Summary
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Differences exist between documents.

New Document:	Old Document:
FinalEIS	ChatfieldReallocationFinalDraftForReview.
84 pages (3.77 MB)	86 pages (7.59 MB)
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Used to display results.	

Get started: first change is on page 1.

No pages were deleted

How to read this report

Highlight indicates a change.
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 indicates pages were changed.
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2. ALTERNATIVES

The CEQ regulations for implementing NEPA require that an EIS "rigorously explore and objectively evaluate all reasonable alternatives" including the No Action Alternative [40 CFR 1502.14(a) and (d)]. In determining the scope of alternatives to be considered for meeting the purpose and need, the CEQ guidance states: "reasonable alternatives include those that are practical or feasible from the technical and economic standpoint using common sense" (CEQ, 1978). The Corps' regulations in 33 CFR 320.4(a)(2)(ii) require an evaluation that considers "the practicability of using reasonable alternative locations and methods to accomplish the objective of the proposed structure or work." Thus, under NEPA, an EIS provides for full disclosure of potential effects of a proposed federal action and of all reasonable alternatives to that proposal to allow for an informed decision made in the public's interest.

This chapter discusses the problems and opportunities that surround the issue of reallocating storage in Chatfield Reservoir. Considering the complexity of water use and water rights in Colorado, the chapter provides some background information to set the stage for describing the components of the alternatives as well as the impact analysis discussions presented in Chapter 4. Readers are referred to the Water Supply Demand Analysis in Appendix C for additional information on the technical and legal framework for water use. This chapter provides a description of the alternative selection process, including the initial screening of alternatives from a large group of potential water supply concepts. This chapter also provides a detailed description of each of the alternatives and their various components for addressing the purpose and need of the project; gives a description of the methodologies used to evaluate the different alternatives; assesses potential economic and environmental impacts; and, lastly, provides a brief summary of the findings detailed in the alternatives' impact analysis presented in Chapter 4.

2.1 Problems and Opportunities

The first step in the planning process, per USACE regulations, is the identification of problems (i.e., undesirable conditions to be solved) and opportunities (positive conditions to be improved) that the planning team seeks to address (ER 1105-2-100, Appendix E, p. E-2). Problems and opportunities encompass current as well as future conditions and are defined in terms of their nature, cause, location, dimensions, origin, timeframe, and importance. The water resource problem to be addressed is the inadequate supply of water to meet increasing water supply demand in the Denver Metro area over the next 50 years due to the combined effects of population growth, depletion of nonrenewable groundwater sources, and agricultural water providers' need for augmentation water for alluvial wells.

Problems

1. Population growth has resulted in increased M&I water demands:

   In the past, the Colorado water picture has been difficult to bring into focus given the multitude of individual water users and providers, the voluminous information available, and the complexity of developing water supply solutions. As a means to address the collective water communities' desire to understand its water supply situation, the CWCB undertook, at the direction of the Colorado General Assembly, the SWSI in 2003-2004 and 2009 to identify water

supply needs now and in the future and inventory current and future projects and processes that local and regional entities are planning to fulfill the water supply needs.

The SWSI report first looked at the predicted increase in the state's population. Colorado's population is projected to double between the years 2000 and 2050 (CWCB, 2009). Similar growth rates are expected during the same time period within the South Platte River Basin, which includes the Denver Metro area (CWCB, 2004, 2009). Based upon the rates of growth, expected per capita M&I water use, and a specified level of long-term water conservation by the area's M&I water providers, SWSI predicted that the South Platte River Basin would require about 1.2 million acre-feet of water by 2050 for M&I purposes (medium scenario demand projection, CWCB, 2009). This volume represents a 409,000 acre-foot increase over current (i.e., 2000) water supplies in the basin. Local and regional projects and processes, as reported in SWSI, are predicted to provide for about 78 percent of the identified M&I water supply gap, leaving approximately 90,000 acre-feet of unmet needs.

The 12 prospective recipients of storage space in Chatfield Reservoir (i.e., "water providers") each have immediate and future water needs influencing their actions to acquire new Chatfield storage space. The municipal water providers must supply water to the growing metropolitan area population and are therefore stretched beyond current supplies by the water provider's growth projections referenced above. The water providers project their demand to increase from 250,000 acre-feet in 2010 to at least 340,000 acre-feet in 2050. The drought of 2002 to 2007 emphasized to water providers that, despite increased levels of water conservation measures, their existing water supplies have a greater vulnerability to periods of water scarcity than previously realized and that additional water development activities, including expanding existing surface water storage facilities, are urgently needed to provide adequate water for the growing population during future droughts.

2. Water need has resulted in the reliance of some municipal water providers on nonrenewable Denver Basin groundwater:

Ten municipal water providers seeking Chatfield storage space, collectively serving over 200,000 residents and businesses in the south portion of the Denver Metro area, are presently using a high percentage of nonrenewable Denver Basin groundwater supplies as their primary water source until more reliable surface water supplies can be developed. The use of Denver Basin groundwater for municipal water supplies has been determined in a recent study to be an unacceptable long-term supply, a path of severely increasing costs and currently reduced water availability and reliability that will continue to worsen in the future (Black & Veatch et al., 2003). The water providers who are now using Denver Basin groundwater have a need to reduce their dependency on this nonrenewable water source if the long-term availability of these sources during periods of drought is to be preserved. This water is legally reusable; however, the practical ability to reuse usually involves recapture (either downstream or upstream by exchange) and storage of effluent after discharge to a stream.

3. Agricultural water providers need augmentation water for alluvial wells:

The agricultural water providers seeking Chatfield storage space are also facing an urgent water supply situation. Numerous agricultural water wells of these providers are located in the alluvium adjacent to the South Platte River. These wells generally were constructed in the 1950s or later and have relatively junior water rights. Owners of senior water rights downstream from the well users normally place a call (or request water) during the irrigation season. The agricultural water well pumping causes a delayed depletive impact to the river system and, if a senior water right is calling for water, the depletion caused from well pumping is considered "out-of-priority." Colorado water law allows this out-of-priority pumping effect only if so-called "augmentation water" is available for release to the river to cover the out-of-priority depletions from the well pumping. Currently, well pumping from approximately 450 alluvial water wells has been curtailed completely and pumping from another approximately 2,000 wells has been partially reduced by court order until necessary augmentation water is secured. These wells supply water to 25,000 to 30,000 irrigated acres and divert approximately 25,000 acre-feet of water per year. The drought of 2002 to 2007, considered the worst drought in the last 300 years, exacerbated the situation. The well pumping curtailment is severely impacting well users as well as adversely impacting local economies. The Chatfield Reservoir storage reallocation project would give agricultural water providers additional ability to store augmentation water for later release, thereby giving some relief from this critical well shutdown situation.

Opportunities

1. There is an opportunity to expand the use of an existing storage facility (Chatfield Reservoir) to provide additional water supply:

To address the water shortages resulting from population growth, Colorado water providers have the options of either stretching existing supplies, developing new supplies, or, most likely, both. SWSI identifies several broad strategies for meeting the South Platte River Basin's future water needs including: development of additional storage, M&I reuse, agricultural water transfers, conjunctive use of surface and groundwater, and additional water conservation (SWSI, Section 8, p 8-1). Developing additional storage is further described as either utilizing new storage projects or expanding the use of existing storage facilities. The reallocation of storage space in Chatfield Reservoir is a project that fits into the strategy of expanding the use of existing storage facilities.

Storage projects capture water during high-flow years and seasons to be used during low-flow periods, a function that is critical to providing reliable water supplies in a semiarid climate such as Colorado's where the hydrologic events are highly variable. SWSI concludes that "new storage and enlargement of existing reservoirs will be major components in meeting 2030 demands" (SWSI, Section 10.1.9.1, page 10-41). The major opportunity offered, of course, by reallocation of storage space in Chatfield Reservoir is that new storage space is made available in an existing structure without the costly and more environmentally impacting action of constructing new storage facilities.

2. Chatfield Reservoir's on-channel location provides the opportunity to logistically and cost-effectively capture available flow:

   The reservoir's location directly on the South Platte River, or "on-channel," allows the reservoir to always immediately capture all available flows that can be legally stored. This is a significant advantage over off-channel reservoirs that are limited by the design capacity of diversion and delivery facilities. In addition, upstream storage at Chatfield Reservoir could be operated in conjunction with existing off-channel storage facilities further downstream to allow certain water providers to maximize the capture of their junior water rights and free river water. For several of the upstream water providers, Chatfield Reservoir is downstream of their wastewater treatment plant outfalls and provides an opportunity for recapture of reusable water for indirect reuse.

3. Chatfield Reservoir's location at a relatively high elevation within the basin provides opportunity to deliver water by gravity flow:

   Chatfield Reservoir's location and relatively high elevation within the watershed provides the opportunity to deliver water by gravity flow. Since some water providers already receive water deliveries from Chatfield Reservoir, there is less need for the construction of new conveyances (e.g., ditches, pump stations, and pipelines) than there would be from new storage facilities.

4. Ability to store augmentation water for future use:

   The Chatfield Reservoir storage reallocation project would give agricultural water providers additional ability to store augmentation water for later release, thereby giving some relief from the well pumping curtailment situation.

2.2 Planning Objectives and Constraints

The end of the first step in the planning process, per USACE regulations, is to identify planning objectives and constraints. Planning objectives are the intended purposes of the planning process, specifically an asserting of what the alternative should try to achieve. Constraints are restrictions that limit the extent of the planning process.

2.2.1 Planning Objectives

The purpose and need is to increase availability and reliability of water supply by providing an additional average year yield (or "average annual yield"; which is defined as the average annual amount of water expected to result from the storage of available water rights with the largest Chatfield reallocation alternative) of up to approximately 8,539 acre-feet of M&I water, sustainable over a 50-year period, to contribute towards meeting a water supply shortfall projected to be 90,000 acre-feet per year by 2050 for the service area of the 12 water providers. The planning objectives for this project are listed below.

- Provide, over the 50-year planning period, water supply of equivalent quality as currently supplied to the Denver Metro region.
- Maintain the authorized purposes of the Chatfield Reservoir as they currently exist which includes maintaining adequate levels of downstream flood control over the 50-year period of analysis.

- Ensure the provision of in-kind recreation facilities and experiences, to the extent possible, during the 50-year period of analysis.
- Ensure maintenance of environmental benefits by minimizing environmental impacts, fully mitigating unavoidable significant impacts, monitoring to evaluate the level of success, and implementing an adaptive management strategy involving input from several agencies.
- Become less reliant on non-renewable groundwater by utilizing renewable water supplies, thus extending the availability and life of these critical aquifers.
- Be consistent with USACE Environmental Operating Principles (EOP) and USACE Campaign Plan goals including robust design, risk management and communication, reliability and adaptability to future change.
- Find collaborative solutions to future Denver Metro area water supply needs.

2.2.2 Constraints

The regulations describe planning constraints as "restrictions that limit the planning process…including resource constraints and legal and policy constraints" (ER 1105-2-100, p. 2-3). Resource constraints are those associated with limits on knowledge, expertise, experience, ability, data, information, money, and time. Legal and policy constraints are those "defined by law, Corps policy and guidance." Planning constraints also include study-specific constraints. Planning studies can evaluate alternatives that would require further authorization or even changes to existing laws and policies to implement.

For efficiency purposes and to save time and money, the study utilizes several recent and relevant water planning studies as cited throughout this FR/EIS. Particularly the analysis focuses on previous South Platte River Basin storage projects as a source of useful information. Data also considered in this analysis were collected from involved water providers to determine the near-term need for water that could be provided by up to a 20,600 acre-foot reallocation at Chatfield Reservoir.

Although the storage reallocation opportunity at Chatfield Reservoir is clearly a favorable water supply option for the various local water providers, the proposed reallocation of storage space does not come without potential conflicts and impacts relating to the existing uses of the reservoir and the land in the immediate vicinity. Reallocation would not impact the primary flood risk management purpose of Chatfield Reservoir. During Tri-Lakes system flood control storage evacuation for Level I (small flood events), as defined in Appendix B – Tri-Lakes Water Control Plans, the reallocation of flood control storage at Chatfield Reservoir slightly increases releases and affects the timing and duration of releases made from Cherry Creek and Bear Creek Reservoirs though the primary flood risk management purpose for Cherry Creek and Bear Creek Reservoirs is not affected. Reference Appendix B – Tri-Lakes Water Control Plans for an example of how the release magnitudes are affected. There is no change to system flood control storage evacuation releases during Level II (large flood events), as defined in Appendix B – Tri-Lakes Water Control Plans. As discussed in Chapter 1, however, Chatfield Reservoir is one of the Colorado State Park's chief attractions. Open space within the park and its environs provide habitat for numerous species of interest including the federally-listed Preble's meadow jumping mouse. Increasing the pool elevation and increasing the magnitude of water level fluctuations within the reservoir would affect

recreational uses and environmental resources within the area. Significant environmental impacts must be mitigated. Recreation modifications can be accomplished within the boundaries of Chatfield State Park, but availability of local lands for environmental mitigation is a constraint. Sufficient lands would be needed onsite and offsite to mitigate environmental impacts from the project.

Legal and policy constraints include compliance with county, state, and federal permitting or other requirements. The project must also comply with the Clean Water Act and other pertinent environmental laws and regulations. A summary of environmental compliance is described in Appendix S.

Study-specific constraints are restrictions unique to the project that alternative plans should avoid. They are designed to avoid undesirable changes between without- and with-plan conditions. Study-specific constraints for this project include:

- The project must be completed in a reasonable timeframe.
- Financial capability of sponsoring water providers may be constraining because they are responsible for 100 percent of the costs involved in implementing any alternative.
- The project should minimize the use of others' land or, to the extent possible, the availability or capability of other projects.
- Maintain the conservation pool in Chatfield between 5,423 feet msl and 5,432 feet msl consistent with the contract between the Corps of Engineers and the state of Colorado (March 1, 1979). The state of Colorado signed an agreement with Denver Water granting them the exclusive right to store water in Chatfield in the conservation pool. Storage below 5,432 feet msl cannot be reallocated because of the in-place contract and agreement.
- Reallocation of storage above elevation 5,444 feet msl could adversely impact the flood risk management (FRM) purposes of Chatfield, Cherry Creek, and Bear Creek Reservoirs as described in Appendix B – Tri-Lakes Water Control Plans, as documented in the Corps' Chatfield Antecedent Flood Study (Appendix R). Modifications of project structures that would allow additional storage to be reallocated to avoid affecting Chatfield's FRM functions would require additional Congressional authorization.
- Reallocation of storage less than 7,700 acre-feet was considered by the water providers to provide too little water supply benefits for the costs involved.
- Water providers would need to hold existing or newly acquired water rights and existing, new, or change-case water storage rights in order to store water in Chatfield Reservoir, another reservoir, or in gravel pits.
- The water rights of the sponsoring water providers are relatively junior in seniority, and the sponsors would be able to store water only when their water rights were "in priority", or during "run of the river" high river flows. Consequently, the average year yield is low compared to the water storage volume.

- Water providers desiring to install any infrastructure associated with on- or off-channel water storage or water distribution systems on Corps project lands must apply to the Corps for a land availability determination. If Corps project lands are determined to be available for the proposed infrastructure, the water providers must acquire the appropriate real estate easements and pay any Corps charges in accordance with Corps real estate regulations.

- Unavoidable impacts to environmental resources that are considered significant would need to be fully mitigated. This includes impacts to the federally listed threatened Preble's meadow jumping mouse habitat, migratory bird habitat, and wetlands. Costs of mitigation maintenance and monitoring costs, and any increase in Corps operation costs of an Alternative would be borne 100 percent by the non-federal entities receiving storage.

- The project must comply with the Clean Water Act and other applicable environmental laws and regulations.

- For any recreational facilities and areas that would be impacted by higher pool levels with reallocation, recreation modifications are required in-kind (the same type and amount of facilities) within the boundaries of Chatfield State Park prior to utilization of the reallocated storage. The cost of recreation modifications must be borne 100 percent by the non-federal entities receiving storage, and are included in the total cost of the project included in Table 5-10.

- Design, materials, and elevations of recreation modification structures need to comply with the provisions of the Northwest Division (NWD) Regulation 1110-2-5, Land Development Guidance at Corps Reservoir Projects, as coordinated with USACE, Omaha District staff.

- If reallocation is implemented, losses of income to Colorado Parks and Wildlife and concessionaires at Chatfield State Park during the construction period for recreation modifications and environmental mitigation will be reimbursed by the non-federal entities receiving storage.

- Water resource infrastructure operations, water sources, including storage and conveyance components, should comprise of proven operational and management practices to minimize risk of failure to provide required yield.

- Any storage expansion or reallocation scenario within an existing reservoir that negatively affects the flood risk management function of the reservoir should be avoided. The Alternatives cannot impact dam safety.

2.3 Development of Alternatives

One of the key aspects of the NEPA process is the assessment of how various alternatives that meet the purpose and need could affect the environment. The purpose and need statement is as follows:

> The purpose and need is to increase availability of water, providing an additional average year yield of up to approximately 8,539 acre-feet of municipal and industrial (M&I) water, sustainable over the 50-year period of analysis, in the greater Denver Metro area, so that a larger proportion of existing and future water needs can be met.

NEPA requires, at a minimum, that a "proposed action" be compared to a "no action" alternative. The No Action Alternative represents the most likely baseline conditions that would occur if the proposed project were not to move forward. The "action alternatives" are developed and screened from a broad range of concepts identified based on problems and opportunities, and then are compared to the No Action Alternative in order to determine the extent and significance of potential impacts. An action alternative (proposed action) is developed to describe the various aspects of the proposal by the lead agency (in this case, the Corps' proposal to reallocate up to 20,600 acre-feet of storage). Other action alternatives may also be developed that reduce the extent of impacts to resource areas while still meeting the purpose and need.

Corps guidance requires an economic analysis as part of the evaluation. As a test of financial feasibility, the governing annual cost of storage is compared to the annual cost of the most likely, least costly alternative that would provide an equivalent quality and quantity of water that the non-federal interest would undertake in the absence of using the federal projects. Normally the No Action Alternative (the one most likely to be implemented if Chatfield Reservoir storage is not reallocated) is also the Least Cost Alternative to the proposed action alternative (that is the least costly financial alternative, but not necessarily least costly in terms of NED). However, in this instance due to the understandable reluctance of area water providers to depend on NTGW as a viable long-term alternative to storage, a separate Least Cost Alternative including this source, referred to as the NTGW/Downstream Gravel Pits Alternative, was developed for the 50-year period of analysis in addition to the No Action Alternative.

History of the Chatfield Reservoir Storage Reallocation Study

Shortly after Chatfield Reservoir was constructed in 1973, local water providers began various individual planning processes with the hope that additional storage space in Chatfield Reservoir might be reallocated. In 1977, Denver Water filed for a conditional storage water right that included reallocated storage space in Chatfield Reservoir, and by 1985 five other entities had filed their own claims for conditional storage water rights in Chatfield Reservoir. In 1986, the authorization for the Chatfield Reservoir storage reallocation study was secured by Congressional action in Section 808 of the Water Resources Development Act. Section 808 authorizes the Secretary of the Army to implement a reallocation of existing storage at Chatfield Reservoir to any of several named purposes if the CDNR requests and coordinates the reallocation, and if the Chief of Engineers finds the reallocation feasible and economically justified. Section 116 of the Omnibus Appropriations Act of 2009 authorizes CDNR to perform facility modifications and mitigation for the project, if the Secretary of the Army collaborates with CDNR and local interests to determine storage cost repayments that reflect the limited reliability of the reallocated storage space.

The planning efforts intensified with the occurrence of the MWSI, a study process initiated by Colorado Governor Roy Romer and the Colorado General Assembly in 1993. The goal of MWSI was to explore cooperative solutions to future Denver Metro area water supply needs (Hydrosphere Resource Consultants, 1999). A MWSI subcommittee on Chatfield Reservoir storage reallocation was formed in 1994 by a consortium of water providers led by the CWCB as project sponsor, per the Section 808 authorization. The MWSI subcommittee held regular meetings with representatives of the Corps and began the formal process requesting the reallocation of Chatfield Reservoir storage space. In the 905(b) Reconnaissance Report (USACE, 1996), a preliminary analysis was made of the recreational impacts to Chatfield Reservoir of storing various water quantities and determined that

large increases in expenses for recreation facility modifications occurred at elevation levels of 5,435 feet msl; 5,438 feet msl; and 5,445 feet msl. From this work, the initial alternatives to be analyzed were determined to be at elevation levels of 5,434 feet msl (2,900 acre-feet of storage); 5,437 feet msl (7,700 acre-feet of storage); and 5,444 feet msl (20,600 acre-feet of storage). Intermediate storage levels were not evaluated because the costs of recreation modifications for a 5,444-foot-msl pool elevation were believed to be similar to those for a 5,438-foot-msl-pool elevation, resulting in economies of scale that were maximized for the 5,444-foot-msl alternative. Ultimately the group determined that within Chatfield Reservoir, 20,600 acre-feet (at 5,444 feet msl) would be the volume of storage that could be reallocated without major incremental costs or jeopardizing the flood risk management function of the reservoir. This fact was further supported by the Chatfield Antecedent Flood Study (Appendix R), which passed an independent external technical review by the Bureau of Reclamation (BOR) and was approved by the Corps Headquarters in February 2006. The Chatfield Antecedent Flood Study showed that a pool raised 12 feet for water supply (with an adjustment of the reservoir flood control operating criteria) would provide the necessary freeboard without any structural modifications. Such a raise was considered to be a reasonable maximum reallocation alternative.

Thus, the proposed action of the Chatfield Reservoir storage reallocation study is to reallocate 20,600 acre-feet of storage space from flood risk management (flood control) to conservation. As further described below, the other action alternative is reallocation of 7,700 acre-feet of storage space, the third alternative is the No Action Alternative, and the fourth alternative is the NTGW/Downstream Gravel Pits Alternative (Least Cost Alternative to Chatfield Reallocation). The explanations below describe how the process was used to develop these alternatives and eliminate other alternatives.

2.3.1 Alternative Selection Process

The action alternatives identified and evaluated in the FR/EIS are designed to meet project objectives (purpose and need). To reach these selected action alternatives, an initial screening of water supply concepts was conducted using a defined set of criteria. This initial set of concepts was identified based on problems and opportunities identified in Section 2.1. The broader view of all concepts to increase the water supplies for the South Platte River Basin is given in SWSI (CWCB, 2004), Sections 8 and 10, which are contained in Appendix C. In general, the concepts are grouped in five categories: (1) increased storage, (2) importation of water, (3) conversion from agricultural use to municipal use, (4) increased NTGW use, or (5) increased water conservation.

Concepts identified for initial screening were evaluated with four general criteria described in the P&Gs: completeness, efficiency, effectiveness, and acceptability. These are specifically detailed in Section 2.6 "Evaluation Criteria." In general terms, these four criteria would encompass the following considerations:

- Ability to meet purpose and need of the action
- Cost
- Logistics and technology

  - Water rights/water availability
  - Land availability/Land use
  - Permitting and mitigation feasibility
  - Design and construction feasibility
  - Operational feasibility

- Environmental impacts

  - Significance
  - Ability to Mitigate

These initial screening criteria definitions were developed based on planning objectives and constraints identified and summarized in Section 2.2. Initial screening criteria and associated rationale for eliminating an alternative or screening it forward, are summarized in Table 2-1.

Table 2-1
Criteria for Preliminary Screening of Alternatives

Criterion Description	Rationale for Screening Criterion
Purpose and Need	
PN1- The purpose and need is to increase availability of water, sustainable over the 50-year period of analysis, in the greater Denver area so that a larger proportion of existing and future (increasing) water needs can be met.	To advance, a concept must be capable of assisting in providing the water providers with a common regional solution, able to provide a reasonably sufficient portion of the total requested average year yield of approximately 8,539 acre-feet (AF), and not be held up in extensive litigation, extensive permitting, or other timeliness issues.
Cost	
C1- The cost of the project must be affordable The cost of a concept includes a broad estimate of land and water rights acquisition, design and permitting, construction and operation. At this early stage in the analysis, a qualitative estimation of costs was employed because detailed information on costs was not available or could not be estimated within the current scope of the project.	To advance, an alternative must not be unreasonably costly relative to other concepts. A reasonable cost considers whether the concept has a reasonable size relative to cost, and is substantially less (i.e., order of magnitude) than the costs associated with other water supply projects in the Colorado Front Range.
Logistics and Technology	
LT1- Water Rights/Water Availability	To advance, concepts would not require the acquisition of water rights through new filings or by purchasing and transferring existing water rights from current water providers in an unreasonably foreseeable time frame. Sites that are already fully subscribed would be eliminated because the water providers do not have the authority to acquire water or storage or it would take agreements not yet in place and unable to achieve. Preference would be given to sites with on-channel location.
LT2- Land Availability/ Land use	To advance, water sources or infrastructure components must not lie in areas that clearly would not be available for purchase or create a significant obstacle for development.
LT3- Permitting and Mitigation Feasibility	To advance, water sources should have acceptable mitigation and permitting requirements.
LT4- Design and Construction Feasibility	To advance, water sources, including storage and conveyance components, should comprise of proven technological methods to minimize risk of failure to provide the required yield. Physical conditions resulting in high risk or requiring unusual engineering solutions would be eliminated.
LT5- Operational Feasibility	To advance, water sources, including storage and conveyance components, should comprise proven operational and management practices to minimize risk of failure to provide required yield. Also, it would

Table 2-1
Criteria for Preliminary Screening of Alternatives

Criterion Description	Rationale for Screening Criterion
	not be practical to operate multiple storage facilities, pipelines or treatment facilities to meet the required yield. Advanced treatment, such as reverse osmosis systems, would not be feasible.
Environmental Impacts	
EC1- Significance –direct, indirect and cumulative impacts to wetlands and perennial streams	To advance, a concept should avoid and minimize impacts to aquatic ecosystems.
EC2- Ability to Mitigate	If significant impacts to wetlands or perennial streams are identified, then a commensurate ability to mitigate must also be identified in order to have the concept advance for further evaluation.

Screening criteria were applied to 38 project concepts. A project concept is defined as a source of water available to meet a substantial portion of the Chatfield Water Provider's requests. Each concept may include various components (e.g., storage facilities, conveyances) that could be independently used, or combined with other components, to make viable alternatives. A description of each concept evaluated in the initial screening process is presented in a summary table (Table 2-2) with a general discussion of the screening process and outcomes provided in the following sections.

Table 2-2
Concepts Considered in Preliminary Screening of Alternatives

	Concept	Description
1.0	Increased Water Conservation	
1.1	Chatfield Water Providers M&I Conservation Programs	Comprehensive and aggressive water conservation (or demand management) programs implemented by the Chatfield water providers group. Key facets include progressive inclining block rate structures, regulatory ordinances, conservation incentive programs, and supply-side efficiency measures.
1.2.	Central Colorado Water Conservancy District Efficiency Program	This program supplies ultra-efficient irrigation equipment to farmers, and provides outreach seminars and in-field conservation services.
2.0	Agricultural Transfers	
2.1	Lower Arkansas River Concept	Delivers water from the lower Arkansas River (near Avondale or La Junta) to the Rueter-Hess Reservoir. Water pumped 96 to 133 miles with static pumping requirement of 3,100 to 3,600 feet. Firming storage required. Reverse osmosis or advanced water treatment would be required.
2.2	Middle & Lower South Platte River Concept	Delivers water from the South Platte River (near Greeley or Sterling) to Brighton. Requires purchase of South Plate River water rights. Water pumped 36 to 84 miles with static pumping requirement of 700 to 1,300 feet. Firming storage required. Reverse osmosis or advanced water treatment would be required.
2.3	Rocky Ford Highline Canal Concept	Delivers water from the Arkansas River Basin to the South Platte River Basin. The project is in a conceptual state with no identified buyer participants nor details on the conveyance route. Requires purchase of water rights and treatment of water.
2.4	South Platte River/ Farmers Reservoir and Irrigation Company (FRICO) Concept	Delivers water from Weld County to East Cherry Creek Valley via the FRICO Ditch. Agricultural water rights are being converted to municipal use, but have not been adjudicated. Treatment would be required.
2.5	Interruptible Agricultural Transfers	Alternative water resource management approaches to traditional purchase and transfer of water from irrigated lands. Example approaches include interruptible water supply agreements, long- and short-term rotational fallowing, water banks, reduced crop consumptive use, multi-year leases, spot market leases and purchase and lease-back arrangements. Principle goal is to provide some water to other uses while maintaining irrigated agricultural practices.

Table 2-2
Concepts Considered in Preliminary Screening of Alternatives

	Concept	Description
3.0	Water Importation	
3.1	Flaming Gorge Reservoir Concept	Delivers water from the Green River to Denver area. A contract with Bureau of Reclamation (BOR) for water from the Flaming Gorge marketable pool would be required. Compact call and legal availability and administration of depletions in Wyoming for use in Colorado would need to be resolved. Conveyance would be 357 to 442 miles of pipeline to the south Denver metropolitan area with static pumping requirements of 1,400 to 3,100 feet. Constructible and permittable West Slope diversion, storage sites, and pipeline routes would need to be evaluated. Estimated yield is 200,000 AF/year. Estimated cost is $3 to $4 Billion.
3.2	Yampa River New Supply Concept	Delivers water from the Yampa River (near Craig) to Denver area. New water rights appropriation required, and Compact call and legal availability related to endangered fish would need to be resolved for a new appropriation. Would require approximately 250 miles of pipeline, with static pumping requirement of 5,000 feet. Constructible and permittable West Slope diversion, storage sites, and pipeline routes would need to be evaluated. Estimated yield is 300,000 AF/year. Estimated cost is $3.2 Billion.
3.3	Green Mountain New Supply Concept	Delivers water from the Blue River to the Denver area via the South Platte River. Water pumped 22 miles with static pumping requirement of 1,000 feet. Requires joint use of Denver Water conveyance system. Estimated yield is 200,000 AF/year. Estimated cost is $700 Million.
3.4	Colorado River Return Concept	Delivers water from the Colorado River, downstream of Grand Junction, to the Denver area. New water rights appropriation required, and Compact call and legal availability related to endangered fish would need to be resolved for a new appropriation. West Slope storage would not be required but East Slope storage would be required. Conveyance on East Slope would be via South Platte and Arkansas Rivers. Water pumped 179 miles with static pumping requirement of 7,000 feet. Reverse osmosis or advanced water treatment would be required. Estimated yield is 250,000 AF/year. Estimated cost is $3.7 Billion.
3.5	Gunnison River Concept	Delivers water from the Gunnison River, and possibly the Blue Mesa Reservoir, to the Denver area. New water rights appropriation required, and Compact call and legal availability would need to be resolved for a new appropriation. Would require approximately 75 miles of tunnels and conduits. Constructible and permittable Western Slope diversion, pumping stations, storage, and pipeline routes would need to be evaluated.
3.6	San Luis Valley Concept	Delivers water from the Arkansas River Basin to the South Platte River Basin via pipeline. The project is in a conceptual state with no identified water rights nor details on the conveyance route. Requires purchase of water rights.
4.0	Additional Storage within the South Platte River Basin	
4.1	New Storage Reservoirs	
4.1.1	Penley Reservoir Site	A potential off-channel reservoir located approximately 11 miles south of Chatfield Reservoir adjacent to Colorado's foothills mountain range. The reservoir site would be created by construction of two embankments approximately 160 feet high with a total length of 3,500 feet, producing approximately 12,725 acre-feet of usable storage space. Delivery of water from the South Platte River includes a 15-mile-long gravity tunnel near Deckers or a 7.5-mile-long tunnel and pump station near Eagle Rock. Water would be delivered into the Penley Reservoir from the South Platte River at the downstream end of Waterton Canyon near the Platte Canyon Reservoir and High Line Canal.
4.1.2	Willow Creek Reservoir	A potential reservoir site located on Willow Creek, a tributary to the South Platte River located approximately one mile south of Chatfield Reservoir, in Douglas County. The property site is owned by the Colorado State Board of Land Commissioners. Planned storage capacity is approximately 4,400 AF.
4.1.3	Hritz Plum Creek Reservoir Site	A privately-owned potential reservoir site located off-channel, on Plum Creek, south of Kellytown in Douglas County and approximately 1.75 miles south of Chatfield Reservoir. A two –reservoir system was envisioned, with a planned storage capacity of approximately 2,300 AF.

Table 2-2
Concepts Considered in Preliminary Screening of Alternatives

	Concept	Description
4.1.4	Highland Ranch Reservoir Series (Reservoir Nos. 6, 7, 8, 10, 11 and 12)	Six new reservoir locations are being considered for potential reservoir sites, and all are located in Douglas County. The reservoir sites are being considered for other projects. These reservoirs are part of the current water system development plans of the Centennial Water and Sanitation District. The concept would require purchasing and transferring existing water rights from a current user. Each of the gravel pit reservoirs would require diversions to/from the South Platte River to the reservoir. The distance from the South Platte River is substantial. Total potential storage capacity is approximately 33,000 AF.
4.1.5	Upstream Local Gravel Pit Reservoirs	Three local gravel pits have been identified as potential South Platte River raw water. These sites, and their potential storage capacity include the Titan ARS Reservoir (4,500 AF), Walker Pit (540 AF), and McLean Pit (450 AF). These are located less than one mile south of Chatfield Reservoir. Each of the gravel pit reservoirs would require diversions to/from the South Platte River to the reservoir.
4.1.6	Lower South Platte River Gravel Pits	Three new gravel pits have been identified to contain 7,835 acre-feet of storage volume and includes Central Colorado WCD Gravel Pit, Western Mutual Ditch Company Gravel Pit, and one unassigned gravel pit. Each of the gravel pit reservoirs would require diversions from the South Platte River to/from the reservoir.
4.2	Storage Expansion of Chatfield Reservoir	
4.2.1	Reallocation of 2,900 AF to Storage	Reallocate storage from the flood control pool to the conservation pool. The base elevation of the exclusive flood control pool would be raised from 5,432 to 5,434 feet msl. Water providers downstream of Chatfield Reservoir would be able to use existing infrastructure to divert their portion of the stored water into their water systems. Some of the downstream water providers would need to construct new delivery facilities to deliver their new water supplies from Chatfield Reservoir. At this level, there is limited wetland inundation and most recreation features can be mitigated without relocation of structures.
4.2.2	Reallocation of 4,500 AF to Storage	Reallocate storage from the flood control pool to the conservation pool. The base elevation of the exclusive flood control pool would be raised from 5,432 to approximately 5,435 feet msl. At this level, some wetlands would be inundated, requiring mitigation. Some recreation facilities would be inundated, requiring relocation.
4.2.3	Reallocation of 7,700 AF to Storage	Reallocate storage from the flood control pool to the conservation pool. The base elevation of the exclusive flood control pool would be raised from 5,432 to 5,437 feet msl, but the reallocation of storage for this project only involves the volume between 5,432 and 5,437 feet msl. At this level, wetlands would be inundated, requiring mitigation. Many recreation facilities would be inundated, requiring relocation.
4.2.4	Reallocation of 20,600 AF to Storage	Reallocate storage from the flood control pool to the conservation pool. The base elevation of the exclusive flood control pool would be raised from 5,432 to 5,444 feet msl, but the reallocation of storage for this project only involves the volume between 5,432 and 5,444 feet msl. At this level, wetlands would be inundated, requiring mitigation. Most recreation facilities would be inundated, requiring relocation. The flood risk management functions of each of the Tri-Lakes projects would be impacted as described in Appendix B – Tri-Lakes Water Control Plans.
4.2.5	Reallocation of Greater Than 20,600 AF to Storage	Reallocate storage from the flood control pool to the conservation pool. The base elevation of the exclusive flood control pool would be raised from 5,432 to as high as 5,450 feet msl. At this level, the footprint of the park is severely affected with associated large impacts to wetlands, recreational facilities, park roadways, and local highways. The flood risk management function of the reservoir would be impacted. The flood risk management functions of each of the Tri-Lakes projects would be impacted.
4.2.6	Reallocate in the existing conservation pool (i.e., below 5,432 feet msl) for large and/or small amounts	Reallocates some of the storage space below elevation 5,432 feet msl now controlled by Denver Water to the Chatfield water providers. Requires acquisition of the storage space in the existing conservation pool from Denver Water. Would result in sufficient yield with little or no increase in reservoir level and consequential impact to recreation facilities and wetlands.

Table 2-2
Concepts Considered in Preliminary Screening of Alternatives

	Concept	Description
4.2.7	Reallocate some water in the conservation pool and some in the flood control pool in proportions that would seek to minimize ecosystem habitat flooded and effects on recreation facilities	Reallocates water from Denver Water to the Chatfield water providers. Could result in sufficient yield with little or no increase in reservoir level and consequential impact to recreation facilities and wetlands.
4.2.8	Deepening the Reservoir	Increase the storage capacity by deepening the reservoir. Requires excavation of both alluvial sediments and bedrock. The upstream side of the outlet works is at a fixed elevation. Could result in a larger "dead pool" with no access to the water without pumping.
4.3	Storage Expansion or Reallocation of Other Existing Reservoirs	
4.3.1	Rueter-Hess Reservoir	An off-stream reservoir, located approximately 9.5 miles south of Chatfield Reservoir, which will rely on surface water from nearby Cherry Creek and Newlin Gulch; and groundwater which may be alluvial groundwater or bedrock aquifer groundwater from the Denver Basin. Owned and operated by the Parker Water and Sanitation District (PWSD). The town of Castle Rock, Castle Pines North Metropolitan District and Stonegate Village Metropolitan District own the storage capacity. Water allocation subscribed and permitted under a separate planning action with the USACE. With the completed expansion, reservoir storage is approximately 72,000 AF.
4.3.2	South Platte Reservoir	A working gravel mine converted into a water storage reservoir in 2007. Located north of the Chatfield Reservoir in Arapahoe and Jefferson Counties. The Centennial Water and Sanitation District owns the site. Raw South Platte River water would be pumped to this reservoir, then to McLellan Reservoir for use within Highlands Ranch. Storage capacity is 6,400 AF.
4.3.3	McLellan Reservoir	An existing reservoir located on Dad's Clark Gulch, a tributary of the South Platte River in Arapahoe and Douglas Counties located less than one mile northeast of Chatfield Reservoir. Owned by the city of Englewood and leased to the Centennial Water and Sanitation District (CWSD). Reservoir capacity is approximately 5,000 AF. Would require diversions from the South Platte River to the reservoir.
4.3.4	Platte Canyon Reservoir	An existing reservoir located on the South Platte River at the mouth of Waterton Canyon in Douglas County, approximately 2 miles south of Chatfield Reservoir. Owned by Denver Water. Water supplied by Highline Canal. Reservoir capacity is approximately 910 AF.
4.3.5	Bear Creek Reservoir	Bear Creek Dam, the last of three dams built to protect the Denver region from floods, is located on the southwest edge of suburban Lakewood at the confluence of Bear Creek and Turkey Creek. Located off-channel, would require diversions to/from the South Platte River to the reservoir. Reservoir capacity is approximately 2,000 AF. During Tri-Lakes system flood control storage evacuation for Level I (small flood events), as defined in Appendix B – Tri-Lakes Water Control Plans, the reallocation of flood control storage at Chatfield slightly increases releases and affects the timing and duration of releases made from Bear Creek though the primary flood risk management purpose for Bear Creek is not affected.
4.3.6	Cherry Creek Reservoir	An existing reservoir on Cherry Creek located approximately 10 miles northeast of Chatfield Reservoir. The first of three dams built to protect the Denver region from floods. Owned and operated by the USACE. Located off channel, would require diversions to/from the South Platte River to the reservoir. Reservoir capacity is approximately 14,000 AF. During Tri-Lakes system flood control storage evacuation for Level I (small flood events), as defined in Appendix B – Tri-Lakes Water Control Plans, the reallocation of flood control storage at Chatfield slightly increases releases and affects the timing and duration of releases made from Cherry Creek though the primary flood risk management purpose for Cherry Creek is not affected.

Table 2-2
Concepts Considered in Preliminary Screening of Alternatives

	Concept	Description
5.0	Conjunctive Use of Surface and Groundwater	
5.1	Additional NTGW with Local Gravel Pit Storage	Further acquisition of non-tributary groundwater (NTGW) from the Denver Basin, with storage in local gravel pits. Requires acquisition of water rights, development of groundwater withdrawal wells, development of gravel pit storage reservoir, and accompanying water conveyance facilities.
5.2	Bedrock Aquifer Conjunctive Use	Involves capturing and using surplus South Platte River surface water supplies and injecting into bedrock aquifer for storage. Requires identification and development of subsurface groundwater storage reservoir and development of surface water collection and injection facilities. A large-scale groundwater pumping and storage concept was informally presented to Douglas County water interests, but never developed into a viable project due primarily to unreasonably high costs and a lack of surface water.
5.3	Alluvial Aquifer Conjunctive Use	Involves capturing and using surplus South Platte River surface water supplies and recharging the alluvial aquifer for storage. Requires the development of surface water collection and injection facilities. No specific projects have been identified.
6.0	Water Reuse	
6.1	Chatfield Water Providers Local Reuse Programs	Various forms of reuse or recapture are currently being employed, or planned to be employed, by those water providers who have reusable water.
6.2	Regional Reuse- WISE Partnership	The WISE Partnership is a proposed regional project between Denver Water ("Denver"), Aurora Water ("Aurora") and the South Metro Water Supply Authority. The Project is looking at the concept of more efficiently using reusable water supplies from Denver and Aurora municipal return flows, while maximizing the use of existing pipeline and pump station infrastructure principally owned by Aurora and the East Cherry Creek Valley Water and Sanitation District. The Partnership Project is currently in the planning stages.

2.3.2 Concepts of Agriculture Transfers and Importation of Water

The initial screening process, which has utilized SWSI and other recent, relevant planning studies (for example, The Colorado River Return Reconnaissance Study Summary Report [Boyle Engineering Corporation, 2003]) identified a number of concepts for the importation of water or permanent agricultural conversion. These concepts are listed in Table 2-2. The initial screening process concluded that these concepts have vastly higher expense, difficulties in obtaining water rights and legal agreements for out-of-basin transfers, and increased environmental impacts compared to the other alternatives.

Permanent Agricultural Transfers

Agricultural uses account for greater than 80 percent of the water diverted and consumed in Colorado (CWCB, 2009). Many agricultural users hold senior water rights that potentially can be converted to provide M&I water supply. In agricultural transfers, the permanent water right is acquired and uncertainty over future water supply is reduced. Permitting may be simpler for such transfers than for development of new supplies since the agricultural water to be acquired has already been diverted from the stream system and a portion consumed. The associated farmland generally is no longer irrigated and therefore not available for agricultural use in the future. Once the water rights are transferred and the land no longer irrigated, the assessed value is reduced significantly. This results in a significant loss of tax base for local governments and school districts.

Four generally known permanent agricultural transfer concepts were considered in the initial screening process: Lower Arkansas River, Middle and Lower South Platte River, Rocky Ford Highline Canal and South Platte River/Farmers Reservoir and Irrigation Company (FRICO). These

concepts are described in Table 2-2. These, and projects similar to these, are very complex, high-impact projects that are feasible only if large volumes of yield are realized. Most concepts have projected annual yields of greater than 100,000 acre-feet. For example, they generally include new storage reservoirs, hundreds of miles of pipelines, multiple pump stations, and advanced water treatment techniques (e.g. reverse osmosis) to meet drinking water requirements. Approximately 2 to 3 acre-feet of storage is required to produce 1 acre-foot of firm annual yield for M&I use since agricultural water is typically seasonal and susceptible to drought conditions. Because these projects are very large and complex, the rudimentary cost estimate is estimated at $1Billion per 100,000 acre-feet annual yield.

These large-scale agricultural transfer concepts are considered not realistic alternatives to a project yielding approximately 8,539 acre-feet per year. These concepts cannot be implemented within a reasonable timeframe due to logistics of obtaining water rights and legal agreements for out-of-basin transfers. Storage, conveyance and treatment costs would be substantial. Therefore these concepts have been eliminated from further alternative consideration.

Smaller-Scale Permanent Agricultural Transfers

Smaller-scale agricultural transfers are generally available in small amounts (100 to 400 acre-feet), comprising amounts used by individual farms. Their availability is temporally and geographically sporadic. Much of this water is located downstream of the study area and, therefore, pipelines and pump stations would be required. The cost of this infrastructure relative to the amount of water transported would be substantially greater than other water supply concepts involving storage expansion of Chatfield Reservoir or various storage concepts within the South Platte River Basin. Its relatively poor water would require advanced water treatment techniques. For these reasons, smaller-scale agricultural transfer concepts were not considered.

Interruptible Agricultural Transfers

Interruptible agricultural transfers consist of temporary arrangements where agricultural water rights are used for other municipal or industrial purposes. The agreement with agricultural users allows the temporary cessation of irrigation so that other water needs can be met. Example approaches include interruptible water supply agreements, long- and short-term rotational fallowing, water banks, reduced crop consumptive use, multi-year leases, spot market leases, and purchase and lease-back arrangements.

These concepts were eliminated from further consideration based on cost, logistics, timing, and sustainability. Although these concepts have been discussed for several years and multiple grants are presently studying alternative approaches, no existing examples exist of successfully implemented programs. These concepts, and particularly the institutional and technical arrangements, continue to be in the developmental stage. The movement of water supplies from agricultural water to municipal users would likely require pipelines over very lengthy distances (multiple miles) and water treatment, possibly including reverse osmosis.

Water Importation Concepts

Similar to the major permanent agricultural transfer concepts discussed above, there are a number of regional water supply concepts involving out-of-basin transfer of water supply. Generally known regional water importation concepts include Flaming Gorge Reservoir, Yampa River New Supply,

Green Mountain New Supply, Colorado River Return, Gunnison River, and San Luis Valley (Table 2-2).

As with the large-scale agricultural transfer concepts, these projects are feasible only if large volumes of yield are realized. These concepts cannot be implemented within a reasonable timeframe due to the logistics of obtaining water rights and legal agreements for out-of- basin transfers. Conveyance and treatment costs would be substantial, and overall project costs would be substantially greater than costs associated with water supply projects in the Colorado Front Range. They are considered not realistic alternatives to a project yielding approximately 8,539 acre-feet per year and therefore have been eliminated from further alternative consideration.

2.3.3 The Concept of Increased Water Conservation

All 12 water providers recognize the importance of incorporating aggressive and meaningful water conservation efforts in their operations. Each of these entities is part of the reallocation project because they need additional water, which is ever increasingly costly and difficult to acquire. Thus, these providers need to reduce their demands and stretch their supplies and have therefore included water conservation. The water conservation (or sometimes called demand management) programs of the water providers have the following common components:

- Progressive inclining block rate structures to send a strong conservation price signal
- Regulatory ordinances, especially with new development, requiring mandatory compliance and enforcement by the entity
- Conservation incentive programs, such as rebates or giveaways, applied to residential, commercial and industrial water users
- Comprehensive education and outreach programs
- Promotion of supply side efficiency measures to include the reuse of legally reusable wastewater and leak detection programs
- Promotion of xeriscape principles

The providers in the southern Denver Metro area have initially developed the non-tributary groundwater resource as part of a conjunctive use supply. Water conservation efforts can reduce demand and give more time to find surface water supplies but do not result in the elimination or lessening of the dependence on the groundwater supplies. Conservation helps to stretch existing resources, but does not solidify additional needed water supplies. The Chatfield Reservoir storage reallocation project would help in the overall need of the water providers to be free of NTGW use.

Similarly, for other municipal providers who are developing supplies in response to growth, conservation can delay the timing of the need for additional supplies but does not in itself eliminate the need for additional supplies. The agricultural providers are aggressively pursuing conservation but also need the additional supplies from this project to allow the continued use of irrigation water as a result of recent court cases. As a result, the providers seeking additional water supplies from this project represent an increasing demand for water in the Denver Metro area.

A summary of water conservation programs of each of the 12 water providers is given in Appendix AA. Some of the key elements showing the comprehensiveness and robust nature of their programs are summarized in Tables 2-3 a, b, c, d, and e below. The complete water conservation reports of seven of the water providers with state of Colorado-approved plans are available at: http://cwcb.state.co.us/public-information/document-search/Pages/main.aspx

Most of the water providers will, of necessity and with or without the Chatfield Reservoir storage reallocation project, develop even more stringent water conservation measures in the future to reduce their future water demands. Unfortunately, the water shortages of sustainable water supplies faced by the water providers will not be resolved by water conservation measures alone and therefore water conservation is not an equivalent practicable alternative to the proposed project.

The specific conservation measures now being implemented by the municipal and agricultural water providers are summarized in Table 2-3a for M&I water providers and Table 2-3b for agricultural water providers. As these tables show, each entity is providing a consistent effort to achieve significant water conservation. These efforts include a process to periodically assess and refine each entity's water conservation efforts. The M&I water providers have each developed, or are in the process of developing, formal water conservation plans, which, by state statute, are both strongly encouraged and are a prerequisite to obtaining state financial assistance for water projects.

All entities serving over 2,000 acre-feet per year are considered a "covered entity" and must submit plans to the CWCB in compliance with state law. Table 2-3c shows the status of submittal and approval of conservation plans for the water providers in the reallocation project. Several water providers have submitted their plans and been approved before they have needed to. The plans, which are required to have an element of public scrutiny and input, are a combination of strategies for attenuating the volume of water withdrawn from a water supply source, reducing the loss of waste of water, maintaining or improving the efficiency of water use, and increasing the reuse of water.

In addition, below are listed specific examples of the leadership and innovations in water conservation programs shown by selected water providers:

- Centennial Water and Sanitation District was the first provider in Colorado, in 2003, to institute an individual account water budget for its customers. This approach has proven extremely successful and now is being used by numerous other providers including Aurora, Castle Rock, Boulder, Colorado Springs, Castle Pines North, and Cottonwood. Centennial has experienced 20 percent water savings from its water budget and other conservation programs.

- In June 2006, Castle Pines North Metropolitan District was the first entity to submit and be approved by the Colorado Water Conservation Board as a covered entity under state statutes. Its plan has become the model document followed by numerous other entities.

Table 2-3a
Municipal and Industrial Water Provider Water Conservation Program Elements

Water Provider	Effluent Reuse	Tiered Rates	Water Budget	Sod Limits	ET Water Controllers	Indoor/ Outdoor Audits	Water Time Restrict	Water Day Restrict	Rebates Xeriscape/ Appliances	Public Education	Water Conservation Staff
Mount Carbon Metropolitan District		P	P	P	P		P	P	P	P	
Town of Castle Rock	I	I	P	I			I	I	I	I	I
Centennial WSD	I	I	I		I	I	I	V		I	I
Castle Pines Metropolitan District	I	I			I	I	V	V	I	I	I
Castle Pines North Metropolitan District	I	I	I		I	I	I	I	I	I	
Other SMWSA Members											
Pinery Water and Wastewater District	I	I	I				V	V		I	
Arapahoe County Water and Wastewater Authority	I	I	P								
Cottonwood WSD	I	I	I				I	I		I	
Stonegate Village WSD	I	I					I	I		I	

I – In Place; P – Planned in < 5 years; V – Voluntary

Explanation of Program Elements:

Water Budgets: A rate structure based upon the calculation of appropriate water use (or budget) for each customer per pay period.

Sod limits: Limitations on the amount of sod that can be installed

ET Water Controllers: Providing incentives promoting the use of ET water controllers

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Table 2-3b
Agricultural Water Provider Water Conservation Program Elements

Water Provider	Water Meter/ Measurement Device	Water Budget	Public Education	Water Conservation Staff
Central Colorado WCD	P	I	I	I
Western Mutual Ditch Company	I	I	I	

I – In Place; P – Planned in < 5 years; V – Voluntary

Explanation of Program Elements:

Water Meter/Measurement Device: Central Colorado WCD installed meters on every well to monitor pumping. Western Mutual Ditch Company has measurement devices installed at every headgate to ensure correct allocation of water is being delivered.

Water Budget: Central Colorado WCD water users are limited to yearly quota allocations based on total water supplies available. Western Mutual Ditch Company water users are limited to pro rata portion of total available ditch deliveries.

Table 2-3c
Status of Covered Entities and Approved Water Conservation Plans

Water Provider	"Covered Entity" under Colorado State Statute	Approved Water Conservation Plan on file with the CWCB
Mount Carbon Metropolitan District	No	No
Town of Castle Rock	Yes	Yes
Centennial Water & Sanitation District	Yes	Yes
Castle Pines Metropolitan District	No	Under review by CWCB
Castle Pines North Metropolitan District	No	Yes
Pinery Water and Wastewater District	Yes	In process
Arapahoe County Water and Wastewater Authority	Yes	Yes
Cottonwood Water & Sanitation District	No	No
Stonegate Village Water & Sanitation District	Yes	In process

* The approved plans can be viewed at http://cwcb.state.co.us/public-information/document-search/Pages/main.aspx

Table 2-3d
Consumption Charges of Water Rates for M&I Water Providers

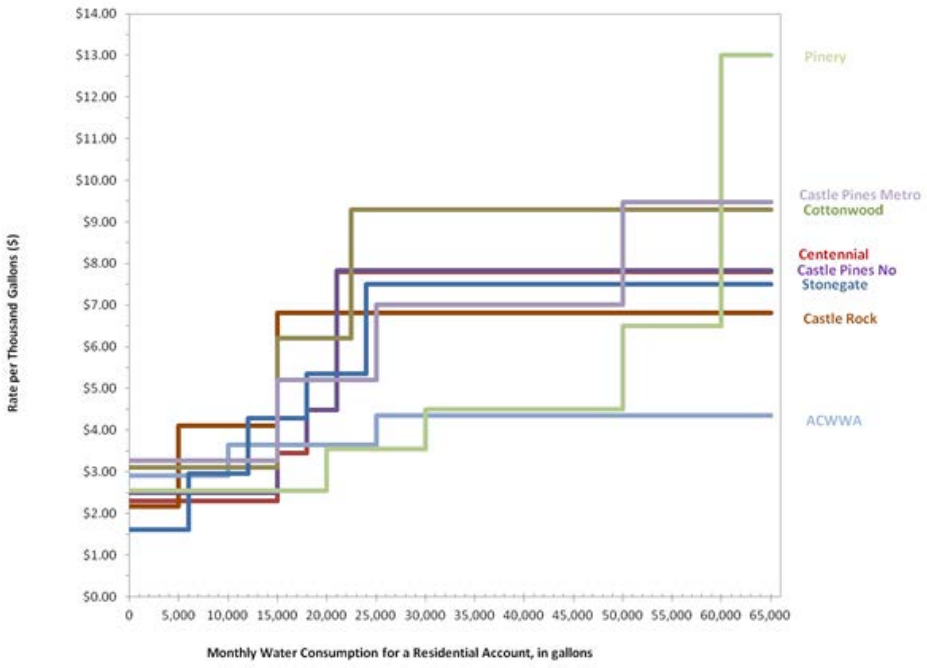


Table 2-3e
Water Conservation Rebate Programs Offered by Chatfield Study Participants

Kind of Rebate	CPN	TCR	CWSD	CPMD	COT	STONE
Toilets: Low Flow or High Efficiency	X		X		X	
	$100		$75		$100	
Clothes Washer	X	X			X	X
	$125	$200			$125	
Waterless/ Ultra Low Flow Urinal			X			
			$100			
Dishwasher						
Low Flow Showerhead	X				X	
	$10				$25	
ET Controllers/Irrigation Audits	X	X		X		X
	$200	$300–$1,500		$500		
Irrigation Head Replacements				X		X
Landscape Replacements per sq ft	X	X				X
	$0.40	$1.00				
Xeriscape: Plants and Sub Soil Replacement				X		
				$1,500		
Irrigation System Repairs				X		
				$1,000		
Rain Sensor	X		X			
	$100		$25–$50			
Irrigation Clock/Timer	X	X				
	$75	$25				
Water Wise Home		X				
		$2,000				
Water Smart Reader						
Tipping Bucket Rain Gages				X		
				$100		
Hot Water Recirculation System	X					
	$100					
Sub-metering		X				
		$200				

CPN: Castle Pines North
TCR: Town of Castle Rock
CWSD: Centennial Water & Sanitation District
CPMD: Castle Pines Metro District
COT: Cottonwood Water &Sanitation District
STONE: Stonegate Village Metropolitan District

- All of the municipal water providers in the Chatfield reallocation study have programs in place to maximize their reuse of indoor and outdoor reusable return flows. The use of reclaimed wastewater for irrigation on golf courses started in the southern Denver area in 1975 (at Inverness) and has expanded to numerous courses in the south metro area. In addition, indirect potable reuse from the recapture of reusable return flows after they have been released to surface streams has been utilized by several providers for over 20 years.

- Castle Rock, in 2003, instituted an innovative program requiring the review and approval of all landscape plans, for both existing and new development, to ensure they include the most stringent water savings elements. All designs for development are reviewed to ensure they comply with regulations requiring "water – wise" landscape designs. In 2009, Castle Rock spent $500,000 to retrofit median landscaping into xeriscape designs and efficient irrigation systems.

- Central Colorado Water Conservancy District is a leader in the evaluation by the agricultural community of how its practices can be altered to increase the efficient use of water.

Table 2-3d shows the inclining block rates used by the municipal providers. Inclining block rate structures are recognized as the most effective rate structure for communicating the value of water and encouraging its efficient use. The approach provides an incentive to conserve and ensures that lower income consumers are able to meet their basic water needs at an affordable cost. Both the number of blocks and the increase in price between blocks influence the effectiveness of water rate structure.

Table 2-3e presents the water providers' programs offering incentives for conservation from rebates. Of note is the number and variety of rebates being offered by the water providers. Rebates take considerable administrative effort and reflect the will of management to seek innovative and effective avenues of water savings. The rebate programs are subject to periodic evaluations of their effectiveness and of the financial capabilities of each entity to offer the programs.

Although water conservation for each water provider will be relied upon as a major tool for reducing their future water demands, further conservation measures alone will not be adequate to make up for the shortfall in water needed by the water providers to meet current and future water needs over the next 50-year period. Therefore, it is concluded that increased water conservation alone is not adequate to address the purpose and need of the proposed action and that additional water supplies are required. Current water conservation practices constitute an independent parallel action and therefore were not explicitly carried forward as components of all alternatives selected for detailed evaluation.

2.3.4 The Concept of Conjunctive Use of Surface Water and Groundwater

Conjunctive use of surface water and groundwater can maximize the benefits and reliability of both surface water and groundwater supplies if the physical limitations can be overcome.

Bedrock Aquifer Conjunctive Use

Bedrock aquifer conjunctive use involves collection of surface water supplies and injecting the supplies into the bedrock aquifer through wells. Conjunctive use integrates groundwater and surface water sources and may be enhanced with aquifer storage and recovery operations. The purpose of this concept is to use available ground-water storage while avoiding the impacts associated with surface water impoundments. It maximizes the benefits of bedrock aquifers and extends their long-term reliability. There may be fewer environmental impacts, and the permitting process is simpler than for surface water storage. Limited aquifer recharge rates, the need for specialized wells and infrastructure for conveyance and treatment, higher energy costs incurred for aquifer recharge and pumping, and the need for interim surface storage to capture peak surface water flow often offset

the potential benefits of bedrock aquifer storage. A large-scale groundwater pumping and storage concept was informally presented to Douglas County water interests, but never developed into a viable project due primarily to unreasonably high costs and a lack of surface water.

The Bedrock Aquifer Conjunctive Use concept was evaluated for the Chatfield Reservoir study and ultimately eliminated from further consideration due to the necessity to build an interim storage reservoir to capture surplus surface water flows and the cost and logistics of constructing a treatment, injection and pumping system.

Alluvial Aquifer Conjunctive Use

Alluvial aquifer conjunctive use consists of diverting surplus surface water supplies and recharging the alluvial aquifer. Aquifer recharge is generally accomplished by spreading basin or canal infiltration. Tributary aquifers generally have high recharge rates. Groundwater is then pumped for water supply when accretions to the river system are needed to meet demands.

General benefits of this concept include minimal evaporation, higher alluvial aquifer groundwater level that support wetlands and other surface water systems, fewer environmental impacts than surface water storage, and a simpler permitting process than surface storage. Constraints include available local aquifer storage capacity, the cost and logistics of building adjacent aquifer recharge basins, and the potential of recharged water to return to the river system if not used or recaptured when needed.

The Alluvial Aquifer Conjunctive Use concept was evaluated for the Chatfield Reservoir study and ultimately eliminated from further consideration due to limited alluvial aquifer storage availability in the area of the project and the requirement to locate and construct aquifer recharge basins.

Use of Non-Tributary Groundwater (NTGW)

Of the water providers seeking storage space in Chatfield Reservoir, 10 of 12 (including the individual water providers in the South Metro Water Supply Authority [SMWSA]) are presently using some amount of NTGW from the Denver Basin as part or all of their water supplies. Of the SMWSA members participating in the Chatfield Reservoir storage reallocation project, collectively 67 percent of their supplies come from NTGW, with the majority of these members using more than 85 percent NTGW. In 2005, the total NTGW usage from the project participants at that time was approximately 30,000 acre-feet.

A major study of this issue was completed in December 2003 that addresses the effects of continued reliance on NTGW for these water providers out to the year 2050. That study, the South Metro Water Supply Study (SMWSS), was conducted by the SMWSS Board (Black & Veatch et al., 2003). Selected pages from that study are included in Appendix C. The heavy use of NTGW from the Denver Basin for municipal demands is a relatively new phenomenon principally occurring since the mid-1970s; therefore, the effects of NTGW use are relatively unknown. To estimate the future effect of continued and increasing groundwater withdrawals, a sophisticated model was developed and peer reviewed as the central planning tool for the study.

A key aspect of the issue is that the Denver Basin groundwater is not significantly recharged by surface waters. The use of the water from the basin is the mining of a nonrenewable resource that

reduces artesian pressure, which causes a significant drop in the rate of well production to the point when it is no longer feasible to extract. This is in comparison to the use of surface water, which, as part of the hydrologic cycle, is replenished continuously.

The SMWSS determined that further use of the NTGW causes the need to replace groundwater wells at an ever increasing pace to maintain the groundwater production. The study concluded that, in general, based on the assumptions of the study, during a 50-year period when water demands will double, the total number of groundwater wells needed to meet the new demands will increase nine fold. For the 11 participants in the SMWSS, their collective 165 present wells will need to grow to 1,529 to accommodate the demands at 2050. Over that same period, average pumping rates from wells in the Arapahoe Aquifer (the most used and most important Denver Basin aquifer) will decrease from 550 gallons per minute (gpm) to an estimated 100 gpm. The groundwater aquifers will get ever more expensive and difficult to extract water from and ultimately, it would no longer be feasible to extract NTGW. For the SMWSA members participating in the Chatfield Reservoir storage reallocation project, their collective 125 wells will need to increase to approximately 993 wells to meet the demands at 2050.

However, due to discounting, the farther into the future that costs occur, the smaller the fraction of these costs that is added to the present value of the cost of providing NTGW. This results in a less costly alternative than that suggested by the No Action Alternative, which includes significant expenditures for surface storage facilities. Although a nonrenewable resource, NTGW is assumed to be available for the 50-year planning period considered in the economic analysis. Colorado statutes restrict pumping of NTGW to no more than 1 percent per year, thereby providing a theoretical aquifer life of 100 years, although due to pumping cost the economic life might be shorter. As the SMWSS report describes, the projected pumping volume will dissipate the artesian pressure from the Denver Basin aquifers to a large extent over the next 10 to 20 years. The problem with continued pumping of the Denver Basin aquifers is related to a significant drop in the rate of well production (the gallons per minute of withdrawal) and not to the diminishment of total water stored in the aquifers. Regardless, the aquifer is assumed to be available for 50 years, and the NTGW is retained in the analysis in conjunction with storage for downstream providers (gravel pit surface storage). Under NEPA, this NTGW/Downstream Gravel Pits Alternative would be considered technically and economically reasonable for consideration in supporting the purpose and need of increasing availability of water, sustainable over the period of analysis, in the greater Denver area so that a larger proportion of existing and future (increasing) water needs can be met. The NTGW/ Downstream Gravel Pits Alternative was screened forward and is discussed in detail in Section 2.4.2.

Conjunctive use and perfection of water rights will likely be a pursuit of water providers in the future, and although the conjunctive use alternatives are screened from further analysis in the EIS, it doesn't preclude water providers to use storage in Chatfield in combination with ground water use and injection/ and or trading/perfecting of water rights. The municipal participants in this project are entities that have developed or are developing conjunctive use systems of both surface water and groundwater. In the years when this project does yield lesser amounts of water, those entities will use their NTGW to provide the reliability of supply their customers expect. For these entities, a primary motivation for the project is to decrease dependence on NTGW whenever that is possible. By utilizing surface water from this project when available, it stretches out the availability of NTGW for use in droughts.

2.3.5 The Concept of Developing New Surface Water Storage

Background

Surface water storage in the Front Range of Colorado generally takes one of two forms—traditional reservoirs constructed using a dam placed across a flowing (or diverted) water course or excavated gravel pits. Most excavated gravel pits are developed in the process of mining sand and gravel while others (usually smaller) may be simply excavated for the purpose of water storage.

New Construction Storage Reservoirs

Reservoirs are usually located where characteristics such as the potential to capture a large volume of water using a relatively small dam are optimized. The reservoirs can be located either on-channel or off-channel. For on-channel reservoirs, flows are captured directly from streams or rivers with access to the stored water coming from delivery systems consisting of ditches and/or pipelines. The potential locations for such facilities are very limited. Off-channel reservoirs, which are more expensive and less common, require developing facilities to divert and convey water from the stream to the reservoir. The proposed Two Forks Dam project, which was vetoed by the EPA more than 15 years ago, serves as an illustration of the permitting complexities and the environmental and fiscal costs that may be associated with construction of an on-channel new reservoir. The Rueter-Hess Reservoir, an off-channel reservoir developed by the Parker WSD, is an example of a new, successfully permitted storage facility. Development of traditional reservoirs is a very expensive and uncertain venture generally taking 20 to 30 years to accomplish.

Four new storage reservoir concepts were evaluated in the initial screening process including the Penley site, Willow Creek site, Hritz Plum Creek site, and a series of Highlands Ranch reservoir sites (Table 2-2).

The proposed Penley Reservoir would be an off-channel reservoir located approximately 11 miles south of Chatfield Reservoir adjacent to Colorado's "foothills" mountain range. The reservoir site would be created by construction of two embankments approximately 160 feet high with a total length of 3,500 feet, producing approximately 12,725 acre-feet of usable storage space. An outlet works approximately 1,100 feet long would be constructed in the northwest embankment. The surface area of the reservoir at a storage volume of 12,725 acre-feet would be approximately 186 acres. Options considered for delivery of water from the South Platte River to Penley Reservoir included a 15-mile-long gravity tunnel near Deckers and a 7.5-mile-long tunnel and pump station near Eagle Rock. The Penley Reservoir site was carried forward because it may provide a reasonable cost, upstream storage body, with sufficient volume and minimal environmental impacts.

The Willow Creek site, Hritz Plum Creek site, and Highlands Ranch reservoir sites were also evaluated as concepts to meet the purpose and need of the project (Table 2-2). Each of these sites was evaluated for potential water storage feasibility in 2003 (Tetra Tech RMC, 2003). These sites are located off-channel and hydraulically upgradient from the Chatfield Reservoir. All require some dam and reservoir configuration, delivery conveyance to and from the South Platte River, and an operating system for combining these small capacity reservoirs into a cohesive reservoir system to meet the needs of the project. The concept has a reasonable size relative to cost, and is substantially less than the costs associated with other water supply projects in the Colorado Front Range. Environmental impacts to wetlands or perennial streams would be small, with a commensurate ability to mitigate.

All sites were eliminated from further evaluation due to their limited storage capacity, and the logistical difficulties of combining reservoirs to meet the storage requirements of the project.

Gravel Pit Reservoirs

The nature of the South Platte River valley is such that alluvium deposited over time has accumulated in and adjacent to the river channel. These alluvial deposits serve as a readily available source of sand and gravel and are used in construction and road building. The mining of this material creates excavated areas, or pits, and once the gravel is completely removed from the pits, they can be lined with an impervious material and used for water storage. Alternatively, the gravel pit can be bounded by slurry walls prior to sand and gravel excavation. The relative ease of planning and permitting gravel pits for water supply makes them an attractive alternative to traditional reservoirs; however, there are limits related to the location and size of these types of water supply facilities.

Gravel pits have been and are being developed in the South Platte River valley from Douglas County to downstream of the Adams/Weld county line near Brighton. There are at least 35 gravel pits in this area either constructed, under construction, or planned to be constructed. One gravel pit reservoir is being constructed a short distance downstream of Chatfield Reservoir. Gravel pits range in size from a few acres to over 100 and are typically 20- to 30-feet deep, producing storage capacities on the order of 500 to 2,000 acre-feet. Gravel pit construction may take from 5 to 10 years to complete.

Two groups of gravel pit reservoirs were identified for initial evaluation (Table 2-2). The first group comprised a number of pits located upstream of the Chatfield Reservoir that could be used to divert water from the South Platte River for storage. This concept was eliminated from further consideration due to limited storage capacity and the logistical difficulties of combining reservoirs to meet the storage requirements of the project.

The second group consisted of reservoirs locally available to the Lower South Platte River Gravel Pit Users component of the water providers (Table 2-2). These reservoirs were screened forward because they represented a cost-effective off-channel storage option with minimal environmental impacts.

Storage Expansion or Reallocation of Other Existing Reservoirs

A number of existing reservoirs serve to store and allocate water supply to Colorado Front Range communities, similar to the water storage function of the Chatfield Reservoir. Depending on respective storage availability, physical attributes, and future plans, one or more reservoirs may be available to meet the needs of the Chatfield Reservoir study. Options for increasing storage in existing facilities include raising dams, raising mean water levels, dredging sediments and deepening the reservoir.

Six existing reservoirs located near the project site were evaluated for potential water supply storage expansion and/or re-allocation, including Rueter-Hess Reservoir, South Platte Reservoir, McLellan Reservoir, Platte Canyon Reservoir, Bear Creek Reservoir, and Cherry Creek Reservoir (Table 2-2).

The Rueter-Hess Reservoir is an off-stream reservoir, located approximately 9.5 miles south of Chatfield Reservoir, which will rely on surface water from nearby Cherry Creek and Newlin Gulch; and groundwater which may be alluvial groundwater or bedrock aquifer groundwater from the Denver Basin. Rueter-Hess Reservoir is owned and operated by the Parker Water and Sanitation District (PWSD), and the town of Castle Rock, Castle Pines North Metropolitan District and Stonegate Village Metropolitan District own the storage capacity. Water allocation is subscribed and permitted under a separate planning action with the USACE. With the completed expansion, reservoir storage is approximately 72,000 acre-feet. The reservoir at its expanded size is anticipated to primarily meet the needs of PWSD in serving its customers. Since completion of the expansion in 2012, PWSD has not made any additional capacity available for sale. Similarly, South Platte Reservoir, McLellan Reservoir, and Platte Canyon Reservoir, were not available due to current storage commitments. Therefore, these concepts were eliminated from further consideration.

Bear Creek Reservoir and Cherry Creek Reservoir are part of the three dams system built by the USACE to protect the Denver region from floods. Located off-channel, both would require diversions to/from the South Platte River to the reservoir. Both concepts were eliminated from further evaluation due to limited storage capacity. In the case of Cherry Creek Reservoir, any expansion of storage would impact the flood control function of the reservoir.

2.3.6 Storage Expansion and Reallocation Concepts for Chatfield Reservoir

As previously discussed, reallocation of storage space in Chatfield Reservoir would provide an estimated 8,539 acre-feet per year of average year yield, to be compared with the identified shortfall of 90,000 acre-feet per year for the South Platte River Basin. An initial preliminary screening study for this project looked at a number of aspects of reallocation within Chatfield Reservoir including water rights, use patterns, demands, and water level fluctuations in terms of four alternatives (CWCB, 2003). The 20,600 Acre-Foot Reallocation (5,444 feet msl) and 7,700 Acre-Foot Reallocation (5,437 feet msl) alternatives were retained for full analysis and are discussed below. The 20,600 Acre-Foot Reallocation Alternative was selected because it was considered a reasonable maximum reallocation storage volume based on flood risk management and modification of recreational facilities (Brown & Caldwell, 2003). The 7,700 Acre-Foot Reallocation Alternative was selected as an intermediate reallocation storage volume, with lesser impacts to recreational facilities and environmental resources than the 20,600 Acre-Foot Reallocation Alternative. The Brown and Caldwell study also evaluated the reallocation of 4,500 acre-feet (5,435 feet msl) and 2,900 acre-feet (5,434 feet msl). The results indicated that the 4,500 acre-foot reallocation alternative was essentially identical to the 7,700 Acre-Foot Reallocation Alternative in regard to effects on recreation facilities; therefore, it was subsequently dropped from further consideration. The 2,900 acre-foot reallocation alternative was determined to provide too little additional storage to make it worth pursuing from the perspective of the water providers. Thus, the 2,900 acre-foot reallocation alternative was not carried through the final analysis because it was not acceptable to the water providers.

An alternative to increase the storage capacity by deepening the reservoir was also analyzed. This alternative would require excavation of both alluvial sediments and bedrock. Since the upstream side of the outlet works is at a fixed elevation this could result in a larger "dead pool" with no access to the water without pumping. For these reasons, this alternative was not carried forward.

The water providers also evaluated creative ways of reallocating water in the conservation pool and some water in the flood control pool in proportions that would seek to minimize ecosystem habitat flooded and effects on recreation facilities. In two variations of this concept evaluated (Table 2-2), both were eliminated due to current storage commitments. Denver Water has no plans to make its storage space in Chatfield Reservoir available to others.

2.3.7 The Concept of Water Reuse

Comments generated during this FR/EIS scoping process identified the possibility of using reuse to provide additional water supplies. Various forms of reuse or recapture of reusable water are presently aggressively being employed or are planned to be employed by the various water providers who have reusable water. Water providers are motivated to maximize this reuse or recapture. The additional new water supply yield that would result from reuse was not screened forward in the FR/EIS as a separate alternative. Instead, the ability of storage in Chatfield Reservoir to facilitate water recapture and reuse or exchange was accounted for in the average year yields of the reallocation alternatives.

One regional water reuse concept was identified for consideration. The Water Infrastructure and Supply Efficiency (WISE) Partnership is a proposed regional project between Denver Water ("Denver"), Aurora Water ("Aurora") and the South Metro Water Supply Authority (SMWSA). The WISE Partnership is a regional water supply project that is contemplated to provide eleven members of SMWSA (water providers in Douglas and Arapahoe Counties) treated water from Denver and Aurora Water. The SMWSA is a lead regional water authority whose mission is to assist its members in planning, sourcing, and implementation of sustainable water needed to transfer off of the non-renewable groundwater resources which they are currently dependent. The WISE Partnership is an independent project from the Chatfield Reallocation. Both projects are key to planning efforts to secure a reliable, sustainable water resource for the entities of SMWSA participating in both.

The project is looking at the concept of more efficiently using reusable water supplies from Denver and Aurora municipal return flows, while maximizing the use of existing pipeline and pump station infrastructure principally owned by Aurora and the East Cherry Creek Valley Water and Sanitation District. The project is currently in the planning stages and was eliminated based on unknown cost, logistics and timing. The final configuration and completion date are unknown and cost estimates have not yet been developed for key components of the project. Additionally, the quality of the water delivered would require either advanced treatment or significant blending with other water of which there is a very limited supply. Finally, the timeframe for the WISE Project implementation is unknown.

2.3.8 Summary of the Initial Screening Process

A total of 38 concepts, comprising the family of general concepts of water development or conservation categories described by SWSI, were evaluated in the initial screening process. This initial set of concepts was identified based on problems and opportunities identified in Section 2.1. These initial screening criteria were developed based on planning objectives and constraints identified and summarized in Section 2.2 and Table 2-1.

The results of this screening process are summarized in Table 2-4. Consistent with identified planning objectives and constraints, those concepts involving large costs, prohibitive logistics or inability to obtain water rights or legal agreements for water transfers were eliminated in favor of local, in-channel and cost effective concepts.

Table 2-4
Summary Results of Initial Screening of Concepts

	Concept*	Relevant Screening Criteria	Rationale for Screening Forward or for Elimination
Increased Water Conservation			
1.1	Chatfield Water Providers M&I Conservation Programs	PN1	An independent parallel action and therefore not explicitly included as components of each alternative. Conservation measures alone would not meet the overall purpose and need of the project.
1.2	Central Colorado Water Conservancy District Efficiency Program	PN1	An independent parallel action and therefore not explicitly included as components of each alternative. Conservation measures alone would not meet the overall purpose and need of the project.
Agricultural Transfers			
2.1	Lower Arkansas River Concept	C1, LT1	Eliminated based on cost, logistics and timing. This concept cannot be implemented within a reasonable timeframe due to logistics of obtaining water rights and legal agreements for out-of-basin transfers. Storage, conveyance and treatment costs would be substantial.
2.2	Middle & Lower South Platte River Concept	C1, LT1	Eliminated based on cost, logistics and timing. This concept cannot be implemented within a reasonable timeframe due to logistics of obtaining water rights. Storage, conveyance and treatment costs would be substantial.
2.3	Rocky Ford Highline Canal Concept	C1, LT1	Eliminated based on cost, logistics and timing. This concept cannot be implemented within a reasonable timeframe due to logistics of obtaining water rights and legal agreements out-of-basin transfers. Storage, conveyance and treatment costs would be substantial.
2.4	South Platte River/ FRICO	LT1	Eliminated based on logistics and timing. This concept cannot be implemented within a reasonable timeframe due to logistics of obtaining water rights.
2.5	Interruptible Agricultural Transfer	C1, LT1, LT4,	Eliminated based on cost, logistics and timing. Although these concepts have been discussed for several years and multiple grants are presently studying alternative approaches, no existing examples exist of successfully implemented programs. These concepts, and particularly the institutional and technical arrangements, continue to be in the developmental stage.
Water Importation Concepts			
3.1	Flaming Gorge Reservoir Concept	C1, LT1	Eliminated based on cost, logistics and timing. This concept cannot be implemented within a reasonable timeframe due to logistics of obtaining water rights and legal agreements out-of- basin transfers. Conveyance and treatment costs would be substantial such that overall project costs would be substantially greater than costs associated with water supply projects in the Colorado Front Range.
3.2	Yampa River New Supply Concept	C1, LT1	Eliminated based on cost, logistics and timing. This concept cannot be implemented within a reasonable timeframe due to logistics of obtaining water rights and legal agreements for out-of- basin transfers. Conveyance and treatment costs would be substantial such that overall project costs would be substantially greater than costs associated with water supply projects in the Colorado Front Range
3.3	Green Mountain New Supply Concept	C1, LT1	Eliminated based on cost, logistics and timing. This concept cannot be implemented within a reasonable timeframe due to logistics of obtaining water rights and legal agreements for out-of- basin transfers. Conveyance and treatment costs would be substantial such that overall project costs would be substantially greater than costs associated with water supply projects in the Colorado Front Range.

Table 2-4
Summary Results of Initial Screening of Concepts

	Concept*	Relevant Screening Criteria	Rationale for Screening Forward or for Elimination
3.4	Colorado River Return Concept	C1, LT1	Eliminated based on cost, logistics and timing. This concept cannot be implemented within a reasonable timeframe due to logistics of obtaining water rights and legal agreements for out-of- basin transfers. Conveyance and treatment costs would be substantial such that overall project costs would be substantially greater than costs associated with water supply projects in the Colorado Front Range.
3.5	Gunnison River Concept	C1, LT1	Eliminated based on cost, logistics and timing. This concept cannot be implemented within a reasonable timeframe due to logistics of obtaining water rights and legal agreements. Overall project costs would be substantially greater than costs associated with water supply projects in the Colorado Front Range.
3.6	San Luis Valley Concept	C1, LT1	Eliminated based on cost, logistics and timing. This concept cannot be implemented within a reasonable timeframe due to logistics of obtaining water rights and legal agreements for out-of- basin transfers.
New Storage Reservoirs			
4.1.1	Penley Reservoir Site	PN1, LT1, LT2, LT3, EC1	Carried forward in the FR/EIS to form a component of the No Action Alternative (Alternative 1). Appears to provide reasonable cost, upstream off-channel storage with minimal environmental impacts.
4.1.2	Willow Creek Reservoir	PN1, LT1, LT5	Eliminated due to limited storage capacity and the logistics of combining with other small capacity reservoirs in the area.
4.1.3	Hritz Plum Creek Reservoir Site	PN1, LT1, LT5	Eliminated due to limited storage capacity and the logistics of combining with other small capacity reservoirs in the area.
4.1.4	Highlands Ranch Reservoir Series (Reservoir Nos. 6, 7, 8, 10, 11 and 12)	PN1,LT1, LT5	Eliminated due to its current storage commitments and the logistics of combining with the other small capacity reservoirs in this series.
4.1.5	Local Upstream Gravel Pit Reservoirs	PN1, LT5	Eliminated due to limited storage capacity, and the logistics of combining with the other small capacity reservoirs in the area.
4.1.6	Lower South Platte Gravel Pits (Central Colorado WCD Gravel Pit, Western Mutual Ditch Company Gravel Pit, and one unassigned gravel pit).	PN1	Carried forward in the FR/EIS to form a component of the No Action Alternative (Alternative 1). Provides reasonable cost, upstream off-channel storage with minimal environmental impacts. Also carried forward in the FR/EIS to form a component of Alternative 2.
Storage Expansion of Chatfield Reservoir			
4.2.1	Reallocation of 2,900 AF to Storage	PN1, LT5	Eliminated due to insufficient storage capacity and the logistics of combining with other small capacity reservoirs in the area.
4.2.2	Reallocation of 4,500 AF to Storage	PN1, LT5	Eliminated due to insufficient storage capacity and the logistics of combining with other small capacity reservoirs in the area.
4.2.3	Reallocation of 7,700 AF to Storage	PN1, LT1, LT2, LT3, LT5, EC2	Carried forward in the FR/EIS as Alternative 4. In channel and existing infrastructure. Does not require acquisition of additional water rights, acceptable permitting, and operational requirements. Significant, but mitigable environmental impacts and recreational impacts.
4.2.4	Reallocation of 20,600 AF to Storage	PN1, LT1, LT2, LT3, LT5, EC2	Carried forward in the FR/EIS as Alternative 3. In channel and existing infrastructure. Does not require acquisition of additional water rights, acceptable permitting, and operational requirements. Significant, but mitigable environmental impacts and recreational impacts.
4.2.5	Reallocation of Greater Than 20,600 AF to Storage	LT2, LT5	Eliminated due to the extensive inundation that would impact wetlands, recreational facilities, park roadways, and local highways. The flood risk management function of the reservoir would be impacted.
4.2.6	Reallocate in the existing conservation pool (i.e. below 5,432 feet msl) for large and/or small amounts	LT1, LT2	Eliminated due to current storage commitments. Denver Water has no plans to make its storage space in Chatfield available to others. Additionally, if 20,600 AF of space were used by the Chatfield water providers, the conservation pool would sometimes drop below the current low level of 5,423 feet msl.

Table 2-4
Summary Results of Initial Screening of Concepts

	Concept*	Relevant Screening Criteria	Rationale for Screening Forward or for Elimination
4.2.7	Reallocate some water in the conservation pool and some in the flood control pool in proportions that would seek to minimize ecosystem habitat flooded and effects on recreation facilities.	LT1, LT2	Eliminated due to current storage commitments. Denver Water has no plans to make its storage space in Chatfield Reservoir available to others.
4.2.8	Deepening the Reservoir	PN1, LT4	Eliminated based on the analysis that the capacity gained with deepening would be small relative to project needs, the engineering complexities anticipated to be encountered and the potential environmental impacts.
Storage Expansion or Reallocation of Other Existing Reservoirs			
4.3.1	Rueter-Hess Reservoir	PN1, LT1	Eliminated due to its current storage commitments. Rueter-Hess Reservoir at its expanded size is anticipated to primarily meet the needs of PWSD in serving its customers. Since completion of the expansion in 2012, PWSD has not made any additional capacity available for sale.
4.3.2	South Platte Reservoir	PN1, LT1	Eliminated due to its current storage commitments. CWSD has no plans to make this reservoir available.
4.3.3	McLellan Reservoir	PN1, LT1	Eliminated due to its current storage commitments. CWSD has no plans to make this reservoir available.
4.3.4	Platte Canyon Reservoir	PN1, LT1	Eliminated due to its current storage commitments. Denver Water has no plans to make this reservoir available.
4.3.5	Bear Creek Reservoir	PN1, LT5	Eliminated due to limited storage capacity, and the cost and logistics of combining with other small capacity reservoirs in the area
4.3.6	Cherry Creek Reservoir	PN1, LT5	Eliminated due to limited storage capacity. The flood risk management function of the reservoir would be impacted.
Conjunctive Use of Surface and Ground water			
5.1	**Additional NTGW with Local Gravel Pit Storage**	PN1	Carried forward in the FR/EIS to form a component of Alternative 2. Considered technically and economically reasonable for consideration in supporting the purpose and need of increasing availability of water, sustainable over the period of analysis.
5.2	Bedrock Aquifer Conjunctive Use	C1, LT4	Eliminated due to the necessity to build an interim storage reservoir to capture surplus surface water flows and the cost and logistics of constructing a treatment, injection and pumping system.
5.3	Alluvial Aquifer Conjunctive Use	C1, LT4	Eliminated due to limited alluvial aquifer storage availability in the area of the project and the requirement to locate and construct aquifer recharge basins.
Water Reuse			
6.1	Chatfield Water Providers Local Reuse Programs	PN1	Eliminated based on the fact that all Chatfield study participants already have in place systems to recapture and reuse the majority of their available reusable wastewaters. This has been a cost effective water management alternative that has already been maximized to the extent that there is no significant additional water supplies available from this concept.
6.2	Regional Reuse-WISE Partnership	C1, LT1, PN1, LT 4	Eliminated based on unknown cost, logistics and timing. The project is currently in the planning stages, and its configuration and completion date are unknown. Additionally, the quality of the water delivered would require either advanced treatment or significant blending with other water of which there is a very limited supply. Finally, the timeframe for the WISE Project implementation is unknown.

*Concepts in bold text were carried forward in the FR/EIS.

A number of existing reservoirs located near the project site were evaluated for potential water supply storage expansion and/or reallocation. These reservoirs were not available due to current storage commitments and/or any potential expansion of storage would impact the flood mitigation function of the reservoir.

New storage reservoir concepts were also considered in the initial screening process. All potential sites, with the exception of the Penley site, were eliminated from further evaluation due to their limited storage capacity and the logistical difficulties of combining reservoirs to meet the storage requirements of the project. The Penley Reservoir site was carried forward because it may provide a reasonable cost, upstream storage body, with sufficient volume and minimal environmental impacts.

Consistent with identified planning objectives, a number of configurations of local storage reallocation within Chatfield Reservoir were eliminated due to insufficient storage capacity (e.g. 2,900 acre-feet and 4,500 acre-feet alternatives) and, consistent with planning constraints, reservoir scenarios involving prohibitively large volumes (>20,600 acre-feet alternative) that would impede flood control functions, and involving acquisition of storage or water rights from Denver Water were eliminated.

Water conservation and reuse practices of the water providers constitute an independent parallel action and therefore were not explicitly included as components of all alternatives selected for detailed evaluation.

Alternatives selected for detailed evaluation are described in Section 2.4.

2.4 Alternatives Considered in Detail

The alternatives considered in detail in this analysis are:

- Alternative 1—No Action, Penley Reservoir combined with Gravel Pit Storage
- Alternative 2—NTGW combined with Gravel Pit Storage (Least Cost Alternative to Chatfield Reservoir Storage Reallocation)
- Alternative 3—Reallocation of 20,600 acre-feet to Storage (20,600 Acre-Foot Reallocation)
- Alternative 4—Reallocation of 7,700 acre-feet to Storage (7,700 Acre-Foot Reallocation) and use of NTGW and Gravel Pit Storage

Each of the alternatives was designed to reach an average year yield of 8,539 acre-feet, which corresponds with the average year yield under the maximum (20,600 acre-feet) reallocation alternative (Alternative 3). The alternatives correspond to the maximum water pool elevations in the reservoir of 5,432 feet msl (Alternatives 1 and 2), 5,444 feet msl (Alternative 3), and 5,437 feet msl (Alternative 4). Each alternative implicitly includes the increased water conservation programs currently planned or implemented (see Section 2.3.3 for details). The following section provides a description of each of the alternatives analyzed in detail.

Background on Chatfield Reservoir

The Chatfield Dam and Lake Project was authorized under Public Law 81-516 with the primary purpose of providing flood control storage. The project was designed to maximize benefits by meeting multiple objectives; secondary uses include recreation, silt control, and fish and wildlife habitat. The initial authorization allocated 180,000 acre-feet to flood risk management storage and 20,000 acre-feet to silt control and for fish and wildlife purposes (USACE 2002b, Design Memorandum PC-46, Master Plan). By contract in 1979, Denver Water is allowed to store approximately 27,000 acre-feet in Chatfield Reservoir with the conditions that storage space between elevation 5,423 feet msl and 5,432 feet msl can be regulated solely by Denver. Denver will use its efforts "as nearly as practicable" to maintain a minimum storage level goal of 20,000 acre-feet from May 1 to August 31 each year, and only during "severe and protracted drought" conditions, as determined by the state of Colorado and endorsed by the Omaha District Engineer (USACE), will the pool be allowed to fall below 5,423 feet msl. Storage in the reservoir is allocated into four pools: inactive, multipurpose-conservation, flood control, and maximum surcharge/spillway design flood. Table 2-5 presents the elevations of the different pools, the volume of storage, and the surface areas under each of the alternatives.

The following characteristics of the reservoir and dam would remain the same under all alternatives[1]:

- Dam
  - Top Elevation — 5,527 feet msl
  - Length of Dam — 13,136 feet
  - Height of Dam — 147 feet
- Spillway
  - Discharge Capacity — 188,000 cfs (at elevation 5,521.6 feet msl)
  - Crest Elevation — 5,500 feet msl
  - Width — 500 feet
  - Gross Storage (5,521.6 feet msl) — 350,676 acre-feet
- Outlet Works
  - Number and size of conduits — Two 11-foot x 16-foot oval conduits (bottom release)
  - Conduit length — 1,280 feet
  - Number/Size/Type of Gate(s) — Two 6-foot x 13-foot hydraulic slide
Two 2-foot x 2-foot slide gate on gate
One 6-foot butterfly
  - Discharge Capacity — 8,400 cfs at elevation 5,500 feet msl

[1] Source: USACE, 2002b

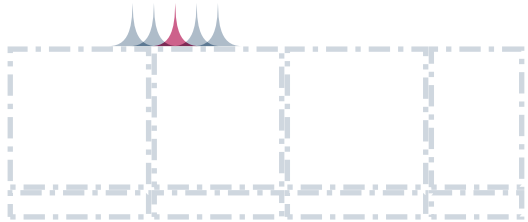
Table 2-5
Comparison of Pool Levels and Volumes Under Each Alternative

Feature	Elevation (feet msl)			Capacity (acre-feet)			Surface Area (acres)		
Alternative	No Action or NTGW*	20,600 Acre-Foot Reallocation	7,700 Acre-Foot Reallocation	No Action or NTGW*	20,600 Acre-Foot Reallocation	7,700 Acre-Foot Reallocation	No Action or NTGW*	20,600 Acre-Foot Reallocation	7,700 Acre-Foot Reallocation
Maximum Surcharge/Spillway Design Flood c/	5,500–5,521.6	5,500–5,521.6	5,500–5,521.6	116,469	116,469	116,469	5,991	5,991	5,991
Flood Control Pool a/, b/, c/, d/	5,432–5,500	5,444–5,500	5,437–5,500	206,779	186,179	199,079	4,779	4,779	4,779
Multipurpose-Conservation Pool b/, c/	5,385–5,432	5,385–5,444	5,385–5,437	27,405	48,005	35,105	1,429	2,009	1,668
Inactive Pool c/, e/	5,377–5,385	5,377–5,385	5,377–5,385	16	16	16	N/A	N/A	N/A

* NTGW refers to the NTGW/Downstream Gravel Pits Alternative.

Sources
a/ Scoping document
b/ Water Control Plan (Appendix B of the FR/EIS)
c/ Master Plan
d/ Calculated (206,729-20,600=186,129 and 206,729-7,700=199,029)
e/ Inactive Pool based on 2010 survey (USACE 2011c).

N/A not applicable



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2.4.1 No Action (Alternative 1)

The No Action Alternative, also known as the "without-project" condition, is the most likely condition expected to exist in the future in the absence of the proposed action, i.e., the Chatfield Reservoir storage reallocation project. In this case, the No Action Alternative means that flood storage space within Chatfield Reservoir would not be reallocated to conservation storage and the operation of the reservoir would remain the same. Since there would be no change in water levels or operations of the reservoir, there would be no observable impacts to users or resources within the immediate vicinity of Chatfield State Park. But, since the water providers desiring Chatfield Reservoir storage space will continue to have their individual water supply needs as described in Chapter 1, the No Action Alternative needs to describe the most likely action or actions that would be taken to realize equivalent benefits to the proposed action. The No Action Alternative constitutes the benchmark against which other alternative plans are evaluated for other than economic purposes. An alternative screening analysis has been conducted to determine what the most likely No Action Alternative would be. The set of potential "no action" options was screened by the providers based on several factors including cost, environmental impacts, project timing, water rights considerations, and likelihood of implementation. The water providers then collectively developed the most likely "no action" alternative, as described below.

For the analysis of a development of storage No Action Alternative, numerous options were identified and screened including alternative reservoirs at the following locations: Willow Creek site, Hritz Plum Creek site, Walker pit site, McClean pit site, Highlands Ranch site 11, Titan ARS pit site, Deer Creek quarry site, and the Tarryall Reservoir site. These are sites for an upstream reservoir location and several unnamed gravel pit sites for downstream reservoir locations that were analyzed. The conclusion from this analysis is that the most likely and lowest cost No Action Alternative for each of the water providers would be either the construction of alternative new storage, with pump and pipeline facilities, at several sites, or, for one user, the combination of a small acquisition of new water rights and storage space in an existing facility.

The main feature of the No Action Alternative is the development of other alternative surface storage units to contain surface water supplies of the same approximate yield of the Chatfield Reservoir storage reallocation project. In addition, it is important to also consider how the water providers' demand will be met until major surface storage features come online. For upstream water providers, primary supply in lieu of a reallocation at Chatfield Reservoir is NTGW until other surface storage is developed. Downstream water providers' supplies are accommodated by junior and senior surface water rights, existing surface water storage and recharge facilities, reuse, and purchase/transfer of agricultural water rights leasing agreements until an alternative surface storage unit can be developed.

The water providers have developed No Action Alternatives generally based upon two logical regional groupings, the so-called Penley Reservoir Users consisting of water providers located approximately at, above, or slightly below the elevation of Chatfield Reservoir, and the so-called Lower South Platte Gravel Pit Users who are either located or able to take water deliveries considerably downstream of Chatfield Reservoir. One water provider has a unique circumstance, which is described as Other User. Because the NTGW and other supplies that will provide water supply in lieu of a reallocation at Chatfield Reservoir are all currently in existence and being used, additional environmental impacts are relatively minor. Therefore, detailed environmental impact analyses will mainly focus on surface storage.

Alternative 1 assumes that Penley Reservoir would provide an average year-yield of 5,275 acre-feet, the downstream gravel pits would provide an average year-yield of_3,248 acre-feet, and Denver Botanic Gardens would have an average year-yield of 16 acre-feet. Several factors, including precipitation, runoff, and the seniority of water rights, play a key role in the availability of water and storage opportunities in any given year. The actual yield of water supplies that would be realized from use of the storage space would vary every year. The water rights of the 12 water providers that would allow them to store water in Chatfield Reservoir are, in general, very junior in their relative priority and therefore they are expected to be in priority relatively infrequently. The reliability of the water supply is similar to the alternatives that are dependent upon the opportunistic capture of excess runoff.

2.4.1.1 Penley Reservoir User Group

The so-called Penley Reservoir User Group includes Mount Carbon Metropolitan District, the eight SMWSA members that are participants in the Chatfield study (see Table 1-1), Colorado Parks and Wildlife, Center of Colorado WCD, and CWCB. Roxborough WSD was in this user group but it is in the process of withdrawing from the project and its share of the reallocated storage is designated as unassigned (as shown in Table 1-1) and will be reassigned to one or more of the water providers or others at a future date.

The collective No Action Alternative for the Penley Reservoir Users is to construct a new regional storage reservoir, known as the Penley Reservoir, at the site shown in Figure 2-1. This site was chosen after analyzing eight alternative storage sites in the nearby area. Many Penley Reservoir Users are participating in the project with this specific goal in mind. Note that the "Proposed Plum Creek Reservoir" shown in Figure 2-1 is not a component of the Chatfield storage reallocation study. It is a project being developed independently by the Castle Pines Metropolitan and Castle Pines North Metropolitan Districts and the town of Castle Rock, and its development is not contingent on the outcome of the Chatfield study (see Section 4.19.1.20 for additional details).

The possible sites for a regional reservoir meeting the collective volume requirement for the Penley Reservoir Users are extremely limited. No reservoir site located upon the South Platte River channel, which would be equivalent to Chatfield Reservoir in its on-channel benefits, was considered practicable. Expenses and impacts are minimized by making this a single regional storage facility to serve multiple water providers. The SMWSA listed Penley Reservoir as a proposed regional storage site in SMWSA's water right application, Colorado Division One water court case number 04CW309, filed in December 2004.

The proposed Penley Reservoir, as shown in greater detail in Figure 2-2, would be an off-channel reservoir located approximately 11 miles south of Chatfield Reservoir adjacent to Colorado's "foothills" mountain range. The reservoir site would be created by construction of two embankments approximately 160 feet high with a total length of 3,500 feet, producing approximately 12,725 acre-feet of usable storage space (this is the same storage volume the collective Penley Reservoir Users would realize from the 20,600 Acre-Foot Reallocation Alternative). An outlet works approximately 1,100 feet long would be constructed in the northwest embankment. The surface area of the reservoir at a storage volume of 12,725 acre-feet would be approximately 186 acres.

Figure 2-1
Proposed Pipelines Associated with Penley Reservoir

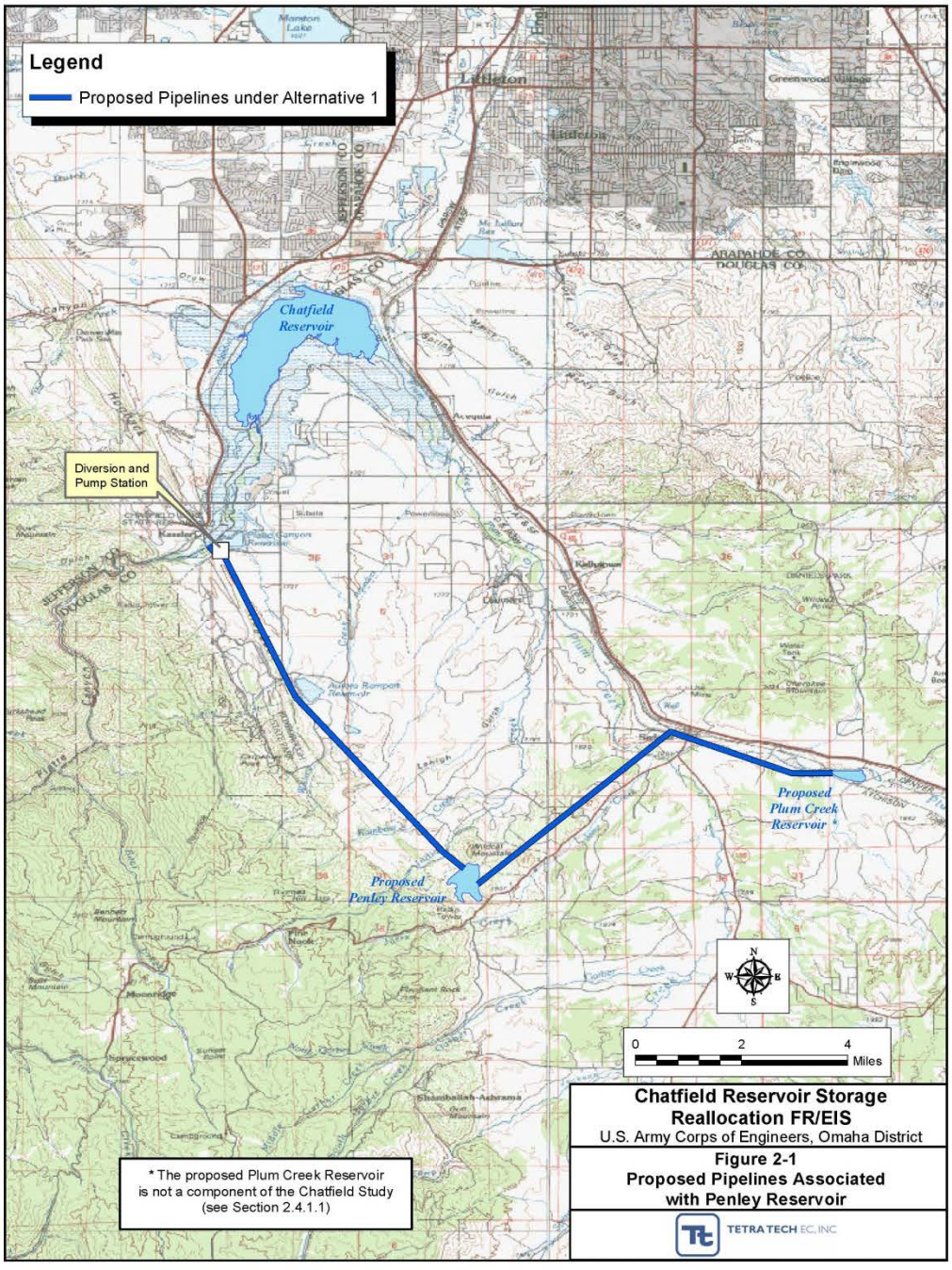

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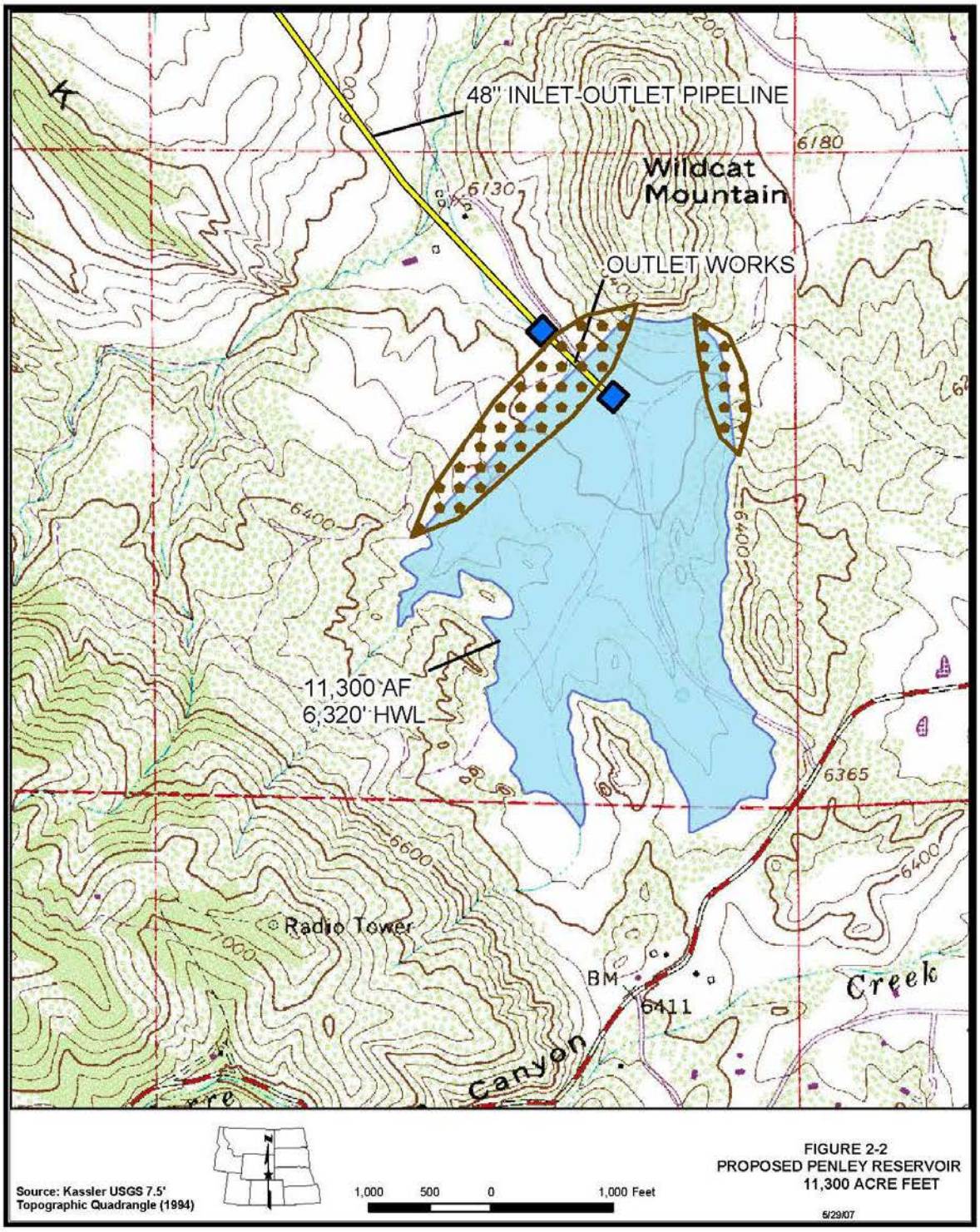
Figure 2-2
Proposed Penley Reservoir, 11,300 Acre-Feet



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Options considered for delivery of water from the South Platte River to Penley Reservoir included a 15-mile-long gravity tunnel near Deckers and a 7.5-mile-long tunnel and pump station near Eagle Rock. The most favorable option is to deliver water into the Penley Reservoir from the South Platte River at the downstream end of Waterton Canyon near the Platte Canyon Reservoir and High Line Canal; this option is used in Alternative 1. This diversion would require a pump station and an approximately 8-mile-long, 48-inch-diameter pipeline to the reservoir (see Figure 2-3) with a capacity of approximately 60 cfs. The anticipated approach is to utilize existing Denver Water facilities (i.e., the High Line Canal and the Platte Canyon Reservoir), thereby avoiding the need for a new diversion structure on the river. This approach would require the approval of Denver Water. If no approval can be obtained, a costly new diversion structure would be required.

Delivery of water from the reservoir to the users would be done using two general approaches. For some water providers, including SMWSA, Centennial WSD, Center of Colorado WCD, and Colorado Parks and Wildlife, the pipeline carrying water to the reservoir would also be used to deliver water back to the South Platte River and to Chatfield Reservoir for subsequent release or diversion. This pipeline would be approximately 8 miles long. A joint inlet and outlet facility would be used. For other water providers in the Penley Reservoir User Group, including Castle Pines Metropolitan District, Castle Pines North Metropolitan District, and town of Castle Rock, a separate delivery system of pipeline and booster pump facilities would be used to deliver water to their respective water systems.

The same 8-mile pipeline and pump station facilities are estimated to be used for the Castle Pines Metropolitan District, Castle Pines North Metropolitan District, and Town of Castle Rock; the other water providers would each have their own water delivery facilities. The Castle Pines Metropolitan Districts/town of Castle Rock pipeline would be approximately 6.95 miles long. Figure 2-4 shows the layouts of these proposed facilities.

Water Rights Considerations for the Penley Reservoir User Group. Most Penley Reservoir Users would not acquire new water rights for the Penley Reservoir alternative. Instead, they would each use the same water rights they had anticipated using in a Chatfield Reservoir storage reallocation project after they had been successful with a so-called change case process in water court to change the place of storage of the water rights. The one exception is the SMWSA, who has already listed Penley Reservoir as an alternative storage location in its pending water rights application and would proceed to acquire that new junior water right. Use of these water rights would give the Penley Reservoir Users approximately the equivalent yield, estimated as 5,275 acre-feet per year of average year yield, compared to the average year yield the users would get with the 20,600 Acre-Foot Reallocation Alternative, since both groups of water rights are relatively junior in their priority. This yield estimate does not account for the possible limitation from the minimum stream flow requirements in Waterton Canyon.

2.4.1.2 Lower South Platte Gravel Pit User Group

The so-called Lower South Platte Gravel Pit User Group is composed of Central Colorado WCD and Western Mutual Ditch Company. The city of Aurora was in this user group but it is in the process of withdrawing from the project and its share of the reallocated storage is designated as unassigned (as shown in Table 1-1) and will be reassigned to one or more of the water providers or others at a future date. If the Chatfield Reservoir storage reallocation project does not happen, these downstream water providers would most likely each develop an individual gravel pit storage

reservoir, located to maximize water supply benefits and minimize connection costs with the user's existing water supply system.

The Lower South Platte Gravel Pit Users considered several other alternatives prior to identifying gravel pit storage as the most likely, as well as least cost, alternative to storage in Chatfield Reservoir. Alternatives that would achieve equivalent benefits to the reallocated storage space in Chatfield Reservoir were developed. These included gravel pit storage along the lower South Platte River; the acquisition of additional direct flow water rights to supply direct flow water that would otherwise be available through storage in Chatfield Reservoir; and participation in a large regional pipeline to convey water to the downstream users from other basins. These alternatives were screened for costs, timing of construction, and institutional considerations (including environmental permitting needs). Based on this screening effort, gravel pit storage was determined to be the least costly option with the highest likelihood of success. Institutional constraints and likely environmental impacts were also the smallest for gravel pit storage. Each Lower South Platte Gravel Pit User then identified a potential gravel pit storage site, based on optimizing the connection with its existing water supply system and infrastructure. These locations, all in Adams County, are identified in Figure 2-5.

Based on depth to bedrock in the general area, each of the gravel pits was assumed to be approximately 20 feet deep. Each of the pits would be surrounded by a slurry wall down to bedrock, and would require inlet and outlet works with associated pumps to allow the gravel pits to fill and return water to the South Platte River as needed. Inlet facilities would be sized to allow adequate capacity to pump from the South Platte River under free water conditions (this also approximates the diversion capability of an on-channel reservoir). Free water consists of inflows available to be stored in Chatfield by the new users when inflows are so high that their relatively junior water rights are in priority. Adequate outlet structures would also be needed to allow the return of required augmentation water. It is assumed that a single gravel pit facility with 1,425 acre-feet of storage space (and approximately 591 acre-feet average annual yield) would require approximately 76 acres of surface disturbance, including required freeboard, room for the slurry wall, and appropriate setbacks. One Lower South Platte Gravel Pit User would need to construct 1,425 acre-feet of storage; one would need to construct 2,849 acre-feet of storage, and the other would need 3,561 acre-feet. Figures 2-6, 2-7, and 2-8 show these facilities.

Water Rights Considerations for the Lower South Platte Gravel Pit User Group. The junior water rights that the Lower South Platte Gravel Pit Users currently hold or have pending in Division 1 water court associated with the Chatfield Reservoir storage reallocation project do not list other future gravel pit storage sites contemplated along the lower South Platte River as points of storage. Like the Penley Reservoir Users, the water rights pending in water court or decreed in Division 1 would have to be amended through a change of water right to allow diversion and storage at locations other than Chatfield Reservoir. Amending applications or changing adjudicated decrees could result in more restrictive and adverse terms and conditions for other non-Chatfield Reservoir related components that the applications and decrees are seeking to adjudicate or have adjudicated respectively. Attempts to change these adjudicated and pending water rights could result in a reduction in the yield of the water rights or a loss of the appropriation dates; thus, this process would only be undertaken as a last resort.

Figure 2-3
Proposed Penley Reservoir Diversion, Pump Station, and Pipelines

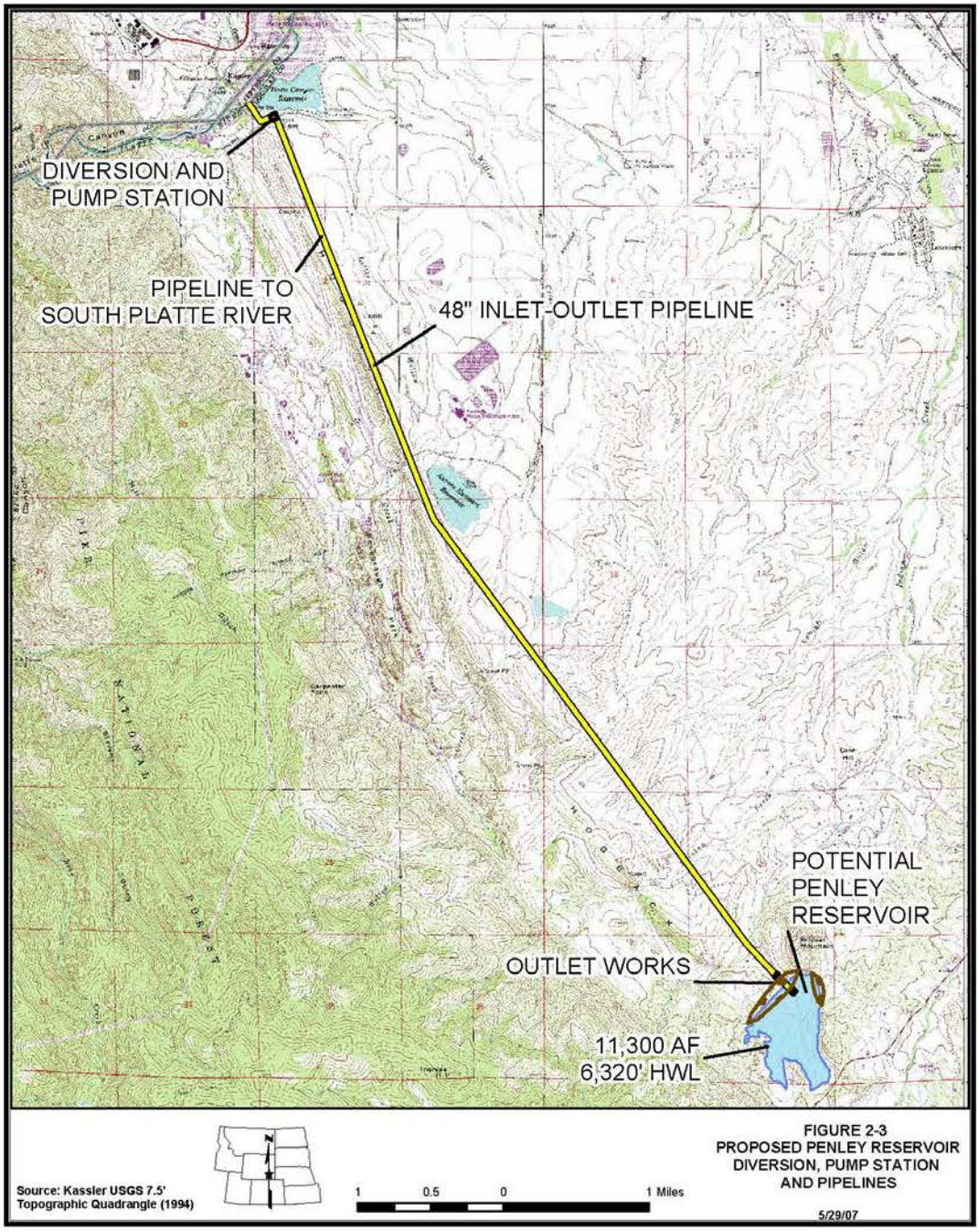

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Figure 2-4
Relative Locations of the Proposed Penley and Plum Creek Reservoirs

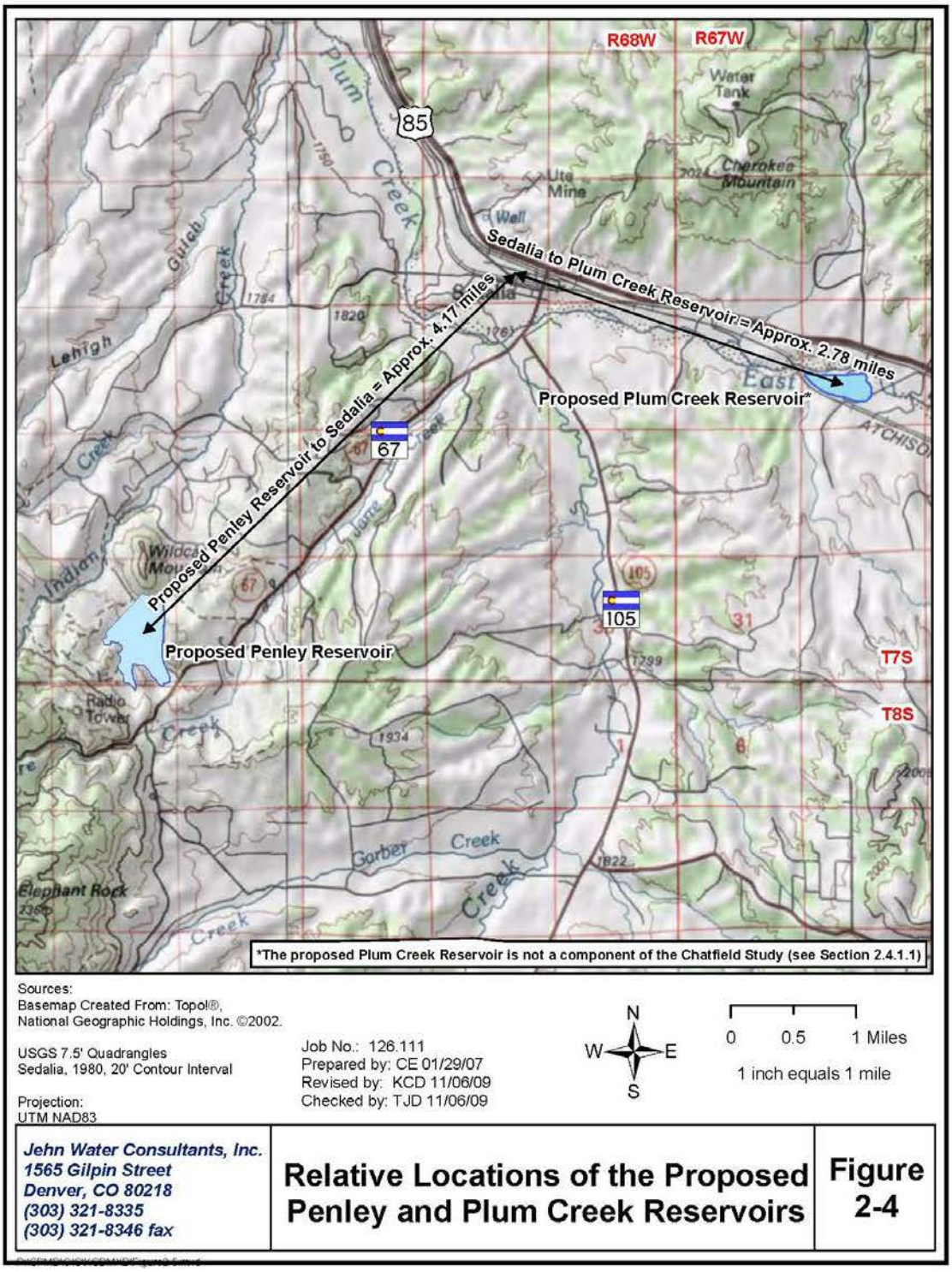

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Figure 2-5
Lower South Platte Gravel Pit Users, Approximate Gravel Pit Location

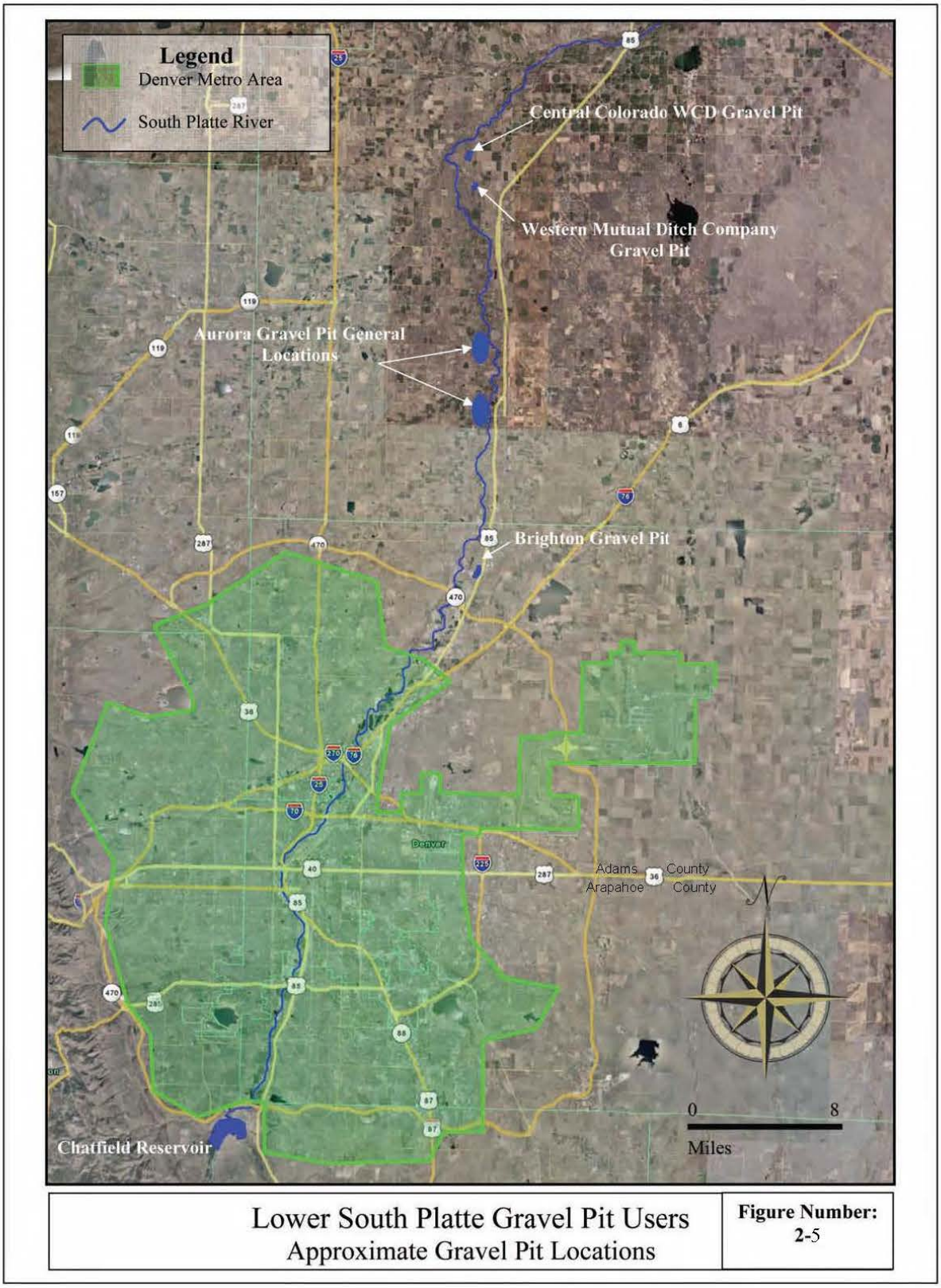

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Figure 2-6
Unassigned Proposed Gravel Pit Site

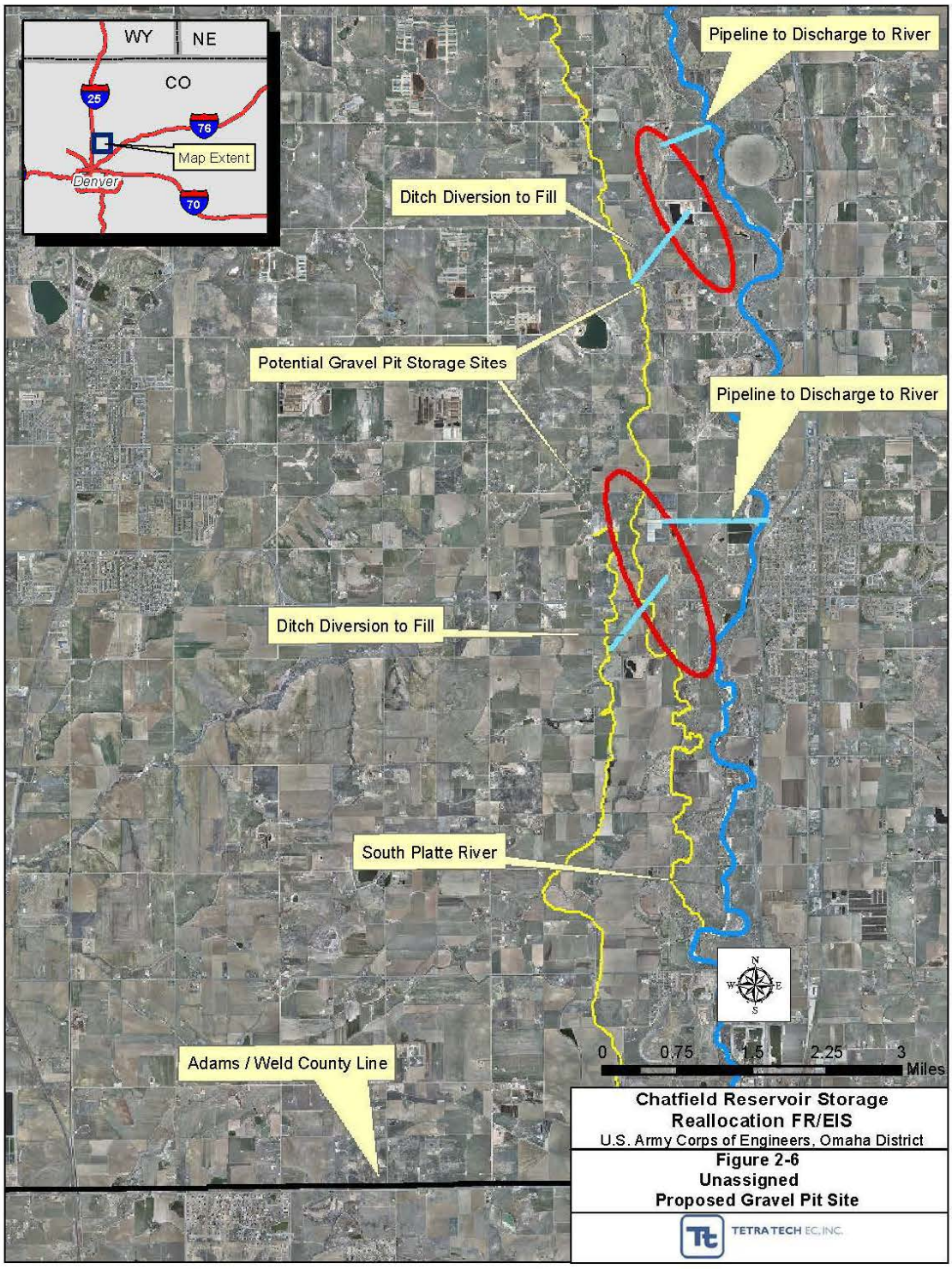

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Figure 2-7
Western Mutual Ditch Company, No Action Alternative

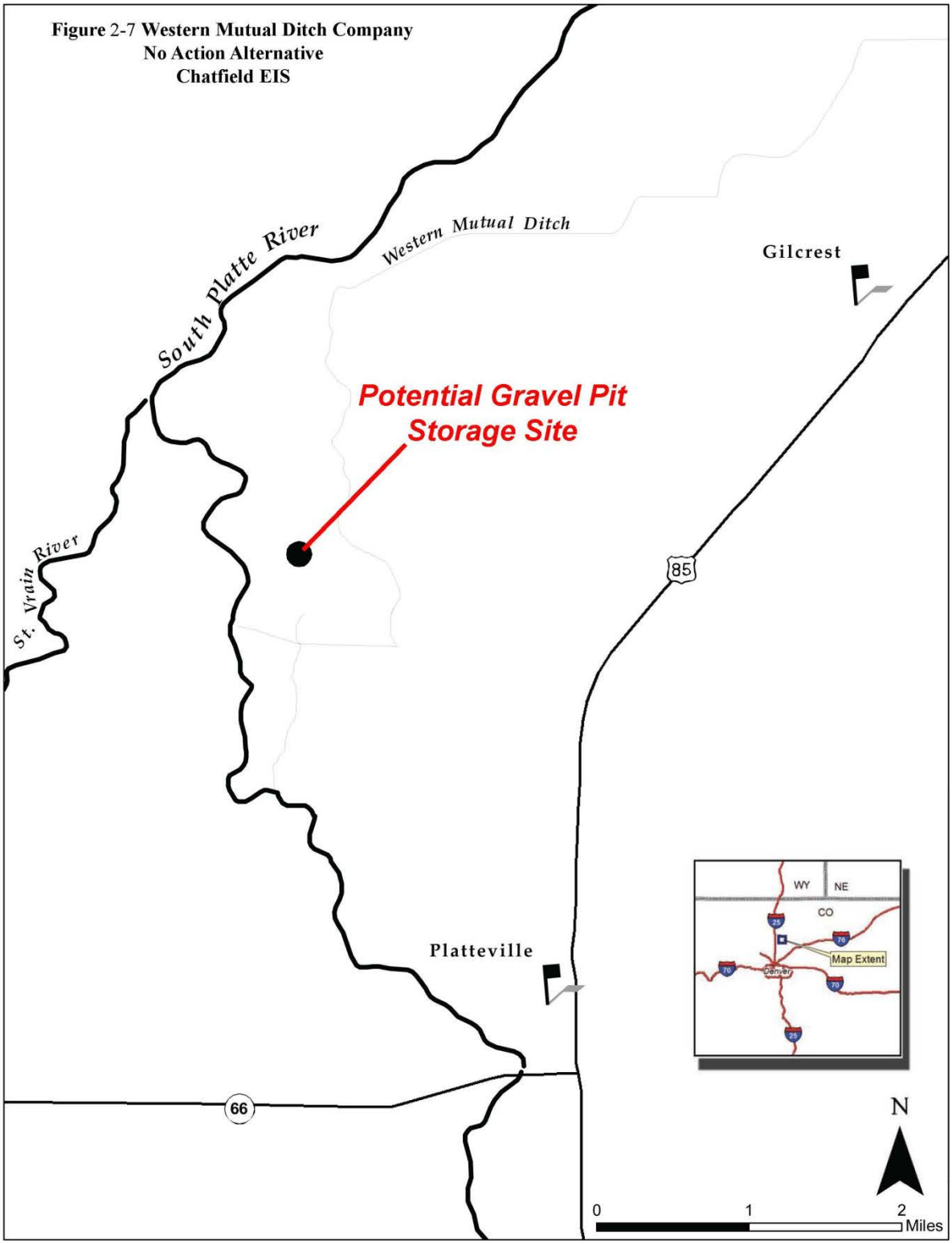

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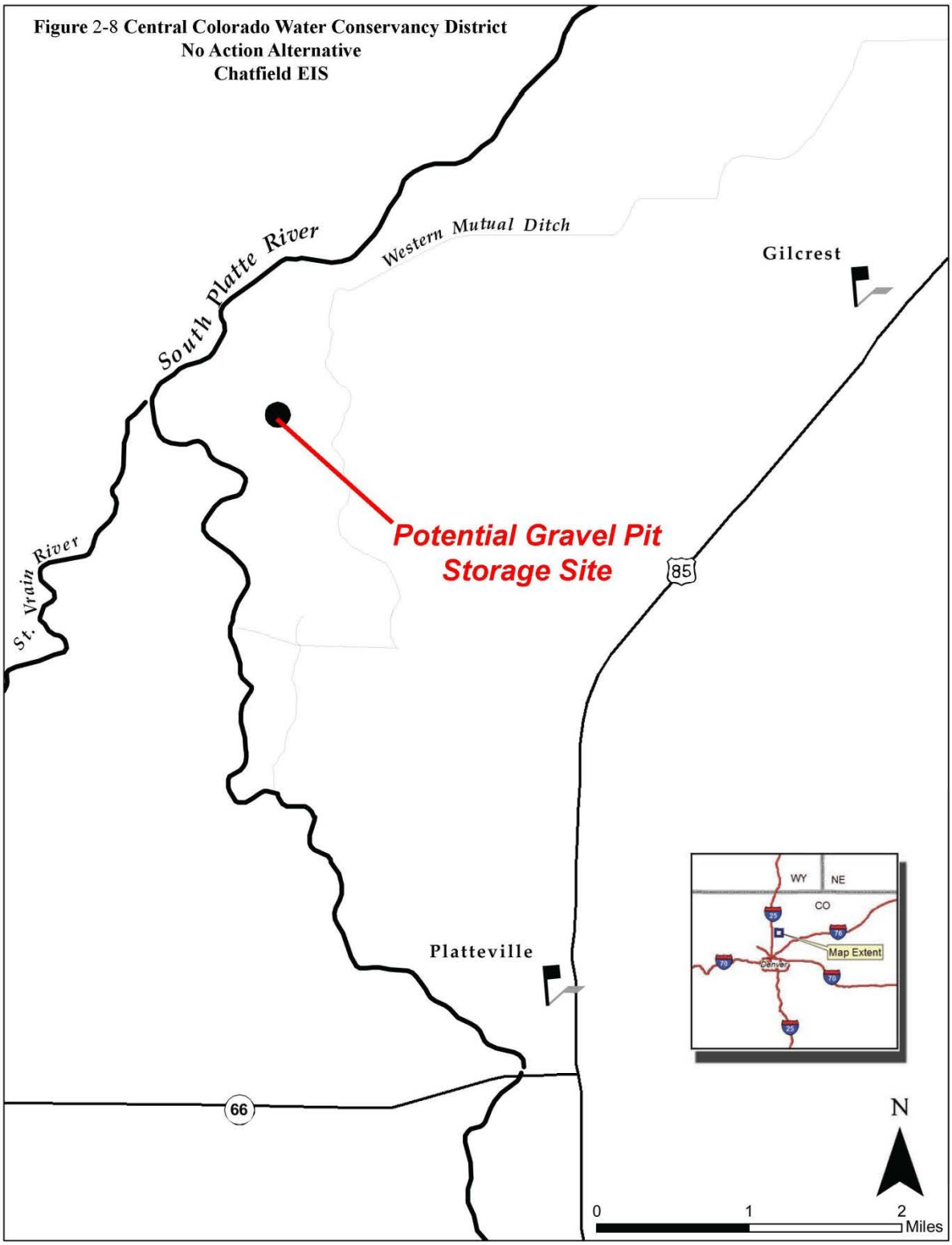
Figure 2-8
Central Colorado Water Conservancy District, No Action Alternative



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Given this background, the specific actions anticipated by each Lower South Platte Gravel Pit User for the No Action Alternative are identified. The two agricultural users, the Central Colorado WCD and the Western Mutual Ditch Company, would file for a change case to allow their existing Chatfield Reservoir storage water rights to be used to fill their new gravel pit facilities. If this process had unforeseen difficulties, they would each file for new junior water rights.

Each of the proposed water court transactions described above would entail significant legal and engineering expenses. The average year yield of these collective water rights, estimated as 3,248 acre-feet per year, are generally equivalent to the yield of the water rights that are planned to be used for the Chatfield Reservoir 20,600 Acre-Foot Reallocation Alternative.

2.4.1.3 Other User

Denver Botanic Gardens at Chatfield is hoping to realize a 40 acre-foot storage space allocation from the Chatfield Reservoir storage reallocation project to assist with its water needs for its facility located at Chatfield Reservoir. The storage space is planned to be used as a backup irrigation supply for an annual pumpkin patch and corn maze attraction at the gardens. Also, the storage space is expected to supply water to support future prairie restoration projects to continue the education mission of Denver Botanic Gardens at Chatfield. The No Action Alternative for Denver Botanic Gardens at Chatfield is expected to be the acquisition of the equivalent water yield expected from the Chatfield Reservoir storage reallocation project consisting of acquiring 10 acre-feet of senior surface water rights or nontributary water rights combined with the acquisition of 25 acre-feet of storage on Deer Creek or near Chatfield Reservoir.

2.4.1.4 Assumptions Used in the Cost Estimates for the No Action Alternative

Penley Reservoir User Group's No Action Alternative Assumptions

Assumptions for the development of off-channel storage at the proposed Penley Reservoir are presented in Table 2-6.

Table 2-6
Assumptions for Penley Reservoir User Group's No Action Alternative

Storage Volume (acre-feet)	Reservoir Disturbance Footprint (acres)	Infrastructure Disturbance* (acres)	Entity Constructing Infrastructure	Inlet Works	Outlet Works
12,725	186	97 (Inlet/Outlet)	Multiple water providers in the Penley Reservoir User Group	Pipeline/Pump	Pipeline/Pump
		85	Town of Castle Rock, Castle Pines Metropolitan District, and Castle Pines North Metropolitan District	Joint facility	Pipeline/Pump
12,725	186	182	Total		

*Assumed pipeline and/or pump station disturbance width is 100 feet.

Lower South Platte Gravel Pit User Group's No Action Alternative Assumptions

Based on the assumption that three new gravel pits would be required to contain the 7,835 acre-feet of storage volume, further assumptions can be made about infrastructure requirements to serve as the basis for the impact analysis. Each of the gravel pit reservoirs would require diversions from the South Platte River to the reservoir. Diversion channels are relatively small (only a few feet wide) and

generally located throughout the project area; therefore, developing lateral lines to serve the reservoirs would involve less than two acres each. Outlet works and pump stations are also relatively small and under a conservative estimate (overestimation of size) would require one additional acre for each reservoir. The length of pipeline necessary to reach from the reservoir to the water provider's treatment and distribution system would depend on the specific location of each, and whether that entity has existing infrastructure in place. For purposes of this analysis it was assumed that half of the water providers have infrastructure available to move the water and half do not. Table 2-7 summarizes the assumptions for the gravel pit storage.

Table 2-7
Assumptions for Lower South Platte Gravel Pit User Group's No Action Alternative

User	Storage Volume (acre-feet)	Reservoir Disturbance Footprint (acres)	Infrastructure Disturbance* (acres)	Inlet Works	Outlet Works
Central Colorado WCD	2,849	152	3	Ditch	Pump/pipe
Western Mutual Ditch Company	1,425	76	3	Ditch	Ditch
Totals	7,835	418	9		

* Assumed pipeline and/or pump station disturbance width is 100 feet.

2.4.1.5 Operation of Chatfield Reservoir for Alternative 1

Chatfield Reservoir is managed based on the elevation of the water level at a given time. When water levels are within the multipurpose-conservation pool (i.e., conservation pool), the State Engineer's Office coordinates discharges from the reservoir based on Colorado water law and the demand for water supply while minimizing water level fluctuations during the recreation season (May 1 through September 30). When water levels reach the flood control pool (above 5,432 feet msl), the Corps manages the discharges in order to release the maximum amount of water possible while keeping below a target flow of 5,000 cfs in the South Platte River at the Denver Gage. Once the pool elevation falls back to the multipurpose-conservation pool, the State Engineer's Office resumes responsibility for managing the discharge. During the recreation season, the state of Colorado and Denver Water (the only provider with Chatfield Reservoir storage water rights presently allowed to store water in the reservoir) have entered an agreement to maintain pool elevations between 5,423 and 5,432 feet msl with the goal of maintaining a minimum storage level goal of 20,000 acre-feet from May 1 through August 31 of each year as much as practicable. In times of severe and prolonged drought, the state of Colorado and the Corps' District Engineer may agree to allow the pool level to fall below 5,423 feet msl (USACE, 1979, 2002b).

On a historical note, the lowest pool elevation on record since the reservoir began operations was 5,423 feet msl in December 1995. The highest pool elevation recorded in Chatfield Reservoir was 5,447.6 feet msl in May 1980 (USACE, 2002b).

2.4.2 NTGW/Downstream Gravel Pits (Alternative 2)

Normally the No Action Alternative is also the Least Cost Alternative. However, when USACE procedures were applied, continued development and future use of NTGW during the 50-year period of analysis was less costly than the no action surface water supply alternative. Because this NTGW/Downstream Gravel Pits Alternative is significantly less costly than the No Action Alternative, it is used in the project economic analysis even though the water providers have

indicated that they would not continue to rely on NTGW as has been the case during recent decades.

For water providers using NTGW, information about Alternative 1A in the SMWSS report (Black & Veatch et al., 2003) was the basis for the NTGW/Downstream Gravel Pits alternative. Alternative 1A evaluates the buildout of the south Denver Metro area based primarily on concentrated development of its NTGW reserves. Alternative 1A assumes that most of the future development is served through continued development of NTGW supplies, with peak demands met through pumping. In addition, Alternative 1A includes a component of conservation and aggressive development of reusable supplies. Centennial WSD, town of Castle Rock, and Castle Pines North Metropolitan District are the three members of the SMWSA group that participated in the SMWSS.

For the Chatfield Reservoir storage reallocation study, it is assumed that NTGW could provide water to a significant portion of the upstream water providers through the 50-year planning period (approximately 4,270 acre-feet per year based on average year yield). The water providers that would be served by NTGW are town of Castle Rock, Centennial WSD, Castle Pines Metropolitan District, Castle Pines North Metropolitan District, the SMWSA, and Colorado Parks and Wildlife. An uncertainty regarding the reliability of the water supply is that for a few upstream water providers near the edge of the aquifer it may not be physically possible to utilize NTGW through the 50-year period of analysis. They may need to pursue alternative sources of water. Due to uncertainties regarding the courses of action of the affected water providers, it is assumed their water needs are satisfied with NTGW for the purposes of this study. To the extent that other alternative water sources are more costly than NTGW, the NTGW/Downstream Gravel Pits Alternative is a conservative least-cost alternative to the Chatfield Reservoir storage reallocation project. Downstream water providers, including Central Colorado WCD and Western Mutual Ditch Company, do not currently use appreciable NTGW due to limitations on available aquifers and high cost of development. These water providers would continue to depend on surface water supplies in the NTGW/Downstream Gravel Pits Alternative, which would include development of gravel pits for water storage (with an average year yield of 3,248 acre-feet). See the No Action Alternative discussion (Section 2.4.1) for information on gravel pit storage.

2.4.3 20,600 Acre-Foot Reallocation (Alternative 3)

The 20,600 Acre-Foot Reallocation Alternative would reallocate storage from the flood control pool to the conservation pool. The additional storage would be used for M&I water supply, agriculture, recreation, and fishery habitat protection and enhancement purposes. Under this alternative, the base elevation of the exclusive flood control pool would be raised from 5,432 to 5,444 feet msl, but the reallocation of storage for this project only involves the volume between 5,432 and 5,444 feet msl. The average year yield is estimated at 8,539 acre-feet, which is based on the Brown and Caldwell study "Chatfield Reallocation Study Storage Use Patterns" (CWCB 2003). The reliability of the water supply is similar to the alternatives that are dependent upon the opportunistic capture of runoff.

The reallocation of the flood control storage to joint-use flood control and water supply storage will require a change in the operations of Chatfield, as well as the other two Tri-Lakes projects as it applies to system-wide flood control regulation. Reallocation would not impact the primary flood risk management purpose of Chatfield reservoir. During Tri-Lakes system flood control storage evacuation for Level I (small flood events), as defined in Appendix B – Tri-Lakes Water Control

Plans, the reallocation of flood control storage at Chatfield slightly increases releases and affects the timing and duration of releases made from Cherry Creek and Bear Creek though the primary flood risk management purpose for Cherry Creek and Bear Creek is not affected. Reference Appendix B – Tri-Lakes Water Control Plans for an example of how the release magnitudes are affected. There is no change to system flood control storage evacuation releases during Level II (large flood events), as defined in Appendix B – Tri-Lakes Water Control Plans. Reallocation would require the construction of additional recreational infrastructure and relocation of some of the existing roads and facilities.

Water providers both upstream and downstream of Chatfield Reservoir would be able to use existing infrastructure to divert their portion of the stored water into their water systems. No new infrastructure would be needed at Chatfield by any water provider.

Operations at Chatfield Reservoir for Alternative 3

Under Alternative 3, operations at Chatfield Reservoir would be based on the four pools described for Alternative 3 in Table 2-5. The base elevation of the flood control pool would be raised from 5,432 to 5,444 feet msl, and the State Engineer would be responsible for managing discharges for water levels within the conservation pool. During forecast high runoff years when Chatfield pool elevation is forecast to exceed 5,444 feet msl, the Corps and the state of Colorado would jointly operate the conservation pool. During the joint operation, Chatfield Reservoir could be drawn down while the surface elevations are still within the conservation pool to accommodate the anticipated high volume of runoff. This would provide benefits during high runoff years such as a lower maximum release resulting in less downstream impacts and possibly fewer in-pool impacts because of less need for exclusive flood control storage. The operations for Alternative 3 are detailed in Appendix B, Water Control Plan. As under the No Action Alternative, the Corps would take control of discharges once the water level reached the exclusive flood control pool elevation, in this case 5,444 feet msl. The pool elevation of 5,444 feet msl would not be achieved every year due to fluctuations in the amount of runoff. There would be no change to the need for Denver Water to maintain a pool at 5,423 feet msl.

The number of water providers with storage rights within the reservoir would increase from one (Denver Water) under the No Action Alternative to 12, including Denver Water (see Table 1-1), under the 20,600 Acre-Foot Reallocation Alternative. While the State Engineer would continue to manage the discharge within the conservation pool, the demand on the additional storage rights would change the volume and pattern of the discharge from that observed under the No Action Alternative. The result is that the pool level could fluctuate more widely than under the No Action Alternative. The analysis presented in Chapter 4 considers the changes in fluctuations by using a model that superimposes operations of Chatfield Reservoir under the existing (base) conditions versus the "with-project" conditions.

2.4.4 7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits (Alternative 4)

The 7,700 Acre-Foot Reallocation Alternative would also reallocate storage from the flood control pool to the conservation pool for multiple purposes. Again, the additional storage would be used for M&I water supply, agriculture, recreation, and fishery habitat protection and enhancement purposes.

In this case, the base elevation of the exclusive flood control pool would be raised from 5,432 to 5,437 feet msl, but the reallocation of storage for this project only involves the volume between 5,432 and 5,437 feet msl. The average year yield from Chatfield Reservoir for the 7,700 Acre-Foot Reallocation Alternative would be approximately 3,160 acre-feet, which is based on the Brown and Caldwell study "Chatfield Reallocation Study Storage Use Patterns" (CWCB 2003). The reallocation would also require a change in the operations of the reservoir and the construction of additional infrastructure and relocation of some of the existing roads and facilities. Because the average year yield from Chatfield Reservoir storage reallocation for Alternative 4 is less than the average year yield for Alternative 3, additional water supply sources (NTGW and downstream gravel pit storage) are also included in Alternative 4 so that the total average year yield equals 8,539 acre-feet. Under Alternative 4, NTGW would have an average year yield of approximately 3,333 acre-feet and downstream gravel pit storage would have an average year yield of approximately 2,046 acre-feet. The footprint of the gravel pits would be approximately 109 acres, and an additional 6 acres for infrastructure disturbance. Reliability of the water supply would be similar to the alternatives that are dependent on the opportunistic capture of excess runoff and the use of NTGW.

Operations at Chatfield Reservoir for Alternative 4

Under Alternative 4, operations at Chatfield Reservoir would be based on the four pools described for Alternative 4 in Table 2-5. The base elevation of the flood control pool would be raised from 5,432 to 5,437 feet msl, and the state engineer would be responsible for managing discharges for water levels within the conservation pool. During forecast high runoff years when Chatfield Reservoir pool elevation is forecast to exceed 5,437 feet msl, the Corps and the state of Colorado would jointly operate the conservation pool. During the joint operation, Chatfield Reservoir could be drawn down while the surface elevations are still within conservation pool to accommodate the anticipated high volume of runoff. This would provide benefits during high runoff years such as a lower maximum release resulting in less downstream impacts and possibly fewer in-pool impacts because of less need for exclusive flood control storage. As under the No Action Alternative, the Corps would take control of discharges once the water level reached the exclusive flood control pool elevation, in this case 5,437 feet msl. The pool elevation of 5,437 feet msl would not be achieved every year due to fluctuations in the amount of runoff.

While the State Engineer would continue to manage the discharge within the conservation pool, the demand on the additional storage rights would change the volume and pattern of the discharge from that observed under the No Action Alternative. The result is that the pool level could fluctuate more widely than under the No Action Alternative. The analysis presented in Chapter 4 considers the changes in fluctuations by using a model that superimposes operations of Chatfield Reservoir under the existing (base) conditions versus the "with-project" conditions. Because the top of the conservation pool would only be at an elevation of 5,437 feet msl, the degree of fluctuation within the reservoir would be intermediate between the fluctuations of the other alternatives.

2.5 Comparison of Alternatives

The main difference among the reallocation alternatives on Chatfield Reservoir water levels is the amount of water that can be stored below the exclusive flood control pool, which is directly reflected in the maximum water level of the base of the exclusive flood control pool. However, these differences would not necessarily be clear to an observer at the reservoir on any given day. The operation of the reservoir and the resulting water levels is based on a number of factors including

the water elevation at the time, flow conditions downstream, the priority of water rights of downstream water providers, requests for release of stored water, precipitation, and evaporation.

The simplest way of looking at water levels in the reservoir under the different alternatives, as well as outflows from the reservoir and flow conditions downstream, is to look at how these factors would appear when considered against historical flow data. Based on known factors and inputs, the Corps is able to use a model (HEC-5) to describe the behavior of water levels in the reservoir. The model is also able to predict how the water levels would have behaved in years prior to its construction. By changing the model parameters, the Corps is also able to determine how the reservoir would behave under the action alternatives as well, based on data from the period of record (POR) from 1942 to 2000. Therefore, the model can describe the pool elevation, the inflow, and the outflow for Chatfield Reservoir for any day during the POR under each of the three alternatives. The impact analysis presented in Chapter 4 uses the modeling results to compare the behavior of Chatfield Reservoir under current or base conditions (No Action Alternative) to conditions under the two action alternatives.

Table 2-8 presents a summary of elevation data describing monthly fluctuations within Chatfield Reservoir. The data are the results of calculations that considered the maximum elevation for the month minus the minimum elevation for the month over the POR (USACE's spreadsheet Annual Monthly Stats.xls, November 2007). The table presents the average fluctuation for each month and the high and low values over the POR. The model used historical data to predict water levels in the reservoir for the years prior to the reservoir's existence. Note that the values for the NTGW/ Downstream Gravel Pits Alternative are the same as the No Action Alternative, as indicated in the table.

Table 2-8
Monthly Pool Elevation Fluctuations (High, Average, Low) within Chatfield Reservoir over the Period of Record (1942–2000) for each Alternative (in feet)

	No Action or NTGW/Downstream Gravel Pits			20,600 Acre-Foot Reallocation			7,700 Acre-Foot Reallocation/NTGW/ Downstream Gravel Pits		
	High	Average	Low	High	Average	Low	High	Average	Low
January	2.4	0.8	0.0	2.0	0.7	0.0	2.3	0.8	0.0
February	1.7	0.4	0.0	2.7	0.6	0.0	2.9	0.6	0.0
March	7.9	0.6	0.0	11.2	0.9	0.0	11.3	0.7	0.0
April	19.6	1.6	0.0	15.9	1.9	0.0	18.0	1.6	0.0
May	26.1	3.3	0.1	21.7	3.5	0.1	23.1	3.4	0.1
June	18.6	2.7	0.0	21.3	2.7	0.0	20.8	2.7	0.0
July	5.7	2.4	0.2	8.9	2.7	0.3	6.8	2.7	0.3
August	8.3	2.1	0.1	14.3	2.9	0.5	10.2	2.6	0.1
September	2.6	1.0	0.0	4.8	1.6	0.0	3.0	1.2	0.0
October	3.3	0.9	0.0	5.0	1.1	0.0	3.4	0.9	0.0
November	2.6	0.8	0.0	3.1	1.0	0.0	3.7	1.0	0.0
December	3.1	0.9	0.0	2.5	0.9	0.0	2.8	0.9	0.0

Source: "AnnualMonthlyStats.xls" spreadsheet from USACE, November 2007.

2.6 Evaluation Criteria

Each of the four alternatives was evaluated using the Corps' *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (USACE, 1983). The P&Gs call for a project to be evaluated on the following criteria: completeness, effectiveness, efficiency, and acceptability. As defined in ER 1105-2-100, pages 2-4, E-4, and E-5, completeness refers to the extent to which an alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planning objectives and/or planned effects. Effectiveness refers to the extent to which an alternative plan contributes to achieve the planning objectives and/or alleviates the specified problems and achieves the specified opportunities. Efficiency is the extent to which an alternative plan is the most cost effective means of achieving the planning objectives and/or alleviating the specified problems and realizing the specified opportunities, consistent with protecting the environment. Acceptability is the workability and viability of the alternative with respect to acceptance by state and local entities and the public, and compatibility with existing laws, regulations, and public policies. The evaluation included environmental and economic impacts, environmental and economic benefits, and project costs.

2.7 Evaluation Methodology

2.7.1 *Environmental Impact Evaluation Methodology*

The focus of the environmental impact evaluation is to compare how each of the alternatives affects each of the resources. The environmental impacts evaluation includes a wide range of resources including water quality, recreation, wildlife, sensitive species, aquatic resources, vegetation, wetlands, socioeconomics, and cultural resources. The methods for the evaluation vary depending on the resource and include quantitative and qualitative assessments. For example, water quality is addressed quantitatively with the use of models to predict changes in water quality that would result from changes in storage volume, while the effect of recreational users observing a "bathtub ring" in times of low water levels is addressed qualitatively.

A variety of tools were used to assess impacts. A geographical information system (GIS) was used to combine a base map of the area with data sets representing resources such as soil types, vegetation/habitat types, and wetlands to determine the acreages affected under existing conditions and under each of the alternatives. To determine the behavior of water levels in the reservoir under the four alternatives, outputs from the Corps' model discussed in Section 2.5 were imported into a statistical analysis software package (MINITAB). The statistical software is able to extract values based on queries about water levels over specific time frames. For example, water level fluctuation (particularly drawdown) at key times in the spring can be detrimental to successful spawning of some fish species. Therefore, the statistical package extracted water level fluctuation data over the POR from March through June. These values were then compared across alternatives to assess potential impacts on fish spawning. This approach was used to assess water levels at strategic times for a number of resources. The discussions in Chapter 4, Environmental Consequences, provide greater detail on the specific methodologies used to assess impacts on each resource.

2.7.2 *Economic Impact and Benefit Evaluation Methodology*

The economic impacts have been determined for each alternative. The hydrology analysis of the downstream flood control showed no significant impacts for any alternative. Chatfield State Park recreation facilities costs were determined for all alternatives. Recreation benefits at Chatfield

Reservoir are also presented for each of the alternatives. The recreation benefits are estimated using current Corps' National Economic Development (NED) procedures. These estimates are the basis for determining alternative NED impacts.

The methodology employed to evaluate the costs and benefits involves a quantitative assessment of all the costs involved in implementing each of the alternatives. In the case of the No Action Alternative, costs include the development of additional storage, distribution, and treatment facilities (as necessary) that would provide an equal amount and quality of water as the proposed action. An alternative's benefit is the difference between its cost and the cost of the least-costly alternative.

The economic benefit evaluation involves a comparison of the total cost of storage in Chatfield Reservoir to its benefit standard. This standard is the cost of the least-costly alternative to be implemented if a Chatfield Reservoir storage reallocation project is not implemented. Reallocation of storage in Chatfield Reservoir is economically justified if it has positive net benefits, or in other words if the total cost of storage in Chatfield Reservoir is less than the cost of the least-costly alternative to Chatfield reallocation.

The total cost of storage includes specific and joint use costs. The specific costs are expenditures needed by the water supply users to access their Chatfield Reservoir water. These include costs to modify and/or relocate existing facilities within Chatfield State Park; costs associated with revision of the Chatfield, Cherry Creek, and Bear Creek water control manual; cost of environmental mitigation; cost associated with dependable yield mitigation water (DYMW); and the costs of building, operating, maintaining, and replacing water supply facilities within the Chatfield Reservoir storage reallocation project and outside of the project. The joint use costs are costs associated with the 20,600 acre-feet of reallocated storage for the construction and operation of Chatfield Reservoir. These include the updated cost of embankment construction and the joint use operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) costs, prorated by the ratio of reallocated storage to gross storage capacity (i.e., top of flood control pool) at Chatfield Reservoir.

The cost of storage to be paid to the U.S. Treasury is normally established as the highest of: (1) the NED benefits foregone; (2) revenues to the U.S. Treasury foregone; (3) the replacement cost of flood control and hydropower benefits foregone; and (4) the updated cost of storage in the federal project. The updated cost of storage is determined by updating all joint use costs and prorating them by the ratio of reallocated storage to total usable storage space in Chatfield Reservoir. For purposes of this calculation, total usable storage does not include space set aside for sediment distribution.

2.8 Evaluation of Alternatives

2.8.1 Environmental Impact Evaluation Summary

Table 2-9 compares impacts among the alternatives that are discussed in detail in Chapter 4. For Alternative 1, impacts include those at the Penley Reservoir site as well as impacts from construction of pipelines and other infrastructure on- and/or off-project, from use of NTGW until Penley Reservoir is completed, and from development and use of gravel pit storage. For Alternative 2, impacts include those from increased use and development of NTGW, from construction of water supply infrastructure on- and/or off-project, and from development and use of gravel pit storage. For Alternative 3, impacts include those at Chatfield Reservoir project and in the South Platte River downstream from Chatfield Dam, as well as impacts from construction of

Table 2-9
Summary Comparison of Environmental Impacts of Alternatives

Resource Area	Alternative			
	Alternative 1: No Action	Alternative 2: NTGW/Downstream Gravel Pits[1]	Alternative 3: 20,600 Acre-Foot Reallocation	Alternative 4: 7,700 Acre-Foot Reallocation/NTGW/ Downstream Gravel Pits
Geology and Soils	Low potential for soil erosion. Best management practices (BMPs) would reduce potential for soil erosion during construction of Penley Reservoir and pipelines.	Low potential for soil erosion; impacts would be less than Alternative 1 because of smaller construction area.	Low potential for soil erosion. Moderate to moderately high risk for wind erosion if vegetation is removed. Relatively high runoff potential. BMPs would reduce potential for soil erosion during construction. No immediate dam safety concerns identified,	Low potential for soil erosion. Moderate to moderately high risk for wind erosion if vegetation is removed, but less than Alternative 3. Relatively high runoff potential. BMPs would reduce potential for soil erosion during construction. Footprints from gravel pits and infrastructure would be less than Alternatives 1 and 2. No immediate dam safety concerns identified.
Hydrology	186 acres inundated at Penley Reservoir. No change from current conditions at Chatfield: 9 feet of pool fluctuations. Maximum pool elevation (5,432 feet msl) reached 31 percent of years. Continued nonrenewable NTGW use until Penley Reservoir is completed.	No change from current conditions at Chatfield. Would contribute to regional problems with NTGW. Approximately 1,364 new wells needed to meet regional water demands with NTGW. Loss of production in Arapahoe Aquifer up to 85 percent by 2050.	587 acres inundated beyond current operations at top of conservation pool. 21 feet of pool fluctuations. Target pool elevation (5,444 feet msl) is reached 18 percent of the days in the POR. No effect on nonrenewable NTGW. Adaptive management would minimize impacts using operation strategies once reallocation begins.	215 acres inundated beyond current operations at top of conservation pool. 14 feet of pool fluctuations. Target pool elevation (5,379 feet msl) reached 25 percent of years. Minimum effect on nonrenewable NTGW. Adaptive management would minimize impacts using operation strategies once reallocation begins.
Water Quality	No anticipated impact. BMPs would reduce potential water quality impacts during construction of Penley and pipelines.	With BMPs, short-term impacts from well construction and conversion of gravel pits to water storage reservoirs not anticipated to be significant.	Possible eutrophication and algae in Chatfield Reservoir in the short term. The upper bound, localized model predicts: 0.057 mg/L total phosphorus in short term, 0.025 mg/L total phosphorus in long term. Internal phosphorus loading would increase, which would increase average total phosphorus concentrations after fall turnover. Lower metals. Escherichia coli (E. coli) in vicinity of	Possible eutrophication and algae in Chatfield Reservoir. Total phosphorus, chlorophyll-a, and metals intermediate between Alternatives 1 and 2 and Alternative 3. No impact to E. coli. Removal of vegetation before inundation could reduce nutrient loads. Increased monitoring and adaptive management would be used to address uncertainty in impacts to

Table 2-9
Summary Comparison of Environmental Impacts of Alternatives

Resource Area	Alternative			
	Alternative 1: No Action	Alternative 2: NTGW/Downstream Gravel Pits[1]	Alternative 3: 20,600 Acre-Foot Reallocation	Alternative 4: 7,700 Acre-Foot Reallocation/NTGW/ Downstream Gravel Pits
			swim beach is not expected to change. Operating the reservoir to manage the outflow (e.g., increasing the retention time) could reduce nutrient concentrations, but may not be implementable given the timing and objectives of water uses. Removal of vegetation before inundation could reduce phosphorus nutrient loads. Aeration or mixing of Chatfield Reservoir to limit anaerobic conditions would reduce potential impacts. Increased monitoring and adaptive management would be used to address uncertainty in impacts to water quality. BMPs would reduce potential water quality impairment during construction. Possible reduction in the assimilative capacity of the South Platte River if releases from Chatfield Dam are reduced during critical low-flow periods. This could potentially impact water quality in the South Platte River downstream of Chatfield Dam during critical low-flow periods. The potential impact could be mitigated by releases of water for water quality management during critical low-flow periods.	water quality. BMPs would reduce potential water quality impairment during construction. Possible reduction in the assimilative capacity of the South Platte River if releases from Chatfield Dam are reduced during critical low-flow periods.
Aquatic Life and Fisheries	No impacts at Chatfield Reservoir. No impacts at Penley site because no significant water resources currently exist there. Reservoir construction would create aquatic habitat that could be used for aquatic life and fisheries. Pipelines associated with Penley	No impacts at Chatfield Reservoir. Aquatic habitat could potentially be created in converting downstream gravel pits to reservoirs.	"New reservoir" effect of nutrient inputs would benefit aquatic ecosystem short-term at Chatfield Reservoir. If pool drawdowns occur during spawning, this could adversely impact crappie, bluegill, smallmouth bass, and largemouth bass.	At Chatfield, "New reservoir" effect benefit would be smaller than Alternative 3; otherwise same as Alternative 3, but effects would be less. Under Alternative 4, a small portion of the South Platte River above

Table 2-9
Summary Comparison of Environmental Impacts of Alternatives

Resource Area	Alternative			
	Alternative 1: No Action	Alternative 2: NTGW/Downstream Gravel Pits[1]	Alternative 3: 20,600 Acre-Foot Reallocation	Alternative 4: 7,700 Acre-Foot Reallocation/NTGW/ Downstream Gravel Pits
	Reservoir would cross several streams that could support fish populations, including Indian Creek, Rainbow Creek, Willow Creek, and Plum Creek. Temporary adverse impacts on fish populations could result during the construction of underground pipelines. If appropriate construction techniques were implemented, the proposed pipelines would have no significant adverse impacts on aquatic life and fisheries. Aquatic habitat could potentially be created in converting downstream gravel pits to reservoirs.		Positive impact to gizzard shad and other forage fish during increased pool elevations, except mid-May to mid-June. Benefit to crayfish populations would result in increased forage for smallmouth and largemouth bass populations. Generally positive effect for sport fish and forage fish. Keeping fallen trees as anchored fish structures would create positive shallow water habitat. Increased flow in July positive for downstream aquatic biota. Slight decrease in baseflow, minimal or no impact to aquatic biota. Reservoir drawdowns in March and April could adversely impact the walleye spawning operation conducted by Colorado Division of Wildlife (CDOW) to collect eggs for statewide walleye propagation by CDOW hatcheries. The Coordinated Reservoir Operations Plan is expected to include a provision to limit the release of water stored in the reallocated pool during critical seasonal periods. Managing water releases from reservoir could mitigate any adverse effects. An approximate 0.7-mile reach of the South Platte River directly above Chatfield Reservoir would be intermittently inundated by the increased pool elevation. The increased perimeter of Chatfield Reservoir would alter the fish and macroinvertebrate	Chatfield Reservoir (slightly smaller than Alternative 3) would be intermittently inundated. Impacts to this reach are similar to those described in Alternative 3, although less of the stream reach would be impacted. Aquatic habitat could potentially be created in converting downstream gravel pits to reservoirs, but less than under Alternatives 1 or 2 because pits would be smaller or fewer. Any adverse impacts would be mitigated through adaptive management.

Table 2-9
Summary Comparison of Environmental Impacts of Alternatives

Resource Area	Alternative			
	Alternative 1: No Action	Alternative 2: NTGW/Downstream Gravel Pits[1]	Alternative 3: 20,600 Acre-Foot Reallocation	Alternative 4: 7,700 Acre-Foot Reallocation/NTGW/ Downstream Gravel Pits
			community composition of this reach from cool and cold-water species to warmer water species. Maintaining instream flow on South Platte downstream, and to Chatfield State Fish Unit, by adaptive management would mitigate adverse effects.	
Vegetation	Inundation of Penley area would impact grasslands and non-unique deciduous oak and mesic upland shrub plant communities. Minimal vegetative loss from buried pipeline. Installation of pipelines and infrastructure to move water to and from existing gravel ponds could have a temporary effect on grasslands, riparian and wetland plant communities. No likely impacts to vegetation from NTGW wells are anticipated.	Less impact than Alternative 1 because there would be no construction of Penley Reservoir or associated pipelines. Temporary impacts of downstream gravel pit development same as Alternative 1. Impacts to vegetation from the downstream gravel pits would be minimal because gravel pits are already present and vegetation has been removed. No likely impacts to vegetation from NTGW wells are anticipated.	Complete or significant kill of cottonwoods between 5,432 to 5,442 feet above median sea level (msl) due to prolonged inundation, with some uncertainty at elevations above 5,439 feet msl. New lower limit of mature cottonwood approximately 5,444 feet msl. Willows established at 5,442 feet msl, based on the frequency of inundation from year to year. An estimated loss from inundation of 474.8 acres of vegetation between 5,432 feet msl to the top of the conservation pool (5,444 feet msl). Less hydric vegetation along the new shoreline. Lost habitat would be offset by establishing similar habitat, emphasizing weed management and native species.	Vegetation, including cottonwoods, likely killed from 5,432 up to 5,437 feet msl due to prolonged inundation. New lower limit of mature cottonwood approximately 5,437 feet msl. An estimated loss from inundation of 199.0 acres of vegetation between 5,432 feet msl to the top of the conservation pool (5,437 feet msl. Lost habitat would be offset by establishing similar habitat, emphasizing weed management and native species. Impacts to vegetation for NTGW and gravel pits would be less than under Alternative 2.

Table 2-9
Summary Comparison of Environmental Impacts of Alternatives

Resource Area	Alternative			
	Alternative 1: No Action	Alternative 2: NTGW/Downstream Gravel Pits[1]	Alternative 3: 20,600 Acre-Foot Reallocation	Alternative 4: 7,700 Acre-Foot Reallocation/NTGW/ Downstream Gravel Pits
Wetlands	Approximately 0.26 acres of wetlands impacted by Penley construction. Penley Reservoir inundation may enhance wetlands. Pipelines would impact approximately 12 acres wetlands. These impacts would be minimized through BMPs. Mitigation would occur for any unavoidable impacts. Gravel pits would impact a maximum of 9 acres of wetland vegetation.	Gravel pits would impact maximum of 9 acres of wetland vegetation.	Approximately 157.2 acres of vegetated wetlands (mostly scrub/shrub) inundated if water levels sustained at 5,444 feet msl for extended periods. Road and recreation facility relocations could adversely impact wetlands. Depending on water level flux, long-term adverse impact from changing wetland to more water-tolerant species or establishing new wetlands within new zone of fluxing inundation. On-site and off-site enhancements and wetland creation would mitigate impacts. Mitigation would occur for any unavoidable impacts. Adaptive management would minimize impacts using operation strategies once reallocation begins.	Approximately 119.8 acres of vegetated wetlands (mostly scrub/shrub) eliminated if the water levels sustained at 5,437 feet msl for extended periods. Road and recreation facility relocations would adversely impact wetlands. Smaller water level flux than under Alternative 3. Gravel pits would impact fewer acres than under Alternatives 1 or 2. On-site and off-site enhancements and wetland creation would mitigate impacts. Mitigation would occur for any unavoidable impacts. Adaptive management would minimize impacts using operation strategies once reallocation begins.
Wildlife	Habitat loss for grassland and upland wildlife species during and after Penley construction. 186 acres inundated at Penley Reservoir. Habitat for wetland and water dependent species would increase. Gravel pit reservoirs would increase habitat for riparian species.	Gravel pit reservoirs would increase habitat for riparian species.	Up to 586 acres of terrestrial wildlife habitat would be converted to aquatic or semi-aquatic habitats, disturbing resident and migratory species. Up to 90 acres of shoreline would be inundated but would be replaced with the same or greater amounts of new shoreline associated with reallocation. Approximately 30 acres of grasslands would be impacted by the permanent footprints of relocated recreational facilities. An additional 2.54 acres of wildlife habitat would be impacted by the relocation of the recreation trail at the Plum Creek day use area.	Fewer terrestrial habitat acres would be converted to aquatic or semi-aquatic habitats than under Alternative 3. Up to 328 acres of terrestrial wildlife habitat would be converted to aquatic or semi-aquatic habitats, disturbing resident and migratory species. Up to 78 acres of shoreline would be inundated but would be replaced with the same or greater amounts of new shoreline associated with reallocation. Approximately 30 acres of grasslands would be impacted by the permanent footprints of relocated recreational facilities. An additional 2.54 acres of wildlife

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Resource Area	Alternative			
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			Would adversely impact terrestrial wildlife, including upland or grassland wildlife, some raptors, large mammals, songbirds, herons, shrub wildlife, and waterfowl. Depending on timing, could benefit shoreline and aquatic wildlife. Loss of mature cottonwood forest habitat. Mitigation would occur to offset impacted habitat. Adaptive management would minimize impacts using operation strategies once reallocation begins.	habitat would be impacted by the relocation of the recreation trail at the Plum Creek day use area. Effects same as Alternative 3 but to lesser extent. Mitigation would occur to offset impacted habitat. Adaptive management would minimize impacts using operation strategies once reallocation begins.
Endangered, Threatened, and Candidate Species, Species of Special Concern, and Sensitive Communities	Construction of Penley and pipelines could benefit bald eagle. There is a potential for loss of habitat for Preble's mouse, plains sharp-tailed grouse, Colorado butterfly plant, and Ute ladies-tresses orchid, if these habitats occur near Penley. Impacts to these habitats would be mitigated. No impacts on Preble's mouse, bald eagle, Ute's ladies-tresses, and Colorado butterfly plant if they do not occur in area of gravel pits. Aquatic species could benefit from the creation of aquatic habitats at the gravel pits.	No impacts on Preble's mouse, bald eagle, Ute's ladies-tresses, and Colorado butterfly plant habitats if they do not occur in the area of the gravel pits. Aquatic species could benefit from creation of aquatic habitats at the gravel pits. No impacts from NTGW well or gravel pits are expected from development.	Potential inundation of approximately 454 acres of Preble's mouse habitat, including approximately 80.0 acres of Critical Habitat in the Upper South Platte critical habitat unit (mostly High Value Riparian habitat) and approximately 75.2 acres of Critical Habitat in the West Plum Creek critical habitat unit. An additional 2.54 acres of Preble's habitat, including 0.48 acres of critical habitat, would be impacted by the relocation of the recreation trail at the Plum Creek day use area. Bald eagle, white pelican, and Iowa darter would benefit. Whooping crane, pallid sturgeon, piping plover, and interior least tern would not be affected assuming SPWRAP is implemented. Small adverse impact on hunting range of ferruginous hawk. Northern leopard frog may be adversely impacted.	Potential inundation of approximately 270 acres of Preble's mouse habitat, including approximately 40.7 acres of Critical Habitat in the Upper South Platte critical habitat unit (mostly High Value Riparian habitat) and approximately 46.9 acres of Critical Habitat in the West Plum Creek critical habitat unit. An additional 2.54 acres of Preble's habitat, including 0.48 acres of critical habitat, would be impacted by the relocation of the recreation trail at the Plum Creek day use area. Otherwise, effects and mitigation actions are the same as Alternative 3 but to lesser extent. Adaptive management would minimize impacts using operation strategies once reallocation begins.

Table 2-9
Summary Comparison of Environmental Impacts of Alternatives

Resource Area	Alternative			
	Alternative 1: No Action	Alternative 2: NTGW/Downstream Gravel Pits[1]	Alternative 3: 20,600 Acre-Foot Reallocation	Alternative 4: 7,700 Acre-Foot Reallocation/NTGW/ Downstream Gravel Pits
			Impacts would be mitigated through on-site and off-site mitigation including wetland, riparian, and terrestrial habitats. Other mitigation actions may include development or maintenance of wildlife corridors, management of water levels during the growing season, recontouring and revegetation, and anchoring snags and downed trees as large woody debris if consistent with boater safety. Adaptive management would minimize impacts using operation strategies once reallocation begins.	
Land Use	Use of gravel pits would not require conversion of irrigated lands to non-irrigated lands. Use of NTGW prior to completion of Penley could affect farming if pumping rates declined, but this effect would be less than under Alternative 2.	Use of gravel pits would not require conversion of irrigated lands to non-irrigated lands. Use of NTGW could affect farming if pumping rates declined to the point that agricultural lands irrigated by NTGW could no longer produce sufficient water from existing wells. Because most agricultural providers rely on alluvial groundwater, this impact is not likely to be significant.	Some open space at the Chatfield State Park would be used to accommodate the relocation of recreation facilities (such as parking lots and structures).	Use of gravel pits would not require conversion of irrigated lands to non-irrigated lands. Use of NTGW would have less effect on farming than under Alternative 2.
Hazardous, Toxic, and Radiological Wastes	No impacts anticipated.	No impacts anticipated.	No impacts anticipated.	No impacts anticipated.
Air Quality	No long-term impacts anticipated. BMPs would reduce potential air quality impairment during construction.	Same as Alternative 1 except that, depending on the energy sources used, drilling and operating NTGW wells could contribute to greenhouse gas emissions and other air pollution	Short-term impacts from construction. BMPs would reduce potential air quality impairment during construction.	Impacts would be of the same type but less in extent than under Alternative 3 because of shorter construction period and less pool fluctuation. BMPs would reduce potential air quality impairment during construction.
Noise	Noise levels reduced at gravel pits. Short-term construction noise during	Impacts would be less than under Alternative 1 because there would be no	Temporary construction (3–5 years) noise in park.	Same impacts near Chatfield as Alternative 3 except with a shorter

Table 2-9
Summary Comparison of Environmental Impacts of Alternatives

Resource Area	Alternative			
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	development of gravel pit storage and Penley Reservoir.	construction at Penley. Noise levels reduced at gravel pits. Short-term construction noise.	On-site construction noise may periodically exceed EPA noise threshold (70 decibel level [dBA]), but public would not be exposed continuously. Noise predicted at less than 50 feet from source. Noise from off-site construction traffic would increase background noise levels, but within normal variation in the area. Construction traffic noise would comply with county ordinances. No exceedances of standards or guidelines.	construction period. Noise levels reduced at gravel pits. Short-term construction noise, but less than under Alternatives 1 or 2 because gravel pits would be fewer or smaller.
Aesthetics	Aesthetics at Penley and gravel pits could be impaired during construction due to views of equipment, but would have positive viewsheds after construction completed. Pipelines would not adversely impact views.	Aesthetics at gravel pits would be affected the same as for Alternative 1.	Water fluctuation could produce more visible mudflats and shoreline rings. During construction, short-term impacts from bare ground and construction vehicles. Planting trees and shrubbery could mitigate impacts on aesthetics.	Same effects at Chatfield as Alternative 3 except with smaller water fluctuations and a shorter construction period. Aesthetic impacts at gravel pits would be of the same type but less in extent than under Alternatives 1 or 2 because gravel pits would be fewer or smaller.
Socioeconomic Resources	Gravel pit conversion would employ approximately 19 workers/day for 2 years for construction. Employment benefits estimated at approximately 4,376 person-years of employment over 50-year period in the study area. Project financial costs estimated at $283.4 million. $623.1 million in economic output estimated in the region. Environmental Justice – No impacts anticipated.	Similar to Alternative 1 except there would be fewer construction jobs since Penley and the associated pipelines would not be constructed. There would, however, be additional NTGW well-drilling jobs. Employment benefits estimated at approximately 2,742 person-years of employment over 50-year period in the study area. Project financial costs estimated at $186.1 million. $391.5 million in economic output estimated in the region. Environmental Justice – No impacts	Construction in the marina area would occur during the off-season to minimize impacts. Colorado Parks and Wildlife expected to lose $3.4 million over 50-year analysis period, including revenue associated with concessionaire agreements. Reduction in NED recreation benefits of approximately $15.6 million over 50 years. The water providers would ensure Colorado Parks and Wildlife is compensated for any lost revenue or increased costs incurred as a result of this project.	Same impacts related to reallocation as Alternative 3 except with a shorter construction period, resulting in lower revenue losses but fewer worker-years. Fewer impacts related to downstream gravel pits and NTGW as Alternative 2. Colorado Parks and Wildlife is expected to lose about $2.7 million over 50-year analysis period, including revenue associated with concessionaire agreements. Reduction in NED recreation benefits of approximately $13.2 million over

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Resource Area	Alternative			
	Alternative 1: No Action	Alternative 2: NTGW/Downstream Gravel Pits[1]	Alternative 3: 20,600 Acre-Foot Reallocation	Alternative 4: 7,700 Acre-Foot Reallocation/NTGW/ Downstream Gravel Pits
		anticipated.	Employment benefits estimated at approximately 2,257 person-years of employment over 50-year period in the study area. Project financial costs estimated at $178.7 million. $318.0 million in economic output estimated in the region. Environmental Justice – No impacts anticipated.	50 years. The water providers would ensure Colorado Parks and Wildlife is compensated for any lost revenue or increased costs incurred as a result of this project. Employment benefits estimated at approximately 2,946 person-years of employment over 50-year period in the study area. Project financial costs estimated at $180.1 million. $419.4 million in economic output estimated in the region. Environmental Justice – No impacts anticipated.
Transportation	No impacts at Chatfield State Park. Traffic would decrease at gravel pits. Traffic would increase in the Penley area during construction.	No impacts at Chatfield State Park. Traffic would decrease at gravel pits. Traffic would increase temporarily during drilling of new NTGW wells.	Realign part of entrance road and part of main park road, including new bridge. Traffic would temporarily increase during construction. Short-term heavy construction traffic likely. Mitigation would include construction when recreation use is low and during daylight. Construction during daylight is per Colorado law, to avoid nighttime disturbance to residences. It is also to reduce hazards/disturbance to wildlife.	Some facilities would be relocated. Traffic would temporarily increase during construction. Similar short-term access issues as Alternative 3, but with shorter duration. Mitigation would include construction when recreation use is low and during daylight. Construction during daylight is per Colorado law, to avoid nighttime disturbance to residences. It is also to reduce hazards/disturbance to wildlife.
Recreation	No impacts anticipated.	No impacts anticipated.	North Boat Ramp partially inundated, affecting two boat ramps, paved parking, support facilities (trails, day use shelters). Substantial fill used to raise portion of parking area. Recreation capacity of Massey Draw	North Boat Ramp partially inundated, making it inoperable and affecting two boat ramps. Remaining areas unaffected. Recreation capacity of Massey Draw reduced but parking area and

Table 2-9
Summary Comparison of Environmental Impacts of Alternatives

Resource Area	Alternative			
	Alternative 1: No Action	Alternative 2: NTGW/Downstream Gravel Pits[1]	Alternative 3: 20,600 Acre-Foot Reallocation	Alternative 4: 7,700 Acre-Foot Reallocation/NTGW/ Downstream Gravel Pits
			reduced. Entire Swim Beach, parking, trails, restrooms, concession building, first aid station, volleyball, and horseshoe pits inundated. Gravel parking and portable restroom at Eagle Cove and half of Deer Creek area inundated. Entire Jamison area relocated to south. Portion of entrance road realigned major segment of main park road moved. Most entrance roads, parking areas, shelters, restrooms, utilities at Catfish Flats and Fox Run group use areas inundated. Kingfisher/Gravel Ponds/Platte River Trailhead areas inundated. Increase in pool fluctuations would affect operations of Riverside Marina. Facilities at Marina Point, south boat ramp, Roxborough day use area inundated. Plum Creek area facilities inundated. Overall visitor use at Chatfield expected to decrease by 17.6 percent (from 1.66 million to 1.37 million visitors) during construction, by 9.4 percent (to 1.51 million visitors) 1 to 5 years after construction, and by 4.1 percent (to 1.60 million visitors) 6+ years after construction. Recreation impacts would be mitigated through relocation and construction of new facilities, construction of berm around large gravel pond, and scheduling construction to avoid the high recreation season.	restroom not inundated. Entire Swim Beach, parking, trails, restrooms, concession building, first aid station, volleyball, and horseshoe pits inundated. Unlike Alternative 3, road not adversely impacted. Kingfisher area inundated. Unlike Alternative 3, gravel ponds not inundated. Most parking in Marina area inundated, impacted use of most facilities. Plum Creek day use area, trailhead, and some segments of the Plum Creek trail inundated. Overall visitor use at Chatfield expected to decrease by 14.1 percent (from 1.66 million to 1.43 million visitors) during construction, by 8.0 percent (to 1.51 million visitors) 1 to 5 years after construction, and by 3.3 percent (to 1.61 million visitors) 6+ years after construction. Recreation impacts would be mitigated through relocation and construction of new facilities and scheduling construction to avoid the high recreation season. Adaptive management would minimize impacts using operation strategies once reallocation begins.

Table 2-9
Summary Comparison of Environmental Impacts of Alternatives

Resource Area	Alternative			
	Alternative 1: No Action	Alternative 2: NTGW/Downstream Gravel Pits[1]	Alternative 3: 20,600 Acre-Foot Reallocation	Alternative 4: 7,700 Acre-Foot Reallocation/NTGW/ Downstream Gravel Pits
			Adaptive management would minimize impacts using operation strategies once reallocation begins.	
Cultural Resources	Pipeline would adversely impact Atchison, Topeka & Santa Fe Railroad (ATSF), eligible for NRHP listing. Site would be avoided through pipeline installation techniques. If avoidance not possible, then there would be thorough documentation in accordance with Colorado State Historic Preservation Office (SHPO) guidelines and standards.	No significant impacts.	Ten prehistoric and historic sites within zone of potential inundation. However, none of these sites are NRHP-eligible and therefore are not protected. No adverse impacts on NRHP-listed or potentially eligible properties.	Same as Alternative 3.

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water supply infrastructure on- and/or off-project. For Alternative 4, impacts include those at Chatfield Reservoir project and in the South Platte River downstream from Chatfield Dam, and impacts from construction of water supply infrastructure on- and/or off-project, from some use and development of NTGW, and from some development and use of gravel pit storage. If no impacts are cited for a component of an alternative, that component has no adverse effects during and after construction/development of that component.

2.8.2 Economic Benefit Evaluation Summary

The benefits from a water supply plan are measured using the cost of the alternative most likely to be implemented in the absence of Chatfield Alternative 3. Alternative 2 (NTGW/Downstream gravel pits) represents the most likely No Action scenario for providing 8,539 acre-feet of water annually to water providers in the absence of storing water at Chatfield, and serves as the baseline against which costs for other alternatives are compared. The average annual costs for Alternative 2 are estimated at $8.4 million including annualized investment costs of $6.6 million. Benefits for other alternatives are estimated as the difference between their average annual costs relative to those for Alternative 2 for providing the same quantity and quality of water. The NED process for selecting a plan for implementation requires the identification of net (benefits less costs) NED benefits. The NED plan is the plan that maximizes net NED benefits. Table 2-10 shows the results of the benefit analysis using annual costs and annual benefits for the alternatives. Alternative 3 is the NED plan because it maximizes net NED benefits.

Table 2-10
National Economic Development Account in Millions

	No Action	NTGW/Downstream Gravel Pits	20,600 Acre-Foot Reallocation	7,700 Acre-Foot Reallocation
Annual NED Cost*	$12.76	$8.42	$7.92	$8.40
Annual NED Benefit*	$8.4	$8.4	$8.4	$8.4
Net Annual NED Benefit*	-$4.34	$0.00	$0.49	-$0.01

* Annual entries were calculated using an interest rate of 3.75 percent over the 50-year planning period.

2.8.3 Consistency of Alternatives with the EOP

In reaffirming its commitment to the environment, USACE formalized a set of seven Environmental Operating Principles (EOP) applicable to all its decision-making and programs. They are identified and explained in ER 200-1-5, dated October 30, 2003. The EOP and associated doctrine highlight the Corps' roles in, and responsibilities for, sustainability, preservation, stewardship, and restoration of our nation's natural resources. It is an important sub-goal of the Corps to meet these EOP. These EOP are consistent with the stated goals and sub-goals of the Chatfield Reservoir storage reallocation study, and can be viewed online at: http://www.usace.army.mil/Missions/Environmental/EnvironmentalOperatingPrinciples.aspx. Corps guidance includes assessing the consistency of proposed actions or projects with the seven EOP. In 2012, the EOP were revised (re-energized) to include processes such as transparent communication and consideration of risk; see http://www.usace.army.mil/Missions/Environmental/EnvironmentalOperatingPrinciples.aspx. Table 2-11 displays the extent of consistency of each of the four alternatives with each of the seven re-energized EOP, and the major differences in consistency among the alternatives.

2.8.4 Compliance with USACE's Campaign Plan

Corps decision documents are required to address how the Chatfield Reservoir storage reallocation study incorporates the key points of the "Campaign Plan of the U.S. Army Corps of Engineers," particularly robust design, risk, reliability, and adaptability to future change. These points are addressed below.

The Chatfield Storage Reallocation FR/EIS employs an integrated, comprehensive systems-based approach to contribute to a solution to water supply demands in the Denver Metro. It evaluates a broad array of environmental, social, economic, and health and safety impacts. Through collaboration with the project's stakeholders which involved Cooperative Agencies, Special Technical Advisors, contractors, and wildlife experts a sustainable water storage alternative utilizing an existing federal facility is proposed to provide a viable solution to an immediate need. The Corps solicited and welcomed collaboration with 26 Cooperating Agencies and 11 Special Technical Advisors as well as several contractors due to the complexity of this project and the many issues involved. Seamless and transparent communication and integration was provided by: 1) holding project progress meetings in the Denver area, so all collaborators had the opportunity to attend; and 2) having these collaborators (and their attorneys) review and comment on chapters of the Preliminary Draft FR/EIS as they were completed by the Corps and its contractors.

The planning process embraced a variety of economic, social, and environmental goals and constraints. Water policies, regulations, procedures, methods and modeling were completed to support national priorities. The conceptual compensatory mitigation plan and the process for designing the conceptual recreation modification plans in the FR/EIS integrated both natural and social system features: the vegetation and wildlife settings of recreation facilities and the amount and types of public use appropriate for the mitigation sites.

The FR/EIS identifies the risk of a greatly reduced water supply to populations in the study area if they continue to rely on NTGW. The FR/EIS also communicates the residual risk that water storage in Chatfield will provide only a small portion of the Denver Metro area's unmet water needs. The non-federal sponsors of the FR/EIS are well aware that to meet their future water needs, they must pursue additional sources of water other than NTGW, as well as continuing to reduce per capita water demands through water conservation measures.

The proposed action in the FR/EIS will focus on sustainability of water supplies by reducing dependence on non-renewable NTGW in the Denver Metro area. The proposed action is also fully compatible with all seven of the Corps' environmental operating principles, as described in Table 2-10 and in Chapter 5. Assets will be more sustainable because they will be floodable without sustaining significant damage. Sustainability of mitigation sites will be enhanced over the long term because costs of monitoring, operation, and maintenance will be borne by the sponsors, and details in this regard will be included in executed agreements between the CDNR and the Chatfield water providers setting out respective obligations for carrying out the Compensatory Mitigation Plan and recreation modifications. The Corps continues to have discussions with the state and the water providers to further refine the legal relationship between the entities.

Table 2-11
Evaluation of Consistency of the Four Alternatives with the Corps' Seven Environmental Operating Principles

Environmental Operating Principles	Alternative 1: No Action	Alternative 2: NTGW/Downstream Gravel Pits[1]	Alternative 3: 20,600 Acre-Foot Reallocation	Alternative 4: 7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits
1. Foster sustainability as a way of life throughout the organization.	Partial. 5,275 of 8,539 acre-foot average year yield for 15 years from non-renewable NTGW until Penley Reservoir finished. Alternative is partly based on non-sustainable NTGW resources.	No. 5,275 of 8,539 acre-foot average year yield will be from nonrenewable NTGW for the entire 50-year period of analysis. Alternative is based on non-sustainable NTGW resources.	Yes. All 8,539 acre-feet of average year yield is from renewable surface water, including upstream effluents recaptured for reuse; none is from nonrenewable, non-sustainable NTGW.	Partial. 3,323 of 8,539 acre-foot average year yield will be from nonrenewable NTGW for the entire 50-year period of analysis. Alternative is partly based on non-sustainable NTGW resources.
2. Proactively consider environmental consequences of all Corps activities and act accordingly.	Yes. Corps would be involved through Sec. 404 permits, and all biotic impacts fully mitigated. NTGW aquifer depletion will abate in 15 years after Penley Reservoir is completed.	Partial. Corps would be involved for new NTGW wells requiring Sec. 404 permits, and all biotic impacts fully mitigated, but NTGW aquifer depletions will continue for the entire 50-year period of analysis.	Yes. All biotic, abiotic, and socioeconomic impacts are assessed and if significant, are receiving full offsets or mitigation, including proactive use of monitoring and adaptive management.	Yes. All biotic, abiotic, and socioeconomic impacts are assessed and if significant, are receiving full offsets or mitigation, including proactive use of monitoring and adaptive management.
3. Create mutually supporting economic and environmentally sustainable solutions.	Partial. Model integrates value of surface water storage 15 years in the future with environmental improvements/mitigation but is the most costly.	No. Model shows NTGW aquifer depletion over 50-year period so is not a long-term environmentally sustainable solution despite being the least costly non-reallocation alternative for 50 years.	Yes. Model integrates value of renewable surface water storage, including additional capture/reuse yields that enhance sustainability, with environmental mitigation that includes monitoring and adaptive management.	Partial. Same as for Alternative 3, but is less environmentally sustainable because NTGW depletion, although less than that of Alternative 2, will occur for the entire 50-year analysis period.
4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments.	Yes. Corps actions required for implementation comply with NEPA and all other environmental laws/regulations.	Yes. Corps actions required for implementation comply with NEPA and all other environmental laws/regulations	Yes. This Corps Action Alternative complies with NEPA and all other environmental laws/regulations and involved collaborative interagency efforts to ensure full offsets and mitigation of recreational and environmental impacts.	Yes. This Corps Action Alternative complies with NEPA and all other environmental laws/regulations and involved collaborative interagency efforts to ensure full offsets and mitigation of recreational and environmental impacts.
5. Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.	Partial. Cumulative biotic impacts mitigated, but 15-year delay for reduction of non-sustainable NTGW mining results in moderate risk of reduced water supply in the future.	No. Cumulative biotic impacts mitigated, but NTGW mining that is not sustainable long-term is not mitigated in 50-year period of analysis, resulting in a high risk of reduced water supply in the future.	Yes. Any cumulative significant biotic/physical/socio-economic environmental impacts are fully mitigated, including adaptive management to flexibly respond to new knowledge. Sponsor is aware of residual risk that reallocation provides only a fraction of additional future water needs.	Partial. Except for NTGW use that has moderate risk of reduced future water supply, cumulative significant biotic/physical/socio-economic environmental impacts are fully mitigated, and adaptive management flexibly responds to new knowledge. Sponsor is aware that residual risk is higher than for

Table 2-11
Evaluation of Consistency of the Four Alternatives with the Corps' Seven Environmental Operating Principles

Environmental Operating Principles	Alternative 1: No Action	Alternative 2: NTGW/Downstream Gravel Pits[1]	Alternative 3: 20,600 Acre-Foot Reallocation	Alternative 4: 7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits
				Alternative 3.
6. Leverage scientific, economic, and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.	Partial. Non-shared Corps/ sponsor development of knowledge base and collaboration would be limited to data needed for Section 404 permit/land availability for water distribution pipelines.	Partial. Non-shared Corps/ sponsor development of knowledge base and collaboration would be limited to data needed for Section 404 permit/land availability for water distribution pipelines.	Yes. Requires most extensive Corps/sponsor knowledge base to be developed collaboratively to understand and model environmental impacts and mitigation plans.	Yes. Corps/sponsor knowledge base a bit less extensive than for Alternative 3 to be developed collaboratively to understand and model environmental impacts and mitigation plans.
7. Employ an open, transparent process that respects' views of individuals and groups interested in Corps activities.	Yes. If reallocation is not implemented, Alternative 1 was identified by the sponsors as their most likely alternative to implement to reduce reliance on non-sustainable NTGW, but is the most costly.	Yes. Sponsors collaborated with the Corps in providing data on costs and risks of continued high NTGW use, ; but sponsors wish to reduce use of non-sustainable NTGW by developing surface water storage even though it is more costly than NTGW in 50-year analysis period.	Yes. Corps agreed to sponsor request for reallocation study; would be an innovation, with maximum possible Corps aid to solution of regional water supply deficit.	Yes. Corps agreed to sponsor request for reallocation study; Alternative 4 is innovative but less than Alternative 3, as it aids regional deficits less and still uses some non-sustainable NTGW.

[1] Alternative 2 is also the Least Cost Alternative to Chatfield Reservoir storage reallocation

The study encompassed ground breaking information as well as creativity to find solutions to complex issues. As situations were resolved, successful utilization of existing technology available between offices was achieved and creative use of new technology was embraced assuring transparency while considering economics. To provide for expected and unexpected changes and satisfy the public over the project's life cycle, adaptive management by manipulation of water releases will be used to enable the mature trees within 2 feet of the top of the reallocated storage pool to survive rather than die and be cut down. Climate change will bring increased variability (more floods and more/longer droughts); this variability will be taken into account by mitigating for environmental impacts from inundation higher than would be expected from the 1942-2000 period of record.

The process to review and approve requests for placement of recreation facilities in Zone 1 which is described as pool elevation 5,453.7 (ft msl) and lower was evaluated per a request from the state. The state completed and submitted a "Evaluation Criteria for Land Development Proposals", a structural analysis conducted by CH2M Hill and a Chatfield Reservoir Recreations Facilities Plan. To assist the State with a multiple recreation structure application for approval versus individual applications, approval has been granted to for multiple recreation structures provided the following criteria are met: 1) All structural requirements of the Technical Memorandum, Chatfield Structural Analysis, dated December 2008 are implemented; 2) In accordance with NWDR 1110-2-5, an evacuation plan is developed for all recreational activities associated with the proposed structures; 3) The proposed structures meet the definition of being closed, floodable, wet-proofed as specified in NWDR 110-2-5; 4) This multiple recreation structure submission is applicable to only structures identified as requiring relocation as part of the Chatfield Reallocation Study. Any additional structures will require separate review and approval. Research to identify the Ecological Functional Values (EFVs) of wetlands that would be impacted by reallocation and of potential wetland mitigation sites used the Beta version of the Functional Assessment of Colorado Wetlands Methodology (FACWet), which is also used by the Corps' Littleton, Colorado Regulatory Office, thus providing synergy in the use of FACWet. New communications technologies were used extensively; much information was shared by the Corps, contractors, sponsors, other Cooperating Agencies, and Special Technical Advisors at a contractor-operated file transfer protocol (ftp) site; in addition, information about the FR/EIS was made available to the general public at several internet sites.

By approaching this study holistically, an integrated, comprehensive systems-based approach was studied and carefully developed to contribute to a solution to water supply demands in the Denver Metro area. A broad array of environmental, social, economic, and health and safety impacts received scrupulous evaluation in the preparation of the Chatfield Reservoir Storage Reallocation FR/EIS and provides documented information for all alternatives regarding robust design, risk, reliability, and adaptability to future change, which also relate to the USACE Campaign Goals as detailed in the following paragraphs.

Robust Design (USACE Campaign Goals 1, 2, and 4)

The planning processes for developing the compensatory environmental mitigation plan and the recreation modification plan integrated both natural and social system features: the vegetation and wildlife settings of recreation facilities and the amount and types of public use appropriate for the mitigation sites. Collaborative planning involved 26 Cooperating Agencies, 11 Special Technical

Advisors, contractors, and other wildlife experts in designing the locally-based model for quantifying impacts to and potential mitigation measures for wetlands, Preble's meadow jumping mouse habitat, and bird/wildlife habitat in terms of ecological functional units. Seamless and transparent integration was provided by: 1) holding project progress meetings in the Denver area, so all collaborators had the opportunity to attend; and 2) having these collaborators (and their attorneys) review and comment on chapters and the entire Preliminary Draft FR/EIS as they were completed by the Corps and its contractors.

The process for prioritizing mitigation sites for Preble's mouse habitat utilizes a systems approach to maximize ecological benefits to Preble's mouse, focusing on connectivity of mitigation sites to parcels that are already protected from development as part of the Recovery Plan for Preble's mouse. To add to the robustness of the design, the Corps has had the ecological functional unit models reviewed by the Corps' center of expertise and independent experts. The recreation modification plan was developed through collaborative planning with the Cooperating Agencies, especially Colorado State Parks. The plan went through numerous drafts beginning with conceptual designs. The Corps developed the tree management plan through collaboration with Colorado State Parks, the Colorado Division of Wildlife, and the Colorado State Forest Service. A modified Unit Day Value (UDV) analysis of the effects on NED recreation benefits at Chatfield State Park of all alternatives that were evaluated in detail included stakeholder participation resulting in better planned and designed recreation facilities. UDV analyses are ordinarily prepared for entire projects or recreation areas within a project, with a maximum of 750,000 annual visits. Although the annual visitation at Chatfield State Park as a whole exceeds 750,000, use of either individual primary activities or individual recreation sites within Chatfield State Park as the unit of analysis for assigning UDV point values would meet the criterion of a maximum of 750,000 annual visits. Because Chatfield State Park visitor counts are activity based, and because the effects of reallocation would be expected to differ among recreational activities, use of UDVs for individual activities (instead of recreation sites) was utilized.

Risk (USACE Campaign Goals 3 and 4)

The Chatfield Storage Reallocation FR/EIS evaluates a broad array of environmental, social, economic, and health and safety impacts. The FR/EIS identifies the risk to much of the population in the study area of a greatly reduced water supply in the future if NTGW is continued to be relied upon for most of the water supply. The FR/EIS also communicates the residual risk that water supply alternatives evaluated would provide only a small portion of the Denver metro area's unmet water needs. The non-federal sponsors of the FR/EIS are well aware that to meet their future water needs, they must pursue additional sources of water other than NTGW, as well as continuing to reduce per capita water demands through water conservation measures.

The consequences regarding the physical, biological, cultural, and other aspects of the human environment are fully disclosed in the FR/EIS for all four alternatives. These consequences include the decline in, and increased costs of, NTGW production if NTGW continues to be relied on to the same extent in the future. Environmental impacts to federally-listed threatened Preble's meadow jumping mouse habitat, wetlands, and habitat for migratory birds and other wildlife are also identified. Impacts to recreational enjoyment and recreation benefits, along with the variability in impacts of reallocation within and among different recreation activities as perceived by activity participants is included in the FR/EIS and detailed in an appendix. The FR/EIS also includes the

risks of downstream flooding and the variability in annual and monthly reservoir water level fluctuations.

To reduce risk for engineered systems and to identify the potential maximum amount of additional water supply to be evaluated for all alternatives regarding Chatfield, two studies were conducted by the Corps and included in the FR/EIS as appendices. First, an antecedent flood study was conducted by the Corps and reviewed by the Bureau of Reclamation. The results of this study determined that 20,600 acre-feet was nearly all the storage that could be reallocated without significantly impacting the freeboard and flood risk management function of Chatfield Reservoir as well as the other two reservoirs in the Tri-Lakes system as described in Appendix B – Tri-Lakes Water Control Plans. In addition, comments provided by members of the general public who recreate at Chatfield are provided in an appendix to the FR/EIS; many of these comments contain suggestions for reducing impacts of reallocation on specific activities or facilities.

Reliability (USACE Campaign Goals 2 and 3)

The proposed action in the FR/EIS would focus on sustainability of water supplies by reducing dependence on non-renewable NTGW in the Denver Metro area. All alternatives were compared regarding their compatibility with all seven of the Corps' environmental operating principles, as described in Table 2-11 and in Chapter 5. Assets would be more sustainable because they would be floodable without sustaining significant damage. Sustainability of mitigation sites would be enhanced over the long term because costs of monitoring, operation, and maintenance would be borne by the sponsors, and details in this regard would be included in the water supply contract with the Corps.

The monitoring plans for the compensatory mitigation plan mitigation sites are robust and would extend for a sufficient time to adequately determine the likelihood of success continuing over the 50-year project life.

The FR/EIS has undergone a chapter-by-chapter Internal Technical Review (ITR) by Omaha District staff, Cooperative Agencies, and Special Technical Advisors; an Agency Technical Review (ATR) of the 75 percent completed Preliminary Draft; and an Independent External Peer Review (IEPR).

Adaptability to Future Change (USACE Campaign Goals 2 and 3)

Adaptive management is used in the Chatfield Reservoir storage reallocation study and is discussed in Section 4.1.1. Adaptive management promotes flexible decision-making that can be adjusted in the face of uncertainties, as outcomes from management actions and other events become better understood. Adaptive management would be used in effectively managing potential impacts to specific resource areas as indicated in Section 4.1.1.

The potential effects of climate change on the study are discussed in Section 4.3 and elsewhere in the FR/EIS. Climate change would likely result in increased variability (more floods and more/longer droughts); this variability would be taken into account by mitigating for environmental impacts from inundation higher than would be expected from the 1942–2000 period of record.

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