Reservoir Substitution and Power Interference Agreements. Reclamation is entering into a Green Mountain Reservoir Substitution Agreement with Colorado Springs Utilities (Springs Utilities), and a Power Interference Agreement with Springs Utilities and Western. Springs Utilities is obligated to provide substitution water for diversions from the Blue River in years when Green Mountain Reservoir does not fill. Springs Utilities currently does this on an annual basis, subject to the terms and conditions of the Blue River Decree. In May and October 2003, Springs Utilities entered into MOAs, which formalized a long-term substitution plan and set forth the terms and conditions among the parties to the MOAs regarding substitution operations by Springs Utilities. The 2003 MOAs specifically approve the additional substitution water sources of Wolford Mountain and Homestake reservoirs, which are beyond the sources authorized in the Blue River Decree. A Substitution and Power Interference Agreements with Reclamation would allow Springs Utilities to comply with the Blue River Decree by approving the 2003 MOAs as Springs Utilities' substitution operation plan. Reclamation conducted an Environmental Assessment to evaluate the effects of operating under 2003 MOAs. The EA was completed in December 2008 and a Finding of No Significant Impact was issued by Reclamation.

Under the agreement, Reclamation will enter into up to a 40-year Substitution Agreement with Springs Utilities. This agreement will approve Springs Utilities' substitution plan according to the terms and conditions set forth in the 2003 MOAs. The elements of the May 2003 MOA that are specific to the agreement are the use of Wolford Mountain and Homestake reservoirs as sources of replacement water in a manner consistent with the terms and conditions of the 2003 MOAs. Another component of the agreement is a contract water exchange, whereby Springs Utilities will provide up to 250 AF stored in the Upper Blue Reservoir to the River District each year in return for a like amount of water stored in Wolford Mountain Reservoir. The 250 AF in Upper Blue Reservoir is intended for water users in the Blue River Basin including Summit County, Vail, Summit Resorts, and Breckenridge. A storage account in an amount up to 1,750 AF is maintained by the River District at Wolford Mountain Reservoir for the benefit of Springs Utilities to store Upper Blue Reservoir water exchanged into Wolford Mountain Reservoir. In addition, under the agreement, a long-term Power Interference Agreement will be formalized with Reclamation, Western, and Springs Utilities. Under the agreement, Springs Utilities will compensate for lost hydropower with power generated from their own facilities, at a time and location determined by Western. Springs Utilities reserves the right to pay Western monetarily or with power. PACSM was configured consistent with the terms and conditions of the Proposed Action.

The hydrologic effects of the agreement action would be minimal. Stream segments affected by the agreement that are within the Windy Gap Project study area include the Colorado River downstream of the confluence with Williams Fork River. Under Springs Utilities' agreement, more water will be released from Springs Utilities'

accounts in Wolford Mountain and Homestake reservoirs while Denver Water's substitution releases for Springs Utilities from Williams Fork or Dillon reservoir will decrease. During substitution years, the average monthly flow decreases for the river segment listed above will be less than 1 cfs. While this project is reasonably foreseeable, because of the minimal effects of these agreements, they were not considered in the evaluation of cumulative effects.

Windy Gap Firming Project and Moffat Collection System Project Fish and Wildlife Enhancement Plans. In addition to the Fish and Wildlife Mitigation plans developed by the Subdistrict as a component of mitigation for the WGFP and by Denver Water for the proposed Moffat Collection System Project (Moffat Project) pursuant to regulations implementing CRS 37-60-122.2(2), both the Subdistrict and Denver Water cooperatively developed separate enhancement plans to further improve existing fish and wildlife resources (Municipal Subdistrict 2011a; Denver Water 2011a). These enhancement plans are intended to improve fish and wildlife resources over and above the levels existing without the WGFP and Moffat Project. The Fish and Wildlife Mitigation plans for both projects were adopted by the Colorado Wildlife Commission on June 9, 2011 and subsequently by the CWCB on July 13, 2011 as the state's position on appropriate mitigation for the fish and wildlife impacts of the projects. The *Fish and Wildlife Mitigation Plan* for the WGFP is found in Appendix E and is discussed in the mitigation sections for applicable resources in Chapter 3 and the mitigation and environmental commitments summary described in Section 3.25. The Fish and Wildlife Enhancement plans for the WGFP and Moffat Project were endorsed by the Wildlife Commission and CWCB at the same time as the mitigation plans were adopted. The components of the enhancement plans are not intended to substitute for any mitigation required by the federal agencies for the projects. The goal of these plans is to coordinate the application of any required mitigation efforts with the voluntary and collaborative efforts of the stream enhancement projects to assure the maximum benefit for the stream environment. Key components of the enhancement plans are described below.

A primary feature of the joint Subdistrict and Denver Water enhancement plans is the Upper Colorado River Habitat Project (Habitat Project). The goal of the Habitat Project is to design and implement a stream restoration program to improve the existing aquatic environment from the Windy Gap diversion at Windy Gap Reservoir to the lower terminus of the Kemp-Breeze State Wildlife Area about 2 miles downstream from the confluence with the Williams Fork. The Subdistrict has committed $3.0 million and Denver Water has committed $1.5 million in funding for the Habitat Project. In addition, $500,000 in funds from CDPW may be available and an additional $1.5 million from the Learning By Doing cooperative effort described below. Future funding of $1.0 million from the Subdistrict and $500,000 from Denver Water would be used for adaptive management and/or maintenance in the Habitat Project area.

The Habitat Project would be implemented through separate Intergovernmental Agreements (IGAs) between Denver Water/CDPW and the Subdistrict/CDPW. Denver Water and the Subdistrict would convey the committed funding to CDPW, and CDPW would design and implement the project. CDPW would also enter into any agreements, as needed, with private landowners or other funding sources. Additionally, the Habitat Project would be managed by CDPW in collaboration with the Habitat Project Stream Team, which includes the Subdistrict, Denver Water, CDPW, Grand County, and other parties that contribute financial resources to the Habitat Project including, but not limited to, landowners. Interested parties not contributing resources include Trout Unlimited and landowners that would serve on an Advisory Team. The Habitat Project would commence when the Subdistrict and Denver Water have received acceptable Records of Decision and permits for their respective projects and as agreed to in the IGAs.

The Habitat Project would be implemented in several phases beginning with setting specific goals to promote functionality of the river system, such as specific biological goals related to the health of the aquatic ecosystem, including fish and macroinvertebrates. The Stream Team would then evaluate the most effective and sustainable restoration opportunities based on site-specific field evaluations, data from the Grand County Stream Management Plan (SMP) (Tetra Tech et al. 2010), and the specific objectives for a given reach. Funds for proposed habitat improvements would be prioritized for public and privately owned stream segments and implemented over time as designs are completed. The CDPW would be responsible for the long-term monitoring and maintenance of the stream restoration activities.

Habitat enhancement plans would be coordinated with the Learning By Doing (LBD) Cooperative Effort to ensure consistency and coordination with the overall stream enhancement efforts in Grand County. This is a cooperative, iterative, and ongoing process to maintain, and when reasonably possible, restore or enhance the stream environment in the Fraser and Williams Fork river basins, and in the mainstem of the Colorado River from the outflow of Granby Reservoir to its confluence with the Blue River. The Grand County SMP is the framework for the overall LBD Cooperative Effort. The SMP would be used as a "living" document that would be revised as additional monitoring data are gathered and as management goals for each stream reach are agreed upon. Types of restoration opportunities include channel bank revegetation, enhancing fish passage, applying enhancement flows to existing low- and/or high-flow conditions, and in-stream habitat restoration.

In addition, West Slope stakeholders and CDPW have expressed concern that the Windy Gap Reservoir has caused changes in water quality and sediment transport below the dam, which may be related to changes in populations of macroinvertebrates and mottled sculpin below the reservoir. Stakeholders also have expressed a desire for structural modifications that would allow free migration of fish around the Windy Gap dam. The Subdistrict has agreed to provide up to $250,000 to fund detailed studies of methods for bypass of flows, sediment, and/or fish around Windy Gap Reservoir. Issues to be studied include sediment transport, water quality (effects on temperature and/or nutrients), and fish passage. CDPW would direct these studies to identify potential modifications that would provide tangible benefits to aquatic resources below Windy Gap Reservoir. If studies identify significant, measurable benefits and there is consensus between the Subdistrict and other stakeholders to pursue the project, the Subdistrict would provide site access, in-kind service for design and construction of any facilities, and long-term operation and maintenance of the facility. All stakeholders would be responsible for investigation of potential sources of funding and procurement of funding for any identified improvements.

Colorado River Cooperative Agreement. As part of negotiations between West Slope parties and Denver Water, Grand County and Denver Water have reached a proposed agreement that addresses some of the issues related to Denver Water's existing operations in Grand County (Denver Water 2011c). In the Proposed Colorado River Cooperative Agreement, Denver Water has committed to the LBD Cooperative Effort and additional resource commitments, as described below, to provide environmental enhancements to benefit the aquatic environment in the Fraser, Williams Fork, and upper Colorado rivers. These commitments are contingent upon the issuance and acceptance by Denver Water of the permits necessary for construction of the Moffat Project. Resource commitments pertinent to the upper Colorado River basin with overlapping benefits in the WGFP project area that are not part of the previously described *Moffat Project Fish and Wildlife Enhancement Plan* include:

- Denver Water would provide $2 million to pay for measures to address nutrient loading in Grand County including, but not limited to, improvements to the capacity of wastewater treatment plants. If the mitigation plan required in the permitting process for the Moffat Project mandates funds for this purpose, this amount would be proportionately reduced.
- Denver Water would provide $2 million for future environmental enhancements in Grand County under the LBD Cooperative Effort.
- Denver Water would contribute up to $2 million to Grand County for the costs of pumping Windy Gap water for environmental purposes. This measure is contingent upon an agreement between Grand County and the Subdistrict to allow Windy Gap water to be pumped, under certain conditions, into Granby Reservoir for later release to the Colorado River to improve streamflow. The funding would be used to cover the cost of pumping, or at Grand County's discretion, the funding could be used in the LBD Cooperative Effort.
- Denver Water would provide 1,000 AF annually of bypass water from the Fraser Collection System for environmental purposes. This water would have the potential to enhance flows in the Colorado River.

- Denver Water would provide 1,000 AF annually of releases from Williams Fork Reservoir and 2,500 AF of carryover storage in Williams Fork Reservoir for environmental purposes. Williams Fork releases would have the potential to enhance flows in the Colorado River.

The details of the proposed agreement may change slightly as each of the 35 participant entities to the agreement conduct the approval processes required by individual ordinances, regulations, or bylaws.

Moffat Collection System Project Fish and Wildlife Mitigation Plan. Denver Water's *Fish and Wildlife Mitigation Plan* for the Moffat Project was adopted by the Colorado Wildlife Commission on June 9, 2011 and subsequently by the CWCB on July 13, 2011. The mitigation plan includes measures on the West Slope in the Fraser, Williams Fork, Blue, and Colorado river basins in addition to East Slope mitigation measures (Denver Water 2011b). Components of the mitigation plan with potential direct effects to the Colorado River below Windy Gap Reservoir include:

- Real-time river temperature monitoring on Ranch Creek near Fraser, Colorado and on the Fraser River near Tabernash, Colorado to determine when stream temperature exceeds designated thresholds. Thus, when stream temperature standards (21.2°C Daily Maximum and 17.0°C Maximum Weekly Average) are exceeded between July 15 and August 31, Denver Water will forego up to 250 AF of diversions from its Fraser River Collection System by releasing up to 4 cfs per day. These releases have the potential to improve flows in the Colorado River downstream from the Fraser River confluence.
- In cooperation with the Subdistrict, two continuous real-time temperature monitoring stations will be located on the Colorado River at the Windy Gap stream gage and upstream of the Williams Fork River confluence. When specified temperature values (23.8°C Daily Maximum and 18.2°C Maximum Weekly Average) are exceeded between July 15 and August 31, Denver Water will forego up to 250 AF of diversions from its Fraser River Collection System by releasing up to 4 cfs per day. This would supplement the curtailed diversions by the Subdistrict when temperature standards are exceeded as described in their *Fish and Wildlife Mitigation Plan* (Municipal Subdistrict 2011b) in Chapter 3.

Climate Change. Climate change refers to a long-term significant change in climatic conditions, such as mean temperature, precipitation, seasonality, and storm frequency. A number of reports and studies by the U.S. Climate Change Science Program, the National Academy of Sciences, and the United Nations Intergovernmental Panel on Climate Change (IPCC) have concluded that climate is changing primarily as a result of increased greenhouse gas emissions. It is difficult to determine at this time whether such emissions will accelerate or decrease in the coming decades. Although climate change is a global event, it can manifest differently depending on regional and local factors. While some effects of climate change have been documented and others are likely to occur, many potential impacts are currently unknown. Climate change research is constantly evolving, and new information is being collected and published to help better understand the implications.

A number of complex computer-based climate models are used to project potential climate change and its effects. These global circulation models (GCMs) use enormous amounts of data about the earth's atmosphere, ocean, and land masses to project possible changes in temperature, precipitation, seasonal shifts in climate, and other parameters. The magnitude and trends of climate change have been the subject of numerous studies based on a variety of global and regional models that attempt to project future climate change. Methods to downscale global projections to local or regional scales are still being developed.

In 2008 the CWCB embarked on a study to identify future water availability in the Colorado River basin based on anticipated climate change projected by a number of GCMs and to downscale that information to the Colorado River basin in Colorado. In 2010 the CWCB published the *Colorado River Water Availability Study* (CWCB 2010), which used information from five GCMs to evaluate potential precipitation and temperature changes in the Colorado River basin. The results were used to project potential flow changes at various points in the Colorado River basin including the Colorado River near Grand Lake. As noted in this study, assumptions underlying the application of GCMs to the regional level include: "1) the inherent uncertainties in the available global climate models in projecting the magnitude and nature of future greenhouse gas emissions; 2) the complexity of modeling

atmospheric circulation; and 3) down-scaling the resulting effects of changed temperature and precipitation on natural flows in an area the size of the Colorado River basin." It can be problematic for GCMs to accurately account for the complex mountainous regions of Colorado with their varying topography, elevation, and snow cover, and GCMs require downscaling to better represent such regional conditions (Western Water Assessment 2008).

Climate change is a growing science with data gaps that need to be addressed to better understand and use climatic data for water resource planning and management (Corps and Reclamation 2011). Information on the strengths and weaknesses of downscaled data and the methodologies used to develop these data is one of the high priority data gaps (Id.).

The potential for climate change globally, as well as in the upper Colorado River basin where Windy Gap diversions are located, has been identified in a variety of studies. The IPCC (2007) has determined that regional changes in temperature and precipitation have occurred and are likely to continue in the future. Climatic changes have the potential to impact available water resources, flood risk, health, agriculture, and aquatic ecosystems (Bates et al. 2008).

Climate models project global temperature increases from 1°C to 2°C in the next 20 to 60 years, with greater consensus over the next 20 years and greater uncertainty in the 40-year projections (Reclamation 2007). Historical data indicate that the north-central mountains of Colorado have warmed about 1.4°C over the last 50 years (Western Water Assessment 2008). Similar results from the National Research Council (2007) found that there has been an approximate 1.6°C increase in the 11-year running mean temperature for the entire Colorado River basin from 1895 to 2005. Regional climate change, based on the results of 112 model projections for Colorado, indicate average annual warming in the state ranging from 1.4°C to 3.1°C by 2050 (Western Water Assessment 2008). Temperature projections for 2040 near Grand Lake indicate an average annual temperature increase of 1.8°C within a range of temperature increases from 0.9°C to 2.8°C (CWCB 2010). The temperature increase is projected to be about the same 1.8°C for each month of the year.

Climate model projections of changes in precipitation near Grand Lake show an increase in 2040 average winter precipitation (November to May) of 113 percent of historical precipitation values (1950–2005) (CWCB 2010). Model projections for the winter ranged from increases of 109 to 122 percent of historical values. Summer precipitation (April to October) for 2040 near Grand Lake was projected to average 92 percent of historical values with model predictions ranging from 82 to 104 percent of historical values. Model projections from the Western Water Assessment (2008) found similar results with increased winter precipitation and lower summer precipitation, although little overall change in annual precipitation was projected for the region between Granby and Steamboat Springs by 2050. Other studies have indicated a high degree of variability in precipitation over Colorado (University of Colorado 2008) and in the Colorado River basin (NRC 2007) with no long-term trends evident.

Climate models also can be used to project changes in streamflow. The Western Water Assessment (2008) indicates an average decline in runoff of 6 to 20 percent by 2050 from the entire upper Colorado River basin although projections are for slightly more precipitation in higher elevations and lower precipitation totals in lower elevations. CWCB (2010) projects that average annual flows in the Colorado River near Grand Lake in 2040 would increase by about 5 percent compared to historical conditions (CWCB 2010). The greatest range in potential changes to flow near Grand Lake would occur in April and May, and peak flow is expected to occur earlier than historic conditions. The Colorado River basin upstream of Windy Gap is at higher elevations, and projections are that peak runoff would be up to a month earlier than historical flows. In April and May flows would be substantially higher than historical averages, while flows from July through September would be substantially lower that historic averages. Although no significant trend in the historic volume of runoff in the Colorado River basin has been detected, studies indicate peak runoff in the western U.S. and Colorado Rocky Mountains is occurring earlier in the spring due to warming temperatures (Western Water Assessment 2008) and is likely to peak in May rather than June as currently occurs.

Reclamation has initiated and participated in climate change studies throughout the western United States (Reclamation 2010, 2011b, 2011c). Many of these investigations developed climate change and water supply projections for large river basins (such as the Colorado River basin) and for smaller subbasins. In response to the SECURE Water Act in the Omnibus Public Land Management (2009), Reclamation (2011b) reported to Congress on anticipated changes to climate and its potential effect on water supply in eight major river basins where Reclamation operates water supply and delivery facilities. This study focused on potential effects of climate change over entire watersheds and is too broad for use for smaller basins at headwater locations such as Grand County. The gage and reporting location closest to Grand County and used in this report is at Cameo.

As a separate component of the SECURE Water Act, Reclamation (2011c) is currently conducting a "basin study" for the Colorado River basin. This study focuses on projected water supply and demands in the basin with an emphasis on likely changes to climate and flow and how they may affect deliveries from the upper to the lower basin.

Reclamation considered these studies, among others, and chose to use information from the CWCB report (2010) because it projects climatic changes on a more appropriate scale to the area being studied for the WGFP. The methodologies used in the CWCB report (2010) to develop climate and flow projections are based on those used by Reclamation in the 2011 SECURE Water Act reports. The CWCB report (2010) focused on potential climate and flow changes in a number of smaller basins and subbasins in Colorado, including the Colorado River basin. Reclamation believes, as a matter of scale, the CWCB report (2010) provides a more appropriate level of analysis than either Reclamation report because rather than the entire Colorado River basin, it considers a much smaller headwater subbasin where the proposed WGFP is located.

Although differences in climate model results demonstrate the uncertainty in projecting future climate conditions, the anticipated effects of warmer temperatures in the Colorado River basin upstream of Windy Gap, as identified by the CWCB (2010), include:

- Average annual runoff increases by about 5 percent;
- Average year-round temperature increase of about 1.8°C;
- Peak runoff in May rather than June as currently happens;
- Higher than current average runoff in April and May;
- Lower than current average runoff in the late summer-fall months;
- Decreased baseflow from ground water in late summer;
- Reduced soil moisture in summer and longer growing seasons extended by an estimated 18 days split equally between the spring and fall;
- A shift from snow to rain in the early and late winter months due to increased temperatures; and
- Greater loss of water by evapotranspiration.

Climate change may affect the timing and operation of the WGFP, as well as the water supply and demand for WGFP Participants. Potential environmental impacts from climate change, as described above, are qualitatively assessed as part of the cumulative effects evaluation for applicable resources such as surface water hydrology, ground water, stream morphology and floodplains, surface water quality, aquatic resources, vegetation, wetlands and other waters, threatened and endangered species, and recreation.

Mountain Pine Beetle Killed Trees. Severe mountain pine beetle infestation in Grand County and other parts of Colorado are significantly impacting the lodgepole pine forest. Many trees have been killed and remaining large trees are likely to die in the near future. The loss of these trees has several implications in the upper Colorado River watershed within the project area depending on harvest activities, the composition and age class of the forest, understory response, forest fire, and other factors. An April 2010 symposium on the hydrologic and water quality impacts of pine beetle infestation identified several potential effects on water yield and the timing of peak

runoff, which varies over time with the cycle of decay and regrowth (Western Water Assessment 2010). Several of the key observations from initial research on runoff and peak flow indicate:

- There is no compelling evidence yet for runoff changes *caused by the current mountain pine beetle infestation*.
- A change in runoff timing to earlier runoff peaks is more likely to occur

A complex array of snowpack process, including changes in canopy interception, sublimation, reflection, radiation, and wind speed are influenced by changes in forest cover and regrowth. Transpiration from forest stands also changes as understory trees, shrubs, and herbaceous cover replace the overstory forest. Harvesting of mountain pine beetle killed trees that results in soil disturbance and compaction can result in increased runoff (Rhoades 2010).

Potential changes in stream water quality from pine beetle infestation are also an issue of concern. Recent studies, as summarized from the Intermountain West Climate Summary (Western Water Assessment 2010), indicate:

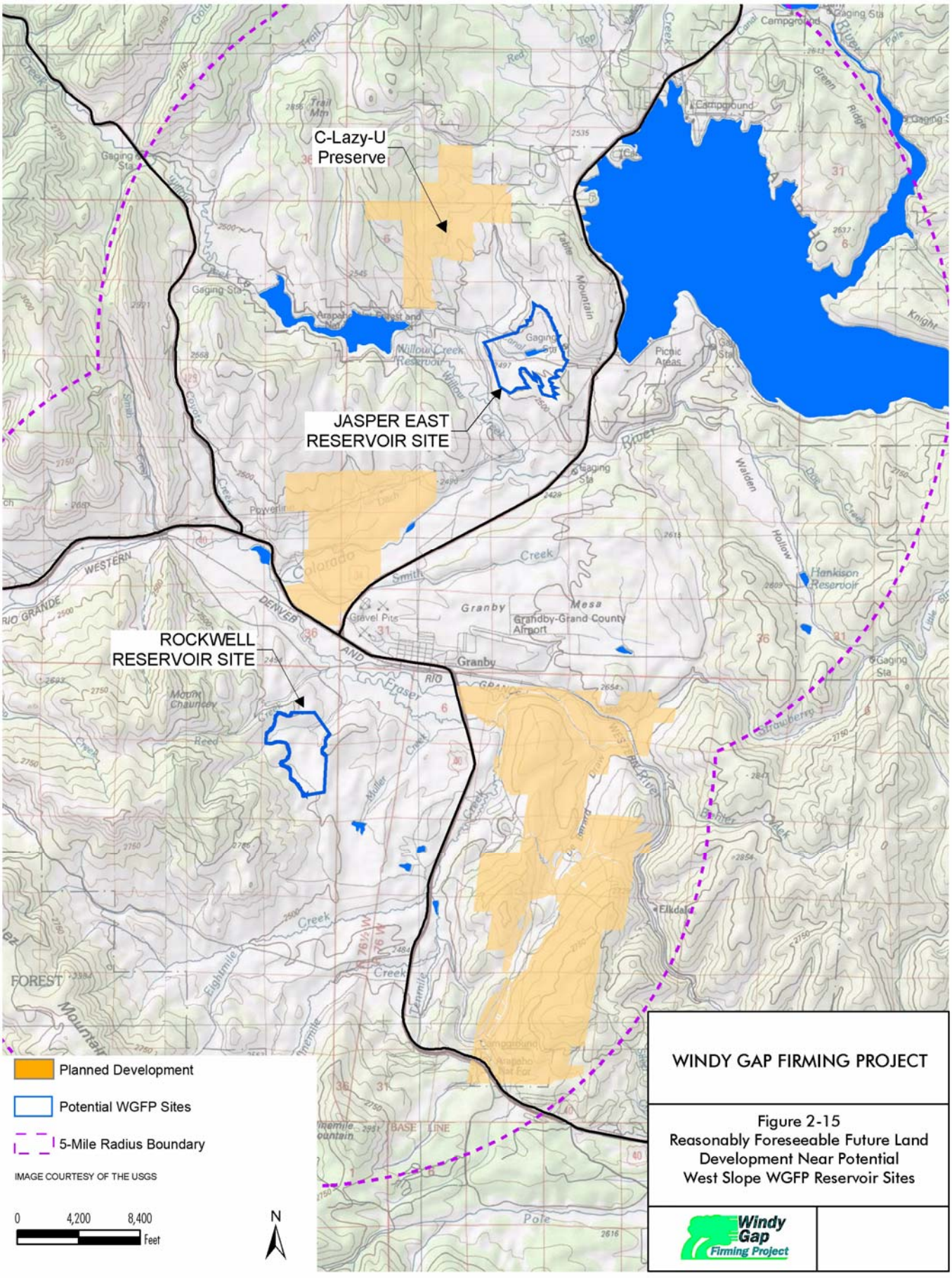
- Mountain pine beetle infestation does not indicate nutrient loading or other water chemistry changes of the magnitude that would present problems for either human water use or aquatic ecosystems.

In general, study results have indicated that nitrogen levels have increased in the soils from decay of wood and foliage after tree death, but the export of nitrogen to streams has been low. Carbon levels in soils and streams have increased following infestation. Phosphorus and magnesium levels in streams have increased according to several studies (Clow 2010; McCutchan 2010). An increase stream temperature has been observed where lodgepole pine forests along riparian areas have been killed by beetles (Stednick 2010). The potential for wildfire may increase in pine beetle damaged forests, which could result in increased runoff along with sediment, nutrient, and temperature increases in the Colorado River basin.

Watershed impacts from pine beetle killed trees or possible fires would impact the watershed in a similar manner under all of the alternatives. Changes in runoff over the long-term are likely to be minimal, but earlier peak flows are possible in the short-term until a new forest canopy is established. A slight increase in phosphorus and carbon loadings is possible in beetle infested watersheds. Because the hydrologic and water quality implications of pine beetle killed trees would be somewhat similar for all alternatives and are likely to be minor with the possible exception of wildfire, a quantitative analysis of the range of potential effects of this reasonably foreseeable action was not conducted in the EIS. Mitigation measures to reduce nutrient loadings from conveyance of Windy Gap water to the Three Lakes would minimize any cumulative effect of nutrient loadings associated with runoff from lands with pine beetle-killed trees.

2.8.2.2 Land-Based Actions

Land Development. A variety of new land developments are expected to occur in the vicinity of the potential WGFP reservoir sites in Larimer and Grand counties. Land use changes or developments within about 5 miles of the Jasper East and Rockwell Reservoir site were identified to provide a context for assessing potential local cumulative effects of multiple land disturbances. Near Jasper East, this includes about 1,590 acres of planned residential and commercial development southwest of the Town of Granby and about 980 acres of planned residential development at C-Lazy-U Preserves located north of the reservoir site (Hale, pers. comm. 2005; Campbell, pers. comm. 2006) (Figure 2-15). Near the Rockwell Reservoir site, about 4,770 acres of residential, commercial, and mixed development would occur in the Granby Ranch area.



WINDY GAP FIRMING PROJECT

Figure 2-15
Reasonably Foreseeable Future Land Development Near Potential West Slope WGFP Reservoir Sites

Windy Gap Firming Project

Western is proposing to replace portions of the existing Granby Pumping Plant to the Windy Gap Transmission Line (Western 2008). The transmission line runs between the Windy Gap Substation located northwest of Windy Gap Reservoir and the Granby Pumping Plant on the north side of Granby Reservoir. The purpose of the project is to increase power reliability and quality of electrical service to residents in Grand County and other users in the region. The proposed transmission line replacement is an independent project and is not related to the WGFP. Several transmission line alternatives are under consideration as part of an ongoing EIS. The transmission line could be rebuilt in the right-of-way of the existing line or a new route could be selected. Vertical steel monopoles would be used for the new line rather than the existing wooden H-frame poles.

On the East Slope, several land developments are planned near potential reservoir sites. As of June 2007, about 1,440 acres of land located within about 5 miles of Chimney Hollow and 1,460 acres of land within about 5 miles of Dry Creek Reservoir were under county development review for subdivision, dispersed residential development, commercial development, and/or special review for a proposed change in land use (Larimer County 2007) (Figure 2-16).

Larimer County Open Space. Larimer County Parks and Open Lands acquired about 1,800 acres of land adjacent to the proposed Chimney Hollow Reservoir site. The County intends to manage this property for recreation use in the future regardless of whether Chimney Hollow Reservoir is constructed.

Population Growth and in the Northern Front Range. Continued population growth and urban development is expected to occur in the northern Front Range Colorado communities served by many of the Firming Project Participants regardless of the proposed WGFP.

2.8.3 Actions Not Considered Reasonably Foreseeable

For purposes of evaluating the cumulative effects of the WGFP, a number of other potential actions that could occur in the future, but that were not considered reasonably foreseeable were identified. A brief summary of potential actions on the West and East Slope and the reasons why they are not reasonably foreseeable are listed in Table 2-4. Although some of these actions are not currently considered reasonably foreseeable, they could occur at some point in the future; however, based on the best available information, these actions did not meet the criteria for reasonably foreseeable actions. Also discussed are several actions that are part of the existing conditions and thus are not considered as reasonably foreseeable actions. The reasons that growth-related impacts are not evaluated as part of cumulative effects are also included in Table 2-4.

2.9 Identification of Reclamation's Preferred Alternative

Alternative 2, construction of Chimney Hollow Reservoir with prepositioning, along with associated operational changes developed as part of mitigation, is the Bureau of Reclamation's preferred alternative.

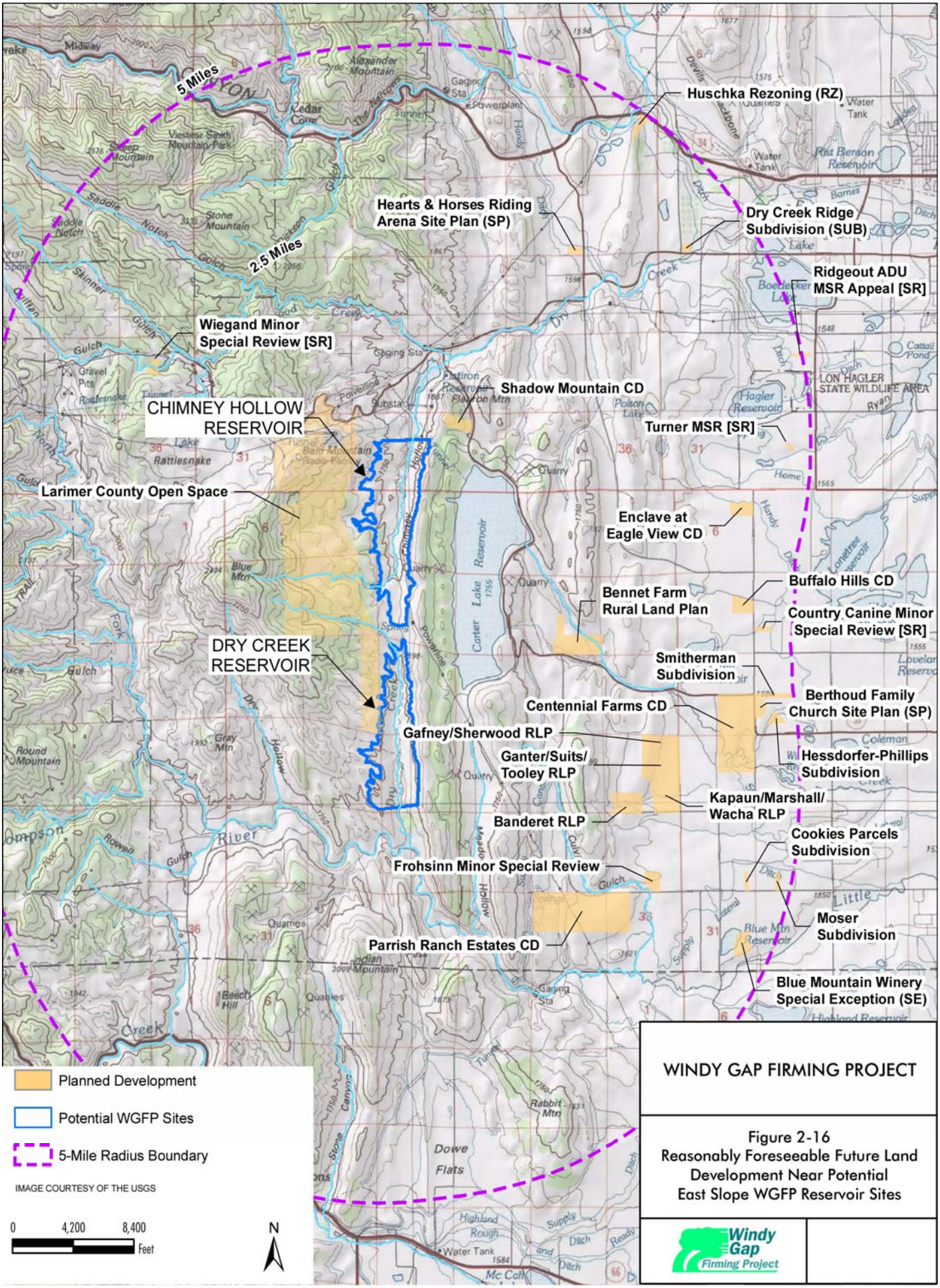
2.10 Summary

2.10.1 Comparison of Alternative Features

Table 2-5 provides a summary comparing the major features associated with each of the four action alternatives.

2.10.2 Comparison of Alternative Impacts

Table 2-6 summarizes the direct and indirect resource effects of the alternatives. Table 2-7 summarizes the cumulative resource effects of the alternatives.



WINDY GAP FIRMING PROJECT

Figure 2-16
Reasonably Foreseeable Future Land Development Near Potential East Slope WGFP Reservoir Sites

Windy Gap Firming Project

Table 2-4. Actions not considered reasonably foreseeable.

Action — Sponsor	Location	Type of Action	Description/Potential Effect	Reasons why Actions is Not Reasonably Foreseeable
West Slope				
Reduction in USFS Bypass Flows — Denver Water	Fraser River Basin	Water-based	Denver Water has an agreement with the U.S. Forest Service for bypass flows on several streams. During drought conditions, bypass flows can be reduced under an existing emergency clause, which can reduce flows in the Fraser and Colorado Rivers.	This agreement is currently in place and is included in the hydrologic modeling for the WGFP to the extent that it has occurred in the past. This is an ongoing action reflected in existing conditions. No new agreements are pending that are reasonably likely to occur in the future.
Wolcott Reservoir — Cooperative agreement among West and East Slope entities, including, Aurora, CRWCD, Denver, Water, NCWCD, Eagle River Water and Sanitation District, Upper Eagle Regional Water Authority, and Vail Associates	Eagle County	Water-based	Construction of Wolcott Reservoir on Alkali Creek, a tributary to the Eagle River was considered to serve several purposes including meeting release requirements for endangered fish species in the lower Colorado River per the Final Programmatic Biological Opinion, water supply storage for West Slope water users, facilitation of trans-mountain exchanges, and enhancing environmental conditions in the Eagle and Colorado Rivers. If implemented, this project would replace current releases from Williams Fork Reservoir and Wolford Mountain Reservoir and reduce flows in the Colorado River below these facilities.	The proposed 10825 Project is currently being evaluated to provide flow releases from Granby Reservoir and Ruedi Reservoir for endangered fish. Thus, Wolcott Reservoir is not currently being considered as an option for this purpose. Development of the reservoir for other purposes in the future is possible, but no definitive plans or federal NEPA action has been initiated. The cumulative effects hydrologic analysis for the EIS assumed that releases from Williams Fork Reservoir and Wolford Mountain Reservoir would not continue.
Sulphur Gulch Reservoir — Northern Colorado Water Conservancy District, Municipal Subdistrict, Northern Colorado Water Conservancy District, and Denver Water	Mesa County	Water-based	Sulphur Gulch is a potential site for construction of a 16,000 AF reservoir. Similar to Wolcott Reservoir, this site has been preliminarily studied as a possible location for storing water pumped from the Colorado River that could be used to provide releases for the East Slope's portion of the 10,825 AF of water required under the Final Programmatic Biological Opinion. The potential effect to Colorado River streamflow would be similar to a Wolcott Reservoir.	The proposed 10825 Project is currently being evaluated to provide flow releases from Granby Reservoir and Ruedi Reservoir for endangered fish. Thus, Sulphur Gulch Reservoir is not currently being considered as an option for this purpose. Development of the reservoir for other purposes in the future is possible, but no definitive plans or federal NEPA action has been initiated.
Webster Hill Reservoir — West Anvil Water and Power Company	Garfield County	Water-based	This project includes a potential 20,000 AF reservoir on the Colorado River below the Roaring Fork River that would provide flows for endangered fish similar to the Sulphur Gulch Reservoir with effects on Colorado River flow similar to Wolcott or Sulphur Gulch reservoirs.	The proposed 10825 Project is currently being evaluated to provide flow releases from Granby Reservoir and Ruedi Reservoir for endangered fish. Thus, Webster Hill Reservoir is not currently being considered as an option for this purpose. Development of the reservoir for other purposes in the future is possible, but no definitive plans or federal NEPA action has been initiated.

Action — Sponsor	Location	Type of Action	Description/Potential Effect	Reasons why Actions is Not Reasonably Foreseeable
Changes in Blue River Operations — Reclamation	Summit County	Water-based	When the WGFP EIS process began in 2003, Reclamation was about to be involved in litigation initiated by several West Slope entities over operation of Green Mountain Reservoir and operational limitations associated with the Heeney slide at the reservoir. At that time the outcome of the litigation was unknown but it was anticipated that any settlement could result in changes in Green Mountain operation that could affect operation of Williams Fork Reservoir, Wolford Mountain Reservoir, Granby Reservoir, and consequently flow in the Colorado River. In December 2005 Reclamation settled the litigation when an agreement among the plaintiffs and defendants was signed. The settlement involves a sharing of shortages between the C-BT and western slope interests when the shortage is due to an operational limitation on Green Mountain Reservoir. If shortages are due to hydrologic conditions they are not shared.	It is anticipated that the settlement agreement will result in minimal changes to operations of Green Mountain Reservoir and flows in the Blue River on an infrequent basis.
Denver Water Cooperative Projects — Denver Water	East Slope	Water-based	Denver Water may evaluate future water supply projects with other entities that could potentially use portions of Denver Water rights or infrastructure. Some of these projects could potentially affect flows in the upper Colorado River.	Denver Water currently has no arrangements pending with entities outside of its Combined Service Area. Potential cooperative projects are not well defined at this time and any assumptions on the nature of the projects and cumulative impacts with the WGFP would be speculative.
Wolford Mountain Reservoir Expansion — Colorado River Water Conservation District	Grand County	Water-based	Preliminary evaluations have indicated the potential to raise the existing Wolford Mountain Reservoir spillway and create 5,000 to 7,500 AF of additional storage. Increased storage in Wolford Mountain could change the timing or release of flows to Muddy Creek and the Colorado River.	The benefits and availability of water for this project are still under evaluation and no decision has been made to pursue this project. Any assumptions on the development of this project are speculative at this time.
Fraser Valley Water Supply — Multiple Grand County water users	Grand County	Water-based	The Upper Colorado River study (UPCO) Management Team sponsored a preliminary evaluation of structural alternatives to help meet projected water needs in Grand County. Several potential reservoir sites and related facilities in Grand County were identified. New storage in the Fraser River Basin could affect flows in the Fraser River and Colorado River.	The potential location, size, operation, and feasibility of new water storage facilities in Grand County are unknown at this time. Insufficient information is available for any meaningful analysis of a project's contribution to cumulative effects.

Action — Sponsor	Location	Type of Action	Description/Potential Effect	Reasons why Actions is Not Reasonably Foreseeable
Eagle River Project — Aurora, Colorado Springs, Vail, Vail Associates, CRWCD	Eagle County	Water-based	East Slope and West Slope entities have explored opportunities for developing storage for Homestake II water rights in the Eagle River Basin, including additional Eagle River diversions and pumping using existing reservoirs. Water development in the Eagle River could affect flows in the Colorado River.	Potential options to develop these water rights have been discussed for a number of years, but there are no immediate plans for implementation of a project. Any assumptions on the development of this project are speculative at this time
Future Development of West Slope Water Rights — Multiple Municipalities	Grand Junction, Eagle, Pitkin, and Garfield Counties	Water-based	Increased municipal and industrial water use associated with population growth could affect flows in the Colorado River.	Future growth and development in communities within the Colorado River Basin are possible, but the effect of any additional water uses this far downstream from the WGFP are not likely to measurably contribute the cumulative effects analysis.
Oil Shale Development — Shell Oil and others	Rio Blanca	Oil development with water needs	Development of oil shale could require a substantial volume of water for production that would require diversion and storage of additional water sources in the Colorado River basin. Exercise of conditional oil shale water rights that are senior to Windy Gap are unlikely to directly impact Windy Gap diversions that are already called downstream by the Shoshone Power Plant.	The economic and technical feasibility of oil shale production is currently being studied. It is not known specifically what the future water requirements would be.
East Slope				
Northern Integrated Supply Project (NISP) — NCWCD and 17 Municipal Participants	Larimer and Weld Counties	Water-based	The Northern Colorado Water Conservancy District, representing 12 municipalities and water districts, is proposing to develop reservoir storage to provide additional water supplies. The Corps, as the lead agency, released a Draft EIS in April 2008 evaluating potential alternatives including diversion of water from the Cache la Poudre River for storage in Glade Reservoir north of Fort Collins and diversions from the South Platte River to Galeton Reservoir, as well as other storage options. This project would primarily affect flows in the Cache la Poudre and South Platte rivers.	Information on sources of water and storage locations for NISP indicates that this project would have little or no interaction or overlap with the area of potential effect for the WGFP. Planned NISP diversions from the Cache la Poudre River or South Platte River would not affect operation of the WGFP or vice versa.

Action — Sponsor	Location	Type of Action	Description/Potential Effect	Reasons why Actions is Not Reasonably Foreseeable
Halligan-Seaman Reservoir Expansion — Fort Collins, Greeley, and Others	Larimer County	Water-based	This project proposes the enlargement of Halligan and Seaman Reservoirs on the North Fork of the Cache la Poudre River to expand storage capacity to meet municipal water needs, improve water management efficiency, and provide drought protection. The Corps of Engineers is the lead agency conducting the NEPA evaluation for this project. This project would affect flows in the North Fork of the Cache la Poudre and the mainstem of the Cache la Poudre River.	Information on currently identified sources of water and storage locations for the Halligan-Seaman Project indicate that this project would have little or no interaction or overlap with the area of potential effect for the WGFP. Planned Halligan-Seaman diversions from the North Fork of the Cache la Poudre River and the Cache la Poudre River would not affect operation of the WGFP or vice versa.
Union Creek Reservoir — City of Longmont	Boulder County	Water-based	The City of Longmont has investigated the potential for enlargement of Union Creek Reservoir to improve the City's water storage capacity.	The City of Longmont may enlarge Union Creek Reservoir in the future. The potential reservoir sizing and operations are not known and would be speculative to consider for the cumulative effects analysis.
Firming Remaining Windy Gap Project Units Not Included in Firming Project — Municipal Subdistrict, NCWCD	East and West Slope	Water-based	The proposed WGFP would not firm all of the units of Windy Gap water. The units not included in the Firming Project include those owned by Estes Park and Boulder. In addition, several WGFP Participants are not firming all of their units in the proposed Firming Project and may firm these units in a future project. Firming remaining Windy Gap units would increase Colorado River diversions and could require additional storage.	Entities that own Windy Gap units not included in the Firming Project may decide to improve the firm yield of these units through storage development or other projects in the future. At the time of the EIS, no specific projects have been identified to firm the yield of those units not included in the proposed Firming Project. Assumptions on the potential actions and the effects in combination with the WGFP are speculative
Miscellaneous Water Right Purchases, Transfers, and Exchanges — Various Entities	East Slope	Water-based	At any given time, a variety of water-related transactions are occurring, including conversion of agricultural water rights to municipal use, changes in points of diversion, sales of C-BT Project water, ditch shares, or other water rights. Specific effects to streams from future water use on the East Slope are unknown.	It is difficult to predict with any certainty what transactions may occur in the future. Assumptions on the potential actions and effects in combination with the WGFP are speculative.

Action — Sponsor	Location	Type of Action	Description/Potential Effect	Reasons why Actions is Not Reasonably Foreseeable
Population Growth in Service Areas of WGFP Participants — Project Participants	East and West Slope	Land development with water demands	As described in Sections 1.6 and 1.7, municipal Project Participants anticipate future population growth within their service areas, which will have environmental effects to various resources from land development and construction.	The rate of future population growth, population density increases, land use changes, and construction within the service areas of Project Participants is likely to remain the same regardless of approval of the WGFP. If water from the WGFP is not available, Project Participants will implement alternative water supplies to meet future demands. Thus, there are no incremental impacts from the WGFP in the service areas of the Project Participants. Because there are no impacts from the WGFP in the geographical area of the project, there are no cumulative effects to evaluate.

Table 2-5. Comparison of action alternative features.

Alternative Feature	Alternative 2 Chimney Hollow (Proposed Action)	Alternative 3 Chimney Hollow/Jasper East		Alternative 4 Chimney Hollow/Rockwell		Alternative 5 Dry Creek/Rockwell	
	Chimney Hollow	Chimney Hollow	Jasper East	Chimney Hollow	Rockwell	Dry Creek	Rockwell
Storage capacity (AF)	90,000	70,000	20,000	70,000	20,000	60,000	30,000
Reservoir footprint (acres)	742	627	434	627	294	589	348
Dam(s) and spillway (acres)	56	47	51	47	41	42	78
Total area (acres)	798	674	485	674	335	631	426
Total combined area (acres)	**798**	**1,159**		**1,009**		**1,057**	
Conveyance	New 1.2-mile pipeline connection with C-BT facilities	New 1.2-mile pipeline connection with C-BT facilities	New 0.9-mile pipeline connection to existing Windy Gap Pipeline	New 1.2-mile pipeline connection with C-BT facilities	New 3.3-mile pipeline connection to Windy Gap Pipeline	New 3.4-mile pipeline connection with C-BT and 0.5-mile pipeline turnout to Flatiron Reservoir; new 2.1-mile pipeline from Dry Creek Reservoir to Carter Lake	New 3.3-mile pipeline connection to Windy Gap Pipeline
Facility relocation	Relocation of about 3.8 miles of transmission line	Relocation of about 3.8 miles of transmission line	Relocation of Willow Creek Canal and Pump Station	Relocation of about 3.8 miles of transmission line	—	—	—
Roads	New 1.5-mile permanent reservoir access road. Construction and maintenance access road	New 1.5-mile permanent reservoir access road. Construction and maintenance access road	Relocation of about 2.4 miles of CR 40	New 1.5-mile permanent reservoir access road. Construction and maintenance access road	Relocation of 0.3 miles of CR 56. New construction and maintenance access road	Construction and maintenance access roads, with several potential options	Relocation of 0.5 miles of CR 56. New construction and maintenance access road
Borrow areas	In reservoir footprint	In reservoir footprint	Off-site 25-acre borrow area	In reservoir footprint	Off-site 56-acre borrow area	In reservoir footprint	Off-site 56-acre borrow area

Alternative Feature	Alternative 2 Chimney Hollow (Proposed Action)	Alternative 3 Chimney Hollow/Jasper East		Alternative 4 Chimney Hollow/Rockwell		Alternative 5 Dry Creek/Rockwell	
	Chimney Hollow	**Chimney Hollow**	**Jasper East**	**Chimney Hollow**	**Rockwell**	**Dry Creek**	**Rockwell**
Recreation	Larimer County would manage the reservoir site as open space	Larimer County would manage the reservoir site as open space	Recreation use is possible, but managing entity unknown	Larimer County would manage the reservoir site as open space	Recreation use is possible, but managing entity unknown	Similar recreation use as Chimney Hollow is possible, but managing entity unknown	Recreation use is possible, but managing entity unknown
CONSTRUCTION COST (in 2005 dollars)							
Dam and Reservoir	$208,600,000*	$165,200,000*	$31,100,000	$165,200,000*	$37,400,000	$157,000,000	$53,200,000
Conveyance	$14,800,000	$14,800,000	$29,000,000**	$14,800,000	$35,000,000	$42,500,000	$35,000,000
Total Capital Cost	$223,400,000	$180,000000	$60,100,000	$180,000000	$72,400,000	$199,500,000	$88,200,000
Total Alt. Cost	**$223,400,000**	**$240,100,000**		**$252,400,000**		**$287,700,000**	
ANNUAL OPERATION AND MAINTENANCE COST (in 2005 dollars)							
Dam and Reservoir	$500,000	$500,000	$250,000	$500,000	$250,000	$500,000	$250,000
Conveyance	$295,000	$295,000	$167,000	$295,000	$478,000	$495,000	$478,000
Power	—	—	$162,000	—	$207,000	$314,000	$207,000
Total O&M Cost	$795,000	$795,000	$579,000	$795,000	$935,000	$1,309,000	$935,000
Total Alt. O&M Cost	**$795,000**	**$1,375,000**		**$1,730,000**		**$2,240,000**	

*This includes the estimated cost of $4.5 million for relocation of Western's transmission line at Chimney Hollow Reservoir.

**Cost includes $15 million to relocate the Willow Creek Pump Station and Canal.

Table 2-6. Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
[ALTERNATIVE IMPACTS ARE BASED ON A COMPARISON WITH EXISTING CONDITIONS]	Enlargement of Ralph Price Reservoir by 13,000 AF for storage of the City of Longmont's Windy Gap water	A 90,000 AF Chimney Hollow Reservoir with prepositioning to allow storage of C-BT water in Chimney Hollow	A 70,000 AF Chimney Hollow Reservoir and a 20,000 AF Jasper East Reservoir	A 70,000 AF Chimney Hollow Reservoir and a 20,000 AF Rockwell Reservoir	A 60,000 AF Dry Creek Reservoir and a 30,000 AF Rockwell Reservoir
SURFACE WATER HYDROLOGY					
West Slope					
**WG diversions (avg. existing conditions=36,532 AF)*					
*WG diversions (avg. annual)	43,573 AF	46,084 AF	48,052 AF	47,997 AF	48,483 AF
*WG diversions (avg. annual wet year)	63,870 AF	73,923 AF	78,940 AF	78,775 AF	77,543 AF
*WG diversions (avg. annual dry year)	Same as existing conditions	Same as existing conditions	Same as existing conditions	Same as existing conditions	Same as existing conditions
Avg. annual decrease in Colo. R. flow blw. WG Res.	8%	14%	14%	14%	14%
Avg. annual decrease in Colo. R. flow blw. Blue R.	2%	3%	3%	3%	3%
Avg. annual reduction in Willow Creek flow	7%	14%	12%	12%	12%
Change in Grand L./Shadow Mountain Res. storage	None	None	None	None	None
Average monthly decrease in Granby Res. storage	3 to 5%	7 to 13%	4 to 6%	4 to 6%	4 to 6%
East Slope					
Big Thompson R. at L. Estes (avg. mo. flow increase)	0 to 1%	1 to 9%	0 to 4%	0 to 4%	0 to 5%
Big Thompson R. at Loveland (max. mo. increase)	0 to 9.8 cfs	0 to 5.1 cfs	0 to 5.1 cfs	0 to 5.1 cfs	0 to 5.1 cfs
North St. Vrain Crk. (avg. monthly flow change)	-45 cfs to +18 cfs	No change	No change	No change	No change
St. Vrain Crk. at Longmont. (max. mo. flow increase)	0.8 to 11.3 cfs	0.5 to 6.4 cfs	0.5 to 6.4 cfs	0.5 to 6.4 cfs	0.5 to 6.4 cfs
Big Dry Crk. at Broomfield (max. mo. flow increase)	3.4 to 8.5 cfs	3.4 to 8.5 cfs	3.4 to 8.5 cfs	3.4 to 8.5 cfs	3.4 to 8.5 cfs
Coal Creek (max. mo. flow increase)	3.2 to 3.4 cfs	3.3 to 4.0 cfs	3.3 to 4.0 cfs	3.3 to 4.0 cfs	3.3 to 4.0 cfs
Avg. mo. decrease in Carter Lake storage	0 to 2%	0 to 1%	0 to 1%	0 to 1%	0 to 1%
Avg. mo. decrease in Horsetooth Res. storage	0 to 1%	3 to 8%	0 to 2%	0 to 2%	0 to 3%
WGFP firm yield	1,229 AF	26,559 AF	25,849 AF	25,849 AF	26,629 AF
GROUND WATER HYDROLOGY Ground water levels	Predicted average monthly decreases in Colorado River stream stage of less than 1.5 inches below the Windy Gap diversion and about 2.0 inches below the Blue River; small changes in Willow Creek stage and small increases in East Slope river stream stage would measurably affect alluvial ground water levels only within tens of feet horizontally from streams. Predicted average decreases in Granby Reservoir, Carter Lake, and Horsetooth Reservoir water levels also would have minimal effect on local alluvial ground water levels and well production.	Effects would be similar to No Action, although the decrease in average monthly Colorado River stream stage would be less than 2.6 inches below the Windy Gap diversion and 3.4 inches below the Blue River. Willow Creek streamflow decreases would be slightly more than No Action and streamflow increases in East Slope streams would be slightly more. Reservoir elevations also would be lower than No Action. Changes in water levels would have minimal effect on local alluvial ground water levels and well production near streams and reservoirs.	Effects would be similar to the Proposed Action although changes in stream stage would be slightly different (smaller change in May and June and less than 1 inch greater in July and August). Changes in reservoir levels would be slightly less than the Proposed Action.	Effects would be similar to the Proposed Action although changes in stream stage would be slightly smaller and changes in reservoir levels would be slightly less.	Effects would be similar to the Proposed Action although changes in stream stage would be slightly smaller and changes in reservoir levels would be slightly less.
Ground water quality	Alluvial ground water quality in the Colorado River, Willow Creek, East Slope streams, and in affected reservoirs would not be measurably affected.	Effects would be similar to No Action, although surface water quality changes would be slightly greater. Effects to ground water quality would not be measurable within the natural variability of ground water quality.	Effects would be similar to the Proposed Action.	Effects would be similar to the Proposed Action.	Effects would be similar to the Proposed Action.

Gross diversion prior to reductions due to agreements with Reclamation, evaporation, deliveries to Middle Park. Is not the same as deliveries to allottees.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
STREAM MORPHOLOGY AND FLOODPLAINS **West Slope**	Colorado River channel maintenance flows (0.8 x 1.5- to 25-year flows) below Windy Gap Reservoir at Hot Sulphur Springs would occur during about 2 to 9% less years. At the Kremmling gage channel maintenance flows would occur during 0 to 3% less years. Projected changes in peak flows and channel maintenance flows are unlikely to substantially affect channel morphology or change sediment transport. Flushing flows greater than 450 cfs would occur 23 days per year on average. Flows would remain adequate to transport fine sediment and prevent deposition. Changes in the magnitude, timing, and frequency of Granby Reservoir spills are not expected to alter channel morphology or sediment transport. Willow Creek flow equal to or greater than the 2-year peak flow discharge would occur slightly less frequently. The potential for flooding on the Colorado River and Willow Creek would decrease with lower flows.	Effects would be similar to No Action except that channel maintenance flows below Windy Gap Reservoir would occur slightly less frequently. Flushing flows greater than 450 cfs would occur 20 days per year on average. Adequate flow should be available to maintain channel capacity, provide periodic scouring, and transport sediment in the Colorado River and Willow Creek.	Effects would be similar to No Action except that channel maintenance flows below Windy Gap Reservoir would occur slightly less frequently. Flushing flows greater than 450 cfs would be similar to the Proposed Action. Jasper East Reservoir could potentially capture flood flows in this small watershed.	Effects would be similar to No Action except that channel maintenance flows below Windy Gap Reservoir would occur slightly less frequently. Flushing flows greater than 450 cfs would be similar to the Proposed Action. Rockwell Reservoir could potentially capture flood flows in this small watershed.	Effects would be similar to No Action except that channel maintenance flows below Windy Gap Reservoir would occur slightly less frequently. Flushing flows greater than 450 cfs would be similar to the Proposed Action. Rockwell Reservoir could potentially capture flood flows in this small watershed.
East Slope	Predicted changes in North St. Vrain Creek and St. Vrain Creek flows upstream of Lyons would be well within the historical range of flow and are unlikely to measurably affect stream morphology or sediment transport. A larger Ralph Price Reservoir could reduce the potential for downstream flooding. Relatively small increases in flows in the Big Thompson River and below WWTPs in St. Vrain Creek, Big Dry Creek, and Coal Creek would be unlikely to measurably affect channel morphology. These flow increases would not substantially increase the risk of flooding.	Effects would be similar to No Action except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow Reservoir could potentially capture flood flows in this small watershed.	Effects would be similar to No Action except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow Reservoir could potentially capture flood flows in this small watershed.	Effects would be similar to No Action except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow Reservoir could potentially capture flood flows in this small watershed.	Effects would be similar to No Action except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Dry Creek Reservoir could potentially capture flood flows in this small watershed.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
SURFACE WATER QUALITY **West Slope** **Abbreviations:** TP = total phosphorus P = phosphorus TN = total nitrogen Mn = Manganese DO = dissolved oxygen TOC = total organic carbon Chlorophyll *a* = a measure of algae concentration Change in clarity = % change in Secchi Disk depth Trophic state = a measure of productivity	**Colorado River.** With average July 25 flows: DO would decrease 0.1 mg/L, ammonia would increase 1.3 µg/L, and inorganic P would increase up to 0.9 µg/L. Assuming diversions to the minimum 90 cfs streamflow for July 25: DO would decrease 0.5 mg/L, ammonia would increase 9.1 µg/L, and inorganic P would increase up to 5.1 µg/L. Modeling indicates an increase in the potential for exceedance of the chronic and acute temperature standards for aquatic life between Windy Gap and the Williams Fork from mid-July to August. Temperature modeling indicates annual increases in chronic temperature exceedances as high as 1 additional week above the WAT standard relative to existing conditions, and as high as 5 additional days above the DM standard relative to existing conditions. Temperature standard exceedances were modeled to increase from existing conditions in 4 out of the 15 years evaluated. Water quality would remain within standards, with the exception of increased potential for exceeding the temperature standard or being below the DO spawning standard at several locations when diversions reduce flow to the minimum streamflow. **Willow Creek.** No change in temperature and slight increase in nutrient and metal concentrations. Water quality would remain within standards. **Granby Reservoir.** TP concentrations would increase 6.3%, TN would increase 0.3%; no change in average chlorophyll *a*, clarity, and trophic state; minimum DO would decrease 2.2%. Dissolved manganese concentrations would continue to exceed standards. **Shadow Mountain Reservoir.** TP concentrations would increase 5.6%; TN would increase 1.1%; average chlorophyll *a* would increase 1.8%; and no change in clarity, trophic state, or minimum DO. No change in manganese concentrations, which currently exceed the standard. **Grand Lake.** TP concentrations would increase 6.0%, TN would increase 0.4%, average chlorophyll *a* would increase 4.2%, clarity would decrease 3.8%, no change in trophic state, and minimum DO would decrease 11.1%. Lower DO would contribute to continued exceedance of the manganese standard.	**Colorado River.** With average July 25 flows: DO would decrease 0.1 mg/L, ammonia would increase 1.7 µg/L, and inorganic P would increase up to 1.5 µg/L. Assuming diversions to the minimum 90 cfs streamflow for July 25: DO would decrease 0.6 mg/L, ammonia would increase 9.3 µg/L, and inorganic P would increase up to 5.7 µg/L. Modeling indicates an increase in the potential for exceedance of the chronic and acute temperature standards for aquatic life between Windy Gap and the Williams Fork from mid-July to August. Temperature modeling indicates annual increases in chronic temperature exceedances as high as 3 additional weeks above the WAT standard relative to existing conditions, and as high as 7 additional days above the DM standard relative to existing conditions. Temperature standard exceedances were modeled to increase from existing conditions in 4 out of the 15 years evaluated. Water quality standards for other parameters would be met except as noted for No Action. **Willow Creek.** Temperature would decrease 0.2°C and nutrient and metal concentrations would increase slightly. Water quality would remain within standards. **Granby Reservoir.** TP concentrations would increase 12.7%, TN would increase 0.7%, average chlorophyll *a* would increase 2.4%, no change in clarity or trophic state, and minimum DO would decrease 4.4%. The dissolved manganese concentrations would continue to exceed standards. **Shadow Mountain Reservoir.** TP concentrations would increase 11.3%, TN would increase 1.8%, average chlorophyll *a* would increase 1.8%, and no change in clarity or trophic state. Minimum DO would decrease 1.4%. A decrease in DO would contribute to continued exceedance of the manganese standard. **Grand Lake.** TP concentrations would increase 12.0%, TN would increase 1.6%, average chlorophyll *a* would increase 6.1%, clarity would decrease 3.8%, no change in trophic state, and minimum DO would decrease 7.4%. Lower DO would contribute to continued exceedance of the manganese standard.	**Colorado River.** With average July 25 flows: DO would decrease 0.1 mg/L, ammonia would increase 1.6 µg/L, and inorganic P would increase up to 0.9 µg/L. Assuming diversions to the minimum 90 cfs streamflow for July 25: DO would increase 0.5 mg/L, ammonia would increase 8.9 µg/L, and inorganic P would increase up to 5.0 µg/L. Temperature standard exceedances would be slightly less than the Proposed Action. Water quality standards for other parameters would be met except as noted for No Action. **Willow Creek.** Same as Proposed Action. **Granby Reservoir.** TP concentrations would increase 4.0%; TN would decrease 2.1%; and no change in average chlorophyll *a*, clarity, trophic state, or minimum DO. No change in DO. Manganese concentrations would continue to exceed the standard. **Shadow Mountain Reservoir.** TP concentrations would increase 8.1%; TN would increase 0.4%; average chlorophyll *a* would increase 1.8%; and no change in clarity, trophic state, or minimum DO. No change in manganese concentrations, which currently exceed the standard. **Grand Lake.** TP concentrations would increase 6.0%, TN would decrease 0.4%, average chlorophyll *a* would increase 4.2%, clarity would decrease 3.8%, no change in trophic state, and minimum DO would decrease 5.6%. Lower DO would contribute to continued exceedance of the manganese standard. **Jasper East Reservoir.** Predicted to be oligotrophic-mesotrophic and retain some TN and P, reducing nutrient delivery to Granby Reservoir.	**Colorado River.** With average July 25 flows: DO would decrease 0.1 mg/L, ammonia would increase 1.6 µg/L, and inorganic P would increase up to 0.9 µg/L. Assuming diversions to the minimum 90 cfs streamflow for July 25: DO would decrease 0.5 mg/L, ammonia would increase 8.9 µg/L, and inorganic P would increase up to 5.0 µg/L. Temperature standard exceedances would be slightly less than the Proposed Action. Water quality standards for other parameters would be met except as noted for No Action. **Willow Creek.** Same as Proposed Action. **Granby Reservoir.** TP concentrations would increase 3.2%; TN would decrease 2.8%; and no change in average chlorophyll *a*, clarity, trophic state, or minimum DO. No change in DO. Manganese concentrations would continue to exceed the standard. **Shadow Mountain Reservoir.** TP concentrations would increase 4.8%; TN would decrease 0.7%; and no change in average chlorophyll *a*, clarity, trophic state, or minimum DO. No change in manganese concentrations, which currently exceed the standard. **Grand Lake.** TP concentrations would increase 6.0%, TN would decrease 0.4%, average chlorophyll *a* would increase 2.0%, clarity would decrease 3.8%, no change in trophic state, and minimum DO would decrease 5.6%. Lower DO would contribute to continued exceedance of the manganese standard. **Rockwell Reservoir.** Predicted to be oligotrophic-mesotrophic and retain some TN and P, reducing nutrient delivery to Granby Reservoir.	**Colorado River.** With average July 25 flows: DO would decrease 0.1 mg/L, ammonia would increase 1.5 µg/L, and inorganic P would increase up to 0.8 µg/L. Assuming diversions to the minimum 90 cfs streamflow for July 25: DO would decrease 0.5 mg/L, ammonia would increase 8.9 µg/L, and inorganic P would increase up to 4.9 µg/L. Modeling indicates an increase in the potential for exceedance of the chronic and acute temperature standards for aquatic life between Windy Gap and the Williams Fork from mid-July to August. Temperature standard exceedances would be slightly less than the Proposed Action. Water quality standards for other parameters would be met except as noted for No Action. **Willow Creek.** Same as Proposed Action. **Granby Reservoir.** TP concentrations would increase 1.6%; TN would decrease 3.5%; and no change in average chlorophyll *a*, clarity, trophic state, or minimum DO. No change in DO. Manganese concentrations would continue to exceed the standard. **Shadow Mountain Reservoir.** TP concentrations would increase 3.2%; TN would decrease 1.1%; and no change in average chlorophyll *a*, clarity, trophic state, or minimum DO. No change in manganese concentrations, which currently exceed the standard. **Grand Lake.** TP concentrations would increase 4.8%, TN would decrease 0.8%, average chlorophyll *a* would increase 2.0%, no change in clarity or trophic state, and minimum DO would decrease 5.6%. Lower DO would contribute to continued exceedance of the manganese standard. **Rockwell Reservoir.** Same as Alternative 4.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
SURFACE WATER QUALITY **East Slope** Note: Water quality would not exceed standards in East Slope streams or reservoirs except as noted.	**N. St. Vrain Creek.** Depending on changes in flows, temperature on a monthly basis would increase up to 1°C or decrease up to 5°C. DO concentrations on a monthly basis would range from a decrease of 0.5 mg/L to an increase of 2.0 mg/L. **St. Vrain Creek.** Estimated ammonia concentrations below Longmont WWTP would increase the most in October (to 2.7 mg/L) and would be higher than action alternatives because of potentially higher maximum WWTP discharges. **Big Thompson River.** Nitrogen and phosphorus concentrations would increase slightly due to additional Windy Gap deliveries through the Adams Tunnel, but would be less than other alternatives because imports would be lower. Ammonia concentrations would decrease slightly below the Loveland WWTP. **Big Dry Creek and Coal Creek.** Increased WWTP discharges would increase ammonia concentrations and the potential for exceeding the water quality standard. **Cache la Poudre River.** Estimated ammonia concentrations below Greeley WWTP would increase the most in November (to 1.4 mg/L). **Carter Lake.** TP concentrations would increase 5.1%, TN would increase 1.8%, average chlorophyll *a* would increase 5.6%, clarity would decrease 3.6%, no change in trophic state or temperature, and a slight decrease in DO. **Horsetooth Reservoir.** TP concentrations would increase 5.1%; TN would increase 2.6%; average chlorophyll *a* would increase 5.7%; no change in clarity, temperature, or trophic state; and a slight decrease in DO. Lower DO concentrations would contribute to continued exceedances of the manganese standard. TOC may increase.	**N. St. Vrain Creek.** No effect. **St. Vrain Creek.** Estimated ammonia concentrations below Loveland WWTP would increase the most in October (to 2.5 mg/L). **Big Thompson River.** Nitrogen and phosphorus concentrations would increase slightly due to additional Windy Gap deliveries through the Adams Tunnel. Ammonia concentrations would decrease below the Loveland WWTP. **Big Dry Creek and Coal Creek.** Same as No Action. **Cache la Poudre River.** Estimated ammonia concentrations below Greeley WWTP would increase the most in January (to 1.4 mg/L). **Carter Lake.** TP concentrations would increase 9.1%, TN would increase 4%, average chlorophyll *a* would increase 11.1%, clarity would decrease 3.6%, no change in trophic state or temperature, and a slight decrease in DO. **Horsetooth Reservoir.** TP concentrations would increase 11.1%, TN would increase 5.8%, average chlorophyll *a* would increase 11.4%, clarity would decrease 3.8%, no change in trophic state or temperature, and a slight decrease in DO. Lower DO would contribute to continued exceedances of the manganese standard. TOC may increase. **Chimney Hollow Reservoir.** Predicted to be oligotrophic, slightly lower water quality than Alternatives 3 and 4.	**N. St. Vrain Creek.** No effect. **St. Vrain Creek.** Same as Proposed Action. **Big Thompson River.** Same as Proposed Action. **Big Dry Creek and Coal Creek.** Same as No Action. **Cache la Poudre River.** Same as Proposed Action. **Carter Lake.** TP concentrations would increase 3.0%, TN would increase 1.3%, no change in average chlorophyll *a*, clarity would decrease 3.6%, no change in trophic state or temperature, and a slight decrease in DO. **Horsetooth Reservoir.** TP concentrations would increase 4%; TN would increase 4.0%; average chlorophyll *a* would increase 5.7%; no change in clarity, temperature, or trophic state; and a slight decrease in DO. Lower DO concentrations would contribute to continued exceedances of the manganese standard. TOC may increase. **Chimney Hollow Reservoir.** Similar to Proposed Action, but with slightly better water quality.	**N. St. Vrain Creek.** No effect. **St. Vrain Creek.** Same as Proposed Action. **Big Thompson River.** Same as Proposed Action. **Big Dry Creek and Coal Creek.** Same as No Action. **Cache la Poudre River.** Same as Proposed Action. **Carter Lake.** Same as Alternative 3. **Horsetooth Reservoir.** TP concentrations would increase 4.0%; TN would increase 3.6%; average chlorophyll *a* would increase 5.7%; no change in clarity, temperature, or trophic state; and a slight decrease in DO. Lower DO concentrations would contribute to continued exceedances of the manganese standard. TOC may increase. **Chimney Hollow Reservoir.** Similar to Proposed Action, but with slightly better water quality.	**N. St. Vrain Creek.** No effect. **N. St. Vrain Creek.** No effect. **St. Vrain Creek.** Same as Proposed Action. **Big Thompson River.** Same as Proposed Action. **Big Dry Creek and Coal Creek.** Same as No Action. **Cache la Poudre River.** Same as Proposed Action. **Carter Lake.** TP concentrations would increase 3.0%, TN would increase 1.8%, average chlorophyll *a* would increase 5.6%, clarity would decrease 3.6%, no change in trophic state or temperature, and a slight decrease in DO. **Horsetooth Reservoir.** TP concentrations would increase 3.0%; TN would increase 3.6%; average chlorophyll *a* would increase 5.7%; no change in clarity, temperature, or trophic state; and a slight decrease in DO. Lower DO concentrations would contribute to continued exceedances of the manganese standard. TOC may increase. **Dry Creek Reservoir.** Predicted to be oligotrophic.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
SURFACE WATER QUALITY (CONT'D) **East Slope**	**Ralph Price Reservoir.** TP concentrations would decrease 3.9%, TN would decrease 5.9%, average chlorophyll *a* would decrease 33.0%, no change in clarity or trophic state, and a slight increase in DO.				
AQUATIC RESOURCES **West Slope**	Anticipated increases in Windy Gap diversions under No Action would be less than the Proposed Action. Thus, the effect on Colorado River and Willow Creek aquatic habitat would be slightly less than described for the Proposed Action. Fish habitat would increase in the spring and decrease in the late summer as a result of Windy Gap diversions. Temperature standard exceedances were modeled to increase from existing conditions in 4 out of the 15 years evaluated. Exceedance of the chronic and acute temperature standards were modeled to occur at a slightly lower frequency and duration than the Proposed Action. Higher stream temperatures may result in less fit individuals and possible fish mortality, particularly if the acute temperature standard is exceeded frequently. No change in fish populations are predicted for the Three Lakes.	The greatest effect to trout habitat in the Colorado River from WGFP diversions would occur between Windy Gap Reservoir and Williams Fork. Adult rainbow trout habitat would be more affected than brown trout habitat. The largest decrease in habitat would occur in August of average and wet years, although WGFP diversions in August of greater than 100 AF would increase from 6 times under existing conditions in the 47-year study period to 15 times. The greatest increase in habitat would occur in June. The potential for exceedance of the aquatic life temperature standards would increase primarily after July 15. Temperature standard exceedances were modeled to increase from existing conditions in 4 out of the 15 years evaluated, which may result in less fit individuals and possible fish mortality if the acute temperature standard is exceeded frequently. Predicted maximum periodic decreases in fish habitat are unlikely to impact fish populations at most locations. Willow Creek rainbow and brown trout habitat would decrease primarily in July. Streamflow changes are unlikely to affect macroinvertebrate populations. No change in fish populations are predicted for the Three Lakes.	Effects would be similar to the Proposed Action, but exceedance of the temperature standards would be slightly less than the Proposed Action.	Effects would be similar to the Proposed Action, but exceedance of the temperature standards would be slightly less than the Proposed Action.	Effects would be similar to the Proposed Action, but exceedance of the temperature standards would be slightly less than the Proposed Action.
East Slope	Projected increases in flow in the Big Thompson River, Big Dry Creek, and Coal Creek would slightly enhance fish habitat. A slight reduction in fish habitat in North St. Vrain Creek and St. Vrain Creek above Lyons is possible with reduced flow in some summer months, but higher flows in the fall and winter would benefit fish habitat. Changes in reservoir storage and water quality in Carter Lake and Horsetooth Reservoir would not measurably impact fish habitat. A larger Ralph Price Reservoir would benefit fish, but productivity would remain low.	Effects to fish in East Slope streams and reservoirs would be similar to No Action except there would be no impact in North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow could support a fishery similar to other Front Range reservoirs.	Effects would be similar to the Proposed Action. Jasper East Reservoir would support a fishery, but large fluctuations in water levels may reduce productivity.	Effects would be similar to the Proposed Action. Rockwell Reservoir would support a fishery, but large fluctuations in water levels may reduce productivity.	Effects would be similar to the Proposed Action. Dry Creek Reservoir would support a fishery similar to Chimney Hollow Reservoir. Rockwell Reservoir would support a fishery, but large fluctuations in water levels may reduce productivity.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
VEGETATION	Enlargement of Ralph Price Reservoir would inundate about 77 acres of mostly upland native forest. Impacts to riparian vegetation from reduced flows on the Colorado River, Willow Creek, and East Slope streams are expected to be negligible based on a minor effect on stream morphology, small changes in stream stage, and ground water levels. Water levels would be lower at Granby Reservoir, Carter Lake, and Horsetooth Reservoir, but would fall within the historical range of operations and are unlikely to affect the limited riparian vegetation bordering these reservoirs.	Construction of Chimney Hollow Reservoir would permanently impact 788 acres of vegetation and temporarily disturb 123 acres. Upland native shrublands, native and mixed grasslands, and native forest would be most impacted. Impacts to riparian vegetation would be similar to No Action although the decrease in Colorado River and Willow streamflow would be greater, as would the decrease in water levels in existing reservoirs.	Construction of Chimney Hollow Reservoir would permanently impact 669 acres of vegetation and temporarily disturb 131 acres. Jasper East Reservoir construction would permanently impact 436 acres and temporarily disturb 114 acres. Grasslands and irrigated meadows would be impacted the most at Jasper East Reservoir. The total permanent vegetation impacts for both reservoirs would be 1,157 acres. Impacts to riparian vegetation would be similar to No Action although the decrease in Colorado River and Willow streamflow would be greater, as would the decrease in water levels in existing reservoirs.	Same impacts as Alternative 3 for Chimney Hollow Reservoir. Construction of Rockwell Reservoir would permanently impact 304 acres of vegetation and temporarily disturb 151 acres. Upland native shrubs would be impacted the most. The total permanent vegetation impacts for both reservoirs would be 973 acres. Impacts to riparian vegetation would be similar to No Action although the decrease in Colorado River and Willow streamflow would be greater, as would the decrease in water levels in existing reservoirs.	Construction of Dry Creek Reservoir would permanently impact 647 acres and temporarily disturb 149 acres. Upland native forests, mixed grasslands, and native shrubland would be most affected. Construction of Rockwell Reservoir would permanently impact 378 acres and temporarily disturb 105 acres. The total permanent vegetation impacts for both reservoirs would be 1,025 acres. Impacts to riparian vegetation would be similar to No Action although the decrease in Colorado River and Willow streamflow would be greater, as would the decrease in water levels in existing reservoirs.
WETLANDS AND OTHER WATERS	Ralph Price Reservoir enlargement would inundate about 0.3 acre of wetlands and about 0.1 acre of North St. Vrain Creek. Dam construction could result in additional impacts to St. Vrain Creek.	About 1.6 acres of wetlands would be permanently impacted and about 0.1 acre would be temporarily disturbed. Permanent effects to other waters would be about 1.3 acres.	Chimney Hollow Reservoir would permanently impact 1.5 acres of wetlands and temporarily disturb about 0.1 acre. Permanent effects to other waters would be about 1.3 acres. Construction of Jasper East Reservoir would permanently affect 21.2 acres of wetlands and temporarily disturb 4.8 acres. Permanent effects to other waters would be about 6.3 acres. Total permanent wetland impacts for both reservoirs would be about 22.7 acres.	Wetland and water impacts at Chimney Hollow would be the same as Alternative 3. Permanent wetland impacts at Rockwell Reservoir would be 3 to 13.6 acres with a temporary wetland impact of 2 to 5 acres. Permanent effects to other waters would be 3.6 acres. Total permanent wetland impacts for both reservoirs would range from 4.5 to 15.1 acres pending field studies.	Dry Creek Reservoir construction would permanently impact 6.2 acres of wetlands and temporarily disturb 0.3 acre. Permanent effects to other waters would be 2.8 acres. Rockwell Reservoir permanent wetland impacts would be 3 to 15.6 acres with a temporary impact of 2 to 5 acres. Permanent effects to other waters would be 3.7 acres. Total permanent wetland impacts for both reservoirs would range from 9.2 to 21.8 acres.
WILDLIFE	Enlargement of Ralph Price Reservoir would result in a loss of 77 acres of elk and mule deer winter range and white-tailed deer, black bear, and mountain lion overall range; the loss of habitat for other terrestrial wildlife species and birds; and displacement of wildlife during construction. No known loss of raptor nests, but suitable habitat is present for several species. Bald eagles, osprey, and waterfowl may benefit from a larger reservoir. About 0.1 acre of potential habitat for northern leopard frog and gartersnake would be lost.	Construction of Chimney Hollow Reservoir would result in a loss of 810 acres of elk winter range, mule deer winter range and concentration areas, and black bear fall concentration areas. Expansion of mountain lion and black bear conflict areas are possible with planned recreation activity. Fragmentation of habitat that would alter local movement patterns by elk, deer, and other wildlife. Foraging and nest habitat would be lost for a variety of bird, mammal, and reptile species. No known raptor nests would be directly affected. A golden eagle nest on the hogback ¼ mile east of the reservoir is outside of the CDPW-recommended buffer. About 7 acres of bald eagle winter range would be temporarily impacted, but the reservoir would provide bald eagle foraging	Chimney Hollow Reservoir construction would result in the permanent loss of 675 acres of elk winter range, mule deer winter range and concentration areas, and black bear fall concentration areas. Other effects at Chimney Hollow would be similar to the Proposed Action. Construction of Jasper East Reservoir would result in the loss of about 480 acres of moose and mule deer summer range and 24 acres of elk winter range. The new reservoir could displace or shift elk movement toward U.S. 34 or residential development. About 93 acres of black bear summer concentration area would be impacted. Habitat for ground-nesting and tree-nesting birds would be lost or disturbed. About 3 acres of bald eagle	Chimney Hollow Reservoir effects would be the same as Alternative 3. Rockwell Reservoir would result in the permanent loss of 312 acres of summer range for moose and mule deer and 73 acres of elk winter range. Habitat for primarily ground-nesting birds would be lost as well as a variety of terrestrial mammals. No known raptor nests would be impacted. Bald eagle winter range would be temporarily affected where the pipeline crosses the Colorado River. The reservoir would provide foraging habitat for bald eagle, osprey, and other water birds. Potential habitat for the state threatened boreal toad and state species of concern northern leopard frog and common gartersnake would be lost in	Dry Creek Reservoir would permanently impact 650 acres of elk winter range, mule winter range, and winter concentration areas. About 619 acres of black bear fall concentration area and overall mountain lion habitat would be lost. A red-tailed hawk nest and habitat for other migratory bird species would be lost. There would a permanent impact to 165 acres of bald eagle winter range, but the reservoir would provide foraging habitat. About 8.5 acres of known northern leopard frog habitat would be lost and about 30 acres of suitable common gartersnake habitat would be lost. Habitat for a variety of CNHP-tracked butterfly species would be lost.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
WILDLIFE (CONT'D)		habitat. Potential habitat for northern leopard frog (2.5 acres) and common gartersnake (50 acres) would be lost. Habitat for several CNHP-tracked butterfly species would be lost.	winter range would be lost. The new reservoir would provide foraging habitat for bald eagle, osprey, and waterfowl. About 125 acres of potential greater sage grouse habitat would be lost, which could affect eastward expansion of a known population. Sagebrush also could provide habitat for sage sparrow, a CNHP-tracked species.	riparian areas. The loss of 290 acres of sagebrush habitat within a sage grouse production and brood rearing area would adversely affect a declining population.	Impacts at the Rockwell Reservoir site would be similar to Alternative 4. Differences include a loss of 393 acres of moose and mule deer summer range and 97 acres of elk winter range. Also there would be a permanent impact to 334 acres of sage grouse breeding and brood rearing habitat.
THREATENED AND ENDANGERED	Depletion effects to Colorado River endangered fish would be similar to the Proposed Action. No other federally listed species would be impacted.	Increased WGFP diversions of 21,317 AF would result in an adverse effect to four Colorado River endangered fish species. The Subdistrict would pay a one-time depletion fee in accordance with the Recovery Program and previous programmatic biological opinion for depletions in the Colorado River. No other federally listed species would be impacted.	Depletion effects to Colorado River endangered fish would be similar to the Proposed Action.	Depletion effects to Colorado River endangered fish would be similar to the Proposed Action. The loss of about 5 acres of potential lynx habitat at Ralph Price Reservoir site may affect, but is unlikely to adversely affect, lynx.	Depletion effects to Colorado River endangered fish would be similar to the Proposed Action. The loss of about 9 acres of potential lynx habitat at Ralph Price Reservoir site may affect, but is unlikely to adversely affect, lynx
GEOLOGY/PALEONTOLOGY	Excavation of geologic material for dam enlargement at Ralph Price Reservoir would be needed. No known geological hazards exist at the site. No known oil/gas, mineral, or coal bearing resources would be affected. Aggregate sources could be affected. No known paleontological resources would be affected.	Excavation of geologic material for Chimney Hollow Reservoir dam construction would be needed. No known geological hazards exist at the site. No known oil/gas, mineral, coal bearing, or aggregate resources would be affected. A sandstone quarry on the east hogback could be affected by construction of an access road. Plant and invertebrate fossils could be found when excavating sandstone formations.	Effects at Chimney Hollow Reservoir would be the same as the Proposed Action. At Jasper East Reservoir no known geological hazards or oil/gas, mineral, or coal-bearing resources would be affected. Excavation in the Troublesome Formation could expose mammal fossils.	Effects at Chimney Hollow Reservoir would be the same as Alternative 3. At Rockwell Reservoir no known geological hazards or oil/gas, mineral, or coal-bearing resources would be affected. Excavation in the Troublesome Formation could expose mammal fossils.	Effects at Rockwell Reservoir would be the same as Alternative 3. At Dry Creek Reservoir no known geological hazards or oil/gas, mineral, coal-bearing, or aggregate resources would be affected. A sandstone quarry on the east hogback could be affected by the pipeline to Carter Lake. No known paleontological resources would be affected.
SOILS	Enlargement of Ralph Price Reservoir would result in the permanent inundation of 77 acres of soils, with possible other disturbances from dam construction and borrow area excavations. Shoreline erosion and sedimentation are likely to be minor. Temporary erosion from construction-related disturbances would occur until revegetation. Poor topsoil suitability could make revegetation difficult in some areas.	Chimney Hollow Reservoir construction would result in a permanent loss of 794 acres of soil resources and temporary soil impacts to about 130 acres. Shoreline erosion would occur during the first several years following construction. Seasonal fluctuations in water levels would be less than 2 feet, which would reduce the exposed shoreline subject to erosion. Sedimentation from other sources in the basin would be minimal. The potential for wind erosion is moderate and for water erosion is severe until revegetation is complete. About 67 acres of temporarily disturbed soils have fair suitability and 62 acres have poor suitability for topsoil.	Chimney Hollow Reservoir construction would result in a permanent loss of 671 acres of soil resources and a temporary impact to 149 acres. Erosion potential is similar to the Proposed Action. Jasper East Reservoir construction would result in the loss of 491 acres of soil and a temporary disturbance of 125 acres. Shoreline erosion is likely with fluctuations in water levels up to 72 feet. Sediment delivery to the reservoir from local sources would be low. The potential for wind erosion is moderate and for water erosion is high. About 93 acres of temporary disturbances have poor suitability and 32 acres have fair suitability for topsoil. The total permanent soil loss for both reservoirs would be 1,162 acres.	Soil impacts at Chimney Hollow Reservoir would be the same as Alternative 3. Rockwell Reservoir would result in a permanent loss of 315 acres of soil and a temporary disturbance of 155 acres. Shoreline erosion is likely with fluctuations in water levels up to 102 feet. Local sources of sediment delivery to the reservoir would be low. The wind erosion hazard is low to moderate and the water erosion is high for most soils. Temporarily disturbed soils mostly have poor topsoil suitability, which could impact revegetation. The total permanent soil loss for both reservoirs would be 986 acres.	Dry Creek Reservoir construction would result in a permanent impact to 633 acres of soils and a temporary disturbance of 158 acres. Some shoreline erosion is likely primarily during the first few years with seasonal fluctuations of up to 17 feet. The undisturbed watershed would have limited sources of local sediment delivery to the reservoir. Wind erosion hazard is moderate and water erosion is moderate to severe on steep slopes. About 74 acres of temporarily disturbed lands have poor topsoil suitability and 71 acres have fair suitability. Rockwell Reservoir would permanently disturb 393 acres and temporarily disturb 161 acres. The total permanent soil loss for both reservoirs would be 1,026 acres.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
AIR QUALITY	Vehicle emissions and fugitive dust generated during the 30-month construction period would result in minor localized and temporary effects to air quality. Exceedance of air quality standards is unlikely.	Similar types of temporary impacts as No Action, but a 3- to 5-year construction period and greater area of surface disturbance, with greater dust and emissions. No exceedances of air quality standards are likely. Construction-related activities would result in negligible increases in vehicle emissions from recreation visitors to the reservoir over the long term.	Similar temporary impacts as the Proposed Action over a 2.5- to 5-year period, but impacts would occur at both the Jasper East and Chimney Hollow reservoir sites.	Similar temporary impacts as the Proposed Action over a 2.5- to 4.5-year period, but impacts would occur at both the Rockwell and Chimney Hollow reservoir sites.	Similar temporary impacts as the Proposed Action over a 2.5- to 4.5-year period, but impacts would occur at both the Dry Creek and Rockwell reservoir sites.
NOISE	Construction equipment, earthmoving equipment, blasting, and other activities would temporarily increase noise levels. Noise levels at several residences about 200 feet from the dam could reach 83 dB(A), which would exceed Larimer County noise standards.	Construction-related activities would temporarily increase noise levels for residents on the hogback ridge to the east of the dam. Noise levels are predicted to reach about 71 dB(A) near these homes, which is within Larimer County standards. Long-term noise levels from a substation would be within County standards. Recreation-related noise levels are expected to be minor over the long term.	Noise-related impacts for construction of Chimney Hollow Reservoir would be the same as the Proposed Action. Residents close to the Jasper East Reservoir site could experience noise levels up to about 65 dB(A) during construction.	Noise-related impacts for Chimney Hollow Reservoir would be the same as the Proposed Action. Residents close to the Jasper East Reservoir site could experience noise levels up to about 71 dB(A) during construction.	Noise-related impacts for construction of Rockwell Reservoir would be the same as Alternative 4. Residents near the Dry Creek Reservoir site could experience noise levels of up to 71 dB(A) during construction. Tunnel boring near Carter Lake could result in noise levels up to 83 dB(A) for nearby residents, which exceeds Larimer County standards.
LAND USE	Ralph Price Reservoir enlargement would be on City of Longmont property. Land use would not change, but public access would be temporarily suspended during construction. No private homes would be directly impacted. During the estimated 2-year construction period, traffic on U.S. 36 and CR 80 would increase. Traffic on CR 80 would increase about 63%.	The Subdistrict owns 84% of the reservoir project area, but would need to acquire several small private parcels and an easement from Reclamation and Larimer County for pipeline connections. Construction access also may require easements across private, Reclamation, and State land. Relocation of Western's transmission line would require easements across Larimer County, Subdistrict, and Reclamation land. No prime farmland would be impacted. No private homes would need to be acquired. The currently undeveloped land use would change to day use recreation activities. During construction, traffic on CR 18E would increase about 79%. Traffic on CR 31 also could increase at the southern construction access point. Following construction, traffic from an estimated 50,000 annual recreation visitors per year at Chimney Hollow Reservoir would occur on CR 18.	Land acquisition and easements for a smaller Chimney Hollow would be slightly less, but similar to the Proposed Action. Other impacts also would be similar. Jasper East Reservoir would be built on land mostly owned by the NCWCD that would need to be acquired by the Subdistrict. About 70 acres of Reclamation land would need to be acquired via a land exchange or a contract. Realignment of CR 40 would require acquisition of private and NCWCD land. About 313 acres of irrigated hay meadows would be lost. No prime farmland would be impacted. No private homes would need to be acquired. During construction, traffic volume on U.S. 34 and CR 40 would increase. Traffic on U.S. 34 would increase about 8%.	Chimney Hollow impacts would be the same as Alternative 3. Construction of Rockwell Reservoir would require acquisition of about 443 acres of private land including four homes. About 29 acres of BLM land at the reservoir site and 56 acres at a borrow area would require acquisition and/or a special use permit. An easement across mostly private land also would be needed for the pipeline to Windy Gap Reservoir. A portion of CR 57 would need to be realigned. Existing land uses of pasture, livestock grazing, and private residential use would be lost. No prime farmland would be impacted. Traffic on CR 56 and CR 57 would increase during construction. U.S. 40 traffic near CR 57 would increase 5% and U.S. 40 near CR 56 would increase 4%.	The Subdistrict would need to acquire about 459 acres of private land, 230 acres of State land, and 18 acres of Reclamation property for construction of Dry Creek Reservoir and facilities. Reservoir construction would impact three homes and displace a commercial llama operation. No prime farmland would be impacted. Traffic during construction on CR 18E would increase about 72%. If access from the south is used, then traffic on CR 31 also would increase. Rockwell Reservoir construction would require acquisition of about 504 acres of private property and 51 acres of BLM land at the reservoir site. Other impacts would be similar to Alternative 4.

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RECREATION **West Slope**	Impacts to preferred boating flows in Big Gore Canyon and Pumphouse would be similar to the Proposed Action. Preferred kayaking flows in Byers Canyon (>400 cfs) would occur about 8 days less per year in 18 years out of the 47-year study period. Predicted effects to aquatic habitat, as discussed for Aquatic Resources, are unlikely to measurably impact sport fishing in the Colorado River or Willow Creek. There would be no change in water levels in Grand Lake and Shadow Mountain Reservoir that would affect recreation. Granby Reservoir surface area in the summer would decrease less than 2% on average and boat ramps would remain accessible except in dry years when water levels could drop below the Arapaho Bay boat ramp in August.	Preferred boating flows in Big Gore Canyon (850 to 1,250 cfs) would decrease less than 3 days per year compared to existing conditions in 10 years out of the 47-year study period. For the Pumphouse reach, preferred boating flows (1,100 to 2,200 cfs) would occur about 1 day less per year on average in 15 years out of the 47-year study period. Preferred kayaking flows in Byers Canyon (>400 cfs) would occur about 12 days less per year in 18 years out of the 47-year study period. Predicted effects to aquatic habitat, as discussed for Aquatic Resources, are unlikely to measurably impact sport fishing in the Colorado River or Willow Creek. There would be no change in water levels in Grand Lake and Shadow Mountain Reservoir that would affect recreation. Granby Reservoir surface area would decrease 6% on average in the summer. Boat ramps would remain accessible except in dry years when water levels could drop below the Arapaho Bay boat ramp in May and August, and possibly the Stillwater and Sunset boat ramps for a portion of the summer.	Impacts to preferred boating flows in Big Gore Canyon and Pumphouse would be similar to the Proposed Action. Preferred kayaking flows in Byers Canyon (>400 cfs) would occur about 11 days less per year in 18 years out of the 47-year study period. Predicted effects to aquatic habitat, as discussed for Aquatic Resources, are unlikely to measurably impact sport fishing in the Colorado River or Willow Creek. There would be no change in water levels in Grand Lake and Shadow Mountain Reservoir that would affect recreation. Granby Reservoir water levels would decrease slightly less than under the Proposed Action with similar potential effects to boat ramps.	Impacts to preferred boating flows in Big Gore Canyon, Pumphouse, and Byers Canyon would be similar to the Proposed Action. Predicted effects to aquatic habitat, as discussed for Aquatic Resources, are unlikely to measurably impact sport fishing in the Colorado River or Willow Creek. There would be no change in water levels in Grand Lake and Shadow Mountain Reservoir that would affect recreation. Granby Reservoir water levels would decrease slightly less than under the Proposed Action with similar potential effects to boat ramps.	Impacts to preferred boating flows in Big Gore Canyon, Pumphouse, and Byers Canyon would be similar to the Proposed Action. Predicted effects to aquatic habitat, as discussed for Aquatic Resources, are unlikely to measurably impact sport fishing in the Colorado River or Willow Creek. There would be no change in water levels in Grand Lake and Shadow Mountain Reservoir that would affect recreation. Granby Reservoir water levels would decrease slightly less than under the Proposed Action with similar potential effects to boat ramps.
RECREATION **East Slope**	Kayaking opportunities in North St. Vrain Creek below Longmont Reservoir would be reduced in July when flows drop below 150 cfs. Increased flows in the Big Thompson River would maintain acceptable kayaking flows. Recreation at Ralph Price Reservoir would be suspended for about 2 years until construction is completed. Average monthly water surface area in Carter Lake would decrease less than 1% and Horsetooth surface area would not change. Boat ramp access could be reduced in dry years.	No effect on North St. Vrain flows or kayaking. Increased flows in the Big Thompson River would maintain existing kayaking. Average monthly water surface area in Carter Lake would decrease less than 1% and Horsetooth surface area would decrease up to 5%. Water levels could drop below Horsetooth's South Bay-South boat ramp in September, and in dry years access to several boat ramps could be affected. Chimney Hollow Reservoir would provide day use fishing, boating, and hiking opportunities with up to 50,000 annual visitors.	Similar to the Proposed Action except the average monthly water surface area at Horsetooth Reservoir would decrease less than 1%. Jasper East Reservoir could provide recreation opportunities if a managing entity is found, although wide fluctuations in water levels could reduce suitability.	Same as Alternative 3 for Chimney Hollow Reservoir. Rockwell Reservoir could provide recreation opportunities if a managing entity is found, although wide fluctuations in water levels could reduce suitability.	Same as Alternative 3 for Rockwell Reservoir. Dry Creek reservoir could provide recreation opportunities similar to Chimney Hollow if a managing entity is found. Rockwell Reservoir could provide recreation opportunities if a managing entity is found, although wide fluctuations in water levels could reduce suitability.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
CULTURAL RESOURCES	No known NRHP cultural resources would be impacted, but a field survey would be needed prior to construction.	Sixteen cultural resource sites eligible or potentially eligible for the NRHP could be affected by construction of Chimney Hollow Reservoir. These sites include the Carter Lake Historic Area, four rock walls, two rock cairns, four contributing elements to the C-BT Historic District, one inaccessible transmission line segment, a possible eagle trap, and three multicomponent sites. A field survey of 17.2 acres that could not be accessed will need to be conducted.	Chimney Hollow cultural resource effects would be the same as the Proposed Action for all but two resources; therefore, 14 sites would be affected. Seven known cultural resource sites eligible or potentially eligible for the NRHP could be affected by construction of Jasper East Reservoir.	Chimney Hollow cultural resource effects would be the same as the Proposed Action for all but two resources; therefore, 14 sites would be affected. One known cultural resource site potentially eligible for the NRHP could be affected by construction of Rockwell/Mueller Creek Reservoir. The reservoir pipeline would cross the Denver and Rio Grande rail line, which elsewhere has been determined eligible. The pipeline also would cross a possible historic water diversion ditch.	Two known cultural resource sites eligible or potentially eligible for the NRHP could be affected by construction of Dry Creek Reservoir. These sites include a historic quarry and the Carter Lake Historic Area. Rockwell Reservoir cultural resources affected would be the same as Alternative 4.
VISUAL RESOURCES	Visual quality would diminish temporarily during construction from earthwork, vegetation clearing, dust, and traffic. The visual quality at Ralph Price Reservoir would not change substantially from existing conditions, but an additional 77 acres of open water would replace forest land. Lower summer water levels in Granby Reservoir would increase the amount of visible shoreline about 108 acres more than existing conditions. Small decreases in Carter Lake and Horsetooth Reservoir storage are unlikely to be noticeable. Lower streamflows could potentially reduce the visual quality of the Colorado River, but for most viewers, these changes would not be discernible for any of the alternatives.	Temporary visual impacts during construction would be similar to No Action. Chimney Hollow Reservoir would be visible primarily from homes along the hogback to the east. The dam would be visible from locations to the north up to 2.5 miles away including Reclamation offices, scattered residences, and CR 18E. The relocated transmission line would be visible from the lake and homes on the hogback. Because Chimney Hollow would remain near full, shoreline exposure would be limited. Lower summer water levels in Granby Reservoir would increase the amount of visible shoreline about 270 acres more than existing conditions. Small decreases in Carter Lake storage would not be noticeable. Exposed shoreline at Horsetooth Reservoir would increase less than 73 acres on average in the summer.	Visual effects at Chimney Hollow would be similar to the Proposed Action, although the dam would be about 30 feet lower and slightly less visible. Jasper East Reservoir and dam would be visible from scattered residential homes to the west and portions of the Arapaho National Recreation Area, as well as the relocated CR 40. Fluctuations in water levels would expose large areas of shoreline, but water levels would be highest in the summer. Lower summer water levels in Granby Reservoir would increase the amount of visible shoreline about 155 acres more than existing conditions. Small decreases in Carter Lake storage would not be noticeable. Exposed shoreline at Horsetooth Reservoir would increase less than 24 acres on average in the summer.	Visual effects at Chimney Hollow would be the same as Alternative 3. Rockwell Reservoir dams would be visible from the Town of Granby, Grand Elk, Granby Ranch, and U.S. 40. Views of the reservoir would be limited to scattered homes at higher elevations. Visual effects for Granby Reservoir, Carter Lake, and Horsetooth Reservoir would be the same as Alternative 3.	Dry Creek Reservoir would introduce a substantial visual change to the valley, but there are few observation points because most of the area is undeveloped. The dam would be visible from several rural roads and residences. Visual effects of Rockwell Reservoir would be similar to Alternative 4, although the dams would be slightly higher and more visible. Visual effects for Granby Reservoir, Carter Lake, and Horsetooth Reservoir would be the same as Alternative 3.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
SOCIOECONOMICS	The average workforce during the 2-year construction period at Ralph Price Reservoir would be 50 employees, with about $8 million of the $31 million total project cost going to direct labor. The Project would generate about $73 million in total economic output and 69 temporary jobs. Because recreation at Ralph Price Reservoir would be closed during construction, there would be a loss of revenue to the City of Longmont. Minority or low-income populations would not be disproportionately impacted. Hydrologic changes that reduce or increase the number of days of preferred flows for boating in the Colorado River could impact recreation-associated spending. The annualized net economic effect from a change in the number of preferred boating days (assuming a total loss of boating use if flows are outside of preferred flow range) on the Colorado River in Big Gore Canyon and the Pumphouse reach would be a decrease of about $750 per year in recreation revenue. The economic effect for the modeled year with the greatest decrease in the number of days in the preferred flow range would result in: a loss of about 429 user days for commercial rafting in Big Gore Canyon with a value of about $31,000 and a loss of about 6,705 user days for boating in Pumphouse with a value of about $493,000. The maximum increase in recreation value from WGFP diversions that reduce high flows to the preferred boating range would be about $233,000. No measurable economic impacts were identified from changes in angling opportunities or satisfaction. Water deliveries to the East Slope would generate a net increase of about 19 GWH of hydropower energy with a production value of $1.1 million.	The average workforce during the 3- to 5-year construction period would be 235 employees, with about $47 million of the $223 million total project cost going to direct labor. If half of the project costs were spent in Larimer and Weld counties, the Project would generate about $292 million in total economic output with 127 temporary jobs created. Reservoir operation would require four new employees. Larimer County would spend about $1 million for recreation development with annual recreation O&M costs of about $265,000. Minority or low-income populations would not be disproportionately impacted. The annualized net economic effect from a change in the number of preferred boating days (assuming a total loss of boating use if flows are outside of preferred flow range) on the Colorado River would result in a decrease in recreation revenue of about $4,189. The economic effect for the modeled year with the greatest decrease in the number of days in the preferred flow range in Big Gore Canyon and Pumphouse would be the same as No Action. The maximum increase in recreation value from WGFP diversions that reduce high flows to the preferred boating range also would be about $200,000. No measurable economic impacts were identified from changes in angling opportunities or satisfaction. Water deliveries to the East Slope would generate a net increase of about 26 GWH of hydropower energy with a production value of $1.5 million.	The average workforce for construction of Chimney Hollow Reservoir during the 2.5- to 5-year construction period would be 190 employees and 65 employees for Jasper East Reservoir. About $49 million of the $240 million total project cost would go to direct labor. If half of the project costs were spent in Larimer and Weld County, the Project would generate about $236 million in total economic output with 102 temporary jobs created. Total economic output in Grand County would be about $35 million and would create 30 temporary jobs. Jasper East Reservoir operation would require two new employees. Minority or low-income populations would not be disproportionately impacted at either reservoir site. The annualized net economic effect from a change in the number of preferred boating days (assuming a total loss of boating use if flows are outside of preferred flow range) on the Colorado River would result in a decrease in recreation revenue of about $4,189. The economic effect for the modeled year with the greatest decrease in the number of days in the preferred flow range in Big Gore Canyon and Pumphouse would be the same as No Action. The maximum increase in recreation value from WGFP diversions that reduce high flows to the preferred boating range also would be the same as the Proposed Action. No measurable economic impacts were identified from changes in angling opportunities or satisfaction. Water deliveries to the East Slope would generate a net increase of about 26 GWH of hydropower energy with a production value of $1.5 million.	Economic effects for Chimney Hollow Reservoir would be the same as Alternative 3. Construction of Rockwell Reservoir would require an average workforce during the 2.5- to 4.5-year construction period of 76 employees. For both reservoirs about $52 million of the $252 million total project cost would go to direct labor. Total economic output in Grand County would be about $41 million with 30 temporary jobs created. Rockwell Reservoir operation would require two new employees. Minority or low-income populations would not be disproportionately impacted at either reservoir site. The annualized net economic effect from a change in the number of preferred boating days (assuming a total loss of boating use if flows are outside of preferred flow range) on the Colorado River would result in a decrease in recreation revenue of about $3,248. The economic effect for the modeled year with the greatest decrease in the number of days in the preferred flow range in Big Gore Canyon and Pumphouse would be the same as the No Action. The maximum increase in recreation value from WGFP diversions that reduce high flows to the preferred boating range also would be about $331,000. No measurable economic impacts were identified from changes in angling opportunities or satisfaction. Water deliveries to the East Slope would generate a net increase of about 26 GWH of hydropower energy with a production value of $1.5 million.	The average workforce for construction of Dry Creek Reservoir during the 2.5- to 4.5-year construction period would be 210 employees and 92 employees at Rockwell Reservoir. About $60 million of the $288 million total project cost would go to direct labor. If half of the project costs were spent in Larimer and Weld County, the Project would generate about $236 million in total economic output with 112 temporary jobs created. Total economic output in Grand County would be about $51 million and would create 42 temporary jobs. Minority or low-income populations would not be disproportionately impacted at either reservoir site. The annualized net economic effect from a change in the number of preferred boating days (assuming a total loss of boating use if flows are outside of preferred flow range) on the Colorado River would result in a decrease in recreation revenue of about $2,335. The economic effect for the modeled year with the greatest decrease in the number of days in the preferred flow range in Big Gore Canyon and Pumphouse would be the same as Alternative 4. The maximum increase in recreation value from WGFP diversions that reduce high flows to the preferred boating range also would the same as Alternative 4. No measurable economic impacts were identified from changes in angling opportunities or satisfaction. Water deliveries to the East Slope would generate a net increase of about 29 GWH of hydropower energy with a production value of $1.7 million.

Table 2-7. Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
[ALTERNATIVE IMPACTS ARE BASED ON A COMPARISON WITH EXISTING CONDITIONS]	Enlargement of Ralph Price Reservoir by 13,000 AF for storage of the City of Longmont's Windy Gap water	A 90,000 AF Chimney Hollow Reservoir with prepositioning to allow storage of C-BT water in Chimney Hollow	A 70,000 AF Chimney Hollow Reservoir and a 20,000 AF Jasper East Reservoir	A 70,000 AF Chimney Hollow Reservoir and a 20,000 AF Rockwell Reservoir	A 60,000 AF Dry Creek Reservoir and a 30,000 AF Rockwell Reservoir
SURFACE WATER HYDROLOGY					
West Slope					
WG diversions (avg. existing conditions = 36,532 AF)					
WG diversions (avg. annual)	38,973 AF	40,791 AF	All hydrologic changes similar to Alternative 5.	All hydrologic changes similar to Alternative 5.	42,991 AF
WG diversions (avg. annual wet year)	62,118 AF	69,417 AF			71,669 AF
WG diversions (avg. annual dry year)	3,860 AF	3,860 AF			3,860 AF
Avg. annual decrease in Colo. R. flow blw. WG Res.	14%	20%			20%
Avg. annual decrease in Colo. R. flow blw. Blue R.[3]	11%	13%			13%
Avg. annual reduction in Willow Creek flow	9%	15%			13%
Change in Grand L./Shadow Mountain Res. storage	None	None			None
Average monthly decrease in Granby Res. storage	4 to 7%	9 to 16%			6 to 8%
East Slope					
Big Thompson R. at L. Estes (avg. mo. flow increase)	0 to 1%	3 to 4%	All hydrologic changes similar to Alternative 5.	All hydrologic changes similar to Alternative 5.	1 to 2%
Big Thompson R. at Loveland (max. mo. flow increase)	0 to 9.8 cfs	0 to 4.8 cfs			0 to 4.8 cfs
North St. Vrain Crk. (avg. monthly flow change)		No change			No change
St. Vrain Crk.-Longmont (max. mo. flow increase)	-42 cfs to +18 cfs				
Big Dry Crk.-Broomfield (max. mo. flow increase)	0.8 to 11.3 cfs	0.5 to 6.1 cfs			0.5 to 6.1 cfs
Coal Creek (max. mo. flow increase)	3.4 to 8.5 cfs	3.0 to 7.6 cfs			3.0 to 7.6 cfs
Avg. mo. decrease in Carter Lake storage	3.2 to 3.4 cfs	2.7 to 3.3 cfs			2.7 to 3.3 cfs
Avg. mo. decrease in Horsetooth Res. storage	0 to 1%	0 to 1%			0 to 1%
WGFP firm yield	0%	2 to 7%			0 to 3%
	579 AF	24,045 AF			23,967 AF
GROUND WATER HYDROLOGY Ground water levels	Predicted average monthly decreases in Colorado River stream stage of about 2.3 inches below the Windy Gap diversion and up to 11 inches below the Blue River; small changes in Willow Creek streamflow and small increases in East Slope river stream stage would measurably affect alluvial ground water levels only within tens of feet from streams. Predicted average decreases in Granby Reservoir, Carter Lake, and Horsetooth Reservoir water levels also would have negligible effects on local alluvial ground water levels and well production.	Effects similar to No Action, although the decrease in average monthly Colorado River stream stage of about 4 inches below the Windy Gap diversion and about 12 inches below the Blue River. Willow Creek streamflow decreases would be slightly more than No Action and streamflow increases in East Slope streams would be slightly more. Reservoir elevations also would be lower than No Action. Changes in water levels would have negligible effects on local alluvial ground water levels and well production near streams and reservoirs.	Effects similar to the Proposed Action although changes in stream stage would be slightly smaller and changes in reservoir levels would be slightly less.	Effects similar to the Proposed Action although changes in stream stage would be slightly smaller and changes in reservoir levels would be slightly less.	Effects similar to the Proposed Action although changes in stream stage would be slightly smaller and changes in reservoir levels would be slightly less.
Ground water quality	Predicted water quality changes in the Colorado River, Willow Creek, East Slope streams, and all affected reservoirs would result in minor to immeasurable effects to alluvial ground water quality.	Effects similar to No Action although surface water quality changes that influence ground water quality would be slightly greater.	Effects similar to No Action although surface water quality changes that influence ground water quality would be slightly greater.	Effects similar to No Action although surface water quality changes that influence ground water quality would be slightly greater.	Effects similar to No Action although surface water quality changes that influence ground water quality would be slightly greater.

[3] Note: Blue River flows to the Colorado River are understated because Denver's Blue River demands are 30,000 AF less than used in the hydrologic modeling for the WGFP. Thus, cumulative impacts to the Colorado River below the Blue River confluence are expected to be less than modeled.

Table 2-7 (cont'd). Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
STREAM MORPHOLOGY AND FLOODPLAINS **West Slope**	Colorado River channel maintenance flows (0.8 x 1.5- to 25-year flows) below Windy Gap Reservoir would occur during up to 28% less years (0.8 x 1.5- to 2-year flows) or as low as 4.5% less years (5- to 10-year flows) . At the Kremmling gage, channel maintenance flows would occur during up to 15% less years (0.8 x 1.5- to 2-year flows) or as low as 3% less years (10- to 25-year flows). Projected changes in peak flows and channel maintenance flows are unlikely to substantially affect channel morphology or change sediment transport. Flushing flows would remain adequate to transport fine sediment and prevent deposition. Changes in the magnitude, timing, and frequency of Granby Reservoir spills are not expected to alter channel morphology or sediment transport. Willow Creek flow equal to or greater than the 2-year peak flow discharge would decrease slightly. Adequate flow should be available to maintain channel capacity, provide periodic scouring, and transport sediment in the Colorado River and Willow Creek. The potential for flooding on the Colorado River and Willow Creek would decrease with lower flows.	Effects similar to No Action except that Colorado River channel maintenance flows would occur slightly less frequently. Note: Blue River flows to the Colorado River are understated because Denver's Blue River demands are 30,000 AF less than used in the hydrologic modeling for the WGFP. Thus, cumulative impacts to Colorado River channel maintenance flows below the Blue River confluence are expected to be less than modeled.	Effects similar to No Action except that Colorado River channel maintenance would occur slightly less frequently. Jasper East Reservoir could potentially capture flood flows in this small watershed.	Effects similar to No Action except that Colorado River channel maintenance flows would occur slightly less frequently. Rockwell Reservoir could potentially capture flood flows in this small watershed.	Effects similar to No Action except that Colorado River channel maintenance flows would occur slightly less frequently. Rockwell Reservoir could potentially capture flood flows in this small watershed.
East Slope	Predicted changes in North St. Vrain Creek and St. Vrain Creek flow upstream of Lyons would be well within the historical range of flow and are unlikely to measurably affect stream morphology or sediment transport. A larger Ralph Price Reservoir could reduce the potential for downstream flooding. Relatively small increases in flow in the Big Thompson River and below WWTPs in St. Vrain Creek, Big Dry Creek, and Coal Creek are unlikely to measurably affect channel morphology. These flow increases would not substantially increase the risk of flooding.	Effects would be similar to No Action except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow Reservoir could potentially capture flood flows in this small watershed.	Effects would be similar to No Action except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow Reservoir could potentially capture flood flows in this small watershed.	Effects would be similar to No Action except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow Reservoir could potentially capture flood flows in this small watershed.	Effects would be similar to No Action except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Dry Creek Reservoir could potentially capture flood flows in this small watershed.

Table 2-7 (cont'd). Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
SURFACE WATER QUALITY **West Slope** **Abbreviations:** TP = total phosphorus P = phosphorus TN = total nitrogen Mn = Manganese DO = dissolved oxygen TOC = total organic carbon Chlorophyll *a* = a measure of algae concentration Change in clarity = % change in Secchi Disk depth Trophic state = a measure of productivity	**Colorado River.** With average July 25 flows: DO would decrease <0.1 mg/L, ammonia would increase 9.5 µg/L, and inorganic P would decrease up to 4.6 µg/L. Assuming diversions to the minimum 90 cfs streamflow on July 25: DO would decrease 0.5 mg/L, ammonia would increase 16.3 µg/L, and inorganic P would decrease up to 4.0 µg/L. Modeling indicates an increase in the potential for exceedance of chronic and acute temperature standards for aquatic life between Windy Gap and the Williams Fork from mid-July to August. Temperature modeling indicates annual increases in chronic temperature exceedances as high as 3 additional weeks above the WAT standard relative to existing conditions and as high as 3 additional days above the DM standard relative to existing conditions. Temperature standard exceedances were modeled to increase from existing conditions in 3 out of the 15 years evaluated. Water quality would remain within standards for other parameters, with the exception of increased potential for exceeding the temperature standard or being below the DO spawning standard at several locations when diversions reduce flow to the minimum streamflow. **Willow Creek.** Less than a 0.2°C decrease in temperature and a slight increase in nutrient and metal concentrations. Water quality would remain within standards. **Granby Reservoir.** TP concentrations would decrease 3.2%; TN would increase 3.1%; and no change in average chlorophyll *a*, clarity, trophic state, or minimum DO. Dissolved manganese concentrations would continue to exceed the standard. **Shadow Mountain Reservoir.** TP concentrations would decrease 1.6%; TN would increase 2.9%; and no change in average chlorophyll *a*, clarity, trophic state, or minimum DO. No change in manganese concentrations, which currently exceed the standard. **Grand Lake.** TP concentrations would decrease 1.2%; TN would increase 1.6%; and no change in average chlorophyll *a*, clarity, or trophic state; and minimum DO would decrease 11.1%. Lower DO would contribute to continued exceedance of manganese standard.	**Colorado River.** With average July 25 flows: DO would decrease 0.1 mg/L, ammonia would increase 11.1 µg/L, and inorganic P would decrease up to 3.8 µg/L. Assuming diversions to the minimum 90 cfs streamflow on July 25: DO would decrease 0.6 mg/L, ammonia would increase 16.7 µg/L, and inorganic P would increase up to 3.7 µg/L. Modeling indicates an increase in the potential for exceedance of the chronic and acute temperature standards for aquatic life between Windy Gap and the Williams Fork from mid-July to August. Temperature modeling indicates annual increases in chronic temperature exceedances as high as 3 additional weeks above the WAT standard relative to existing conditions and as high as 4 additional days above the DM standard relative to existing conditions. Temperature standard exceedances were modeled to increase from existing conditions in 3 out of the 15 years evaluated. Water quality standards for other parameters would be met except as noted for No Action. **Willow Creek.** Similar to No Action with slightly higher nutrient and metal concentrations. Water quality would remain within standards. **Granby Reservoir.** TP concentrations would increase 2.4%, TN would increase 3.8%, no change in average chlorophyll *a*, clarity, or trophic state, minimum DO would decrease 4.4%. Dissolved manganese concentrations would continue to exceed the standard. **Shadow Mountain Reservoir.** TP concentrations would increase 3.2%, TN would increase 3.6%, no change in average chlorophyll *a*, clarity, or trophic state. Minimum DO would decrease 1.4%. Decrease in DO would contribute to continued exceedance of manganese standard. **Grand Lake.** TP concentrations would increase 4.8%, TN would increase 3.2%, average chlorophyll *a* would increase 2.0%, clarity would decrease 3.8%, no change in trophic state, and minimum DO would decrease 7.4%. Lower DO would contribute to continued exceedance of manganese standard.	Water quality effects on the West Slope would be similar to Alternative 5. **Jasper East Reservoir.** Not modeled for the cumulative effects analysis, but would be similar to Rockwell Reservoir in Alternative 5.	Water quality effects on the West Slope would be similar to Alternative 5.	**Colorado River.** With average July 25 flows: DO would decrease 0.1 mg/L, ammonia would increase 10.7 µg/L, and inorganic P would decrease up to 4.7 µg/L. Assuming diversions to the minimum 90 cfs streamflow on July 25: DO would decrease 0.6 mg/L, ammonia would increase 16.4 µg/L, and inorganic P would decrease up to 4.7 µg/L. Modeling indicates an increase in the potential for exceedance of the chronic and acute temperature standards for aquatic life between Windy Gap and the Williams Fork from mid-July to August. Temperature standard exceedances would be slightly less than the Proposed Action. Water quality standards for other parameters would be met except as noted for No Action. **Willow Creek.** Similar nutrient concentrations as the Proposed Action and slightly higher metal concentrations. Water quality would remain within standards. **Granby Reservoir.** TP concentrations would decrease 13.5%; TN would increase 4.8%; average chlorophyll *a* would decrease 2.4%; and no change in clarity, trophic state, or minimum DO. Dissolved manganese concentrations would continue to exceed the standard. **Shadow Mountain Reservoir.** TP concentrations would decrease 9.7%, TN would increase 4.0%, average chlorophyll *a* would decrease 5.3%, clarity would improve 5.0%, and no change in trophic state or minimum DO. No change in manganese concentrations, which currently exceed the standard. **Grand Lake.** TP concentrations would decrease 7.2%, TN would increase 3.6%, average chlorophyll *a* would decrease 6.1%, clarity would improve 3.8%, no change in trophic state, and minimum DO would decrease 5.6%. Lower DO would contribute to continued exceedance of the manganese standard. **Rockwell Reservoir.** Predicted to be mesotrophic and retain some TN and P, reducing nutrient delivery to Granby Reservoir.

Table 2-7 (cont'd). Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
SURFACE WATER QUALITY **East Slope** Note: Water quality would not exceed standards in East Slope streams or reservoirs except as noted.	**East Slope Streams.** Cumulative water quality effects to North St. Vrain Creek, St. Vrain Creek, Big Thompson River, Big Dry Creek, Coal Creek, and the Cache la Poudre River would be nearly identical to direct effects summarized in Table 2-6. **Carter Lake.** No change in TP concentration or temperature; TN would increase 2.2%; no change in average chlorophyll *a*, clarity, or trophic state; and a slight decrease in DO. **Horsetooth Reservoir.** No change in TP concentrations; TN would increase 3.3%; average chlorophyll *a* would increase 2.9%; no change in clarity, temperature, or trophic state; and a slight decrease in DO. Lower DO concentrations would contribute to continued exceedance of the manganese standard. TOC may increase. **Ralph Price Reservoir.** TP concentrations would decrease 3.9%, TN would decrease 5.9%, average chlorophyll *a* would decrease 33%, no change in clarity or trophic state, and a slight increase in DO concentration.	**East Slope Streams.** Cumulative water quality effects to St. Vrain Creek, Big Thompson River, Big Dry Creek, Coal Creek, and the Cache la Poudre River would be nearly identical to direct effects summarized in Table 2-6. There would be no effect to North St. Vrain Creek. **Carter Lake.** TP concentrations would increase 5.1%; TN would increase 4.9%; average chlorophyll *a* would increase 11.1%; no change in clarity, temperature, or trophic state; and a slight decrease in DO concentration. **Horsetooth Reservoir.** TP concentrations would increase 6.1%, TN would increase 6.6%, average chlorophyll *a* would increase 8.6%, clarity would decrease 3.8%, no change in trophic state or temperature, and a slight decrease in DO. Lower DO would contribute to continued exceedance of the manganese standard. TOC may increase. **Chimney Hollow Reservoir.** Predicted to be oligotrophic and slightly lower water quality than Alternatives 3 and 4.	Similar water quality effects on the East Slope as Alternative 5.	Similar water quality effects on the East Slope as Alternative 5.	**East Slope Streams.** Same as the Proposed Action. **Carter Lake.** TP concentrations would decrease 2.0%; TN would increase 4.4%; average chlorophyll *a* would increase 5.6%; no change in clarity, temperature, or trophic state; and a slight decrease in DO. **Horsetooth Reservoir.** TP concentrations would increase 3.0%; TN would increase 6.2%; average chlorophyll *a* would increase 2.9%; no change in clarity, temperature, or trophic state; and a slight decrease in DO. Lower DO concentrations would contribute to continued exceedance of the manganese standard. TOC may increase. **Dry Creek Reservoir.** Predicted to be oligotrophic.
AQUATIC RESOURCES **West Slope**	Effects on Colorado River aquatic habitat would be greater than described for the Proposed Action because even though less water would be available for Windy Gap diversions, reasonably foreseeable actions would divert more water. Temperature standard exceedances were modeled to increase from existing conditions in 3 out of the 15 years evaluated. Exceedance of the chronic and acute temperature standards were modeled to occur at a slightly lower frequency and duration than the Proposed Action. Higher stream temperatures may result in less fit individuals and possible fish mortality, particularly if the acute temperature standard is exceeded frequently. Granby Reservoir releases as part of the 10825 Project would help moderate higher stream temperatures in late summer. Aquatic life impacts on Willow Creek would be slightly less than the Proposed Action.	WGFP diversions would be lower in the future with reasonably foreseeable actions: however, cumulative effects to aquatic resources in the Colorado River would be greater than direct effects. The greatest effect to trout habitat on the Colorado River would occur between Windy Gap Reservoir and Williams Fork. Adult rainbow trout would be more affected than brown trout. The largest decrease in habitat would occur in late August and the greatest increase in habitat would occur in early June. Predicted maximum periodic decreases in fish habitat are unlikely to impact fish populations at most locations. The potential for exceedance of the aquatic life temperature standard would increase at lower flows in the summer. Temperature standard exceedances were modeled to increase from existing conditions in 3 out of the 15 years evaluated, which may result in less fit individuals and possible fish mortality if the acute temperature standard is exceeded frequently. Granby Reservoir releases as part of the 10825 Project would help moderate higher stream temperatures in late summer.	Effects would be similar to the Proposed Action.	Effects would be similar to the Proposed Action.	Effects would be similar to the Proposed Action.

Table 2-7 (cont'd). Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
AQUATIC RESOURCES (CONT'D) **West Slope**		Willow Creek rainbow and brown trout habitat would decrease primarily in July. Streamflow changes are unlikely to affect macroinvertebrate populations. No change in fish populations are predicted for the Three Lakes.			
East Slope	Projected increases in flow in the Big Thompson River, Big Dry Creek, and Coal Creek would slightly enhance fish habitat. A slight reduction in fish habitat in North St. Vrain Creek and St. Vrain Creek above Lyons is possible with reduced flow in some summer months, but higher flow in fall and winter would benefit fish habitat. Changes in reservoir storage and water quality in Carter Lake and Horsetooth Reservoir would not measurably impact fish habitat. A larger Ralph Price Reservoir would benefit fish, but productivity would remain low.	Effects to East Slope fish in streams and reservoirs would be similar to No Action except there would be no impact in North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow could support a fishery similar to other Front Range reservoirs.	Effects would be similar to the Proposed Action. Jasper East Reservoir would support a fishery, but large fluctuations in water levels may reduce productivity.	Effects would be similar to the Proposed Action. Rockwell Reservoir would support a fishery, but large fluctuations in water levels may reduce productivity.	Effects would be similar to the Proposed Action. Dry Creek Reservoir would support a fishery similar to Chimney Hollow Reservoir. Rockwell Reservoir would support a fishery, but large fluctuations in water levels may reduce productivity.
VEGETATION	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative vegetation effects. Colorado River streamflow would decrease with anticipated reasonably foreseeable actions. However, impacts to riparian vegetation from reduced flows on the Colorado River are expected to be negligible based on stream morphology, small changes in stream stage, and ground water levels. Similar minor effects are possible for lower flows in Willow Creek and higher flows in East Slope streams. Water levels would be lower at Granby Reservoir, Carter Lake, and Horsetooth Reservoir, but would fall within the historical range of operations and are unlikely to affect the limited riparian vegetation bordering these reservoirs.	Larimer County development of recreation facilities on Chimney Hollow Open Space lands adjacent to the reservoir would contribute a minor cumulative disturbance to vegetation in the Chimney Hollow basin. Impacts to riparian vegetation would be similar to No Action, although the decrease in Colorado River and Willow Creek streamflow would be greater, as would the decrease in water levels in existing reservoirs.	Effects would be similar to the Proposed Action at Chimney Hollow. Planned residential development on a portion of a 980-acre parcel in the Jasper East Reservoir basin would add to the cumulative vegetation disturbance from reservoir construction. Impacts to riparian vegetation would be similar to No Action, although the decrease in Colorado River and Willow Creek streamflow would be greater, as would the decrease in water levels in existing reservoirs.	Effects would be similar to the Proposed Action at Chimney Hollow. No reasonably foreseeable land-based actions were identified in the Rockwell Reservoir basin that would contribute to cumulative effects. Impacts to riparian vegetation would be similar to No Action, although the decrease in Colorado River and Willow Creek streamflow would be greater, as would the decrease in water levels in existing reservoirs.	Development of Chimney Hollow open space to the north of Dry Creek Reservoir would contribute minor additional impacts to vegetation. Impacts to riparian vegetation would be similar to No Action, although the decrease in Colorado River and Willow Creek streamflow would be greater, as would the decrease in water levels in existing reservoirs.

Table 2-7 (cont'd). Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
WETLANDS AND OTHER WATERS	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative wetland effects.	Development of Chimney Hollow Open Space is unlikely to contribute cumulative effects to wetlands.	Wetland impacts from development of C-Lazy-U Preservers near Jasper East Reservoir could contribute to cumulative wetland impacts, but no specific impacts have been identified.	Wetland effects would be similar to the Proposed Action for Chimney Hollow Reservoir. No reasonably foreseeable land-based actions near Rockwell Reservoir were identified that would contribute to cumulative wetland effects.	Chimney Hollow Open Space development is unlikely to contribute cumulative wetland impacts to impacts from Dry Creek Reservoir construction. No reasonably foreseeable land-based actions near Rockwell Reservoir were identified that would contribute to cumulative wetland effects.
WILDLIFE	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative wildlife effects.	Reasonably foreseeable land developments within 5 miles of Chimney Hollow Reservoir could result in the incremental loss of 1,440 acres of wildlife habitat, for a total cumulative loss of 2,240 acres of wildlife habitat. Cumulative loss of elk winter range would be 866 acres, loss of mule deer winter range would be 2,090 acres, and loss of bald eagle winter range would be 1,382 acres.	Reasonably foreseeable land developments within 5 miles of Chimney Hollow Reservoir could result in a total cumulative loss of 2,115 acres of wildlife habitat. The cumulative loss of elk winter range would be 741 acres, mule deer winter range would be 1,965 acres, and a similar amount of bald eagle winter range as the Proposed Action. Reasonably foreseeable land development within 5 miles of Jasper East Reservoir could result in the incremental loss of 2,570 acres of wildlife habitat, for a total cumulative loss of about 3,005 acres of habitat. The cumulative loss of elk winter range would be 1,254 acres, moose winter range would be 327 acres, and bald eagle winter range would be 222 acres. A cumulative loss in sage grouse habitat is also likely, but unquantified.	Wildlife effects at Chimney Hollow would be the same as Alternative 3. Reasonably foreseeable land development within 5 miles of Rockwell East Reservoir could result in the incremental loss of 4,770 acres of wildlife habitat, for a total cumulative loss of about 5,105 acres of habitat. The cumulative loss of elk winter range would be 3,173 acres. A cumulative loss of 740 acres of sage grouse habitat could result in the complete loss of this declining population.	Reasonably foreseeable land developments within 5 miles of Dry Creek Reservoir could result in the incremental loss of 1,460 acres of wildlife habitat, for a total cumulative loss of 2,091 acres of wildlife habitat. The cumulative loss of elk winter range would be 682 acres, mule deer winter range would be 1,934 acres, and bald eagle winter range would be 1,574 acres. Reasonably foreseeable land development within 5 miles of Rockwell Reservoir could result in a total cumulative loss of about 5,196 acres of wildlife habitat. The cumulative loss of elk winter range would be 3,197 acres. A cumulative loss of 784 acres of sage grouse habitat could result in the complete loss of this declining population.
THREATENED AND ENDANGERED	Same as the Proposed Action	WGFP Colorado River depletions would be lower and impacts to Colorado River endangered fish would be less. Reasonably foreseeable actions would undergo separate ESA compliance. No other cumulative effects have been identified.	Effects would be the same as the Proposed Action.	Effects would be the same as the Proposed Action, but incremental effects to potential lynx habitat are possible with reasonably foreseeable future land development. This may affect, but is unlikely to adversely affect lynx.	Effects would be the same as the Proposed Action, but incremental effects to potential lynx habitat are possible with reasonably foreseeable future land development. This may affect, but is unlikely to adversely affect lynx.
GEOLOGY	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative geology effects.	Effects would be the same as No Action.	Effects would be the same as No Action.	Effects would be the same as No Action.	Effects would be the same as No Action.
SOILS	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative soil effects.	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative soil effects.	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative soil effects.	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative soil effects.	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative soil effects.
AIR QUALITY	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative air quality effects.	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative air quality effects.	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative air quality effects.	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative air quality effects.	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative air quality effects.

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Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
NOISE	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative noise effects.	Recreation on Larimer County open space lands adjacent to Chimney Hollow would result in a minor long-term increase in noise.	Effects would be the same as the Proposed Action.	Effects would be the same as the Proposed Action.	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative noise effects.
LAND USE	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative land use effects.	Reasonably foreseeable residential land developments on 1,440 acres within 5 miles of the Chimney Hollow Reservoir site would contribute to the cumulative loss in undeveloped land use in the region. Larimer County development of Chimney Hollow Open Space would contribute to a cumulative increase in recreation-based land use.	Effects would be similar to the Proposed Action for Chimney Hollow. Future planned residential and commercial land development on 1,590 acres within 5 miles of Jasper East Reservoir would contribute to a possible cumulative loss in agricultural land use and a reduction in undeveloped open land.	Effects would be similar to the Proposed Action for Chimney Hollow. Future planned residential, commercial, and mixed land development on 4,770 acres within 5 miles of Rockwell Reservoir would contribute to a possible cumulative loss in agricultural land use and a reduction in undeveloped open land.	Reasonably foreseeable residential land developments on 1,460 acres within 5 miles of the Dry Creek Reservoir site would contribute to the cumulative loss of undeveloped land in the region. Rockwell Reservoir land use effects would be similar to Alternative 4.
RECREATION **West Slope**	Impacts to preferred boating flows in Big Gore Canyon and Pumphouse would be slightly less, but similar to the Proposed Action. Preferred kayaking flows in Byers Canyon (>400 cfs) would occur about 11 days less per year in 25 years out of the 47-year study period[3]. Predicted effects to aquatic habitat, as discussed for Aquatic Resources, are not predicted to measurably impact sport fishing in the Colorado River or Willow Creek. There would be no change in water levels in Grand Lake and Shadow Mountain Reservoir that would affect recreation. Recreation in Grand Lake and Shadow Mountain Reservoir would not be affected. Granby Reservoir surface area in the summer would decrease less than 3% on average, and boat ramps would remain accessible except in average and dry years when water levels could drop below the Arapaho Bay boat ramp in May.	Preferred boating flows in Big Gore Canyon (850 to 1,250 cfs) would average 2 days or less than existing conditions in 34 years out of the 47-year study period. For the Pumphouse reach, preferred boating flows (1,100 to 2,200 cfs) would occur about 5 days less per year on average in 40 years out of the 47-year study period. Preferred kayaking flows in Byers Canyon (>400 cfs) would occur about 12 days less per year in 25 years out of the 47-year study period[3]. Predicted effects to aquatic habitat, as discussed for Aquatic Resources, are not predicted to measurably impact sport fishing in the Colorado River or Willow Creek. There would be no change in water levels in Grand Lake and Shadow Mountain Reservoir that would affect recreation. Granby Reservoir surface area would decrease 7% on average in the summer. Boat ramps would remain accessible except in average and dry years when water levels could drop below the Arapaho Bay and Stillwater boat ramps in May.	Effects would be similar to Alternative 5.	Effects would be similar to Alternative 5.	Preferred boating flows in Big Gore Canyon (850 to 1,250 cfs) would average 2 days or less than existing conditions in 34 years out of the 47-year study period. For the Pumphouse reach, preferred boating flows (1,100 to 2,200 cfs would occur about 2 days less per year on average in 40 years out of the 47-year study period. Preferred kayaking flows in Byers Canyon (>400 cfs) would occur about 13 days less per year in 25 years out of the 47-year study period[3]. Predicted effects to aquatic habitat, as discussed for Aquatic Resources, are not predicted to measurably impact sport fishing in the Colorado River or Willow Creek. There would be no change in water levels in Grand Lake and Shadow Mountain Reservoir that would affect recreation. Effects would be similar to the Proposed Action except Granby Reservoir surface area during the summer would decrease less than 4% on average.

Table 2-7 (cont'd). Comparison of cumulative effects by alternative.

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RECREATION **East Slope**	Kayaking opportunities in North St. Vrain Creek below Longmont Reservoir would be reduced in July when flows drop below 150 cfs. Increased flows in the Big Thompson River would maintain acceptable kayaking flows. Recreation at Ralph Price Reservoir would be suspended for about 2 years until construction is completed. The water surface area in Carter Lake and Horsetooth Reservoir would change little on average. Boat ramp access could be reduced in dry years.	No effects on North St. Vrain flows or kayaking. Increased flows in the Big Thompson River would maintain acceptable kayaking flows. The average monthly water surface area in Carter Lake would decrease less than 1% and Horsetooth Reservoir surface area would decrease up to 4%. Water levels could drop below the South Bay-South boat ramp in September, and in dry years access to several boat ramps could be affected. Larimer County development of open space at Chimney Hollow and on adjacent county lands would result in a cumulative increase in recreation opportunities in the area.	Effects would be the same as Alternative 5.	Effects would be the same as Alternative 5.	Effects would be similar to the Proposed Action except the average monthly water surface area at Horsetooth Reservoir would decrease less than 2%.
CULTURAL RESOURCES	Reasonably foreseeable land-based actions have not been identified.	Although reasonably foreseeable land-based actions have not been identified, new land developments near the Chimney Hollow Reservoir site could result in cumulative effects to eligible or potentially eligible cultural resources within the APE. In addition, Larimer County Parks and Open Lands have acquired acreage adjacent to the Chimney Hollow Reservoir for future recreation use.	Although reasonably foreseeable land-based actions have not been identified, new land developments near the Chimney Hollow and Jasper East Reservoir sites could result in cumulative effects to eligible or potentially eligible cultural resources within the reservoir APE. In addition, Larimer County Parks and Open Lands have acquired acreage adjacent to the Chimney Hollow Reservoir for future recreation use.	Although reasonably foreseeable land-based actions have not been identified, new land developments near the Chimney Hollow and Rockwell/Mueller Creek Reservoir sites could result in cumulative effects to eligible or potentially eligible cultural resources within the reservoir APE. In addition, Larimer County Parks and Open Lands have acquired acreage adjacent to the Chimney Hollow Reservoir for future recreation use.	Although reasonably foreseeable land-based actions have not been identified, new land developments near the Chimney Hollow and Dry Creek Reservoir sites could result in cumulative effects to eligible or potentially eligible cultural resources within the reservoir APE. In addition, Larimer County Parks and Open Lands have acquired acreage adjacent to the Chimney Hollow and Dry Creek Reservoirs for future recreation use.
VISUAL RESOURCES	No reasonably foreseeable land-based actions have been identified that would contribute to cumulative visual quality effects. Lower summer water levels in Granby Reservoir would increase the amount of visible shoreline about 160 acres more than existing conditions. Small decreases in Carter Lake and Horsetooth Reservoir storage are unlikely to be noticeable.	Reasonably foreseeable land developments and Larimer County development of Chimney Hollow Open Space would result a cumulative change to the local landscape. Lower summer water levels in Granby Reservoir would increase the amount of visible shoreline about 348 acres more than existing conditions. Small decreases in Carter Lake storage are unlikely to be noticeable. Additional exposed shoreline at Horsetooth Reservoir would be less than 72 acres on average in the summer.	Visual effects at Chimney Hollow would be similar to the Proposed Action. Reasonably foreseeable land developments near Jasper East Reservoir would result in a cumulative change to the local landscape. Granby Reservoir, Carter Lake, and Horsetooth Reservoir effects would be similar to Alternative 5.	Visual effects at Chimney Hollow would be the same as Alternative 3. Reasonably foreseeable land developments near Rockwell Reservoir would result a cumulative change to the local landscape. Granby Reservoir, Carter Lake, and Horsetooth Reservoir effects would be similar to Alternative 5.	Reasonably foreseeable land developments near Dry Creek Reservoir would result a cumulative change to the local landscape. Cumulative visual effects of Rockwell Reservoir would be similar to Alternative 4. Lower summer water levels in Granby Reservoir would increase the amount of visible shoreline by about 166 acres more than existing conditions. Small decreases in Carter Lake storage are unlikely to be noticeable. Additional exposed shoreline at Horsetooth Reservoir would be less than 25 acres on average in the summer.

Table 2-7 (cont'd). Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action Enlarge Ralph Price Reservoir	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
SOCIOECONOMICS	The annualized net economic effects from a change in the number of preferred boating days (assuming a total loss of boating use if flows are above or below the preferred flow range) on the Colorado River in Big Gore Canyon and the Pumphouse reach would be a decrease of about $135,000 in recreation revenue. The economic effects for the modeled year with the greatest decrease in the number of days in the preferred flow range could result in a loss of about 897 user days for commercial rafting in Big Gore Canyon with a value of about $65,000, and a loss of about 25,200 user days for boating in Pumphouse with a value of about $1,840,000. The maximum increase in recreation value from Windy Gap diversions that reduce high flows to the preferred boating range would be about $1,067,000. No measurable economic impacts were identified from changes in angling opportunities or satisfaction. Water deliveries to the East Slope would generate a net increase of about 15 GWH of hydropower energy with a production value of $850,000.	Construction of Chimney Hollow Reservoir could result in temporary cumulative increases in employment and income. The annualized net economic effects from a change in the number of preferred boating days (assuming a total loss of boating use if flows are above or below the preferred flow range) on the Colorado River could result in a decrease in recreation revenue of about $149,000. The economic effects for the modeled year with the greatest decrease in the number of days in the preferred flow range could result in a loss of about 1,200 user days for commercial rafting in Big Gore Canyon with a value of about $88,000, and a loss of about 25,200 user days for boating in Pumphouse with a value of about $1,840,000. The maximum annual increase in recreation value from WGFP diversions that reduce high flows to the preferred boating range also would be about $1,081,000. No measurable economic impacts were identified from changes in angling opportunities or satisfaction. Water deliveries to the East Slope would generate a net increase of about 21 GWH of hydropower energy with a production value of $1.2 million.	Future local land developments occurring during Chimney Hollow Reservoir and Jasper East Reservoir construction could result in temporary cumulative increases in employment and income. The annualized net economic effects from a change in the number of preferred boating days (assuming a total loss of boating use if flows are above or below the preferred flow range) on the Colorado River could result in a decrease in recreation revenue of about $144,000. The economic effects for the modeled year with the greatest decrease in the number of days in the preferred flow range in Big Gore Canyon and Pumphouse would be the same as the Proposed Action. The maximum annual increase in recreation value from WGFP diversions that reduce high flows to the preferred boating range would be about $1,015,000. No measurable economic impacts were identified from changes in angling opportunities or success. Water deliveries to the East Slope would generate a net increase of about 21 GWH of hydropower energy with a production value of $1.2 million.	Future local land developments occurring during Chimney Hollow Reservoir and Rockwell Reservoir construction could result in temporary cumulative increases in employment and income. The annualized net economic effects from a change in the number of preferred boating days (assuming a total loss of boating use if flows are above or below the preferred flow range) on the Colorado River could result in a decrease in recreation revenue of about $144,000. The economic effects for the modeled year with the greatest decrease in the number of days in the preferred flow range in Big Gore Canyon and Pumphouse would be the same as the Proposed Action. The maximum annual increase in recreation value from WGFP diversions that reduce high flows to the preferred boating range would be about $1,015,000. No measurable economic impacts were identified from changes in angling opportunities or success. Water deliveries to the East Slope would generate a net increase of about 21 GWH of hydropower energy with a production value of $1.5 million.	Future local land developments occurring during Dry Creek Reservoir and Rockwell Reservoir construction could result in temporary cumulative increases in employment and income. The annualized net economic effects from a change in the number of preferred boating days (assuming a total loss of boating use if flows are above or below the preferred flow range) on the Colorado River could result in a decrease in recreation revenue of about $144,000. The economic effects for the modeled year with the greatest decrease in the number of days in the preferred flow range in Big Gore Canyon and Pumphouse would be the same as the Proposed Action. The maximum annual increase in recreation value from WGFP diversions that reduce high flows to the preferred boating range would be about $1,015,000. No measurable economic impacts were identified from changes in angling opportunities or success. Water deliveries to the East Slope would generate a net increase of about 25 GWH of hydropower energy with a production value of $1.4 million.