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FinalEIS	ChatfieldReallocationFinalDraftForReview.
166 pages (5.19 MB)	162 pages (5.34 MB)
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4. ENVIRONMENTAL CONSEQUENCES

4.1 Environmental Consequences Introduction

This chapter addresses the environmental consequences of the proposed reallocation of flood storage from the flood control pool to the conservation pool in Chatfield Reservoir that would result from implementation of the proposed action or alternatives. This study focuses mainly on the environmental consequences at Chatfield Reservoir and surrounding state park, but because Chatfield Reservoir provides flood reduction benefits to downstream neighborhoods and businesses, and because components of other alternatives being considered occur downstream adjacent to the South Platte River (gravel pit storage), areas downstream from the reservoir to the Adams/Weld county line are also considered in the analysis. In addition, the area south of Chatfield Reservoir that would be used to construct Penley Reservoir and associated pipelines under Alternative 1 (No Action) is also discussed where appropriate. Section 2.4 reports the number of acres of disturbance from the construction and infrastructure associated with each alternative, including the proposed Penley Reservoir and pipeline areas under Alternative 1 (Table 2-6) and the gravel pits under Alternatives 1 and 2 (Table 2-7) and 4. An impact analysis was conducted for each of the 17 resources introduced in the affected environment chapter (Chapter 3). Consideration was given to whether potential environmental consequences would result from the proposed action or alternatives and whether the consequences are short-term or long-term, insignificant or significant, and adverse or beneficial. This study specifically focuses on four alternatives as described in Chapter 2:

- Alternative 1—No Action, Penley Reservoir combined with gravel pit storage
- Alternative 2—NTGW combined with gravel pit storage
- Alternative 3—Reallocation of 20,600 acre-feet of storage (20,600 Acre-Foot Reallocation)
- Alternative 4—Reallocation of 7,700 acre-feet of storage (7,700 Acre-Foot Reallocation) and use of NTGW and gravel pit storage so average annual yield totals 8,539 acre-feet per year

Under the No Action Alternative (Alternative 1), Chatfield Reservoir would not be reallocated to multipurpose storage, and the operation of the reservoir would remain unchanged. Water levels would remain unchanged at 5,432 feet msl, but since there is a need for water storage, this alternative would include the construction of Penley Reservoir and downstream gravel pit storage. Under Alternative 2 the status of Chatfield Reservoir would remain the same as Alternative 1, except that future water demands would be met through NTGW and the downstream gravel pits. Alternative 3 is proposed to raise the target water level 12 feet to an elevation of 5,444 feet msl, but the reallocation of storage for this project only involves the volume between 5,432 and 5,444 feet msl. Alternative 4 is proposed to raise the target water level 5 feet to an elevation of 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 level of impact is based on regulatory standards, criteria and ordinances, available scientific documentation, and professional judgment of the resource specialists. Based on the impact analysis, additional mitigation and modification measures may be proposed in this chapter to further minimize potential adverse impacts. Cumulative impacts are also discussed in this chapter.

4.1.1 Adaptive Management

Each of the alternatives would use adaptive management to evaluate conditions and minimize potential impacts. Adaptive management involves an iterative process of cycling through several steps: problem assessment, design, implementation, monitoring, evaluation, adjustment, and continued cycling through earlier steps (Barnes, 2009). Successful adaptive management programs use iterative decision-making (i.e., evaluating results and adjusting actions on the basis of what has been learned). They allow for feedback between monitoring and decision-making, and they embrace risk and uncertainty as a way of building understanding (Barnes, 2009). Adaptive management is framed within the context of structured decision making, with an emphasis on uncertainty about resource responses to management actions and the value of reducing that uncertainty to improve management. Though learning plays a key role in adaptive management, it is a means to an end, namely good management, and not an end in itself (Williams et al., 2009).

As described in Section 1.3.3, the WRDA of 2007, as amended, and the Corps' Planning Guidance Notebook (ER 1105-2-100), require that mitigation planning be an integral part of the overall planning process. Under Section 2036(a) of WRDA, the Corps must ensure that any report submitted to Congress for authorization does not select a project alternative without either a specific plan to mitigate fish and wildlife losses or a determination of negligible adverse impacts. Specific mitigation plan components are required, including "the development of contingency plans (i.e., adaptive management)" (USACE, 2009a, p.1). The Corps defines adaptive management as an organized and documented undertaking of goal-directed actions, while evaluating their results to determine future actions. Simply stated, adaptive management is doing, while learning in the face of uncertain outcomes (Barnes, 2009). According to the National Research Council's 2004 Adaptive Management for Water Resources Project Planning, 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.

Subsequent to the draft FR/EIS, an Adaptive Management Plan (AMP) was prepared for the recommended plan for Chatfield Reallocation (Appendix GG). The AMP consolidated and added to information on adaptive management previously provided in the draft FR/EIS. The AMP addresses the following resources and management actions:

- Target environmental resources (Preble's meadow jumping mouse, wetlands, and bird habitat);
- Tree clearing within the fluctuation zone;
- Weed control within the fluctuation zone;
- Water quality;
- Operations; and
- Fisheries and downstream aquatic habitat.

These resources and management actions have uncertainties, will be monitored, and are likely to require adjustments to their proposed management plans and actions. Each individual mitigation activity will be monitored at least annually for a minimum of five years or until success criteria are met. The impacts and mitigation associated with other resources (vegetation, wildlife, socioeconomics, and recreation) are unlikely to require iterative adjustments informed by monitoring as is the case for the resources and management actions addressed by the AMP.

The following components for the AMP provide a framework that can be built upon as more information becomes available through monitoring of impacts, mitigation and resource management.

1. Establish Core Objectives – Each resource or management action subject to adaptive management has a defined core objective or set of core objectives. The core objectives are those objectives that are not proposed to be modified by adaptive management. The means of achieving the core objectives may be changed through the adaptive management process.

2. Identify Uncertainties – For each resource or management action, the potential uncertainties that are currently known and for which adaptive management may be needed are identified.

3. Develop Contingencies – For each identified uncertainty, a corresponding potential adjustment to the currently identified action is identified. The identified contingency or adjustment could be modified in the future, but given what is currently known, is the recommended course of action.

The AMP establishes core objectives, identifies uncertainties, and develops corresponding contingencies for each of the resources and management actions it addresses. The AMP will inform and guide adjustments and modifications to the mitigation and management that is currently proposed. These adjustments and modifications will require review and oversight to make sure they are needed, sound approaches are taken, and that they are aligned with achieving the core objectives. The FR/EIS established oversight responsibilities for mitigation and monitoring, and these responsibilities will also extend to adaptive management.

Discussions of adaptive management as applied to specific resources can be found throughout this FR/EIS, including in Sections 4.3.5 under Hydrology; 4.4.5 under Water Quality; 4.6 under Vegetation; 4.7.5 under Wetlands; 4.8.5 under Wildlife; and 4.9.5 under Endangered, Threatened, and Candidate Species, Species of Special Concern, and Sensitive Communities; as well as in Appendices J, Water Quality; K, Compensatory Mitigation Plan; V, Draft Biological Assessment; and Z, Tree Management Plan. In addition, adaptive management for each potentially impacted resource is summarized in Table 4-1.

In summary, this FR/EIS discloses potential impacts to many resources based on the best available information. Many of those impacts depend on the timing and duration of pool level fluctuations under the proposed reallocation alternatives (Alternatives 3 and 4) or on other sources of uncertainty. Several factors contribute to the pool elevation at Chatfield Reservoir, including hydrologic conditions, reservoir operations, and even long-term climate change. To address uncertainty in mitigating impacts under all alternatives, the water providers and the Corps are dedicated to implementing a strong adaptive management strategy involving active monitoring and

Table 4-1
Summary of Adaptive Management Measures to Address Potential Impacts and Uncertainty

Resource	Potential Impact	Uncertainty	Required Adaptive Management
Hydrology	Under Alternatives 3 and 4 pool elevations would fluctuate more than under Alternatives 1 and 2.	Climate change may result in more floods and more or longer periods of drought, which cannot be accurately predicted now. Annual average streamflow volumes in the South Platte could decrease with climate change (Water Research Foundation, 2012). The Corps model uses inflows during the 1942–2000 POR, which tend to be greater on average than predicted for future conditions for all alternatives. This results in a greater probability of adequate mitigation for all types of inundation-related environmental impacts.	In terms of hydrology, potential changes in pool fluctuations would be difficult to minimize under Alternatives 3 or 4. The effects of those fluctuations on other resources (e.g., target environmental resources, tree clearing, weed control, water quality, and aquatic life and fisheries) and ways to reduce effects through adaptive management are discussed under those resources.
Water Quality	Under Alternatives 3 and 4, increases in total phosphorus are expected. Removal of vegetation prior to inundation could reduce nutrients released, but concentrations could exceed Alternative 1 because of hypolimnion increase and nutrient release from inundated soils.	• Water quality analysis shows there may be uncertainty regarding internal nutrient (i.e., phosphorus) loading from increased hypoxic conditions and associated anaerobic sediments. • Water quality could be adversely affected by shoreline erosion associated with increased water level fluctuations. • The hypoxic area could expand and potentially increase the release of reduced contaminants from anaerobic sediments and increase methylation of mercury within the reservoir. • Vegetation establishment within the fluctuation zone that would eventually be inundated could increase internal nutrient loading.	• Water quality monitoring would be implemented at Chatfield Reservoir to allow for the initial and ongoing application of a dynamic water quality model and assessment of reservoir water quality conditions for compliance with water quality standards. Dynamic water quality modeling would require the appropriate monitoring of reservoir, inflow, and outflow water quality conditions. Appropriate water quality data will be collected in Chatfield Reservoir to assess compliance with promulgated water quality standards criteria. This information will be used to help determine if mitigation actions need to be taken. • Remove vegetation below 5,439 ft msl to minimize the introduction of nutrients associated with inundation, as discussed under Tree Management within the Fluctuation Zone. • Control weeds within the fluctuation zone that could increase nutrient levels when inundated. • Monitor the establishment of vegetation within the fluctuation zone that could increase nutrient levels when inundated. • Water Quality Modeling. An initial application of a dynamic water quality model could be attempted using historic water quality, meteorological, pool level, and flow data. Annual dynamic water quality models would be developed where historical data allow. If sufficient historical data are lacking, an initial application of a dynamic water quality model would be based on newly collected data. Once initially developed, a dynamic water quality model would be applied annually on an ongoing basis. Water quality, meteorological, pool level, and flow data for the past year would be used to develop a specific dynamic water quality model for the year. As the annual dynamic water quality models are developed, they could be used to conduct scenario testing of possible water quality management measures. If core objectives are threatened, a

Table 4-1
Summary of Adaptive Management Measures to Address Potential Impacts and Uncertainty

Resource	Potential Impact	Uncertainty	Required Adaptive Management
			dynamic water quality model could be used to scope out the water quality concern, and, if appropriate, identify mitigation actions to manage water quality conditions. • Determine if mitigation actions need to be taken based on an assessment of collected water quality data and findings of the dynamic water quality modeling. • If mitigation actions are needed, use dynamic water quality modeling to identify effective and reasonable actions that can be implemented. • Properly implement selected water quality mitigation actions. • Assess implemented water quality mitigation actions for effectiveness. • As necessary, adjust implemented mitigation actions or implement new mitigation actions as determined by effectiveness assessments. • Continue water quality monitoring and mitigation actions as needed.
Aquatic Life and Fisheries	Fluctuating pool levels during fish spawning and embryo development could impact reproductive success of walleye broodstock in the reservoir. Low flows and higher temperatures could increase stressors on the aquatic community downstream of the reservoir.	Adaptive management will be used to address uncertainties associated with the effects of operations of the reallocated storage related to the walleye broodstock program and to the aquatic life and fisheries in the South Platte River below Chatfield Reservoir. The uncertainties associated with operations related to aquatic life and fisheries include: • How the provisions of a coordinated reservoir operations plan relating to aquatic life and fisheries would affect project yield of the Chatfield water providers. • Factors other than reservoir operations that could adversely affect the success of the walleye broodstock program or the health of the walleye populations within Chatfield Reservoir. • Factors other than releases from Chatfield Reservoir that could adversely affect the aquatic life and fisheries of the South Platte River below Chatfield Reservoir such as alterations in flow from changes in water use by others, climate change, threats to aquatic life such as disease or invasive species, flood events, toxic spills, and increased public use. • How frequently the Chatfield water providers will be able to meet the objectives of an operations plan that includes downstream releases designed to minimize adverse	The following iterative process will be used to address uncertainties associated with aquatic life and fisheries: • The operations plan includes multiple regularly scheduled meetings involving the CPW, Chatfield water providers, and others where the current conditions relating to operations will be discussed and future operational actions will be forecasted. • Monitoring the status of the aquatic life and fisheries both within and downstream of Chatfield Reservoir are part of the regular activities conducted by CPW. CPW will share this information with the Chatfield water providers at the periodic operations meetings. • CPW will be given the opportunity at the operations meetings to discuss the status and make recommendations for improvements of operations at Chatfield Reservoir relating to both the walleye broodstock program and the fishery in the South Platte River downstream of Chatfield Reservoir. • Any alterations to the operations plan related to aquatic life and fisheries can be proposed, discussed, and mutually agreed upon by the CPW, Chatfield water providers, and Corps as part of the regular business of the operations meetings.

Table 4-1
Summary of Adaptive Management Measures to Address Potential Impacts and Uncertainty

Resource	Potential Impact	Uncertainty	Required Adaptive Management
		impacts and/or benefit aquatic life and recreation? • Changes in the Chatfield water providers' water systems that could affect operations. • Changes made to the physical habitat of the South Platte River from habitat, drainage, or flood improvement projects. • Future water demands unrelated to this project, which could change flow patterns in the South Platte River and impact aquatic life.	
Tree Clearing Within the Fluctuation Zone	A Tree Management Plan (TMP) was developed to address the removal of trees that would be inundated under Alternative 3 or 4 (FR/EIS, Appendix Z). Under Alternative 3, as proposed in the TMP, the majority of trees between 5,432 ft msl (the current high water elevation) and 5,439 ft msl would be removed prior to raising the pool elevation.	The following are uncertainties that could require adjustments to the methods used to implement the TMP: • The degree of tree survival below the new high water elevation of 5,444 ft msl; • The exact area and location of trees to be cleared; • Locations and size of tree stands to be retained below 5,439 ft msl; • Locations of where downed trees will be used for aquatic habitat enhancement; • Locations of where downed trees will be used for Preble's habitat enhancement; and • The degree of new tree establishment in the upper portions of the new fluctuation zone.	The following will be used to adaptively manage uncertainties that can affect implementation of the TMP: • Monitor the trees between 5,439 and 5,444 ft msl, and any trees retained below 5,439 ft msl, for signs of severe stress and mortality, and remove unhealthy and dead trees from this area on an as-needed basis when they pose a significant risk to visitor, boater or dam safety. • Monitor the trees between 5,439 and 5,444 ft msl, and any trees retained below 5,439 ft msl, to determine if adjustments to impact estimates and mitigation are needed. • The Corps and CPW will work together to identify areas where trees will need to be removed prior to storing water in the reallocated conservation pool to eliminate significant risks to visitor, boater or dam safety. • The Corps and CPW will work together to identify areas where removed trees will be placed to enhance aquatic habitat prior to storing water in the reallocated conservation pool. Methods to secure the trees and eliminate significant risks to visitor, boater or dam safety will also be determined. • The Corps, CPW, and FWS will work together to identify areas where removed trees will be placed to enhance Preble's habitat. The Corps and CPW will evaluate trees within the reallocated pool after water has been stored and trees have been inundated, and based on their evaluation will notify the Chatfield Reservoir Mitigation Company of the trees that need to be removed based on significant risks to visitor, boater, or dam safety/operations. • Monitor the establishment of cottonwoods and willows above and below the new high water line of 5,444 ft msl.

Table 4-1
Summary of Adaptive Management Measures to Address Potential Impacts and Uncertainty

Resource	Potential Impact	Uncertainty	Required Adaptive Management
Target Environmental Resources (wetlands, Preble's and birds)	The adverse impacts estimated for the target environmental resources are a conservative maximum estimate of the impacts. The impact estimate assumes that all of the target environmental resources below the maximum pool elevation of 5,444 feet mean sea level (ft msl) would be lost. As a practical matter, this may not be the case, and will be addressed through monitoring and adaptive management. Implementation of the CMP is expected to produce quantitative and qualitative benefits for the target environmental resources. The quantitative benefits will be measured by monitoring the ecological functional units (EFUs) gained.	The following are uncertainties that could require adjustments to the methods used to achieve objectives in the CMP as currently proposed. • All of the compensatory mitigation measures may not be completely successful; • Some compensatory mitigation activities may provide more benefit than currently estimated; • Impacts associated with inundation may be less than have been conservatively estimated for the CMP; • Not all private property owners targeted for land protection may be willing to enter into agreements to protect their property or portions of their property at a fair market price; and • Other opportunities may become available to provide mitigation determined to be of value to the target environmental resources.	The following strategies will be used to adaptively manage issues and events that adversely affect or limit proposed compensatory mitigation. • Broaden the geographic scope of the target off-site mitigation area identified in the CMP to increase the potential for protection of private lands or enhancement of public lands; • Employ corrective actions to unsuccessful mitigation activities (e.g., grade adjustments, reseeding, replanting, increased weed control, fencing, and temporary irrigation); • Reconsider the use of approved wetland mitigation banks; • Investigate opportunities to partner on future regional conservation and mitigation projects; • Adjust operations by Chatfield water providers in either the storage or release of water without adversely affecting the yield of the Chatfield water providers as identified in this reallocation project; • Investigate incentives or other options for private land owners who are unwilling to enter into agreements to protect their property or portions of their property at fair market rates; • Adjust impact assessment and mitigation based on monitoring associated with the tree management plan; and • Other measures agreed upon by the Project Coordination Team and the Chatfield water providers that are appropriate to address mitigation issues.
Weed Control Within the Fluctuation Zone	The proposed reallocation of storage at Chatfield Reservoir is predicted to result in a greater magnitude and frequency of reservoir level fluctuations compared to historical reservoir operations. When exposed, the expanded fluctuation zone provides potential habitat for the establishment of weeds.	Adaptive management will be used to address uncertainties associated with the establishment and control of weeds within the fluctuation zone. Monitoring will determine which weeds invade the fluctuation zone, their distribution, and methods that prove effective in their eradication and control. The following are uncertainties that could require adjustments to weed control in the fluctuation zone. • It is currently unknown if weeds will invade the fluctuation zone; • It is currently unknown which weeds may in become established in the fluctuation zone; • It is currently unknown which methods will prove most effective for controlling or eradicating a specific weed species; • Weed species, not currently known to the region, could	The following iterative process will be used to address uncertainties associated with controlling weeds within the fluctuation zone and will need to be incorporated into a weed control program: 1. Monitoring the fluctuation zone annually for weeds; 2. Identifying areas requiring weed control or eradication; 3. Selecting the appropriate treatment for control or eradication; 4. Properly implementing the selected treatment for control or eradication; 5. Post-treatment monitoring to determine the effectiveness of control or eradication methods; 6. Adjusting treatment as required; and 7. Continuing monitoring and treating as needed.

Table 4-1
Summary of Adaptive Management Measures to Address Potential Impacts and Uncertainty

Resource	Potential Impact	Uncertainty	Required Adaptive Management
		invade the fluctuation zone in the future; and • New methods of weed control and eradication may become available in the future and could be effective in controlling and eradicating weed species found in the fluctuation zone.	
Operations	Operation of storage in the reallocated space in Chatfield Reservoir can affect the environmental and recreation resources. It may be possible to operate the reallocated storage in a manner that will reduce the estimated impacts.	Adaptive management will be used to address uncertainties associated with the effects of inundation and operations of the reallocated storage. The uncertainties associated with the effects of inundation are discussed in the previous sections on the Target Environmental Resources and the Tree Management Plan. The uncertainties associated with operations include: • How a coordinated operations plan could affect project yield. • If a target elevation range for water surface elevations and a schedule for water storage and releases for the reallocated space can be identified that could benefit the target environmental resources and recreation. • How frequently the Chatfield water providers are able to meet the objectives of an operations plan designed to minimize adverse impacts and/or benefit the target environmental resources and recreation. • Changes in water law or water administration. • Changes in water availability due to climate change or other phenomena. • Changes in the Chatfield water providers. • Changes in the Chatfield water providers' needs or relative allocations of storage. • Changes in the Chatfield water providers' water systems, which could affect operations. • Results from monitoring that provide ongoing information on the effects of inundation on the target environmental resources. • Effects on other resources that need to be considered in reservoir operations (e.g., weeds, water quality, and downstream aquatic habitat).	The Project Coordination Team and the Chatfield Reservoir Mitigation Company will explore ways to adjust their management and operation of the reallocated storage to further minimize impacts on the target environmental resources considering system constraints and project yield. The ability to minimize these impacts may be opportunistic and/or programmatic. However, these opportunities also may be limited by water rights, costs, or other constraints. Opportunistic operations to minimize impacts associated with inundation that will be explored by the Chatfield Reservoir Mitigation Company include: • Reducing water elevations at Chatfield Reservoir to a targeted elevation range during the growing and recreation season; • Moving water from Chatfield Reservoir to other facilities when water levels are above a targeted elevation range during the growing and recreation season; and • Developing an agreement and an accounting system among the Chatfield water providers and other Chatfield Reservoir users (e.g., Denver Water) that would allow storage exchanges in other facilities to be repaid at Chatfield Reservoir outside of the growing season when water elevations at the reservoir are above a targeted elevation range during the growing and recreation season. Adaptive management will be used to address uncertainties associated with the effects of inundation and operations of the reallocated storage.

mitigation adjustments based on actual conditions. The adaptive management strategy is presented in Appendix GG and will be executed with involvement of many additional entities, including the CWCB, the Project Coordination Team, and the Technical Advisory Committee. Table 4-1 summarizes the main areas of uncertainty identified in this FR/EIS and how adaptive management will address them. A detailed assessment of impacts for every affected resource follows in the remaining sections of Chapter 4.

4.2 Geology and Soils

The four proposed alternatives could have potential adverse impacts on geology and soils. Specific issues include possible impacts of the alternatives on geologic hazards (mass wasting and flooding) and possible impacts on soils (erosion and compaction). Mass wasting is a general term used for any downslope movement of rock, soil, snow, or ice under the influence of gravity, including landslides, creep, rock falls, and avalanches. Potential damages from downstream flooding are addressed in Section 4.15. The remaining issues are evaluated by alternative in the following sections.

4.2.1 Alternative 1—No Action

Under Alternative 1, reservoir levels and operations at Chatfield Reservoir would remain unchanged (Table 4-2 and Figure 4-1). Mass wasting, flooding, soil erosion, and soil compaction near the reservoir would not be affected under this alternative. The primary source of sediment deposition into Chatfield Lake is watershed sheet, rill, and gully erosion; the secondary source is shoreline erosion (USACE, 2007). However, to achieve sufficient water storage, additional facilities, pumps, and pipelines would be constructed by the non-federal entities. Groundwater would be pumped, agricultural water rights would be purchased, and services would be reduced. Several of these changes could affect geology and soil resources.

Table 4-2
Area of Inundation Beyond Current Operations at Chatfield Reservoir Under Each Alternative

Alternative	Conservation Pool Elevation (feet msl)	Total Area That Would Be Inundated at Maximum Pool Elevation (acres)	Area Beyond Current Operations That Would Be Inundated at Maximum Pool Elevation (acres)
1	5,432	1,507	0
2	5,432	1,507	0
3	5,444	2,094	587
4	5,437	1,722	215

Following the assumptions of ground disturbance outlined in Chapter 2, this alternative could include up to 506 acres of disturbance related to gravel pit water storage (Table 2-7), and up to 377 acres of disturbance related to water storage facilities (i.e., Penley Reservoir) (Table 2-6). The impact to geology and soils related to these potential projects would depend on the affected geologic units, slopes, and soil types. In general, geologic hazards would not likely be increased under this alternative, especially because the proposed Penley Reservoir would be constructed off-channel (as opposed to impounding a stream for storage). Soils would be compacted and likely irreversibly committed in areas of ground disturbance. Although these projects would be implemented on private lands, they should be coordinated with the Corps' Regulatory office as early as possible in the project planning process in regard to Section 404 and Section 401 permit actions, appropriate NEPA documentation, and other requirements.

Under the No Action Alternative, prime and unique farmland within the study area, as well as prime and unique farmland outside of the study area but within the watershed, would not significantly change unless the municipalities build another reservoir (i.e., Penley Reservoir) or buy out the farmers' water rights. No irrigated land would be converted to dryland agriculture for the downstream gravel pits (Table 2-7).

4.2.2 Alternative 2—NTGW/Downstream Gravel Pits

Under Alternative 2, gravel pits would be converted to water storage reservoirs, the same as under Alternative 1. The impacts on geology and soils related to the use of downstream gravel pits would be the same as described under Alternative 1. Under Alternative 2, however, the remaining water storage would be obtained from NTGW instead of surface water resources. Construction of additional groundwater wells and pipelines to connect them into the distribution system would be needed to meet both existing and growth-related production demands. This construction could disturb soils locally, with approximately one acre of disturbance for each well. No additional impacts to geology and soils from the use of NTGW would be expected.

Based on studies cited in Section 4.3, the continued long-term use of NTGW would reduce the pumping rates for water wells in the area. Agricultural lands, including prime and unique farmland, that rely on NTGW would be affected under this alternative. No irrigated land would be converted to dryland agriculture for the downstream gravel pits.

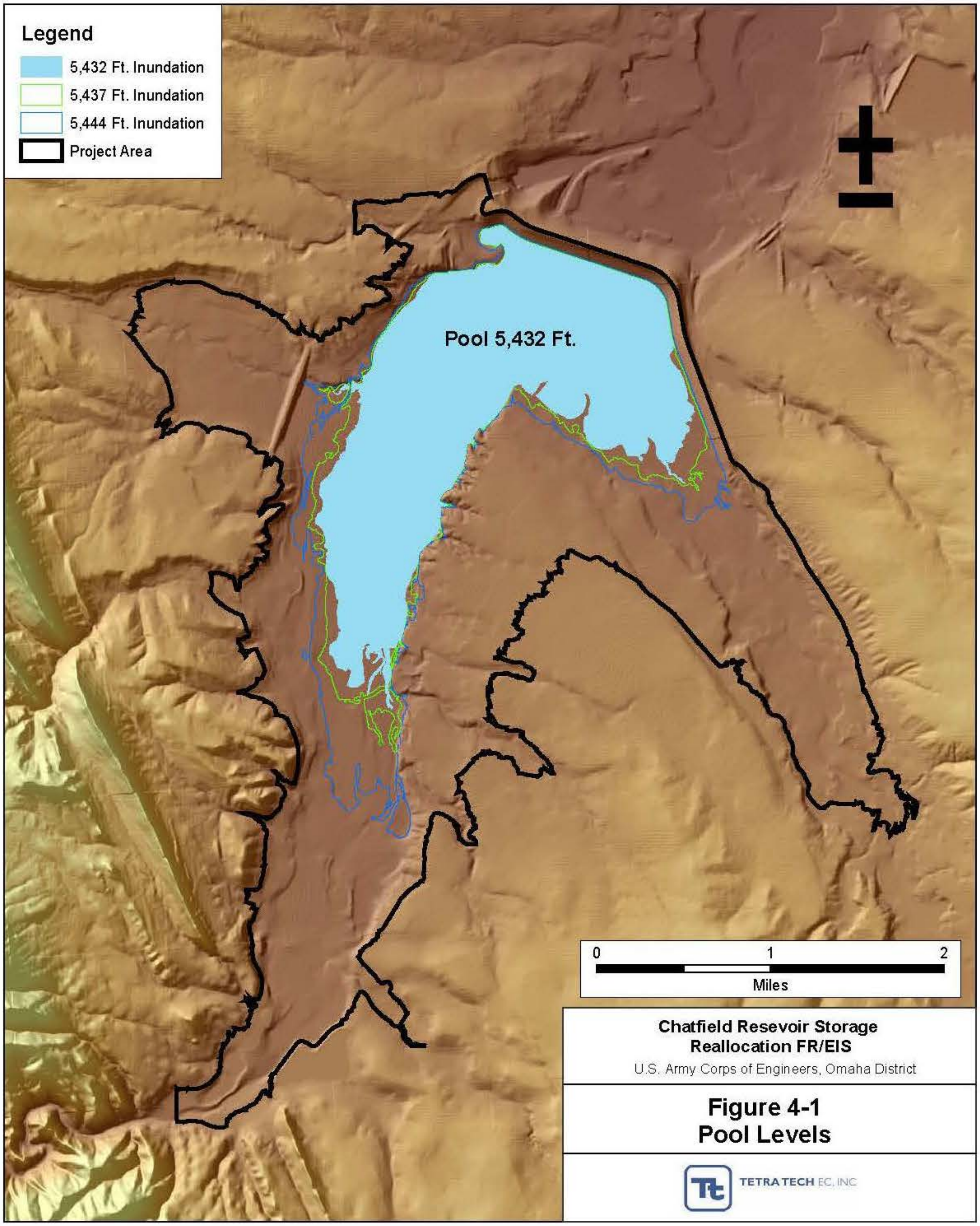
4.2.3 Alternative 3—20,600 Acre-Foot Reallocation

Under this alternative, the management of the conservation pool would be changed to target 20,600 acre-feet of reallocated storage by allowing the water level to rise to as much as 5,444 feet msl. Based on elevation contours generated using field survey data of the area immediately surrounding the reservoir, increased water levels would inundate additional acres of land adjacent to the existing reservoir. Table 4-2 and Figure 4-1 show the area beyond current operations that would be inundated at the top of the conservation pool under each alternative. Under Alternative 3, approximately 587 additional acres would be inundated at water levels of 5,444 feet msl.

Under this alternative the Chatfield Reservoir level would fluctuate more than under the other alternatives. As a result, portions of the shoreline that would be commonly under water under this alternative, and therefore have little stabilizing vegetative cover, would be exposed to erosion by wind and water. Furthermore, silt and fine sediments would likely accumulate in inundated areas. As the waterline receded, these fine sediments would be susceptible to erosion by wind and water. Because this alternative would involve the greatest inundated area and the most fluctuations in water levels, the potential for erosion of these fine materials would be greatest. For more information on the potential impacts of wind erosion on air quality, see Section 4.12. For more information on the potential impacts of sediment erosion on water quality, see Section 4.4.

Changes in the potential for mass wasting would not be expected under Alternative 3 because of the relatively gentle slopes immediately surrounding Chatfield Reservoir. Alternative 3 would involve changing the water management at the reservoir, but would not require construction of a new reservoir, which would translate into a lower likelihood for soil compaction or irretrievable soil commitment than under Alternative 1. Alternative 3 would not involve the construction of pumps or pipelines to transport water from Chatfield Reservoir. However, there would be land disturbance from construction for relocation of recreation facilities and roads.

Figure 4-1
Flood Pools



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The soil map units that would be inundated when the conservation pool reached 5,444 feet msl, according to NRCS soil mapping, are shown in Table 4-3 and Figure 4-2. Relevant soil characteristics are presented for each unit. Acres are summed for the total inundated area (referred to as the total including water) and for the inundated area not including water mapped by NRCS (referred to as the total excluding water).

Of the additional acres that would be inundated under Alternative 3 (587 acres), approximately 18 percent (108 acres) are characterized as gravel pits, dam, or water by the NRCS. Because these soil map units are not susceptible to erosion or compaction, they would not be impacted by the proposed changes in operations. Of the remaining 82 percent that would be inundated, soil textures range from fine loams to coarse sands with Kw factors between 0.05 and 0.28. Soil K factors represent a relative index of the susceptibility of bare, cultivated soil to particle detachment and transport by rainfall. This quantitative measure of soil erodibility and runoff potential is based primarily on the percentage of silt, sand, and organic matter; soil structure; and soil permeability. K factors include both Kf, which represents the K factor of the fine fraction of the soil, and Kw, which represents the K factor of the whole soil, including rock fragments. For the purposes of indicating the potential surface erodibility by water of different soils near the Chatfield Reservoir, the Kw factor is shown. By convention, Kw factors range from 0.02 to 0.69 (NRCS, 2005b). Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water. The area-weighted average Kw factor for the soils listed in Table 4-3 is 0.19. These Kw factors reflect a relatively low potential for surface soil erosion by water under Alternative 3. The impacts to surface soil erosion by water are insignificant. However, this does not apply to shoreline erosion.

Wind erodibility indices range from 0 to 180 in the area affected by Alternative 3. The wind erodibility index is assigned based on groupings of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The soil properties that are most important with respect to soil blowing are soil texture, organic matter content, effervescence from carbonate reaction with hydrochloric acid, rock fragment content, mineralogy, and moisture. By convention, the wind erodibility index ranges from 0 to 310 (NRCS, 2005b). Other factors being equal, the higher the value, the more susceptible the soil is to erosion by wind. The weighted average wind erodibility index for the soils listed in Table 4-3 is 87. These indices reflect a relatively low potential for surface soil erosion by wind under Alternative 3. For most soils at the Chatfield Reservoir storage reallocation project, the impacts to surface soil erosion by wind are insignificant. The two soils rated with the highest wind erodibility indices, 134 and 180, represent a total of 8 percent of the additional inundated area. If vegetation were removed during periodic inundation, these areas could be considered at moderate to moderately high risk for wind erosion. These areas are outside the pool.

The soil hydrologic group is a group of soils having similar runoff potential under similar storm and cover conditions. Soil properties that influence runoff potential are depth to a seasonally high water table, intake rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. Hydrologic groups range from A to D, with A representing the lowest runoff potential and D representing the highest runoff potential (NRCS, 2005b). The hydrologic group with the greatest extent (37 percent) that is mapped in the additional inundated area under Alternative 3 is soil hydrologic group C, soils with a high runoff rate. Approximately 13 percent is mapped with a soil hydrologic group of A, 15 percent is B, and 19 percent is D. The remaining 16 percent consists of the dam and mapped water and is not classified.

The soils that would be inundated when the pool reached 5,444 feet msl would have a relatively high potential for runoff. Because these soils are not highly erodible (as explained in the previous paragraphs), the soils themselves would not likely erode. However, if fine sediments were deposited as water levels subsided, these materials would be relatively likely to be eroded by rainfall and transported back into the reservoir. The net impacts to soil erosion based on the soil hydrologic classifications are insignificant. However, this does not apply to shoreline erosion.

Under Alternative 3, prime and unique farmland within the study area and surrounding watershed would not change significantly. No agricultural water rights would be transferred under Alternative 3.

As described in Section 3.2.1, according to the Dam Safety Report (Appendix A), no immediate dam safety concerns have been identified based on a projected reservoir elevation of 5,444 feet msl, considering static loading. All of the structures at the site have been designed to withstand the small increase in loading caused by the proposed pool elevations. In addition, the most recent periodic inspection report (2008) found these structures to be in very good condition, which provides confidence that these structures are functioning as designed. Raising the normal pool elevation by up to 12 feet would not have a direct bearing on the adequacy of the slope protection material. Furthermore, the slope protection material would continue to be monitored during routine dam safety inspections (e.g., monthly, annual, periodic). Existing areas of riprap displacement also would be inspected during low reservoir elevations.

Increased monitoring of the project would be pursued as part of the routine dam safety program to assure continued safe operation of the dam. A Reservoir Raise Monitoring Plan would be developed and implemented, and would include additional inspection efforts, instrumentation data acquisition, and data analysis. The Project Surveillance Plan and Emergency Action Plan also would be updated as appropriate. Installation of additional instrumentation prior to rising pool levels, along with an increase in instrumentation readings and inspection frequencies during and following the pool raise, would be warranted.

Under Alternative 3, Chatfield Dam would be subject to elevated dam safety monitoring and evaluation. Water supply storage could be reduced by Interim Risk Reduction Measures (IRRM) or other remediation if deemed necessary by USACE.

Table 4-3
Soil Types, Extents, and Descriptions Within Area of Inundation Under Alternative 3

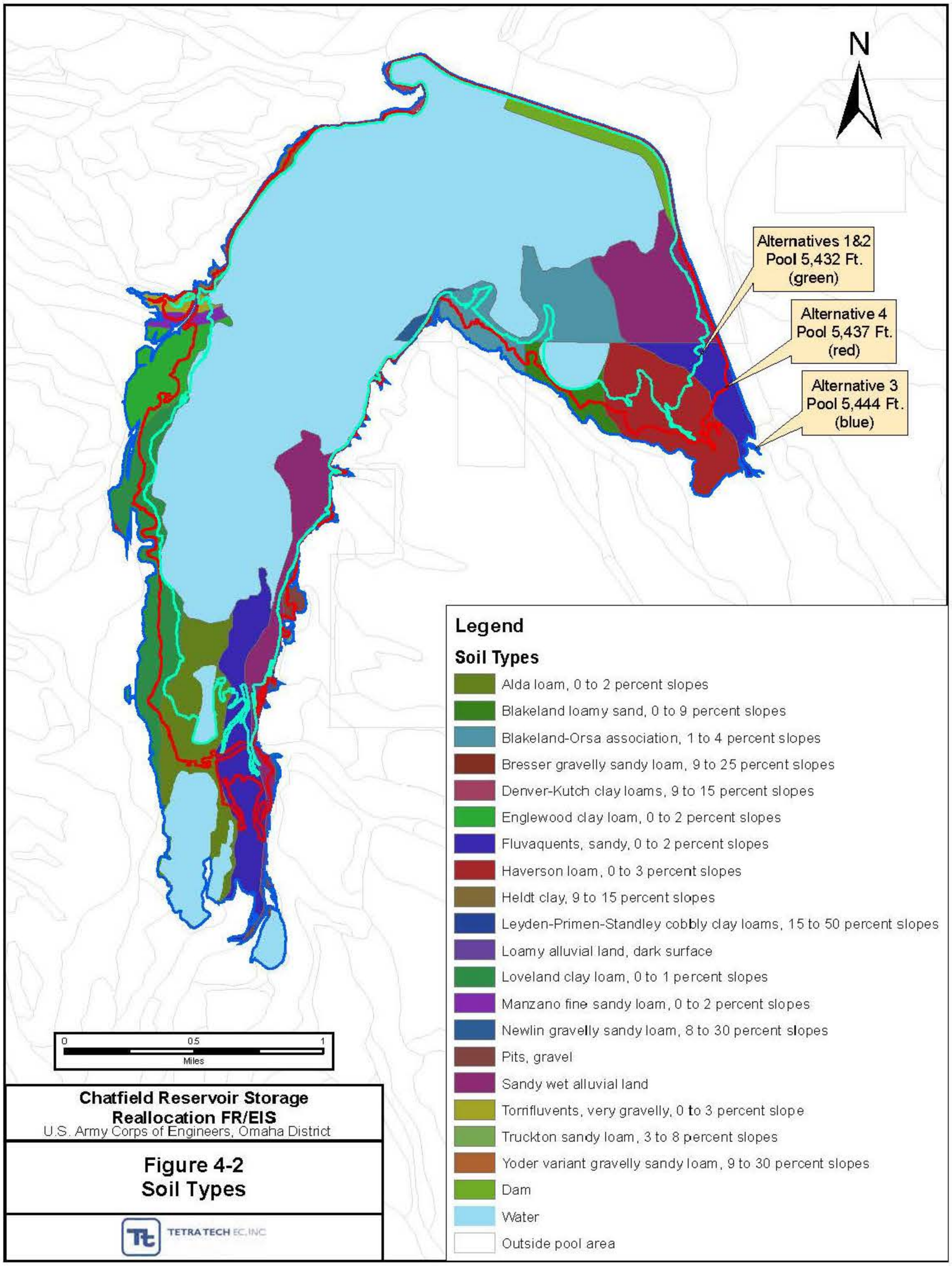
Soil Map Unit Name	Soils Inundated Under Alternative 3 (20,600 acre-feet) Area Including Water (acres)	Extent Including Water (%)	Area Excluding Water (acre)	Area Excluding Water (%)	Dominant Surface Soil Texture	Dominant Surface Erosion Factors Kw[1]	Wind Erodibility Index[2]	Dominant Hydrologic Group[3]
Alda loam, 0 to 2 percent slopes	56.0	10	56.0	11	Loam	0.24	86	C
Blakeland loamy sand, 0 to 9 percent slopes	21.9	4	21.9	4	Loamy sand	0.10	134	A
Blakeland-Orsa association, 1 to 4 percent slopes	27.2	5	27.2	5	Sandy loam	0.20	86	A
Bresser gravelly sandy loam, 9 to 25 percent slopes	2.4	<1	2.4	0	Gravelly sandy loam	0.15	86	A
Denver-Kutch clay loams, 9 to 15 percent slopes	6.0	1	6.0	1	Clay loam	0.17	48	C
Englewood clay loam, 0 to 2 percent slopes	48.2	8	48.2	10	Clay loam	0.17	48	C
Fluvaquents, sandy, 0 to 2 percent slopes	90.5	15	90.5	18	Gravelly sandy loam	0.15	86	D
Haverson loam, 0 to 3 percent slopes	73.3	12	73.3	14	Loam	0.28	86	B
Heldt clay, 9 to 15 percent slopes	12.2	2	12.2	2	Clay	0.17	86	C
Leyden-Primen-Standley cobbly clay loams, 15 to 50 percent slopes	2.2	<1	2.2	0	Cobbly clay loam	0.10	48	C
Loamy alluvial land, dark surface	0.1	<1	0.1	0	Sandy loam	0.20	86	C
Loveland clay loam, 0 to 1 percent slopes	89.6	15	89.6	18	Clay loam	0.20	86	C
Manzano fine sandy loam, 0 to 2 percent slopes	7.2	1	7.2	1	Fine sandy loam	0.20	86	B
Newlin gravelly sandy loam, 8 to 30 percent slopes	9.7	2	9.7	2	Gravelly sandy loam	0.10	86	B
Sandy wet alluvial land	23.0	4	23.0	5	Coarse sand	0.15	180	D
Torrifluvents, very gravelly, 0 to 3 percent slope	9.5	2	9.5	2	Variable to 6 inches	0.05	0	A
Truckton sandy loam, 3 to 8 percent slopes	<0.1	<1	<0.1	<1	Sandy loam	0.24	86	B

Table 4-3
Soil Types, Extents, and Descriptions Within Area of Inundation Under Alternative 3

Soil Map Unit Name	Soils Inundated Under Alternative 3 (20,600 acre-feet): Area Including Water (acres)	Extent Including Water (%)	Area Excluding Water (acre)	Area Excluding Water (%)	Dominant Surface Soil Texture	Dominant Surface Erosion Factors: Kw[1]	Wind Erodibility Index[2]	Dominant Hydrologic Group[3]
Yoder variant gravelly sandy loam, 9 to 30 percent slopes	0.1	<1	0.1	0	Gravelly sandy loam	0.15	86	B
Pits, gravel	13.7	2	13.7	3	Gravel	Not applicable	Not applicable	A
Dam	13.6	2	13.6	3	Not applicable	Not applicable	Not applicable	Not applicable
Water	80.3	14	--	--	Not applicable	Not applicable	Not applicable	Not applicable
Total Including Water	586.6	100	--	--				
Total Excluding Water	--	--	506.3	100				

Sources: NRCS 1974, 1984.
[1] See Section 4.2.3 text for discussion of Kw.
[2] See Section 4.2.3 for discussion of wind erodibility index.
[3] See Section 4.2.3 for discussion of hydrologic group.

Figure 4-2
Soil Types



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4.2.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

Under this alternative, the management of the conservation pool would be changed to target 7,700 acre-feet of reallocated storage by allowing the water level to rise to as much as 5,437 feet msl. As shown in Figure 4-1 and Table 4-2, approximately 215 acres of land adjacent to the existing reservoir would become inundated at the top of the conservation pool. An additional 5,347 acre-feet (for a total average annual yield of 8,539 acre-feet, same as Alternative 3) would be obtained from NTGW and from downstream gravel pits. Under Alternative 4, gravel pits would be converted to water storage reservoirs. This would result in an approximately 143 acre footprint from gravel pit storage and 6 acres of disturbance from construction of infrastructure. Alternative 4 would not involve the construction of pumps or pipelines to transport water from Chatfield Reservoir. However, there would be land disturbance from construction for relocation of recreation facilities and roads. The impacts on geology and soils related to the use of downstream gravel pits would be less than those described under Alternative 1. Under Alternative 4, the remaining water storage would be obtained from NTGW. Those impacts are described under Alternative 2.

Under this alternative the Chatfield Reservoir level would fluctuate less than under Alternative 3. Although smaller than under Alternative 3, portions of the shoreline that would be commonly under water under Alternative 4, and therefore have little stabilizing vegetative cover, would be exposed to erosion by wind and water. Similar to Alternative 3, silt and fine sediments would likely accumulate in inundated areas. As the waterline receded, these fine sediments would be susceptible to erosion by wind and water. This alternative would involve a smaller inundated area and fewer fluctuations in water levels than Alternative 3.

Changes in the potential for mass wasting would not be expected under Alternative 4 because of the relatively gentle slopes immediately surrounding Chatfield Reservoir. Like Alternative 3, construction of a new reservoir would not be required under Alternative 4, which would translate into a lower likelihood for soil compaction or irretrievable soil commitment than under Alternative 1. The soil map units that would be inundated when the target pool reached 5,437 feet msl, according to NRCS soil mapping, are shown in Table 4-4 and on Figure 4-2. Relevant soil characteristics are presented for each unit. Acres are summed for the total inundated area (referred to as the total including water) and for the inundated area not including water mapped by NRCS (referred to as the total excluding water).

Of the additional acres that would be inundated under Alternative 4 (215 acres), approximately 6 percent (13 acres) are characterized as gravel pits, dam, or water by the NRCS. These soil map units would not be impacted by the proposed changes in operations. Of the remaining 94 percent that would be inundated, soil textures range from fine to coarse loams with Kw factors between 0.05 and 0.28. The area-weighted average Kw factor for the soils listed in Table 4-4 is 0.19. These Kw factors reflect a relatively low potential for surface soil erosion by water under Alternative 4. The impacts to surface soil erosion by water are insignificant. However, this does not apply to shoreline erosion.

Wind erodibility indices range from 0 to 180 in the area affected by Alternative 4. The weighted average wind erodibility index for the soils listed in the Table 4-4 is 90. These indices reflect a relatively low potential for surface soil erosion by wind under Alternative 4. For most soils at the Chatfield project, the impacts to surface soil erosion by wind are insignificant. The two soils rated with the highest wind erodibility indices, 134 and 180, represent a total of 11 percent of the additional inundated area. If vegetation were removed during periodic inundation, these areas could be considered at moderate to moderately high risk for wind erosion. These areas are outside the pool level under Alternative 1 and would therefore not be inundated under the No Action Alternative.

Under Alternative 4, the hydrologic group with the greatest extent (36 percent) that is mapped in the additional inundated area is soil hydrologic group C, soils with a high runoff rate. Approximately 14 percent is mapped with a soil hydrologic group of A, 20 percent is B, and 25 percent is D. The remaining 5 percent consists of the dam and mapped water and is not classified. The soils that would be inundated when the pool reached 5,437 feet would have a relatively high potential for runoff. Because these soils are not highly erodible (as explained in the previous paragraphs), the soils themselves would not likely erode. However, if fine sediments were deposited as water levels subsided, these materials would be relatively likely to be eroded by rainfall and transported back into the reservoir. The net impacts to soil erosion based on the soil hydrologic classifications are insignificant. However, this does not apply to shoreline erosion.

Under Alternative 4, prime and unique farmland within the study area and surrounding watershed would not change significantly. No irrigated land would be converted to dryland agriculture for the downstream gravel pits. As described under Alternative 3, no immediate dam safety concerns have been identified under Alternative 4, considering static loading (Appendix A). Under Alternative 4, Chatfield Dam would be subject to elevated dam safety monitoring and evaluation. Water supply storage could be reduced by Interim Risk Reduction Measures (IRRM) or other remediation if deemed necessary by USACE.

4.2.5 Reduction of Potential Impacts

Potential impacts to soil resources from ground disturbing activities can be avoided or minimized through implementation of BMPs. For example, avoiding disturbances while soils are wet, stockpiling topsoil, and reseeding disturbed areas following construction would reduce both the magnitude and duration of potential impacts to soil resources. The CDPHE offers more detailed examples of appropriate BMPs for construction activities in the Stormwater Management Plan Preparation Guidance document (CDPHE, 2008b).

4.3 Hydrology

This section discusses the impacts of implementing the alternatives on the hydrological conditions of Chatfield Reservoir and the South Platte River downstream of the reservoir (Figure 1-2). Chapter 2 describes the alternatives in detail, including the water supply management strategies that would be implemented under each alternative. Under any of the alternatives, when flows enter the reservoir, the first commitment would be to meet senior water rights needs. Once those needs were met, any excess flow would be retained in the available storage of the reservoir (below the maximum elevation of the pool containing conservation storage). After the water levels reached the base elevation of the exclusive flood control pool, any excess flows would be released downstream. Identified hydrological issues include the quantity and quality of surface water, as well as the control of floodwaters. The impacts of the alternatives on water quality are discussed in Section 4.4; the impacts on flooding are discussed in Section 4.15. The following sections describe the potential impacts of the proposed alternatives on hydrology. Appendices H and I include additional information on USACE hydrology and hydraulics modeling, respectively.

Table 4-4
Soil Types, Extents, and Descriptions Within Area of Inundation Under Alternative 4

Soil Map Unit Name	Soils Inundated Under Alternative 4 (7,700 acre-feet) Area Including Water (acre)	Extent Including Water (%)	Area Excluding Water (acre)	Extent Excluding Water (%)	Dominant Surface Erosion Factors Dominant Surface Soil Texture	Kw[1]	Wind Erodibility Index[2]	Dominant Hydrologic Group[3]
Alda loam, 0 to 2 percent slopes	23.5	11	23.5	11	Loam	0.24	86	C
Blakeland loamy sand, 0 to 9 percent slopes	8.6	4	8.6	4	Loamy sand	0.10	134	A
Blakeland-Orsa association, 1 to 4 percent slopes	12.5	6	12.5	6	Sandy loam	0.20	86	A
Bresser gravelly sandy loam, 9 to 25 percent slopes	0.8	<1	0.8	0	Gravelly sandy loam	0.15	86	A
Denver-Kutch clay loams, 9 to 15 percent slopes	1.1	1	1.1	1	Clay loam	0.17	48	C
Englewood clay loam, 0 to 2 percent slopes	11.8	5	11.8	6	Clay loam	0.17	48	C
Fluvaquents, sandy, 0 to 2 percent slopes	38.0	18	38.0	18	Gravelly sandy loam	0.15	86	D
Haverson loam, 0 to 3 percent slopes	35.4	17	35.4	17	Loam	0.28	86	B
Heldt clay, 9 to 15 percent slopes	5.8	3	5.8	3	Clay	0.17	86	C
Leyden-Primen-Standley cobbly clay loams, 15 to 50 percent slopes	0.9	<1	0.9	0	Cobbly clay loam	0.10	48	C
Loveland clay loam, 0 to 1 percent slopes	34.9	16	34.9	17	Clay loam	0.20	86	C
Manzano fine sandy loam, 0 to 2 percent slopes	3.7	2	3.7	2	Fine sandy loam	0.20	86	B
Newlin gravelly sandy loam, 8 to 30 percent slopes	3.7	2	3.7	2	Gravelly sandy loam	0.10	86	B
Sandy wet alluvial land	15.6	7	15.6	7	Coarse sand	0.15	180	D
Torrifluvents, very gravelly, 0 to 3 percent slope	5.5	3	5.5	3	Variable to 6 inches	0.05	0	A
Pits, gravel	3.0	1	3.0	1	Gravel	Not applicable	Not applicable	A
Dam	4.8	2	4.8	2	Not applicable	Not applicable	Not applicable	Not applicable
Water	5.0	2	--	--	Not applicable	Not applicable	Not applicable	Not applicable
Total Including Water	214.5	100	--	--				
Total Excluding Water	--	--	209.5	100				

Sources: NRCS 1974, 1984.
1 See Section 4.2.4 text for discussion of Kw.
2 See Section 4.2.4 for discussion of wind erodibility index.
3 See Section 4.2.4 for discussion of hydrologic group.

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To examine the potential hydrologic impacts of Alternatives 1, 3, and 4, historical (1942 to 2000) data from South Platte River stream gages and Chatfield Reservoir operations (beginning after the reservoir was constructed) were entered into a Corps reservoir simulation computer model (HEC-5). The hydrologic modeling of Chatfield Reservoir under Alternative 1 also represents the reservoir levels and fluctuations that would be expected under Alternative 2. A detailed description of the modeling efforts, including the model assumptions, is included in Appendices H and I. The model output describes the daily pool elevation, inflow, and outflow for Chatfield Reservoir over the POR under each of the three alternatives. In summary, this study used historical flow data over the POR, which will reflect any impacts to the river flows over time, including changes in available water rights, water supply needs, timing of runoff, or additional reservoirs constructed upstream. Since this study used historical flow data with no corrections for present day conditions, there is a tendency for the model to overestimate the water available for the potential new water supply in Chatfield. Because of this tendency, the average pool levels reflected in the reallocation alternatives would likely be lower than what is shown in the tables and on the graphs in this chapter. Thus the results of the impact analysis based on the modeled reservoir pools under the reallocation alternatives will tend to show somewhat greater impacts than would likely be experienced in an actual reallocation scenario, but will provide a good basis for relative comparison between alternatives.

Although the historical data represent a wide range of possible future flow conditions, it is possible that future flows may include periods of wet or dry conditions that are outside the range observed in the historical record, particularly as a result of climate change and increased hydrologic variability. As described in greater detail in Section 4.19, with climate change the southwestern United States is likely to experience precipitation and evapotranspiration changes that result in less runoff and water availability (Brekke et al., 2009; Ray et al., 2008). Additional research is needed to quantify the uncertainty in current estimates to better understand the risks of current and future water resource management decisions. The uncertainties include the actual uncertainty in the climate response as well as the uncertainty caused by differences in methodological approaches and model biases. In an attempt to address this need, a group of Front Range water agencies collaborated to complete the Joint Front Range Climate Change Vulnerability Study (Water Research Foundation, 2012 available at http://cwcb.state.co.us/environment/climatechange/Pages/JointFrontRangeClimateChangeVulnerabilityStudy.aspx. This study examines the effects of climate change scenarios on several watersheds, including the South Platte. The central objective was to assess potential changes in the timing and volume of hydrologic runoff for the years 2040 and 2070 as compared with 1950-1999. Two hydrologic models were calibrated and implemented, and modeled streamflows were compared to historic streamflows to estimate the sensitivity of water supplies to climate change. The study considered a pool of 112 general circulation models (GCMs), which show broad variability in projected future temperature and precipitation for the North-Central region of Colorado. Five GCM projections for each future period (2040 and 2070) were selected and used for hydrologic simulations. These projections were selected to represent the general range in projections and are described broadly as “Warm & Wet”, “Hot & Wet,” “Median,” “Warm & Dry,” and “Hot & Dry.” Though all 10 projections showed warming, the average annual temperature changes ranged from just over 1^0 to nearly 6^0 Fahrenheit (F) for the 2040 time period and from about 2^0 to nearly 10^0 F for the 2070 time period. The average annual percent change in precipitation ranged from -15 percent to +17 percent for the 2040 time period and from -18 percent to +28 percent for the 2070 time period. Likewise, hydrologic responses simulated from the selected GCM projections vary significantly. For example, average annual change in streamflow volume for the South Platte below Henderson ranges from +33 percent (under the Warm & Wet scenario) to -35 percent (under the Hot & Dry scenario) for the 2040 period. Analysis of the change in timing for the 10 scenarios indicates that the annual runoff could arrive 1 to 14 days earlier in the 2040 simulations and 7 to 17 days earlier in the 2070 simulations. These ranges result from the differing average annual changes in temperature and precipitation, from the difference in the monthly distribution of those changes in each projection, and from differences in the spatial distribution of the changes. Although the results indicate both increases and decreases in annual streamflow volume, more of the 10 selected climate projections resulted in decreases rather than increases. When decreased annual streamflow volume is indicated for a given projection, it is a result of the computed increase in evapotranspiration due to increased temperatures, coupled with either a decrease in precipitation or else a small increase in precipitation that is insufficient to offset the increased temperature effect. (The GCMs do not model changes in wind speed, solar radiation, relative humidity, or other factors beyond temperature that also affect evapotranspiration rates.) Drier basins, including portions of the South Platte, experience larger percent reductions in streamflows due to warmer conditions, while wetter basins, including the upper areas of Colorado, show smaller percent reductions. Although the study results indicate broad variability and uncertainty about future streamflows in the South Platte, they suggest that reduced future streamflow volumes are possible above and below Chatfield Reservoir in the future as a result of climate change.

To interpret the behavior of reservoir water levels and downstream flows under the alternatives, outputs from the HEC-5 model (described in Appendix H) were imported into a statistical analysis software package (Minitab®) and analyzed, as appropriate, for each resource in this FR/EIS. The statistical results and plots generated in Minitab® are used in the following subsections to demonstrate the differences in the quantity of water stored in Chatfield Reservoir and released to the South Platte River between alternatives.

Chatfield Reservoir inflows used in the computer model are identical under all of the alternatives. Waters in the South Platte River upstream of Chatfield Reservoir consist primarily of snowmelt, which generally occurs in spring and early summer, as shown in Figure 4-3, and (to a lesser extent) stormwater. Mean flow for the entire POR is 231 cfs. A flow duration curve (Figure 4-4) illustrates that flows entering Chatfield Reservoir, which are affected by streamflow regulation at Antero, Spinney Mountain, Eleven Mile, Cheesman, and Strontia Springs Reservoirs, are sustained throughout the year. These base flows allow Chatfield Reservoir operators to minimize potential adverse impacts on the reservoir caused by rapid spring runoff or large storm events. Flows greater than approximately 500 cfs occur less than 10 percent of the time in the POR. Inflows could fluctuate depending on future conditions, but would not be affected by the activities proposed under any of the alternatives.

Summary of Impacts on Flood Control Benefits

The evaluation of impacts of reallocation on flood control benefits included evaluation of impacts at Chatfield Reservoir, as well as impacts at Bear Creek Reservoir and Cherry Creek Reservoir, and on the South Platte River from Chatfield Reservoir to Julesburg, Colorado. This analysis is described in Appendix H, USACE Hydrology Report: Chatfield Dam and Reservoir. Impacts on flood control benefits were evaluated through use of a hydrologic model to simulate the operations at Chatfield Reservoir, Cherry Creek, and Bear Creek Reservoirs for the historical period of record. Because the

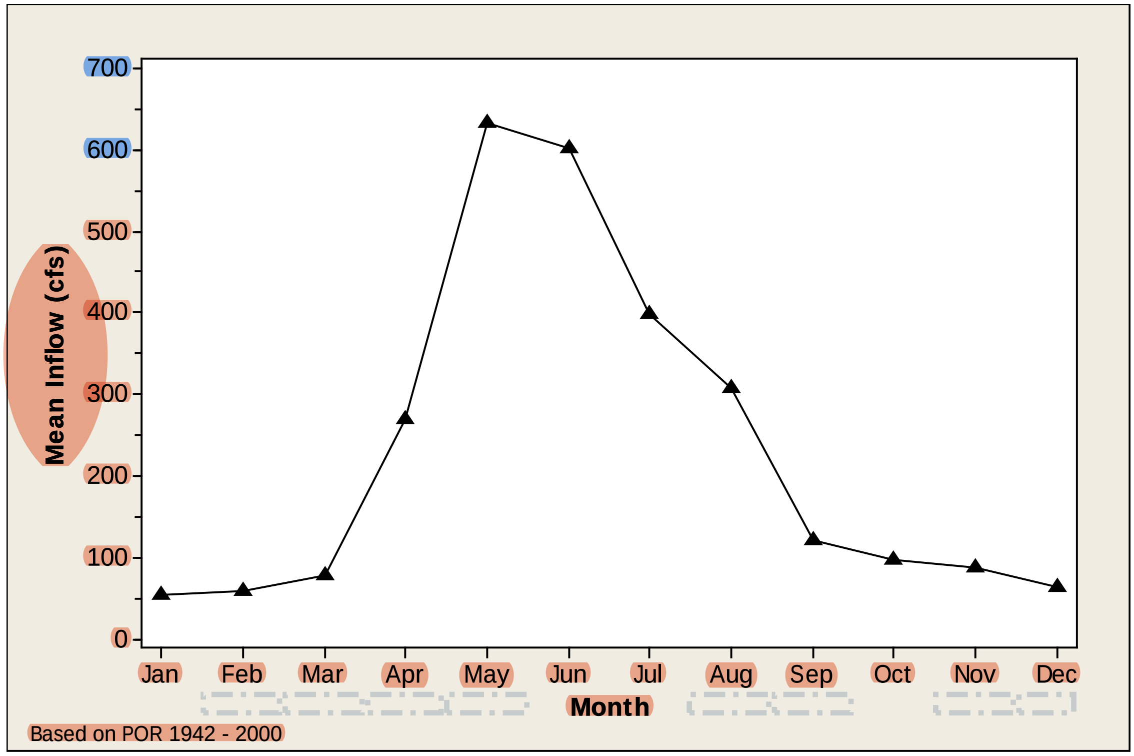


Figure 4-3
Mean Monthly Inflow to Chatfield Reservoir

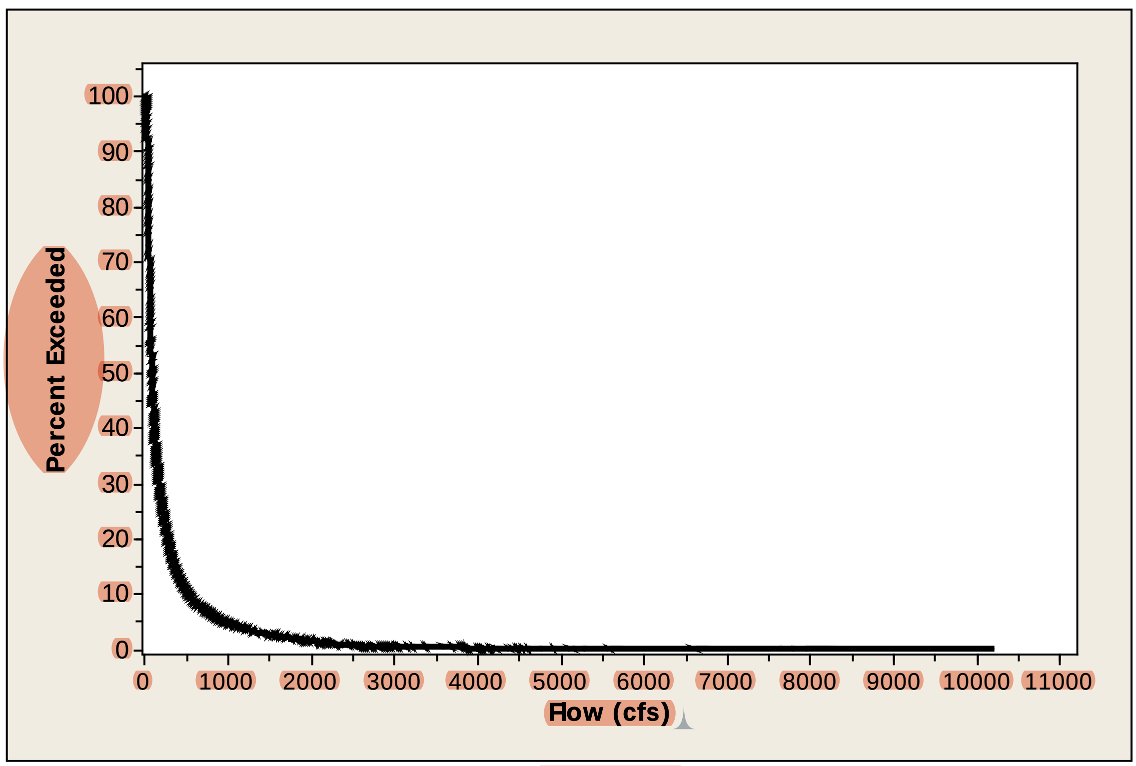


Figure 4-4
Daily Inflows to Chatfield Reservoir over the POR

Note: The flow duration curve was created by ranking all the daily mean stream flows for the POR in order of magnitude then computing the percentage of time each flow volume is equaled or exceeded.

period of record does not include extremely large flood events, the impacts of reallocation on the Reservoir Design Flood (RDF) and Inflow Design Flood (IDF) were also evaluated.

At Chatfield Reservoir, for peak pool probabilities, the 100-year pool elevation is 5465.5 feet msl for the base condition, and increasing the top of conservation pool to 5444 feet msl resulted in a 100-year pool of 5474.3 feet msl, or an increase of 8.8 feet when compared to the base condition. For release flow probabilities at Chatfield Reservoir, the base condition and the with-reallocation condition are nearly identical. The with-reallocation condition had slightly lower outflow values for the 10-year return periods. The 50-, 100-, and 500-year Chatfield outflows are all 5,000 cfs for both the base condition and with reallocation. This is due to the releases being constrained to a maximum allowable outflow of 5,000 cfs until the pool reaches the uncontrolled spillway crest. Table 4-5 shows the flow probability relationship for baseline and with-reallocation conditions at Chatfield, Cherry Creek, and Bear Creek Reservoirs and at selected locations along the South Platte River downstream of Chatfield Reservoir.

Table 4-5
Peak Discharge Probability - South Platte River Basin, Colorado
Comparison of Baseline and With-Reallocation Conditions

Location	Chatfield Conservation Pool (feet msl)	Peak Discharge Probabilities (cfs)				
		2-Year	10-Year	50-Year	100-Year	500-Year
Chatfield Releases	5432	950	4,300	5,000	5,000	5,000
	5437	950	3,800	5,000	5,000	5,000
	5444	950	4,000	5,000	5,000	5,000
Bear Creek Releases	5432	230	790	1,750	2,000	2,000
	5437	230	790	1,750	2,000	2,000
	5444	230	790	1,750	2,000	2,000
Cherry Creek Releases	5432	150	1,250	5,000	5,000	5,000
	5437	150	1,250	5,000	5,000	5,000
	5444	150	1,250	4,100	5,000	5,000
Denver	5432	9,800	16,200	21,900	24,300	30,100
	5437	9,700	16,100	21,900	24,300	30,300
	5444	9,700	16,200	22,000	24,500	30,600
Henderson	5432	11,600	21,800	31,900	36,500	47,900
	5437	11,500	21,700	31,800	36,400	47,800
	5444	11,500	21,800	32,100	36,800	48,600
Kersey	5432	11,200	21,800	32,600	37,500	50,000
	5437	11,200	21,700	32,400	37,400	49,800
	5444	11,100	21,700	32,400	37,300	49,800
Julesburg	5432	6,800	18,600	34,200	42,400	65,500
	5437	6,700	18,500	34,100	42,200	65,300
	5444	6,700	18,400	33,800	41,900	64,800

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.

For extremely large floods, an evaluation was made of the impacts of reallocation on the RDF and the IDF. More detailed information about these evaluations is contained in Appendix R, Antecedent Flood Study. The RDF is the size of flood a reservoir is designed to store with releases that are within the downstream channel capacity, and this flood normally produces a reservoir pool elevation near the spillway crest. At Chatfield Reservoir the original design storage for the RDF was based on releasing no water for five days after the heaviest portion of the rainfall, then initiating a release of 500 cfs and increasing releases of 500 cfs a day until a release of 5,000 cfs was achieved. With reallocation, the maximum pool elevation during the RDF does not stay below the spillway crest when using the original design criteria of a 5-day shutdown period with a 500 cfs per day stepped-release. Alternative design criteria for reservoir operations were evaluated that included: a) a shutdown period adjusted to three days while the stepped-release remained 500 cfs per day, and b) a shutdown period at five days and increased the stepped-release to 1,300 cfs per day. Both alternatives are considered acceptable design assumptions and during the RDF both resulted in a maximum pool elevation below the spillway crest. If storage reallocation is implemented, during flood control operations the primary consideration in determining reservoir releases will continue to be keeping releases as large as possible up to the 5,000 cfs target at the Denver gage on the South Platte River. However, consideration will also be given to the design assumptions for shutdown period and rate of stepping up releases. This will ensure adequate capacity for the Chatfield Reservoir to control the RDF without uncontrolled spillway releases and not compromising flood control benefits downstream.

The IDF (or Spillway Design Flood) is used to determine the size of the spillway and height of the dam embankment. Corps of Engineers regulations for routing the IDF requires consideration of an antecedent flood of a magnitude of 50 percent of the IDF assumed to occur five days prior to the occurrence of the IDF. For Chatfield Dam, the IDF is based on the Probable Maximum Precipitation (PMP) occurring over the upstream watershed. A statistical analysis of streamflow and meteorological data was conducted to determine if the 50 percent criterion was appropriate or if some other value would be more appropriate for use in the Chatfield IDF routings (Appendix R). Based upon this analysis, approval was obtained from HQUSACE to use an antecedent flood of 40 percent of the PMF instead of the traditional 50 percent. With the proposed reallocation, and use of an antecedent flood of 40 percent of the PMF, the resulting maximum pool elevation in the reservoir was 5520.9 feet msl, as compared to the original maximum pool elevation of 5521.6 feet msl.

A hydraulic analysis was conducted to develop water surface profiles to be used in the evaluation of impacts of reallocation on downstream flood stages. More detailed information about this evaluation is contained in Appendix I, USACE Hydraulic Analysis. The basis for the information used in this analysis was a HEC-RAS hydraulic model of the South Platte River from the Chatfield Reservoir to the Colorado-Nebraska state line, Cherry Creek from the Cherry Creek Reservoir to the confluence with the South Platte River and Bear Creek from the Bear Creek Reservoir to the confluence with the South Platte River. Utilizing this model, water surface profiles for the baseline and with reallocation conditions were calculated for the 2-, 10-, 50-, 100- and 500-year flood events using flow values from the above Table 4-5. The following Table 4-6 shows a comparison of average water surface elevations for the baseline and reallocation conditions. As shown on Table 4-6, in most cases there was no increase in average water surface elevations due to reallocation, and the maximum average difference in water surface elevations was 0.1 feet. These differences are considered negligible and would not warrant any changes to existing flood frequency criteria used for flood plain regulation.

Table 4-6
Water Surface Profiles - South Platte River Basin, Colorado
Comparison of Baseline and With-Reallocation Conditions

Location	Chatfield Conservation Pool (feet msl)	Average Difference in Water Surface Elev. (feet)				
		2-Year	10-Year	50-Year	100-Year	500-Year
Bear Creek	5437	0.0	0.0	0.0	0.0	0.0
	5444	0.0	0.0	0.0	0.0	0.0
Cherry Creek	5437	0.0	0.1	0.0	0.0	0.0
	5444	0.0	0.1	0.0	0.0	0.1
South Platte River	5437	0.0	-0.1	0.0	0.0	0.0
	5444	0.0	0.0	0.0	0.0	0.1

4.3.1 Alternative 1—No Action

Under Alternative 1, flood storage space within Chatfield Reservoir would not be reallocated to conservation storage, and the operation of the reservoir would remain the same. (Refer to Chapter 2 for a description of current operations.) The impact on hydrology under Alternative 1 would be to develop surface water resources to meet the future water demands that would otherwise be met by Chatfield. The specific approach considered under Alternative 1 to meet the water demand would involve construction of Penley Reservoir and associated pipelines, as well as conversion of downstream gravel pits into water storage reservoirs.

Operations of the reservoir would not change under Alternative 1. Like the other alternatives, when flows enter the reservoir, the first commitment would be to meet senior water rights needs. Once those needs were met, any excess flow would be retained in the available storage of the reservoir (below the maximum elevation of the pool containing conservation storage). After the water levels reached the base elevation of the exclusive flood control pool, any excess flows would be released downstream. The maximum elevations of the pool containing conservation storage would be lower under Alternative 1 (5,432 feet msl) than under Alternative 3 (5,444 feet msl) or Alternative 4 (5,437 feet msl). As a result, water levels would be more likely to reach the maximum elevation of the conservation pool under Alternative 1 than under the reallocation alternatives. During low flows, the pool levels could drop below 5,432 feet msl under each alternative. During most of the year (outside of low flows), more water would be released downstream under Alternative 1 than the reallocation alternatives because the pool level would reach 5,432 feet msl before 5,437 or 5,444 feet msl. Under Alternatives 3 and 4, water would continue to be stored in the conservation pool until the target pool elevations were reached.

Based on the output from the HEC-5 model, the mean annual outflow from the reservoir into the South Platte River would range from approximately 56.2 to 780.4 cfs under Alternative 1, compared to the slightly lower mean annual ranges under Alternative 3 (54.2 to 759.3 cfs) or under Alternative 4 (55.4 to 772.5 cfs), which reflect storage of some flows in Chatfield Reservoir. Figure 4-5 shows the mean annual outflow for each alternative, and Figure 4-6 shows monthly outflows. The magnitude of difference between mean annual outflows under Alternative 1 and under the reallocation alternatives is greatest in the wettest water years, when the most water is available to store or release downstream. Higher flows in the South Platte River downstream of Chatfield Reservoir under Alternative 1 would typically occur in the months of May and June because of increased flow into the reservoir and greater potential for some inflows to be stored under Alternatives 3 and 4 rather than released as outflows during spring runoff events (Figures 4-7 and 4-8). Still, the magnitude of difference in downstream flows between the alternatives would be insignificant, which reflects storage of some flows in Chatfield Reservoir. Section 4.15 and Appendix I disclose the effects of hydrology on downstream flooding.

No new inflows would be added to the reservoir under any of the alternatives. Outflows from Chatfield Reservoir consist of both water rights releases and flood control releases. Water rights releases are made pursuant to a directive from the State Engineer's office to satisfy a call by those whose water rights are in priority. Flood control releases are made in accordance with the Corps' Water Control Plan. While more water rights releases would occur under Alternatives 3 and 4 than under Alternative 1, the amounts would be relatively small compared to the excess (flood) flows that would be released more regularly under Alternative 1. Furthermore, the extra stored water in these alternatives would result in a pool with a larger surface area, which would be subject to greater evaporation. Also, not all of the water rights flows provided under the reallocation alternatives would be released downstream; some of the flows that would have been released downstream under Alternative 1 would be diverted directly from the reservoir (upstream of the reservoir outlet). However, because more water would be stored under Alternatives 3 and 4 and some of that water would be released downstream later in the year than under Alternative 1, average outflows would be slightly greater under the reallocation alternatives during some months (such as July), which is an insignificant beneficial effect, and less during other months.

The most notable hydrologic difference between alternatives would be the magnitude of pool level fluctuations that could occur. Based on the HEC-5 model, the pool elevation would fluctuate the least (9 feet) under Alternative 1 compared to the reallocation alternatives, from the historical low elevation of 5,423 feet msl to the maximum conservation pool elevation of 5,432 feet msl. The maximum conservation pool elevation (5,432 feet msl) would not be reached in approximately 69 percent of the days in the POR (Table 4-7). Losses of water through evaporation of the conservation pool would be the smallest under Alternative 1 compared to the reallocation alternatives because the maximum surface area of the reservoir would be the smallest.

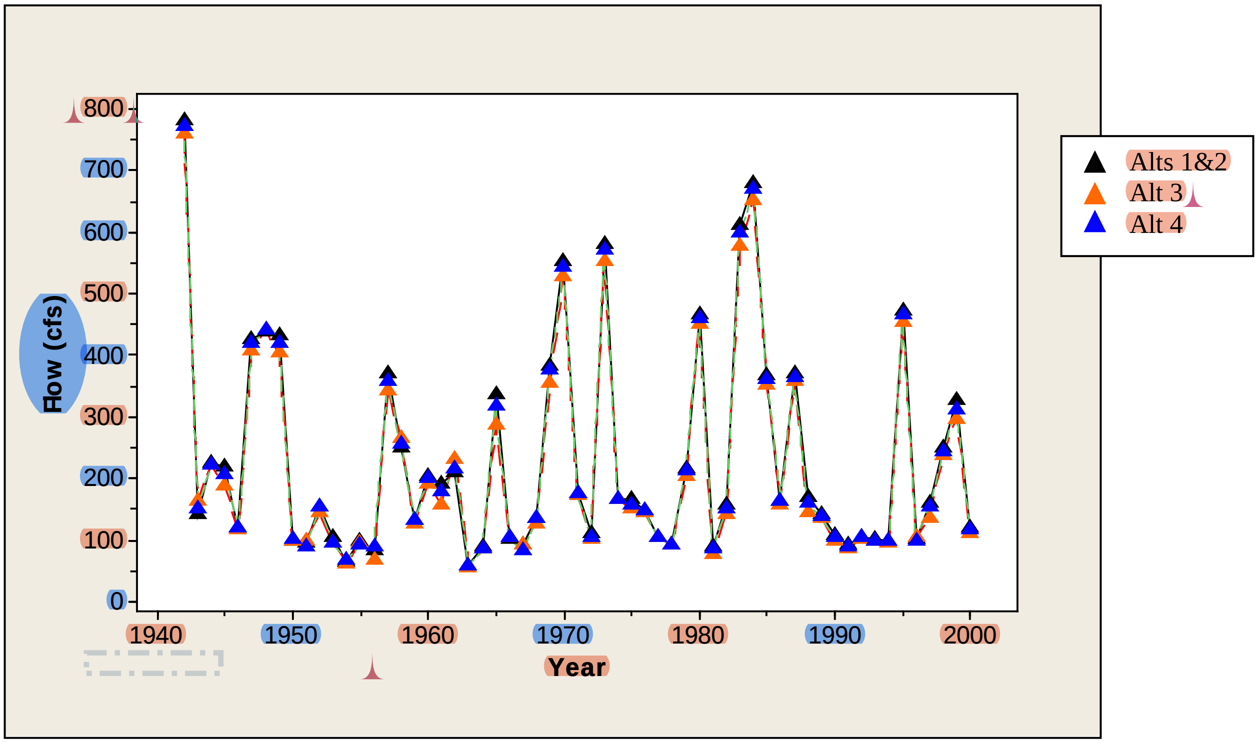


Figure 4-5
Mean Annual Outflow from Chatfield Reservoir by Alternative

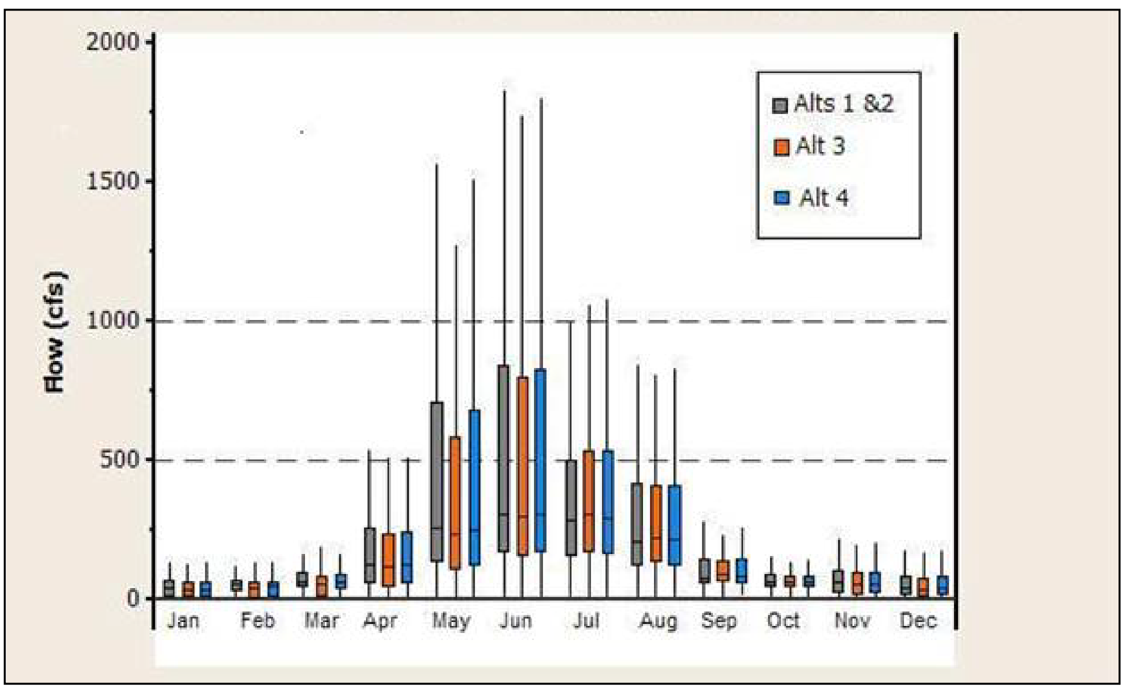


Figure 4-6
Comparison of Outflows by Month

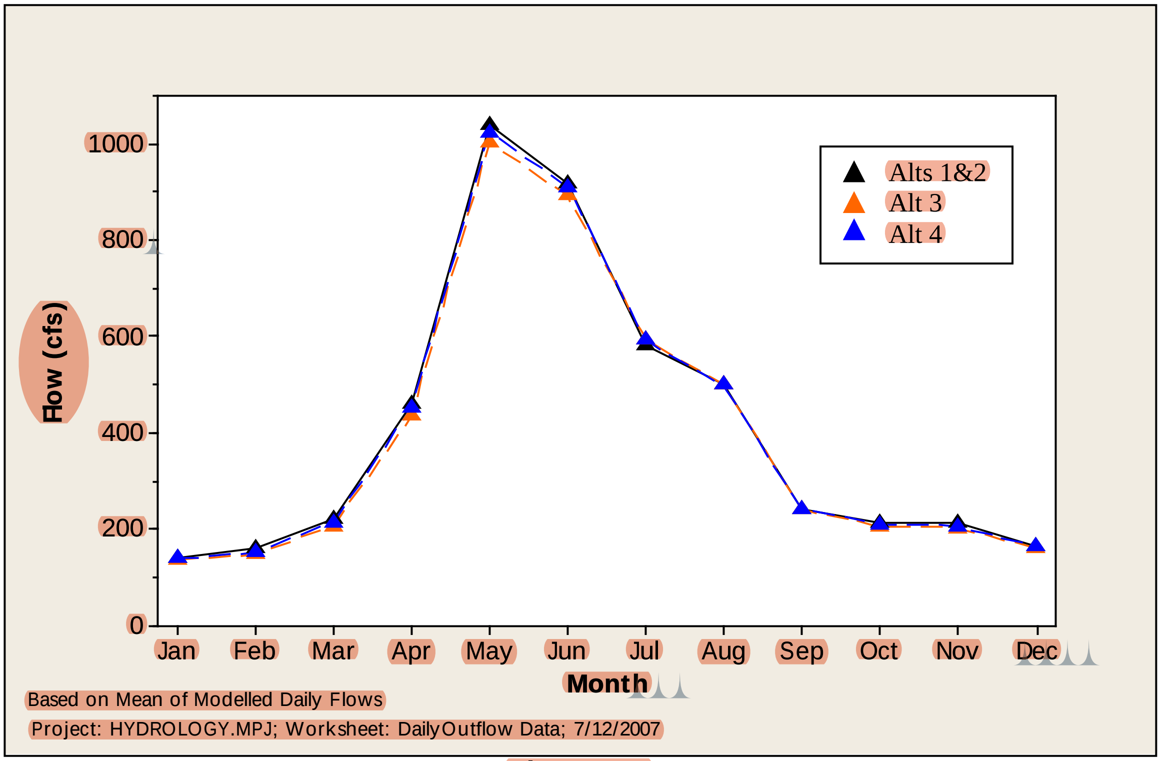


Figure 4-7
Mean Monthly Flow at the Denver Streamgage on the South Platte River

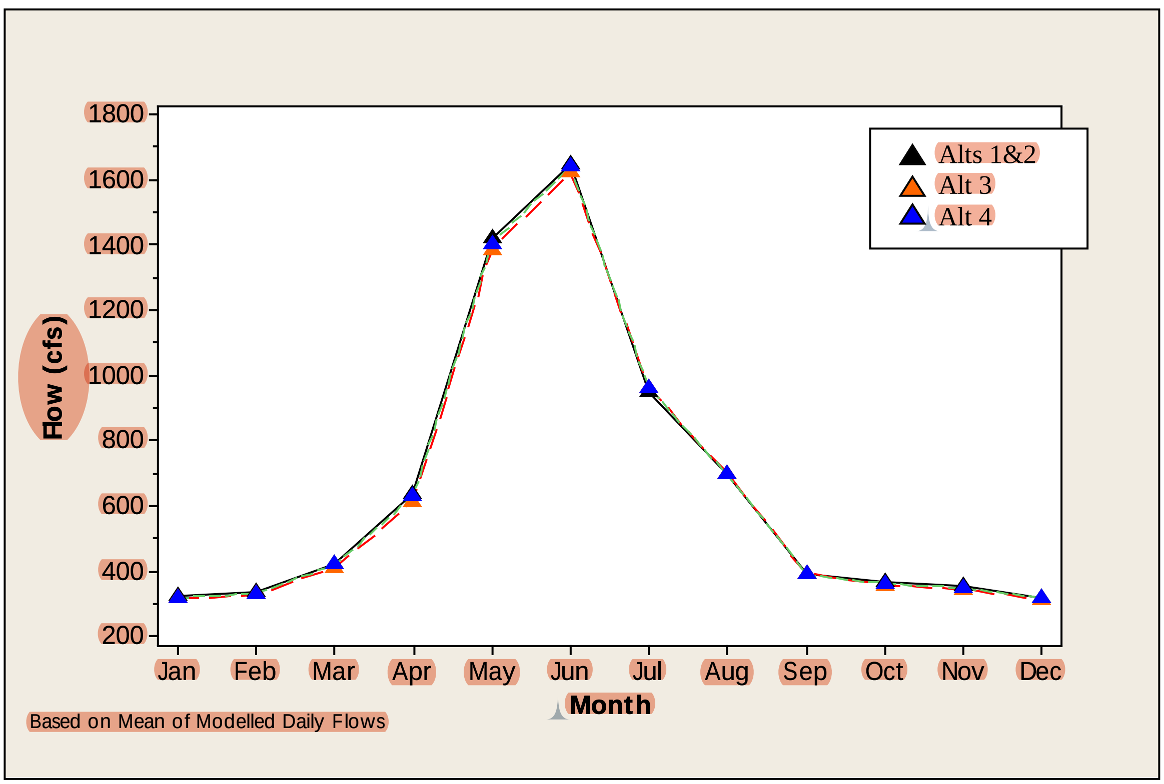


Figure 4-8
Mean Monthly Flow at the Henderson Streamgage on the South Platte River

Note: The Denver and Henderson gage locations are shown on Figure 1-2.

Table 4-7
Pool Elevation Statistics by Alternative

Parameter	Alternative 1 or 2	Alternative 3	Alternative 4
Target Pool Elevation	5,432 feet msl	5,444 feet msl	5,437 feet msl
Percent of Days in POR Below Target	69	82	75
Maximum Fall in Pool Elevation Below Target	9.0 feet	21.0 feet	14.0 feet
Difference Between Pool Elevation and Target Equaled or Exceeded in 10 Percent of Days in POR that were Below Target	7.5 feet	17.3 feet	12.0 feet
Difference Between Pool Elevation and Target Equaled or Exceeded in 50 Percent of Days in POR that were Below Target	3.0 feet	5.5 feet	3.8 feet
Difference Between Pool Elevation and Target Equaled or Exceeded in 90 Percent of Days in POR that were Below Target	0.2 feet	0.75 feet	0.3 feet

As described above, to meet the water demand under Alternative 1, upstream water providers would construct Penley Reservoir (Figure 2-1) and associated pipelines, and downstream water providers would convert gravel pits into surface water storage reservoirs. The proposed Penley Reservoir would be constructed off-channel and would therefore not inundate existing streams in the area. Inundating the off-channel site would result in 186 acres under water at Penley Reservoir.

The pipelines that would be built to transport the water from the South Platte River to the proposed Penley Reservoir would cross several perennial streams, including Indian Creek, Rainbow Creek, and Willow Creek. Several techniques are available to minimize the impact of constructing pipelines through water bodies. These are designed to maintain water flow and minimize changes in waterbody flow characteristics. For example, standard upland, cross-country construction methods can be used in intermittent streams or ditches that are dry or non-flowing at the time of construction. For flowing water bodies, several types of dry crossing techniques are possible (i.e., flume, dam and pump). The flume method typically is used to cross small to intermediate flowing water bodies that are either fish-bearing or non-fish-bearing streams. The flume technique involves diversion of stream flow into a carefully positioned pipe of suitable diameter to convey the maximum flow of the stream across the work area, and ensures that stream flow rate is not interrupted. With the dam and pump method, stream flow is diverted around the work area by pumping water through hoses over or around the construction work area. The goal of this technique is to create a relatively "dry" work area to minimize the transport of sediment and turbidity downstream of the crossing. If appropriate construction techniques were implemented, the proposed pipelines would have little impact on hydrology.

Conversion of downstream gravel pits to water storage reservoirs would involve constructing slurry walls down to bedrock around the entire circumference of the gravel pit between the pits and the South Platte River and pumping water into the gravel pits from the river. This diversion of water from the river would reduce flows slightly in the South Platte by the amount pumped from the river.

4.3.2 Alternative 2—NTGW/Downstream Gravel Pits

Under Alternative 2, water demands would be met by using NTGW and the downstream gravel pits along the South Platte River. The impacts on hydrology from converting downstream gravel pits to water storage reservoirs would be the same as those described under Alternative 1. The impacts to hydrology from relying on NTGW are described below, and focus on overall demand of the entire Denver Metro area. It should be noted that the average annual yield of 8,539 acre-feet that would be achieved under the reallocation alternatives represents only a portion of the overall pressure being placed on NTGW.

As described in Chapter 2, the South Metro Water Supply Board completed a major study (the SMWSS) in December 2003 (Black & Veatch et al., 2003) analyzing the potential impacts of continuing to rely on NTGW through 2050. The information presented in the following discussion primarily comes from the SMWSS.

NTGW has been an excellent source of municipal water supply in Denver, but it is a resource that recharges at very minimal rates and is essentially a non-renewing water resource that is being mined at ever increasing rates. In south metropolitan Denver, NTGW comes from the Denver Basin, which includes (from top to bottom) the Dawson Aquifer, the Denver Aquifer, the Arapahoe Aquifer, and the Laramie-Fox Hills Aquifer. Of these, the Arapahoe Aquifer contains the greatest number of productive wells and is used extensively for municipal purposes. Water quality in this aquifer is very high and meets state and federal drinking water standards.

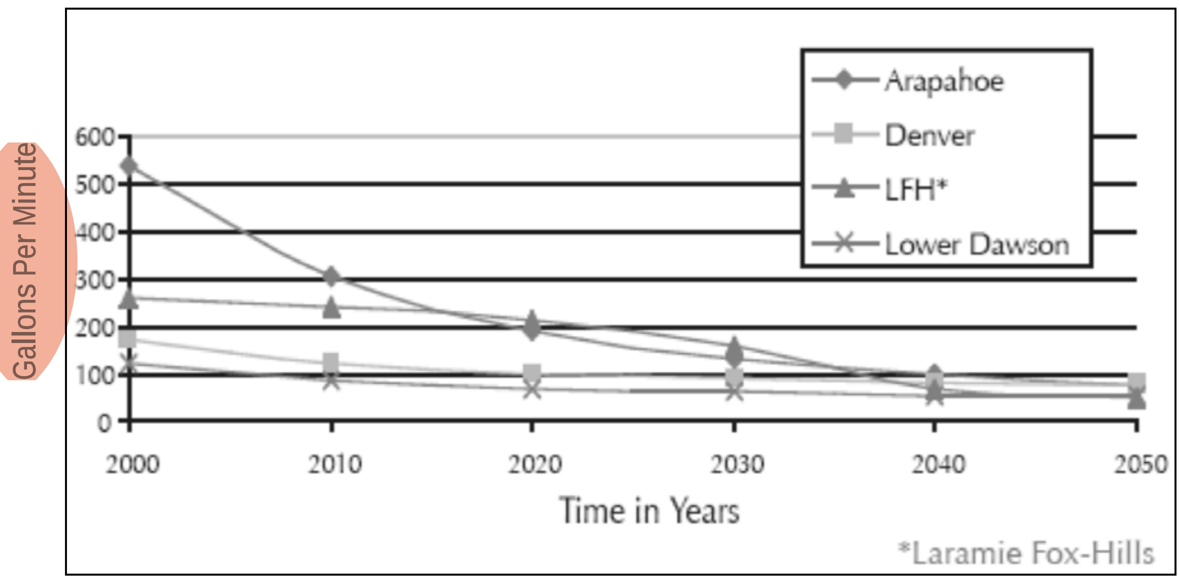
The USGS (1987) estimated that the Denver Basin aquifer system stores 467 million acre-feet of groundwater. Of that total, 257 million acre-feet are considered potentially recoverable, and of that, a smaller volume occurs within the study area. A portion of this groundwater is NTGW, which is either not directly connected to the surface water system or legally defined as NTGW. Water levels in the bedrock aquifers have been decreasing steadily since the early 1980s. Between 1995 and 2000, water levels in the Arapahoe Aquifer declined at an average rate of almost 30 feet per year in the study area. Even so, the amount of water that resides in storage in the Denver Basin bedrock aquifers is enormous. However, the geologic character of the bedrock aquifers (i.e., the hydraulic conductivity of the more permeable materials that comprise the aquifers, together with the complicating effects associated with the low-permeability interbeds within the aquifers) results in steep drawdowns immediately near pumping wells. In other words, accessing the abundant water in storage is not easy.

Falling water levels in the Denver Basin have reduced the ability to obtain NTGW by reducing the artesian pressure. The ability to pump water is directly proportional to pressure. While the water loss associated with the loss in artesian pressure is a small percentage of the total water volume in the aquifer, the loss in pressure represents a large percentage of the total pressure available to obtain water from the aquifers. As such, the problem with continued pumping of the Denver Basin bedrock aquifers is much more related to a significant drop in the rate of well production, the gallons per minute (gpm) of withdrawal, than to a scarcity in the total water stored in the aquifers. Furthermore, reasonably high pumping rates are required to meet urban water demands.

Under Alternative 2, it is assumed that NTGW would continue to be pumped from the Denver Basin bedrock aquifers to provide an average annual yield of 5,275 acre-feet, with the balance (3,248 acre-feet) of the 8,539 acre-feet of average annual yield coming from gravel pits. The SMWSS developed and peer reviewed a sophisticated model to estimate the potential impacts of an alternative similar to Alternative 2. Again, the model considered a much greater yield than Alternative 2 or the reallocation alternatives would provide. Interpreting the output of this model suggests that the volume of pumping projected to meet water demands in the south Denver Metro area would continue to dissipate the regional head from these aquifers. Aquifer levels would be drawn down over time and would not recover as annual pumping continued. Water would be pumped locally at much greater rates than could be replenished through natural recharge or from inflow from around the perimeter of the pumping area. As described previously, this situation is largely the result of the geologic characteristics of the Denver Basin aquifers, which are tight sandstones with relatively low transmissivities.

According to the SMWSS, the loss in regional head also would be compounded by the interference between nearby wells that would occur if these aquifers were pumped at the rates predicted to meet peak water demands in the Denver Metro area. The SMWSS evaluated this potential well-to-well interference with an individual well analysis, which evaluated the maximum well pumping rates and the number of additional wells that would be needed to meet water demands. The analysis predicted that 1,364 additional wells would need to be constructed to meet water demands solely with continuing use of NTGW (even during peak demands). Well-to-well interference could reduce water levels by 100 to 300 feet. Under this scenario, pumping rates would also decrease, as shown in Figure 4-9.

Figure 4-9
Average Pumping Rates by Aquifer under Simulation of Continuing to Use NTGW to Meet Increased Water Demands



Efficient well production combined with good water quality makes the Arapahoe Aquifer the most desirable of the Denver Basin aquifers for municipal water supply (Colorado Foundation for Water Education, 2007). As a consequence, its water levels are dropping the fastest, particularly in the south Denver Metro area. The combined effect of the drop in regional water levels and the well-to-well interference could result in a loss of production in the Arapahoe Aquifer of as much as 85 percent by 2050. In 2003, the maximum Arapahoe Aquifer pumping rates in the study area ranged from 500 to 600 gpm. Under Alternative 2, the regional trend is that the pumping rate in a typical well could drop to 300 gpm by 2010, and to 80 gpm by 2050. By 2050, a well producing 100 gpm would be considered successful in terms of production. However, at that rate the well would be uneconomical for municipal use. Because 80 gpm is an average rate, some wells could be pumping more than 100 gpm. Uneconomic wells would be replaced by additional wells at new locations, which is accounted for in the cost estimates related to Alternative 2. Results in the other three aquifers show the same significant regional declines in production as these aquifers are used to meet increasing production.

The SMWSS also modeled the costs of continued reliance on NTGW at the exclusion of other potential water sources and concluded that this approach would result in very large increases in production costs in the foreseeable future, and the eventual loss of NTGW as an economically-viable resource. Continued increases in pumping would severely affect well production rates over the next 20 years, and costs of facilities would be several times the current costs. Under Alternative 2 pumping would become increasingly expensive in the foreseeable future and would be economically unsustainable in the long term if continued use of NTGW was not supplemented with surface supplies. Although the reallocation alternatives would only provide a small portion of water to help meet the overall demand, this portion would be considered an important piece to reduce reliance on NTGW.

The SMWSS predicted that without any storage to meet peak demands, 1,364 additional wells would be required to meet demands by 2050. Well construction and infrastructure are very costly and these wells represent huge increases in required capital facilities costs. To maintain existing production rates new wells will need to be drilled on an increasing frequency because the yield of the new wells will be smaller and smaller over time. The total costs of relying on NTGW without any storage to meet peak demands were modeled at over $4 billion, including approximately $2.3 billion for initial construction costs and approximately $41 million in annual operations and maintenance costs.

Other documents that provide additional, recent perspectives related to the problems and high costs associated with continued NTGW use include the SMWSA Regional Water Master Plan (CDM and Meurer & Associates, 2007); the Water Resources Strategic Master Plan for Town of Castle Rock (CH2MHILL, 2006); the Castle Pines North Metropolitan District Integrated Water Resources Plan (CDM and Applegate Group, 2006); the Engineering Report for the Long Range Master Plan for the Castle Pines Metropolitan District (Rothberg, Tamburini & Windsor, Inc., 2006), which includes the Long Range Master Plan for the Castle Pines Metropolitan District (prepared by Jehn Water Consultants) as Appendix A; the Water Resources Implementation Plan for the Town of Castle Rock, the Castle Pines Metropolitan District, and the Castle Pines North Metropolitan District (CDM, 2008); the Citizen's Guide to Denver Basin Groundwater (Colorado Foundation for Water Education, 2007); and Aquifers of the Denver Basin, Colorado (Topper, 2004). These documents present the collective conclusion of water providers to develop alternative sources of surface water and surface water storage as soon as possible. Highlights from each are summarized below.

According to the SMWSA Regional Water Master Plan, the SMWSA's aggregate NTGW rights of about 111,000 acre-feet per year could nearly meet buildout demands. However, because of concerns related to the long-term sustainability of NTGW, the group's members intend to substantially transition away from groundwater, using less than 15,000 acre-feet per year (approximately 13 percent of total supplies) of NTGW at buildout. The Master Plan builds on the SMWSS (Black & Veatch et al., 2003), but does not evaluate continued groundwater pumping. Rather, the Master Plan identifies phased ways of meeting the entire renewable water supply goal of each SMWSA water provider. Some providers, such as Castle Pines North Metropolitan District, anticipate eliminating groundwater use completely.

The town of Castle Rock Water Resources Strategic Master Plan explains that by 2055 NTGW will be relied upon to provide only 17 percent of the town's water needs, as opposed to the 100 percent reliance on groundwater the town had in 2005. The town of Castle Rock intends to work in partnership with other South Metro area providers to import surface water to reach an overall water supply mix of renewable and reusable water that is 75 percent sustainable. The town of Castle Rock concluded that investing $250 million in a groundwater system that did not meet its long-term needs did not make sense. Looking beyond 2055, groundwater levels and the amount of water that wells can produce will decline to such an extent that it will become economically, and probably technically, unfeasible to produce groundwater at rates needed to meet the town's water demands. Determination of an exact time when the groundwater may become unfeasible depends on many variables and cannot be reliably predicted, but extrapolation of modeling suggests it could happen by 2060.

The Castle Pines North Metropolitan District Final Integrated Water Resource Plan describes the Denver Basin bedrock aquifers as the primary source of water supply to Castle Pines North Metropolitan District. Groundwater levels and well production rates are declining in most of the district's 10 wells (including at least 6 in the Arapahoe Aquifer) as a result of the groundwater pumping needed to meet the area's water demands. Within approximately 20 years, the Castle Pines North Metropolitan District's well production will decline and water levels will fall below the maximum allowable levels for operational purposes. It is very likely that the district will face an unacceptable production decline in less than 20 years because of well production declines during the peak summer pumping period. Under current conditions, within approximately 15 to 20 years the district will not be able to adequately meet peak monthly demands during the irrigation season. Increased costs with decreasing groundwater levels will occur, including electrical costs because well pumps will have to lift water a greater distance up to the surface, and equipment costs associated with upgrading existing pumps, electrical systems, and discharge piping to handle the increased lift. As an example, one of the district's Arapahoe Aquifer wells recently had a new pump, motor, electrical system, and piping replaced at a cost of approximately $400,000. To achieve a sustainable water supply, the Castle Pines North Metropolitan District is pursuing renewable water supplies.

The Long Range Master Plan for the Castle Pines Metropolitan District and the related Engineering Report indicate that the district currently is growing at approximately 6 percent per year. If the district was to maintain this growth rate, it is projected it would reach build out in 2021. The district currently relies solely on nonrenewable groundwater supplies to meet water demands. The district also has surface water rights on East Plum Creek. This water is currently not available for consumption because the District does not have any surface water conveyance or treatment facilities, or wells and pipelines from East Plum Creek. Developing the infrastructure to use surface water rights is estimated to cost $37.1 million through 2056. The estimated cost for relying on NTGW was estimated to be $42.3 million through 2056. Much of the cost to continue to use NTGW is predicted to occur in the future, to install additional wells to maintain supply. The large future cost suggests that it would continue to be considerably more costly to rely on NTGW beyond 2056. The report concludes that it would be more cost effective for the District to develop infrastructure to utilize their East Plum Creek water rights in conjunctive use with their existing groundwater supply than to continue to solely rely on groundwater.

The town of Castle Rock, the Castle Pines Metropolitan District, and the Castle Pines North Metropolitan District participated in the Water Resources Optimization Study (WROS). The results of the WROS were incorporated in the Water Resources Implementation Plan (CDM, 2008), a joint project undertaken to establish a plan to fully utilize water supplies and return flows that are currently unused or under-utilized. These entities rely primarily on NTGW supplies to meet the water needs of their respective service areas. Looking towards development of sustainable water supplies, these entities are planning for development of a regional approach to using the local renewable supplies.

The Citizen's Guide to Denver Basin Groundwater describes that although the Denver Basin contains about 200 million acre-feet of recoverable water in storage, water levels are declining at rates of one inch per day (30 feet per year). Water level trends in the dominant municipal water supply aquifers (the Arapahoe and Laramie-Fox Hills) are not favorable. Between 1990 and 2000, development in the south Denver Metro area resulted in localized declines up to 40 feet per year in the Arapahoe Aquifer. The future prospects for this aquifer are of great concern to water managers. The Laramie-Fox Hills Aquifer, used for municipal water supply in the southeast Denver Metro area, has experienced localized water-level declines of up to 125 feet in the past decade. Furthermore, much of the estimated recoverable water is spread across the eastern part of the basin, where demand is minimal and the cost of extraction and conveyance is presently prohibitive. It is likely that economics will prevent the Denver Basin aquifers from being completely exhausted. Over time, large-capacity pumping may become so expensive that it simply becomes too costly to drill more wells or keep pumping existing wells with diminishing returns. Drilling more wells is not necessarily a viable long-term solution because of well-to-well interference, particularly in areas with high demand. Some well users on the western margin of the Denver Basin in Douglas County already have been forced to deepen their wells or pumps in an attempt to find more water.

"Aquifers of the Denver Basin, Colorado," is a peer-reviewed article that describes that available water reserves in the Denver Basin may be one-third less than previously estimated. There is no legal protection for pressure levels in the aquifer, and water managers are becoming increasingly concerned about the rapid water level declines (30 feet per year). Approximately 33,700 wells of record have been completed in the sedimentary rock aquifers of the Denver Basin for municipal, industrial, agricultural, and domestic purposes. The volume of annual withdrawal appears to indicate a significant acceleration in groundwater withdrawal from the Denver Basin aquifers between 1985 and 1995.

4.3.3 Alternative 3—20,600 Acre-Foot Reallocation

Alternative 3 would reallocate storage from the flood control pool to the conservation pool. Under this alternative, the elevation of the conservation pool would be raised from 5,432 feet msl (under Alternative 1) 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 annual yield under Alternative 3 is estimated at 8,539 acre-feet. The "average annual yield" is the average annual amount of water expected to result from the storage of available water rights. The pool elevation of 5,444 feet msl would not be achieved every year due to fluctuations in the amount of runoff available on an annual basis.

The mean annual outflow from the reservoir into the South Platte River under Alternative 3 would range from 54.2 to 759.3 cfs, based on the output from the HEC-5 model. Of the alternatives, mean annual outflows into the South Platte River would be smallest under this alternative (Figure 4-5) because more water would be maintained in the conservation pool to reach the targeted 5,444 feet msl pool elevation. However, the magnitude of difference in outflows between the alternatives is small. The reduced flows in the South Platte River would be most noticeable in the months of May and June when incoming runoff is retained to fill the reservoir (Figures 4-7 and 4-8). The small magnitude of differences between alternatives appears constant at the Chatfield Reservoir outflow, the Denver gage downstream, and the Henderson gage further downstream.

Following the review of the draft FR/EIS, the city of Brighton, a downstream user, withdrew from the project. Brighton had an allocated storage amount of 1,425 acre-feet. Its shares were picked up by upstream users in the following amounts: Centennial (1,181 acre-feet), Castle Pines Metro (125 acre-feet), and Castle Pines North (119 acre-feet). Brighton's withdrawal from the project will change the with-project flows presented in the FR/EIS slightly but would be a small change to an insignificant impact. It should be noted that 1425 acre-feet of storage would yield less than 500 acre-feet per year or less than one cfs spread over the year. This amount of change would not have a measurable impact on streamflow along the South Platte River.

Peak flows would not be significantly different under Alternative 3 than under Alternatives 1 or 2. The USACE modeled 500-year streamflows (Q_{500}) under each Alternative (see Appendix I for results). The alternatives would not substantially alter the frequency of Q_{500}. The magnitude of Q_{500} along the South Platte River downstream of the reservoir would change by ±2 percent under Alternative 3 compared with Alternatives 1 and 2.

The largest observable difference between alternatives appears to be the magnitude of pool elevation fluctuations. Under Alternative 3, elevations would fluctuate up to 21 feet (from the historical low elevation of 5,423 feet msl to the maximum elevation under Alternative 3 of 5,444 feet msl) (Table 4-7). The demand on the additional water storage rights would change the volume and pattern of the discharge from that observed under Alternative 1, allowing the pool level to fluctuate more widely under Alternative 3 than under Alternative 1. The maximum conservation pool elevation (5,444 feet msl) would not be reached in approximately 82 percent of the days in the POR (Table 4-7). Several of the following sections address the potential impacts of pool fluctuations on habitat of the shoreline and aquatic wildlife and vegetation, as well as recreational users. Losses of water through evaporation of the conservation pool would be the largest under Alternative 3 because the surface area of the reservoir would be the largest.

4.3.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

Alternative 4 would also reallocate storage from the flood control pool to the conservation pool. In this case, the pool containing conservation storage 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 annual yield would be approximately 3,160 acre-feet. Under Alternative 4, the additional 5,379 acre-feet would be obtained from NTGW and downstream gravel pits. The impacts on hydrology related to the use of downstream gravel pits would be less than those described under Alternative 1. Under Alternative 4, the remaining water storage would be obtained from NTGW. Those impacts are described under Alternative 2.

The mean outflow from the reservoir into the South Platte River under Alternative 4 would range from 55.4 to 772.5 cfs, based on the output from the HEC-5 model. Outflows into the South Platte River under Alternative 4 would fall between the other two alternatives because water would be maintained in the pool containing conservation storage at a level between the other two alternatives (Figure 4-5). However, the magnitude of the differences would be small. The difference in flows in the South Platte River would be most noticeable in the months of May and June when incoming runoff is retained to fill the reservoir (Figures 4-7 and 4-8).

Peak flows would not be significantly different under Alternative 4 than under Alternatives 1 or 2. The magnitude of Q_{500} along the South Platte River downstream of the reservoir would change by ±1 percent under Alternative 4 compared with Alternatives 1 and 2 (Appendix I).

Because the pool containing conservation storage would increase only to an elevation of 5,437 feet msl, the degree of fluctuation (approximately 14 feet) within the reservoir would be greater than under Alternative 1 and less than under Alternative 3. The target pool elevation (5,437 feet msl) would not be reached in approximately 75 percent of the days in the POR (Table 4-7). Losses of water through evaporation of the conservation pool would fall between Alternatives 1 and 3 because the surface area of the reservoir would fall between the two.

4.3.5 Reduction of Potential Impacts

Climate change will result in greater variability in climate. There may be more floods and more or longer periods of drought, which cannot be accurately predicted at this time (Ray et al., 2008). The Corps model uses inflows during the 1942–2000 POR, which tend to be greater on average than predicted for future conditions for all alternatives. This results in a greater probability of adequate mitigation for all types of inundation-related environmental impacts. Reduced streamflow volumes in the South Platte River from climate change also could result in fewer years when usable water storage would occur in Chatfield Reservoir's conservation pool, but the same lack of water storage would occur under Alternatives 1, 2 (for gravel pit storage), 3 and 4, or other water supply projects involving surface water sources. Surface water projects satisfy one component of the project's purpose and need (described in Chapter 1, Section 1.6), which is to reduce dependence on nonrenewable NTGW use in the Front Range.

Alternative 2 could contribute to the loss of production in the Arapahoe Aquifer over the Denver Metro area. As a regional problem, this issue would cause a significant adverse impact on hydrology. This impact would be difficult to reduce without decreasing the reliance on NTGW required under Alternative 2.

The largest potential impact on hydrology under Alternatives 3 and 4 compared to Alternative 1 would be the amount of fluctuations in pool elevations. In terms of hydrology, potential changes in pool fluctuations would be difficult to minimize. The effects of those fluctuations on other resources (e.g., the target environmental resources, tree removal and weed control within the fluctuation zone, water quality and fisheries and downstream aquatic habitat) and ways to reduce fluctuations and their effects through adaptive management are discussed under those resources and in the Adaptive Management Plan (Appendix GG). Adaptive management by an established group would be used to implement operation strategies to minimize impacts once reallocation begins. The

Chatfield water providers will pursue development of an operations plan to minimize impacts as discussed in the AMP (Appendix GG).

4.4 Water Quality

4.4.1 Chatfield Reservoir

Interested parties were invited to participate in a water quality workgroup to determine the scope of the water quality modeling necessary for this FR/EIS. Participants included representatives from the Chatfield Watershed Authority, Colorado State Parks, CDOW, the water providers, the Corps, and Tetra Tech (who assisted the Corps in preparing the FR/EIS). Four workgroup meetings were held between April and September 2005. The workgroup reviewed, evaluated, and considered scoping comments on water quality; identified the water quality parameters of greatest concern; and developed the following approach for addressing water quality concerns associated with storage reallocation at Chatfield Reservoir.

Three broad categories were identified as the primary water quality issues associated with the proposed alternatives: changes in nutrient levels, metals concentrations, and bacteria counts. Available physical, chemical, and biological data for the reservoir were evaluated, and the proposed conditions under each alternative were modeled. A detailed description of the approach is presented in the complete water quality impacts report in Appendix J. The analysis provided a simplified, representative assessment of potential impacts on water quality under each alternative. As discussed in Section 4.3, the average pool levels reflected in the reallocation alternatives would likely be lower than the Corps model predicts. Because the water quality model includes average lake levels, water quality impacts may vary from those predicted. Because simple models generally do not represent fully the dynamic, time-variable nature of a system, they involve a high level of uncertainty. Potential sources of uncertainty are disclosed in Appendix J. Despite some limitations, simple modeling approaches can be useful analytical tools. The water quality workgroup considered more complex modeling approaches but ultimately determined that the approach documented in Appendix J was adequate and reasonable to evaluate the potential impacts associated with the proposed project.

During the public comment period on the Draft FR/EIS, the U.S. Environmental Protection Agency commented on Appendix J, requesting that the Corps evaluate additional water quality data collected at Chatfield Reservoir since 2009. Earlier water quality sampling characterized the top approximately 33 feet (10 meters) of the reservoir, while more recent sampling characterizes the entire approximately 59-foot (18-meter) water column. The recent data indicate that Chatfield Reservoir stratifies strongly throughout the summer at relatively deep levels. As part of the stratification process, reservoirs develop pronounced thermal barriers (thermoclines) and hypoxic zones (less than 2.0 mg/L dissolved oxygen) in the summer, and "turnover" or mix during the fall. In Chatfield Reservoir, the upper limit of the deep hypoxic zone migrates up from the bottom to a maximum elevation in July and then migrates down again in September until dissipating during the fall turnover (Appendix J). During a meeting following the public comment period, EPA and the Corps agreed that the Corps would revise the phosphorus loading analysis presented in the Draft FR/EIS to incorporate recent water quality data. Output from the revised model is summarized in this section and described in greater detail in Appendix J.

Potential impacts on water quality from the proposed Penley Reservoir, pipeline areas, and gravel pit reservoirs are also discussed below, as applicable, by alternative.

Nutrients. A detailed, localized nutrient analysis was conducted to address the uncertainty regarding possible increases in anaerobic and inundated vegetation nutrient fluxes from total phosphorus and internal phosphorus loading. This assessment of the potential long-term impacts on nutrients of the alternatives focused on potential changes in the number of hypoxic layers (based on 1-meter depth increments) and volume of the hypolimnion (i.e., cold bottom layer of water in the reservoir, characterized by low dissolved oxygen conditions) and the resulting effects on nutrient loading and concentrations in Chatfield Reservoir. Excessive nutrients stimulate plant growth (e.g., algae, weeds). When that plant material dies, the decomposition process reduces the amount of dissolved oxygen in the hypolimnion. Water with a low concentration of dissolved oxygen is called hypoxic; water with no dissolved oxygen is anoxic. These conditions can limit aquatic life and mobilize sediment-bound nutrients (including phosphorus) through oxidation-reduction processes that would not occur to the same extent under more oxygen-rich conditions. Releasing additional phosphorus can further increase eutrophication in the reservoir.

As described in Chapter 3, the TMAL for nutrients (19,600 pounds total phosphorus per year under a median inflow of 100,860 acre-feet per year) for Chatfield Reservoir was developed to protect Chatfield Reservoir against increasing eutrophication and exceedances of standards for total phosphorus and chlorophyll-a (a measure of eutrophication). The phosphorus standard is 0.030 mg/L and the chlorophyll-a standard is 0.010 µg/L. These standards are attained when the assessment criteria for total phosphorus (0.035 mg/L) and chlorophyll-a (11.2 µg/L) are met, as measured through the collection of samples that are representative of the mixed layer during summer months (July, August, and September) and with a maximum allowable exceedance frequency of once in five years. The modeled changes under each alternative are compared with these standards to determine the impacts of each alternative on nutrients.

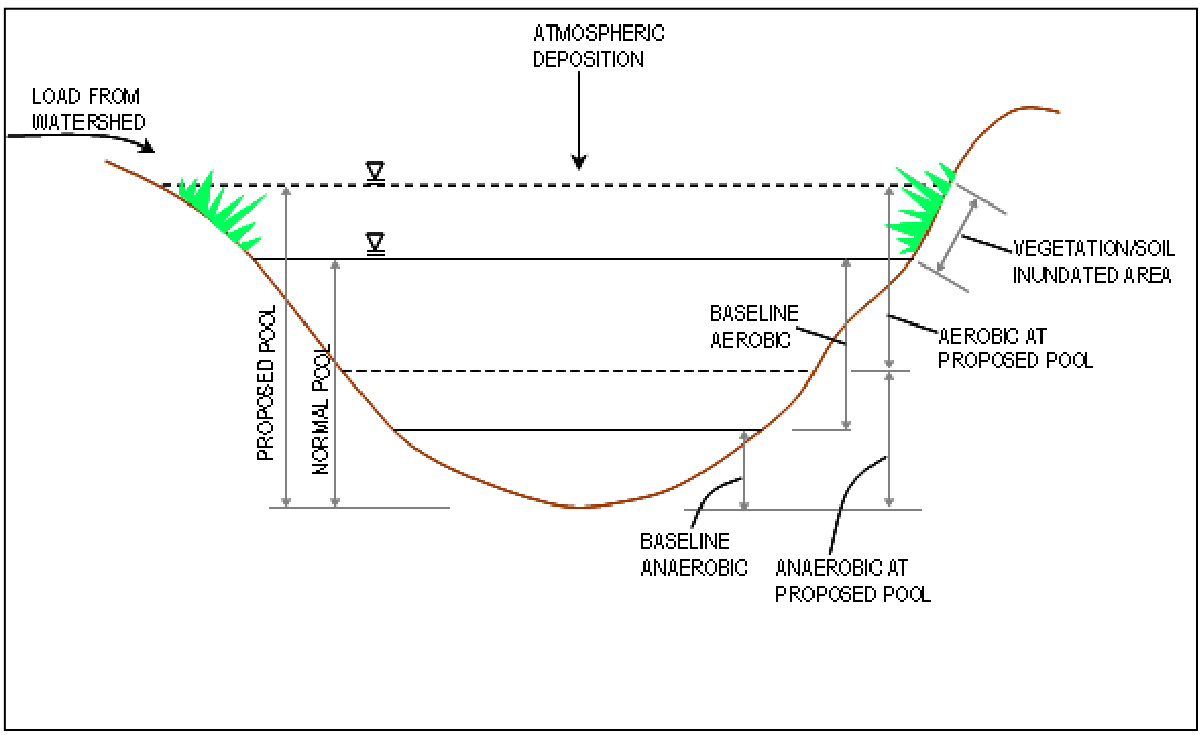
Metals. The evaluation of the potential impacts of the proposed alternatives on metals concentrations considered that increasing the bottom surface area of the reservoir could lead to greater releases of metals bound to bottom sediments. A simple model was used to compare the predicted metals releases under each alternative. The fluxes of sediment-based metals to and from the water column were estimated for the reservoir bottom. Fluxes depended on environmental conditions and varied by orders of magnitude. Only four metals (copper, iron, mercury, and manganese) exceeded water quality standards historically in the reservoir. The exceedances occurred in 2004 and likely resulted from accelerated sedimentation from burn areas associated with the Hayman fire. Metals considered in the water quality impacts analysis were copper, lead, mercury, cadmium, selenium, and arsenic. There were limited sediment data for these metals (one data point during August every year), but they were sufficient to perform simple analysis calculations. The estimated metals concentrations under the alternatives were compared with the copper, mercury, lead, cadmium, selenium, and arsenic water quality standards of 15.3 mg/L, 1.4 mg/L, 75 mg/L, 4.96 mg/L, 18.4 mg/L, and 50 mg/L, respectively (assessed water quality standard is based on a hardness value of 111 mg/L).

Bacteria. The assessment of the potential effects of the proposed alternatives on bacteria focused on the swim beach and surrounding areas where changes would be most likely to occur. Waterfowl and shorebird usage of the reservoir could increase with increasing shoreline area. With increasing usage, additional bacteria loading would be expected, which would affect bacteria levels at the swim beach. The water quality impacts analysis considered the relationship among the surface area and volume of the beach, the amount of use by birds and humans (especially children), and the potential E. coli bacteria concentration. Further discussion of E. coli is included in Appendix J.

4.4.1.1 Alternative 1—No Action

Nutrients. A localized analysis to address the uncertainty regarding possible increases in anaerobic and inundated vegetation nutrient fluxes due to total phosphorus was evaluated for Alternative 1. A baseline condition was evaluated for Alternative 1. Baseline reflects Chatfield Reservoir while the reservoir is stratified between May and September under normal pool conditions. The epilimnion and hypolimnion were defined by estimating the hypolimnetic depth for each month based on the number of anoxic layers (1-meter depth increments), which ranged from a minimum of two layers in May and September to a maximum of nine layers in July. The analysis considered separate components of the total load from several sources, including the South Platte River and Plum Creek watersheds upstream of the reservoir, atmospheric deposition, and the internal load from the reservoir (Figure 4-10). The anaerobic depth shown in Figure 4-10 corresponds to the depth of the hypolimnion. The proposed condition in this figure refers to Alternative 3. Alternative 1 would not involve periodic increases in water levels above 5,432 feet msl, as would Alternatives 3 and 4. As such, the evaluation of nutrient loading under Alternative 1 did not address inundated soil and vegetation above 5,432 feet msl. Sediment nutrient fluxes were estimated using a sediment flux model developed by DiToro (2001) (see Appendix J for details).

Figure 4-10
Phosphorus Sources to the Chatfield Reservoir Considered in the Nutrient Analysis



The localized analysis showed that there may be water quality concerns regarding internal loading from increased anaerobic conditions due to increases in reservoir pool levels and inundated vegetation in Alternative 3 or 4 compared to Alternative 1. The model predicted average total phosphorus concentrations in the epilimnion from July to September of approximately 0.023 mg/L, less than the current phosphorus standard (0.030 mg/L) for the mixed layer and the mean summer assessment criteria of 0.035 mg/L.

Metals. Metal loads for copper, lead, mercury, cadmium, selenium, and arsenic from the watershed and from internal loads were evaluated under Alternative 1. The analysis indicated that metals concentrations in the reservoir under the maximum pool elevations (i.e., 5,432 feet msl for Alternative 1) would be higher under Alternative 1 than under Alternative 3 or 4. The concentrations of copper, mercury, lead, cadmium, selenium, and arsenic were estimated at 6.75, 0.63, 0.15, 0.022, 0.0005, and 0.123 µg/L, respectively, under Alternative 1. The standards for all these metals except mercury and arsenic are table value standards, which means that the standard is computed based on site-specific hardness values. Table value standards were calculated using representative hardness values in the reservoir (Chatfield Watershed Authority, 2006). None of the predicted metals concentrations exceeds the applicable standard. According to the Chatfield Watershed report, a maximum concentration of 68.8 µg/L for copper was reported in 2006, which exceeded the acute copper standard, a table value standard dependent on water hardness (as presented in Chapter 3). Mercury, measured in the dissolved form, has also exceeded the total mercury standard of 0.01 µg/L in the reservoir. None of the other metals were reported as exceeding standards in 2006.

E. coli. Changes in the number of birds using the swim beach area or in the number of recreational users could affect E. coli concentrations. Under Alternative 1, the swim beach and nearby areas would not be modified. As a result, the shoreline and beach areas are not expected to change, and E. coli concentrations would not be affected.

Penley Reservoir, Pipeline Areas, and Downstream Gravel Pits. The potential effects on water quality of constructing Penley Reservoir and associated pipelines under Alternative 1 would be limited to the amount of sedimentation or potential spills that occurred during and immediately following construction activities. Ground disturbance could lead to soil erosion and transport of sediments to water bodies, which could result in short-term increases in turbidity. With effective construction BMPs and successful implementation of stormwater, erosion control, and spill prevention plans, the long-term adverse impact of these activities on water quality likely would be minor. Similarly, the construction of slurry walls in downstream gravel pits could result in localized, short-term increases in sedimentation that could reach the nearby South Platte River. BMPs and implementation of stormwater, erosion control, and spill prevention plans would reduce the potential for adverse impacts on water quality. These impacts on water quality would not be significant.

4.4.1.2 Alternative 2—NTGW/Downstream Gravel Pits

NTGW. No direct impacts are anticipated to water quality from using NTGW. Short-term indirect adverse impacts could occur if many additional wells were constructed to meet water demands. Ground disturbances could lead to short-term increases in turbidity at nearby water bodies, and the use of drilling rigs and related construction equipment could increase the potential for spills. With proper BMPs, these impacts are not anticipated to be significant.

Downstream Gravel Pits. The potential impacts on water quality from the conversion of downstream gravel pits to water storage reservoirs would not be significant, as explained above under Alternative 1.

4.4.1.3 Alternative 3—20,600 Acre-Foot Reallocation

Nutrients. In reviewing the water quality analysis, it is important to consider that Chatfield Reservoir does not contribute phosphorus and would not under the proposed alternatives. Instead, phosphorus inputs from the watershed upstream of Chatfield Reservoir influence concentrations in the reservoir. Changing the operation of Chatfield Reservoir could influence the reactivity of those minerals. Internal loading is not currently a concern in Chatfield Reservoir, as described in Regulation No. 38 (page 191): "Chatfield Reservoir presently has good water quality and uses are being attained… The data record amassed through more than 20 years of water quality monitoring shows that trophic condition has remained stable... The Commission believes that eutrophication of Chatfield Reservoir has been averted through the control of phosphorus loads from the watershed."

The evaluation of nutrients for Alternative 3 used a site-specific phosphorus loading model to assess water quality conditions.

This analysis assumed that increased depth and reduced outflow under increased storage maintained summer thermal stratification and resulted in expanded hypoxic conditions in the hypolimnion that would increase internal phosphorus loading from bottom sediments. As under Alternative 1, nutrient loads (including the watershed, atmospheric deposition, and internal loads) for phosphorus were evaluated under Alternative 3. The internal phosphorus loading from the reservoir was estimated based on expansion of the anaerobic hypolimnion and the resulting increase in sediment phosphorus fluxes. Baseline conditions and two "with-project" scenarios were evaluated. The "with-project" scenarios assumed the elevation to the top of the hypolimnion increased by the same amount as the increase in pool elevation. The two "with-project" scenarios evaluated were: 1) a typical condition which includes an increase in hypolimnetic elevation and anaerobic volume based on the monthly increase in summer pool elevation, and 2) a maximum impact condition which includes an increase in hypolimnetic elevation and anaerobic volume based on a maximum 12 ft increase in summer pool elevation. The 12 ft increase in the hypolimnion elevation condition provides an upper bound for the phosphorus concentrations that can be expected, while the typical scenario provides an average typical summer condition case based on proposed pool elevation conditions.

Under Alternative 3, water would inundate periodically the soil and vegetation between 5,432 and 5,444 feet msl that would not be inundated under Alternative 1. This inundation would occur only during relatively high flows. The nutrient model considered the short-term additional phosphorus load that would result from the initial inundation of the soils and vegetation. The model evaluated the magnitude of internal phosphorus loading from vegetation and sediment that would be inundated with increased pool elevations in Chatfield Reservoir (Appendix J). Most of the phosphorus release is expected to occur in the first year after inundation and to decrease substantially with time.

The upper bound model of the 12-foot hypolimnion elevation increase indicates that the reservoir would experience an increase in total phosphorus concentrations under Alternative 3 above those modeled under Alternative 1. This conservative modeling approach predicts 0.057 mg/L of total phosphorus in the epilimnion (the layer where the 0.035 mg/L water quality assessment criteria are evaluated), as phosphorus is released from the newly inundated soil and vegetation. However, most of the phosphorus would be released in the first year after inundation (see Appendix J for details). Over the longer term, concentrations of total phosphorus under this conservative scenario would reach approximately 0.025 mg/L, about a 9 percent increase over Alternative 1 and below the water quality standard. Again, the conditions that were modeled represent that conservative scenario, which would not necessarily occur under Alternative 3 and would be unlikely to occur every year. In the unlikely event the hypolimnion elevation did increase by 12 feet in one year, it would not likely persist at that size throughout the growing season. This modeled prediction is useful because it provides an upper bound for the phosphorus concentrations that could be expected under Alternative 3.

Phosphorus concentrations were also modeled based on the more typical pool elevations expected under Alternative 3. Mean increases in pool elevations range from 8.47 to 9.61 feet between May and September (Appendix J). The model varied the size of the anaerobic hypolimnion during this critical period (when stratification occurs). Similar to the upper bound scenario, the elevation of the top of the hypolimnion was assumed to increase by the same amount as the mean monthly increase in pool elevation. Based on modeling, total phosphorus concentrations in the epilimnion would be expected to be approximately 0.048 mg/L in the short term and 0.023 mg/L after the first year of inundation. The long-term total phosphorus concentrations in the epilimnion modeled for Alternative 3 under typical conditions is similar to total phosphorus concentrations under Alternative 1.

The total phosphorus standard (0.030 mg/L) is evaluated based on the assessment criteria of 0.035 mg/L, as measured through the collection of samples that are representative of the mixed layer during summer months (July, August, and September). The localized phosphorus loading model predicted that the average concentration would be less than the phosphorus assessment criteria (and the standard). However, this result reflects the low phosphorus concentrations in the epilimnion during July, August, and early September when the hypolimnion is isolated and when dilution from the increase pool levels occurs in the epilimnion. The internal phosphorus loading in Chatfield Reservoir would increase under Alternative 3. The increased loading would not affect the total phosphorus concentrations in the epilimnion until late summer because internal loading from the anaerobic sediment would not be available during the stratified period (when the epilimnion and hypolimnion do not mix). The increased phosphorus concentrations in the hypolimnion would become available during the fall turnover. The localized phosphorus loading model shows a corresponding increase in total phosphorus in the water column during late September for the mixed condition (Appendix J). As a result, implementation of Alternative 3 could trigger a need to implement adaptive management measures.

Metals. As with Alternative 1, metal loads for copper, lead, mercury, cadmium, selenium, and arsenic from the watershed and from internal loads also were evaluated under Alternative 3. The analysis indicated that metals concentrations in the reservoir under the maximum pool elevations (i.e., 5,444 feet msl for Alternative 3) would be lower under Alternative 3 than under either Alternative 1 or 4. A conservative analysis of metals resulted in an estimated decrease in metals concentrations in Chatfield Reservoir under Alternative 3. The predicted increase in volume at the maximum pool elevation would provide sufficient dilution to offset the decreased outflow (i.e., longer hydraulic retention time) and increased metals loading from the newly inundated areas. The concentrations of copper, mercury, lead, cadmium, selenium, and arsenic were estimated at 6.29, 0.53, 0.13, 0.021, 0.0004, and 0.120 µg/L, respectively, under Alternative 3. These correspond with decreases that range from approximately 2 percent (for arsenic) to 20 percent (for selenium) compared with concentrations predicted under Alternative 1. These predicted concentrations are estimates based on estimated diffusive fluxes and could change if sediment core sampling were performed to more precisely estimate the site-specific sediment metal fluxes.

E. coli. As with Alternative 1, possible changes in the number of birds in the immediate vicinity of the swim beach or in the number of recreational users using the swim beach were considered during the evaluation of the potential effects of Alternative 3 on *E. coli* concentrations. Under Alternative 3, the swim beach and nearby areas would be modified as described in Appendix M. To meet the goal of replacing affected facilities and use areas "in-kind", the relocation plan is based on maintaining current walking distances at the swim beach. Under this conceptual design, the beach area would be graded to minimize the distance between swim beach facilities and the water's edge at low water conditions. As a result, the configuration of the shoreline near the beach area and the overall dimensions of the swim beach would be similar to current conditions. Given this proposed modification to the swim beach, changes in *E. coli* concentrations are not expected under Alternative 3.

Colorado's 2012 Integrated Water Quality Report identifies the South Platte River downstream from Chatfield Dam to its confluence with Big Dry Creek as non-supporting of recreation due to *E. coli*. Segment 14 (South Platte River from Chatfield Dam to the Burlington Ditch) has a TMDL in place for *E. coli* and thus is not listed for *E. coli* on Colorado's 2012 303(d) list of impaired waters. The *E. coli* TMDL for Segment 14 states that significant E. coli contributions to this segment are conveyed through urban stormwater collection systems during storm events and dry weather conditions. Contributions from Chatfield Reservoir are not identified as a source of *E. coli*, and Alternative 3 is not expected to contribute *E. coli* to the South Platte River downstream of Chatfield Dam.

Pipeline Areas. Alternative 3 would not involve constructing pipelines to transport water from Chatfield Reservoir thus there would be no impacts to water quality from construction of infrastructure under this alternative.

4.4.1.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

Nutrients. The likely water pool elevations and depths of the hypolimnion under Alternative 4 would be intermediate between Alternatives 1 and 3. As a result, the predicted nutrient concentrations also would be intermediate between the concentrations predicted for those alternatives. The maximum elevation of the conservation pool under Alternative 4 would be 5,437 feet msl. As described under Alternative 3, this condition would occur only during relatively high flows (see Section 4.3 for more information) and would not last throughout the entire growing season. The correlated increase in the depth of the hypolimnion could range from little to the entire 5 feet. Similar to Alternative 3, under Alternative 4 water would periodically inundate the soil and vegetation between 5,432 and 5,437 feet msl that would not be inundated under Alternative 1. The 5,437-foot msl elevation would be reached only during relatively high flows. The predicted total phosphorus concentrations would be expected to be lower than those reported under Alternative 3 and higher than those reported under Alternative 1.

As in Alternative 3, increasing the hypolimnion elevation and expanding hypoxic conditions could affect nutrient concentrations and could alter water quality in Chatfield Reservoir, particularly during the first years after inundation. However, the hypolimnion is not likely to change as much as modeled under Alternative 3. The internal phosphorus loading in Chatfield Reservoir would increase under Alternative 4, but to a lower extent than under Alternative 3. Total phosphorus concentrations in the water column would be expected to increase during late September during turnover under Alternative 4, which could trigger a need to implement adaptive management measures. The contribution of phosphorus from inundated vegetation and soil would likely increase nutrients in the short term, but would likely decrease substantially with time.

Metals. Metal concentrations in the reservoir at the target pool elevation (i.e., 5,437 feet msl for Alternative 4) would be intermediate between concentrations under Alternatives 1 and 3. As in Alternative 3, the predicted increase in volume at the target pool elevation would provide sufficient dilution to offset the decreased outflow (i.e., longer hydraulic retention time) and increased metals loading from the newly inundated areas. The magnitude of the decrease would be expected to be lower than under Alternative 3 because the volume increase would be lower.

E. coli. Like Alternative 3, changes in *E. coli* concentrations are not expected under Alternative 4, given the proposed modification to the swim beach area (described in Appendix 5 of Appendix M). Under the conceptual design, the beach would be graded to minimize the distance between the swim beach facilities and the water's edge at low water conditions. As a result, the configuration of the shoreline and the dimensions of the swim beach would be similar to current conditions, and *E. coli* concentrations would not be affected.

Pipeline Areas. Alternative 4 would not involve constructing pipelines to transport water from Chatfield Reservoir thus there would be no impacts to water quality from construction of infrastructure under this alternative.

NTGW and Downstream Gravel Pits. An additional 5,348 acre-feet would be obtained from use of NTGW and downstream gravel pits. The potential effects on water quality from conversion of downstream gravel pits to water storage reservoirs and use of NTGW are disclosed under Alternatives 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2. These impacts on water quality would not be significant.

4.4.1.5 Reduction of Potential Impacts

Increases in total phosphorus in the short term are expected under Alternatives 3 and 4. Under Alternative 1, using an upper bound scenario, modeled concentrations of total phosphorus reach 0.023 mg/L and are not expected to exceed the standard of 0.030 mg/L, which is measured as the July-September average. The upper bound scenario under Alternative 3 was modeled with a total phosphorus concentration of 0.057 mg/L. Removal of vegetation prior to inundation could reduce the amount of phosphorus released under Alternatives 3 or 4, but the short-term concentrations would still be greater than those predicted under Alternative 1 because of the increased release of phosphorus from anoxic sediments and inundated soils.

The nutrient analysis shows that there may be water quality uncertainty regarding internal phosphorus loading from inundated vegetation and expanded anaerobic conditions due to increases in reservoir pool levels. Adaptive management would be used to address this uncertainty should the proposed Chatfield Reservoir storage reallocation project be implemented (Appendix GG). Water quality monitoring will be conducted on an on-going basis to identify any water quality impacts and evaluate their level of significance. The following approach using a dynamic water quality model could be executed to adaptively manage water quality uncertainties:

- Water Quality Monitoring and Assessment. Water quality monitoring would be implemented at Chatfield Reservoir to allow for the initial and ongoing application of a dynamic water quality model and assessment of reservoir water quality conditions for compliance with water quality standards. Dynamic water quality modeling would require the appropriate monitoring of reservoir, inflow, and outflow water quality conditions. Appropriate water quality data will be collected in Chatfield Reservoir to assess compliance with promulgated water quality standards criteria. This information will be used to help determine if mitigation actions need to be taken.

- Inundated Vegetation.

  - Remove vegetation below 5,439 ft msl to minimize the introduction of nutrients associated with inundation, as discussed under Tree Management within the Fluctuation Zone.

  - Control weeds within the fluctuation zone that could increase nutrient levels when inundated.

  - Monitor the establishment of vegetation within the fluctuation zone that could increase nutrient levels when inundated.

- Water Quality Modeling. An initial application of a dynamic water quality model could be attempted using historic water quality, meteorological, pool level, and flow data. Annual dynamic water quality models would be developed where historical data allow. If sufficient historical data are lacking, an initial application of a dynamic water quality model would be based on newly collected data. Once initially developed, a dynamic water quality model would be applied annually on an ongoing basis. Water quality, meteorological, pool level, and flow data for the past year would be used to develop a specific dynamic water quality model for the year. As the annual dynamic water quality models are developed, they could be used to conduct scenario testing of possible water quality management measures. If core objectives are threatened, a dynamic water quality model could be used to scope out the water quality concern, and, if appropriate, identify mitigation actions to manage water quality conditions.

- Feedback and Learning.

  - Determine if mitigation actions need to be taken based on an assessment of collected water quality data and findings of the dynamic water quality modeling.

- If mitigation actions are needed, use dynamic water quality modeling to identify effective and reasonable actions that can be implemented.
- Properly implement selected water quality mitigation actions.
- Assess implemented water quality mitigation actions for effectiveness.
- As necessary, adjust implemented mitigation actions or implement new mitigation actions as determined by effectiveness assessments.
- Continue water quality monitoring and mitigation actions as needed.

As described in Section 4.1.1, adaptive management planning will involve an iterative process of cycling through several steps: problem assessment, design, implementation, monitoring, evaluation, adjustment, and continued cycling through earlier steps (Barnes, 2009). Adaptive management will involve structured decision making, with an emphasis on incorporating water quality monitoring results into decision-making to minimize potential impacts to water quality. The project participants will coordinate their adaptive management work related to water quality with the Chatfield Watershed Authority, because they are working to maintain and improve the water quality of Chatfield Reservoir. Water providers will use adaptive management (including increased water quality monitoring) to address state concerns that water quality could be impacted by shoreline erosion caused by increased water level fluctuations. Monitoring and adaptive management will also be used to address the state's concern that under an upper bound scenario, dissolved oxygen levels could decrease, releasing mercury from the sediments and potentially accumulate in aquatic species in Chatfield Reservoir. Water quality modeling conducted as part of this analysis suggests that mercury levels would decrease under the reallocation alternatives.

4.4.2 South Platte River Immediately Downstream of Chatfield Reservoir

Comments on the Draft FR/EIS, and subsequent discussions with the EPA, identified the possible reduction of flows in the South Platte River downstream of Chatfield Dam as a water quality concern. Average annual outflow from Chatfield Dam over the 1942 to 2000 period would have been reduced by 4.4 percent under the proposed conditions for storage reallocation (Table 2-1, Appendix J). As noted in the FR/EIS, the Chatfield storage reallocation project would not result in the direct discharge of pollutants to the South Platte River. The project would likely reduce flows somewhat in the river downstream of Chatfield Dam. The reduction of flows could reduce the available pollution assimilative capacity of the South Platte River. Water Quality, TMDLs, and permitted dischargers could be adversely impacted by a reduced assimilative capacity to dilute pollutants discharged to the river downstream of Chatfield Dam during critical low flow periods. If water quality impacts were to occur, TMDLs and water quality-based permits may need to be recalculated. This concern is further evaluated in (Appendix J).

Under Alternative 3, the proposed Chatfield storage reallocation could potentially reduce critical low flows in the South Platte River immediately downstream of Chatfield Dam by storing 19 acre-feet of water annually instead of releasing the water to the river during critical low flow periods. Critical low flows have been identified for the South Platte River immediately downstream of Chatfield Dam to support implementation of a Nitrate TMDL. As part of the FR/EIS, the occurrence of days below the identified water quality critical low flows during the 10-year period 1991 through 2000 was determined for baseline and with-project (Alternative 3) conditions (Table 4-8). It may be possible to adjust the timing of Chatfield Dam releases in order to meet the currently identified critical low flows in the South Platte River immediately downstream of Chatfield Dam. Only the South Platte River immediately downstream of the Chatfield Dam outlet would seemingly be impacted as extensive diversions and discharges to and from the river occur in the Metro Denver area. See Appendix J for further discussion.

Table 4-8. Monthly Occurrence of Days below Water Quality Critical Low Flows in the South Platte River immediately downstream of Chatfield Dam during the 10-Year Period 1991 through 2000 under Baseline and With-Project (Alternative 3) Conditions .

Condition	Number of Days by Month												Total Days
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Baseline	11	11	4	0	0	0	0	1	3	0	1	12	43
With-Project	32	42	64	38	5	2	1	2	6	0	11	7	210

4.5 Aquatic Life and Fisheries

4.5.1 Alternative 1—No Action

Under Alternative 1, Chatfield Reservoir would continue under baseline conditions with a top of multipurpose pool elevation of 5,432 feet msl (Figure 4-1 and Table 4-2). Adverse impacts on aquatic biota in the Chatfield Reservoir study area would not occur. Water levels would continue to fluctuate with the current maximum 9-foot annual range in water level goal and therefore no augmentation would be required regarding Chatfield Reservoir's current management of sport fish, forage fish, or any native species present. Pool fluctuation shows how many feet, on average, the pool elevation ranges (between highest and lowest elevations) in a given month. Even Alternative 1 fluctuates because the inflow to Chatfield Reservoir does not necessarily match the outflow from Chatfield Reservoir; the pool fluctuates up or down depending on which flow is higher.

Alternative 1 would not change the current fluctuations in flow in the South Platte River and thus would not change the impacts on the aquatic biota present. The river would continue to fluctuate by the controlled release from Chatfield Reservoir and therefore would not affect the South Platte River's cool- or warm-water fish species present.

In addition, tributaries to Chatfield Reservoir would not be affected under Alternative 1. There would be no further inundation of the tributaries from Chatfield Reservoir. The dam releases at Strontia Springs Reservoir would continue to maintain both minimum winter and summer flows in the South Platte River above Chatfield Reservoir.

Penley Reservoir would be constructed under Alternative 1. Existing aquatic life and fisheries would not be impacted because no significant water resources currently exist in the area that would be inundated by Penley Reservoir. Reservoir construction would create aquatic habitat that could be used for aquatic life and fisheries. Diversion of water to the reservoir may impact fisheries resources downstream by decreasing flows in streams and rivers.

Pipelines associated with Alternative 1 would cross several streams that could support fish populations, including Indian Creek, Rainbow Creek, Willow Creek, and Plum Creek (Figure 2-1). The precise pipeline location is not yet known; therefore, alignment to the various waterways could change. Temporary adverse impacts on fish populations could result during the construction of underground pipelines, but these impacts can be minimized if proper techniques were used to reduce changes in hydrologic conditions during construction. Culverts at road crossings could alter stream flow and decrease fish movement upstream and downstream. Changes to vegetation and temperature along the stream bank could decrease spawning habitat. If appropriate construction techniques were implemented, the proposed pipelines would have no significant adverse impacts on aquatic life and fisheries.

The downstream gravel pits would not affect existing aquatic life and fisheries because none currently occur in these active gravel pits. Converting the gravel pits to water storage would create aquatic habitat for aquatic life and fisheries.

4.5.2 Alternative 2—NTGW/Downstream Gravel Pits

Under Alternative 2, reservoir levels and operations at Chatfield Reservoir would remain unchanged as in Alternative 1. As in Alternative 1, aquatic biota in Chatfield Reservoir or downstream in the South Platte River would not be affected. Penley Reservoir would not be constructed because water would be obtained from underground sources (NTGW). Aquatic life would not be impacted by NTGW use. Impacts resulting from converting downstream gravel pits to water reservoirs would be the same as under Alternative 1.

4.5.3 Alternative 3—20,600 Acre-Foot Reallocation

Alternative 3 would generally provide a positive impact to the Chatfield Reservoir aquatic ecosystem as included in the discussion of potential water quality impacts from nutrient loading in Section 4.4.3 and Appendix J. Precise quantification of increases in primary productivity may be difficult to determine between the two reallocation alternatives (Alternatives 3 and 4).

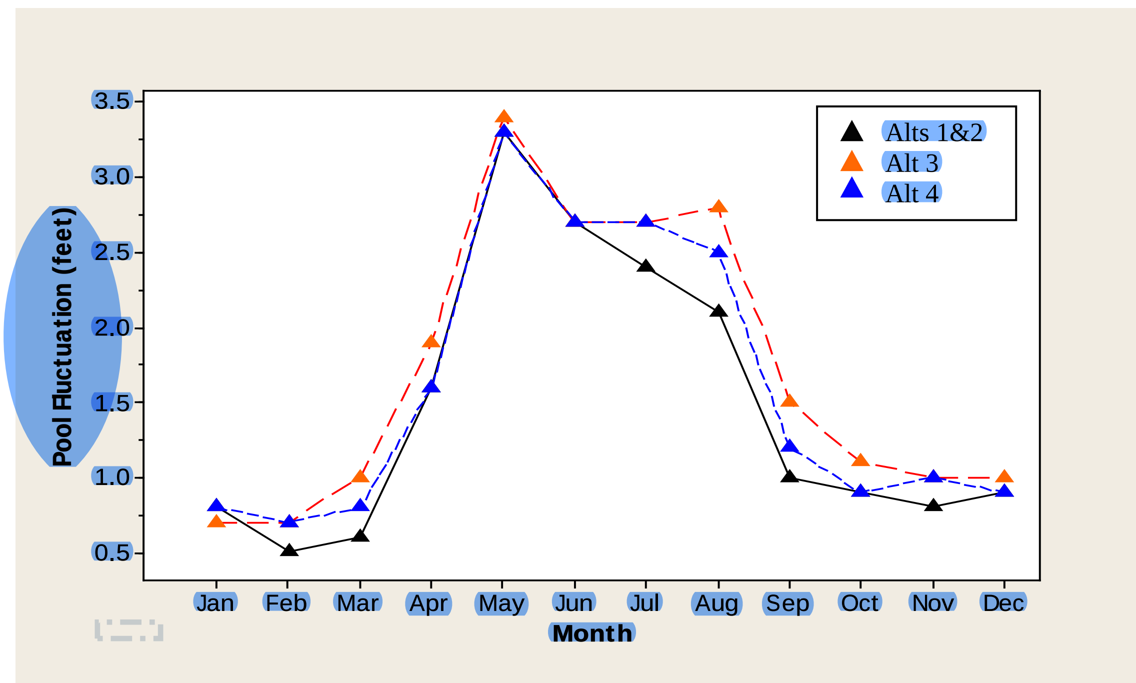
There would be a 587-acre gain in pool area and a 27,748-foot increase in pool perimeter under Alternative 3 (Figure 4-1). On average, the pool area would increase by approximately 49 acres, and the perimeter would increase approximately 2,312 feet, for every 1 foot of pool elevation increase between 5,432 and 5,444 feet msl. There is a net increase of about 20 acres of shallow water (i.e., <4 ft) between the 5,432 and 5,444 feet msl pool levels, but at 5,444 feet msl the proportion of shallow water to the total volume decreases slightly when compared to 5,432 feet msl. Shoreline Development (DL) is a parameter in lake morphometry that “reflects the potential for greater development of littoral communities in proportion to the volume of the lake” (Wetzel, 1975). Comparison of the DL values calculated for the 5,432 and 5,444 ft msl pool levels showed there was a slight increase (approximately 15 percent) in shoreline development at 5,444 ft msl compared to 5,432 ft msl. This suggests a slight increase in the littoral zone (the area containing emergent, floating, and rooted aquatic plants) compared to the lake volume, and thus a slight increase in lake productivity relative to volume.

The areas inundated due to this reallocation would essentially be shallow water areas within the reservoir. These shallow water areas would potentially affect several key components of the reservoir’s aquatic community. These include impacts on sport fish, forage fish, and native species populations.

Reservoir filling to 5,444 feet msl could potentially influence natural reproduction by cool- and warm-water fish communities in the reservoir. Timeframes for natural reproduction by various cool-water sport fish in Chatfield Reservoir begin in mid-March, when walleye spawn and egg-taking operations commence. As currently projected, pool elevations would increase during this period, with filling occurring during spring runoff and from seasonal storm events (Figure 4-11). However, based on filling and storage scenarios for Alternative 3, there would not be a negative impact on natural reproduction of these sport fish species in Chatfield Reservoir. Natural reproduction for the primary sport fish of concern would be finished before the decrease in water levels occurs. In addition, populations of walleye, rainbow trout, and channel catfish in Chatfield Reservoir have been and would continue to be maintained by annual stocking (CDOW, 2007a).

Warm-water sport fish spawning occurs from May to mid-June when fish including crappie, bluegill, smallmouth bass, and largemouth bass spawn. Increased pool elevation would create new shallow water habitat areas that these warm-water species require for spawning. However, greatly decreasing pool elevations during their spawning period would have a negative impact on spawning success and, in turn, could impact warm-water fish populations within Chatfield Reservoir. As shown in Figure 4-11, projected water withdrawals would begin in late spring and continue through the summer months. Larger predator fish species could also be negatively impacted by the increase in shallow water zones, creating more habitat and therefore more protection for the forage fish.

Figure 4-11
Average Monthly Pool Fluctuations in Chatfield Reservoir[1]



[1] This figure portrays the average monthly pool fluctuations in Chatfield Reservoir by alternative, based on the modeling described in Appendix H. The water quality modeling (described in Appendix J) evaluates more extreme (and less probable), upper bound pool fluctuations.

As with sport fish, the inundation of new pool areas under Alternative 3 would provide a generally positive impact on forage fish populations in the reservoir. Increases in primary productivity would especially benefit gizzard shad populations, which are dependent on plankton populations as primary food sources. Inundation of new pool areas and the resultant infusion of new nutrients from decay of organic material would enhance plankton populations in the reservoir and provide a positive impact to gizzard shad and other forage fish populations during the period of increased pool elevations. One possible limit to positive impacts is that gizzard shad reproduction occurs from approximately mid-May to mid-June depending on reservoir water temperature. The onset of greatly decreasing water levels under Alternative 3 during reproduction along with slight increases in water temperatures would adversely affect gizzard shad populations.

Crayfish populations would benefit from newly inundated pool areas with a resulting enhancement of forage for smallmouth and largemouth bass populations. Additional forage production consists of young-of-the-year (YOY) of certain game fish, primarily yellow perch and bluegill (Nesler, 2003).

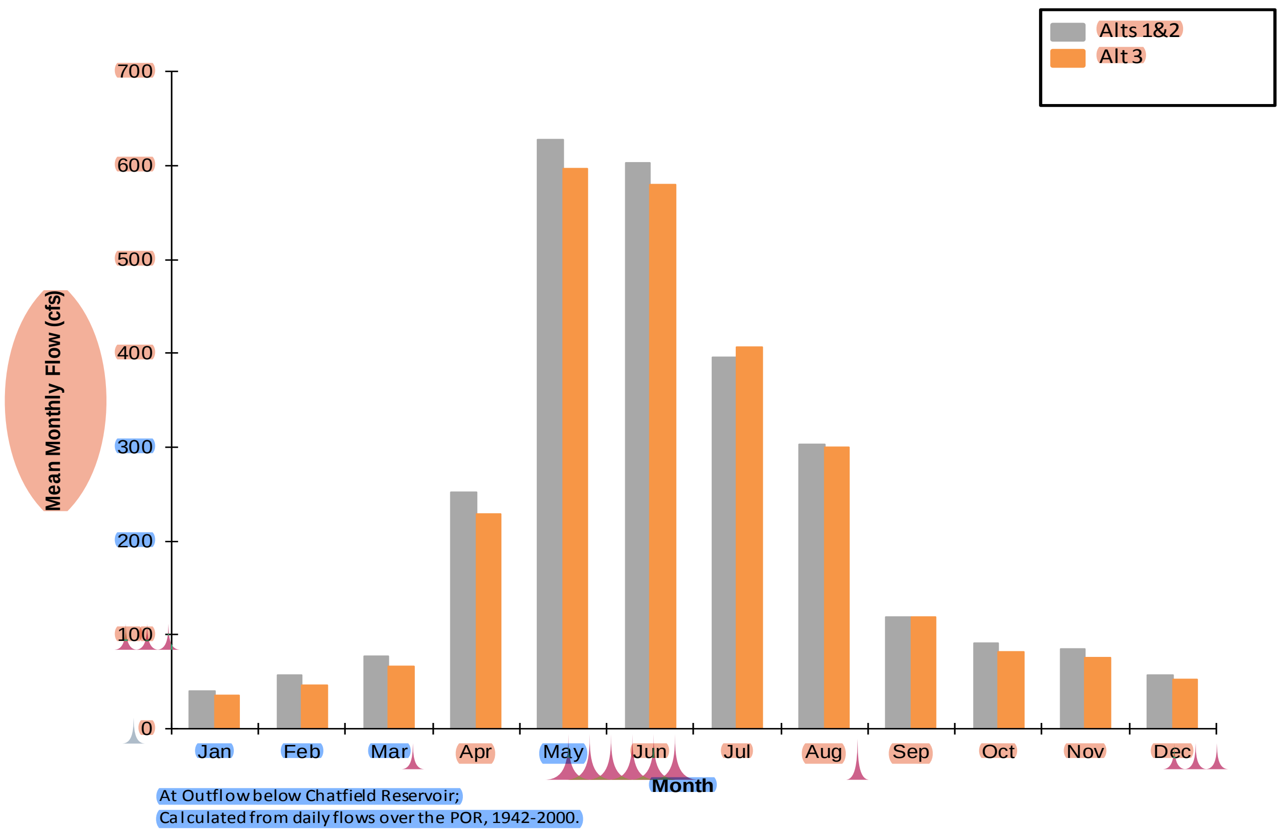
A few native fish species exist within Chatfield Reservoir and include the gizzard shad, western white sucker, and green sunfish. None of these species are recognized as sensitive, threatened, or of special status concern in Colorado and all are likely to be found in many aquatic habitats throughout Colorado. One other native species, Iowa darter, has been sampled in Chatfield Reservoir by CDOW. However, only two individuals have been collected over an 8-year sampling period (CDOW, 2007a). Iowa darters are more commonly found in and associated with a limited number of streams in northeastern Colorado (Woodling, 1985). Consistent with previously discussed impacts, it is anticipated that the higher pool elevations experienced under Alternative 3 would enhance habitat conditions for the native species in Chatfield Reservoir and would not adversely impact them.

Prolonged low pool levels after drawdown or during drought under Alternative 3 could increase temperatures in the bottom of the reservoir. This creates possible eutrophication and algal issues in Chatfield Reservoir and also in downstream sections of the South Platte River. Because of the potential for stored water to be carried over from prior non-drought years, however, low pool levels would not occur as frequently under Alternative 3 as under Alternative 1.

Another potential impact under Alternative 3 to Chatfield Reservoir is the periodic inundation of two ponds to the south of the reservoir near the inlet of the South Platte River (Figure 4-1). All fish species present in these ponds are currently found in Chatfield Reservoir, so inundation of these areas would not impact the species composition of Chatfield Reservoir (CDOW, 2007a). However, the species composition of the ponds could change, as these ponds will be inundated and become incorporated into the reservoir perimeter.

Under Alternative 3, the South Platte River below Chatfield Reservoir would have minimal changes during base flow conditions and a small increase in flow during the late summer months (Figure 4-12). Figure 4-12 shows that there could be a slight decrease in flows below the reservoir during May and June, when inflows are captured and the reservoir is filling. It is possible that these reduced flows could affect spawning, but the significance of the effect would be very small. Managing the timing, duration, and amount of flow from the Chatfield Reservoir is an important tool in enhancing aquatic biota in the South Platte River. For example, a projected increase in flow during July would have a positive effect on aquatic biota downstream of the reservoir. The current cool- and warm-water species present experience stress during late summer months from increased water temperatures and decreased flow.

Figure 4-12
Comparison of Flows in the South Platte River Below Chatfield Reservoir if Alternative 3 Were Implemented



Another critical aquatic stressor is base flow conditions during the winter months. Based on the Corps' modeling results, the projected change during winter base flow conditions would result in a slight decrease that would result in minimal or no impact to aquatic biota present. Appendix D, prepared by Great Western Institute et al., includes additional modeling and evaluation of wintertime flows in the South Platte River under various water release scenarios from Chatfield Reservoir. These analyses indicate that the proper management of outflow from the Chatfield Dam to the South Platte River by maintaining a minimum of 10 cfs could greatly improve the habitat available for fish in this downstream reach.

While sport fish are present in the fish community below Chatfield Reservoir, the population is not actively managed by the CDOW as a sport fishery. Virtually all the sport fish found in this reach of the South Platte River are more typically found in standing water habitats and are actually migrants from Chatfield Reservoir or adjacent pond habitats connected to the river. It is believed that most of these fish are not year-round residents of the river, and size distribution of this population indicates that most of these fish are YOY to 1-year-old fish with little adult representation of the species (CDOW, 2007a). In addition, none of the sport or non-sport native fish species found in the South Platte River below Chatfield Reservoir are currently recognized as special status, threatened, or endangered species and all are considered common in Colorado (Nesler, 2003).

An increased flow to the South Platte River below Chatfield Reservoir during the warmer months and low-flow periods would help in protecting aquatic biota from poor water quality conditions that currently exist. For example, treated wastewater effluent can account for as much as 100 percent of stream flow downstream from Denver during these months and this effluent was the primary source of nitrate, ammonia, and phosphorus in the South Platte River and adjoining Front Range streams (National Water-Quality Assessment Program [NAWQA], 2002). An addition of cool, flowing water would assist in flushing high nutrient content and lowering instream water temperatures, and thus help prevent possible eutrophication. Much of the downstream water from Chatfield Reservoir is recycled at some point for municipal use, and any increase in flow would be beneficial to all aquatic biota present. The focus of any such flow management would be to improve habitat conditions above those that currently exist, by way of enhancement to the resource rather than required mitigation of adverse effects attributable to reallocation.

Alternative 3 would not have adverse impacts on aquatic life in the tributaries to Chatfield Reservoir. Increases in flow would primarily occur along the South Platte River, which is partially controlled by the release of water from Strontia Springs Reservoir (see Section 3.5). The South Platte River above Chatfield supports cold-water habitats that contain cold-water game fish such as rainbow and brown trout. Also occurring are white sucker, longnose sucker, and longnose dace. The other reservoir tributaries, Plum Creek and Deer Creek, described above, are limited in flows and in quality of game fish habitats (USFWS, 2006).

Under Alternative 3, an approximate 3,643-foot (0.69-mile) reach of the South Platte River directly above Chatfield Reservoir would be intermittently inundated (Figure 4-1). This reach is within the flood control pool of Chatfield Reservoir and has been periodically inundated in the past during large storm events. However, under Alternative 3 the duration of inundation of this reach is expected to be longer than under flood events, and this could result in changes in the aquatic habitat and the composition of species utilizing the habitat. This reach of the South Platte River contains typical cold-water riverine habitat and aquatic biota as well as some occasional warm-water species that migrate from the reservoir. The increased perimeter of Chatfield Reservoir would alter the fish and macroinvertebrate community composition of the inundated tributaries. Fish composition would change from cold- and cool-water species to more warm-water species by increasing the shallow still-water areas along the reservoir perimeter. The macroinvertebrate community in the South Platte River contains many sensitive taxa such as Ephemeroptera, Plecoptera, and Trichoptera (EPT) orders of insects that typically best thrive in cold-water streams. Inundation of this small stretch could alter the species composition of macroinvertebrates by removing or reducing stream-sensitive species and increasing taxa that are tolerant of a larger range of temperature and dissolved oxygen conditions.

4.5.4 Alternative 4—7,700 Acre-Feet Reallocation/NTGW/Downstream Gravel Pits

In addition to the reallocation, another 5,379 acre-feet would be obtained from NTGW and/or other storage downstream gravel pits under Alternative 4. The potential effects on aquatic life from conversion of downstream gravel pits to water storage reservoirs and use of NTGW are disclosed under Alternatives 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2.

Alternative 4 would generally provide a positive impact to the Chatfield Reservoir aquatic ecosystem as included in the discussion of potential water quality impacts from nutrient loading in Section 4.4.4 and Appendix J. An overall increase in productivity under Alternative 4 would be less than under Alternative 3. Precise quantification of increases in primary productivity may be difficult to determine between the two reallocation alternatives; however, an index of potential benefits can be gained when comparing increases in pool area and pool perimeter.

There would be a 215-acre gain in pool area and a 2,854-foot increase in pool perimeter between Alternatives 1 and 4 (Figure 4-1). On average, the pool area would increase by approximately 43 acres, and the perimeter would increase approximately 2,854 feet, for every 1 foot of increase in pool elevation. The areas inundated due to the reallocation would essentially be shallow water areas within the reservoir. These shallow water areas would increase overall productivity and could potentially affect several key components of the reservoir's aquatic community. These include impacts on sport fish, forage fish, and native species populations.

Reservoir filling to 5,437 feet msl could potentially influence natural reproduction by cool- and warm-water fish communities in the reservoir. Timeframes for natural reproduction by various cool-water sport fish in Chatfield Reservoir begin in mid-March, when walleye spawn and egg-taking operations commence. As currently projected, pool elevations would increase during this period, with filling occurring during spring runoff and from seasonal storm events (Figure 4-11). However, based on filling and storage scenarios for Alternative 4, there would not be an adverse impact on natural reproduction of these sport fish species in Chatfield Reservoir. Natural reproduction for the primary sport fish of concern would be finished before the decrease in water levels. As mentioned previously, populations of walleye, rainbow trout, and channel catfish in Chatfield Reservoir are and would continue to be maintained by annual stocking (CDOW, 2007a).

Warm-water sport fish spawning occurs in mid-June when fish including crappie, bluegill, smallmouth bass, and largemouth bass spawn. Declining water levels during this time period could have negative impacts on successful natural reproduction for these species and adversely impact their populations within Chatfield Reservoir. As shown in Figure 4-11, projected water withdrawals would begin in late spring and continue through the summer months.

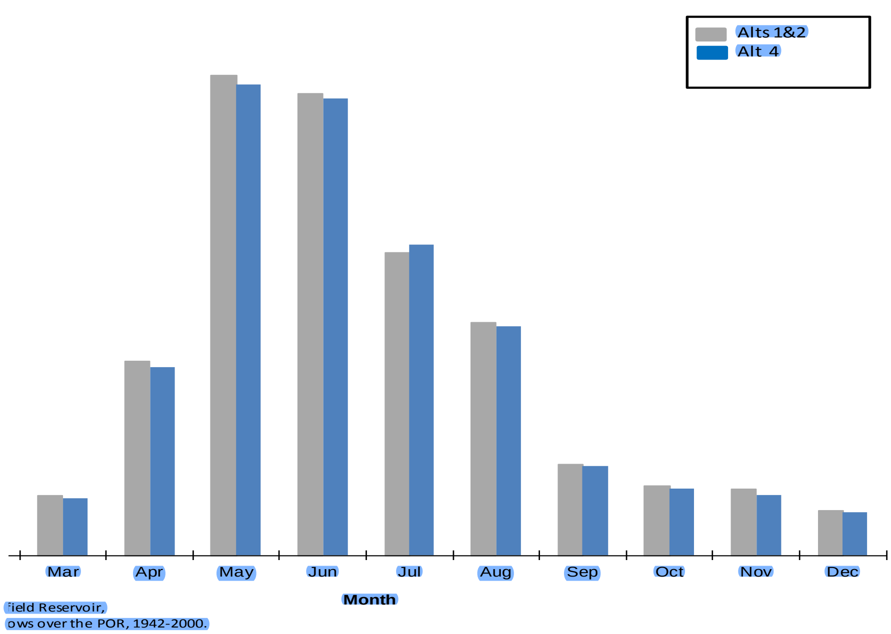
As with sport fish, the inundation of new pool areas under Alternative 4 would provide a generally positive impact on forage fish populations in the reservoir, although not to the same degree as in Alternative 3. Increases in primary productivity would especially benefit gizzard shad populations, which are dependent on plankton populations as primary food sources. Inundation of new pool areas and the resultant infusion of new nutrients from decay of organic material would enhance plankton populations in the reservoir and provide a positive impact to gizzard shad and other forage fish populations during the period of increased pool elevations. One possible limit to positive impacts is gizzard shad reproduction, which occurs from approximately mid-May to mid-June depending on reservoir water temperature. The onset of decreased water levels under reallocation Alternative 4 during reproduction along with slight increases in water temperatures could adversely affect gizzard shad populations.

Crayfish populations would benefit from newly inundated pool areas with a resulting enhancement of forage for smallmouth and largemouth bass populations. Additional forage production consists of YOY of certain game fish, primarily yellow perch and bluegill (Nesler, 2003). As with sport fish, the inundation of new pool areas under Alternative 4 would provide a generally positive impact to forage fish populations in Chatfield Reservoir.

A few native fish species exist within Chatfield Reservoir and include the gizzard shad, western white sucker, and green sunfish. None of these species are recognized as sensitive, threatened, or of special status concern in Colorado, and all are likely to be found in many aquatic habitats throughout Colorado. One other native species, Iowa darter, has been sampled in Chatfield Reservoir by CDOW. However, only two individuals have been collected over an 8-year sampling period (CDOW, 2007a). Iowa darters are more commonly found in and associated with a limited number of streams in northeastern Colorado (Woodling 1985). Consistent with previously discussed impacts, it is anticipated that the higher pool elevations experienced under Alternative 4 would enhance habitat conditions for the native species in Chatfield Reservoir and would not adversely impact them.

Under Alternative 4, similar conditions would exist in the South Platte River below Chatfield Reservoir, with minimal changes during base flow conditions and a very small increase in flow during the late summer months (Figure 4-13). Managing the timing, duration, and amount of flow from the Chatfield Reservoir is an important tool in enhancing aquatic biota in the South Platte River. For example, a projected increase in flow during July would have a positive effect on aquatic biota downstream of the reservoir. The current cool- and warm-water species present experience stress during late summer months from increased water temperatures and decreased flow.

Figure 4-13
Comparison of Flows in the South Platte River
Below Chatfield Reservoir if Alternative 4 Were Implemented



Another critical aquatic stressor is base flow conditions during the winter months. Based on the Corp's modeling results, the projected change during winter base flow conditions is a very slight decrease that would have minimal impact on the aquatic biota present. However, this decrease in base flow may impact the Chatfield SFU during the late fall or winter months. Currently, there are no minimum base flows required below Chatfield Dam and senior water right holders can choose to use all available water during the late fall and winter months. This action often leaves the river dry until the next water effluent is reached (likely Marcy Gulch). Therefore, a decrease, however slight, would further decrease water needed for the Chatfield SFU.

For impacts to the sport fish community and to water quality to the South Platte River below Chatfield Reservoir, see Alternative 3. Alternative 4 would not adversely impact aquatic life in the tributaries to Chatfield Reservoir. Increases in flow would primarily occur along the South Platte River, which is partially controlled by the release of water from Strontia Springs Reservoir (see Section 3.5). The South Platte River above Chatfield Reservoir supports cold-water habitats that contain cold water game fish such as rainbow and brown trout. Also occurring are white sucker, longnose sucker, and longnose dace. The other reservoir tributaries, Plum Creek and Deer Creek, described above, are limited in flows and in quality of game fish habitats (USFWS, 2006).

Under Alternative 4, a small portion of the South Platte River above Chatfield Reservoir (slightly smaller than Alternative 3) would be intermittently inundated (Figure 4-1). Impacts to this reach are similar to those described in Alternative 3, although less of the stream reach will be impacted.

4.5.5 Reduction of Potential Impacts

Managing the release of water from Chatfield Reservoir could be an important tool in enhancing all aquatic communities present. If the releases of water from the reservoir were more evenly distributed throughout the year so that appropriate pool levels were maintained during fish spawning and embryo development, there could be less impact on reproductive success of warm-water fish species in the reservoir. Similarly, keeping instream flow rates high on the South Platte River below the reservoir during times of low flow and higher temperature could reduce stressors put on the aquatic community in this reach. However, future water demands would dictate alterations in current flow patterns in the South Platte River regardless of increased storage capacity in Chatfield Reservoir.

Increased habitat structure would be expected to occur with the inundation of trees adjacent to Chatfield Reservoir. As indicated in the Tree Management Plan (Appendix Z), selected trees within the inundated area will be cut and anchored in place for fisheries habitat. This would create positive habitat for fish, aquatic insects, and aquatic flora that inhabit these areas. Visitor and dam safety will take priority in determining where trees can be retained and anchored.

The Corps has conducted coordination and informal consultations with the USFWS regarding potential impacts to fish and wildlife resources and their recommendations for mitigation, including a Planning Aid Report (February 2006) and progress letter (July 2010) (see Appendix X).

Within Chatfield Reservoir, the CPW currently conducts a walleye broodstock program that includes an annual egg-taking process used to populate multiple Colorado reservoirs with the popular game fish. Since an abrupt release of pool levels has been shown in the past to have significant adverse impacts on walleye reproductive success, 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. The critical period for the walleye broodstock program is from March 1 to April 15. Monitoring by CPW will be used to verify that the provisions of the Coordinated Reservoir Operations Plan limiting the magnitude of releases from the reallocated pool provide the desired protections from adverse release events or will inform if adjustments to operations are needed to benefit the walleye broodstock program.

The adaptive management process (Appendix GG) will allow the water providers, Corps, and resource agencies to be responsive to issues should they arise. In addition, beyond the mitigation measures that are part of the Selected Plan, the water providers propose to fund stream habitat improvements on up to 0.7 miles of the mainstem of the South Platte River above Chatfield Reservoir. Also, while this analysis does not suggest a significant loss of habitat downstream, to allay CDOW concerns, the water providers have agreed to pursue stream habitat improvement on up to 0.5 miles of the mainstem of the South Platte River downstream of Chatfield Reservoir. The specific sites and project designs for these measures will be selected in coordination with CDOW.

4.6 Vegetation

All types of vegetation are susceptible to the impacts of flooding and inundation. Trees are more susceptible to the impacts of flooding and inundation during the growing season (Kozlowski, 1997), and flooding during the dormant season typically has little impact on trees (Bell & Johnson, 1974). Thus, the analysis of impacts on trees focused on the pool elevations reached during the growing season. This analysis of impacts on trees is also based on the maximum level of inundation for each alternative, or the upper bound scenario. The growing season at the Chatfield study area was estimated from data from the Colorado Climate Center for a weather station at Kassler, Colorado (Doesken, 2006). The boundaries of the growing season were based on the median dates at which 28 degrees Fahrenheit is last reached in the spring and first reached in the fall, based on the years 1975 to 2005. These dates are April 25 and October 11, respectively, and correspond to a growing season of approximately 170 days.

Trees that are tolerant of flooding, including the plains cottonwood, may withstand an entire growing season of inundation. However, they are killed when they are inundated for two consecutive growing seasons (USFS, 1993; Teskey & Hinckley, 1978; Whitlow & Harris, 1979). Some studies indicate that flooding for even one growing season can result in significant mortality in mature cottonwoods (Yin et al. 1994). Saplings are even more susceptible to flooding than mature trees (Yin et al., 1994).

The reservoir modeling results were used to calculate the number of days in each growing season that exceeded specific pool elevations. These results were used to estimate at what pool elevations trees are likely to be killed. The analysis focused on the plains cottonwood (*Populus deltoides* var. *occidentalis*) since it is the dominant tree in the area potentially inundated by increased storage in Chatfield Reservoir.

The drawdown zone would be alternately inundated and exposed for variable periods each growing season. The cyclic disturbance would allow invasion of both native and exotic species that must be monitored and managed. Likely invasive species are listed in the following paragraphs and further identified in Chapter 3 (see Section 3.6). A combination of exotic species control and native species encouragement would be needed to prevent exotic species domination. A complex of factors that control vegetation establishment would vary each year and require an adaptive management approach to achieve the desired goal. Factors that would affect vegetation establishment include the duration and timing of inundation, soil characteristics, water quality, availability of native and exotic species propagules, and proposed treatments.

The duration of inundation, as well as the duration and depth of soil saturation, are the primary factors affecting the establishment of plant species and succession of plant communities on the reservoir margin. Over the short term, changes can be expected to be quite variable since the natural availability of native or exotic weed seed combined with the site-specific conditions can be unpredictable. Over the long term, vegetation management can enhance the establishment of targeted native species and prevent exotics from proliferating by using monitoring data from weed control efforts to develop more effective control procedures.

The highest priority should be the management of weedy perennials such as the woody species tamarisk (*Tamarix ramosissima*), crack willow (*Salix fragilis*), and Russian olive (*Eleagnus angustifolia*), as well as aggressive perennial herbaceous species such as Canada thistle (*Breea arvensis*) and reed canarygrass (*Phalaris arundinacea*) or annuals such as puncturevine (*Tribulus terrestris*). Vegetation management should also include the intentional establishment of native species such as plains cottonwood and sand bar willow (*Salix exigua*) in areas with shorter periods, or lower frequencies, of inundation, and aggressive natives such as foxtail barley (*Critesion jubatum*) in areas that are regularly inundated for longer periods.

The drawdown zone would be in a cycle of disturbance that would limit vegetation establishment to annuals, biennials, and short-lived perennials. It is anticipated that woody species such as plains cottonwood, crack willow, sandbar willow, and potentially tamarisk could become naturally established apart from any intentional vegetation establishment program at the upper extent of the drawdown zone where soil conditions are adequate for germination. However, any natural establishment would be restricted, as mentioned above, by the duration and timing of inundation, precipitation, soil characteristics, water quality, and availability of native and weed species propagules. The necessary convergence of timely precipitation throughout the spring and early summer during the first one or two growing seasons, the presence of live seed of native riparian species, the absence or low competitive pressure from aggressive weedy species, and a high pool elevation to charge the groundwater table make the likelihood of natural establishment very low in the short term, although probable in the long term. Therefore, the short-term uncertainty associated with natural establishment would mean that natural establishment would only serve as a fortunate support system to any intensive, adaptive management program for vegetation establishment at or immediately above the drawdown zone. The next cycle of inundation would be expected to kill those newly established individuals that are submerged. Those individuals above the ordinary high water mark (OHWM) may survive if precipitation and an elevated groundwater level coincide.

A comparison of the fluctuation zones of other reservoirs in the region indicates that it is not very likely that an expanded fluctuation zone at Chatfield will be dominated by mud flats (Appendix HH "Comparative Review of Reservoir Fluctuation Zone Chatfield Reallocation Project"). The potential for weeds to invade the fluctuation zone of Chatfield will need to be monitored and if weeds do invade, controlled (Appendix GG). A review of other reservoirs in the metro area indicated that they do not appear to have substantial weed issues within their fluctuation zones, although some reservoirs in southeast Colorado do have weed problems within the fluctuation zone. Mud flats were uncommon at these reservoirs, and the substrate for these reservoirs was finer than the course sands and pea gravel that currently comprise the fluctuation zone at Chatfield Reservoir.

A Tree Management Plan (Appendix Z) has been developed to address the removal of trees that would be inundated under Alternatives 3 or 4. In general, under Alternative 3, the majority of trees between 5,432 and 5,439 feet msl would be removed prior to raising the pool elevation. Selected trees in some areas may be retained for fisheries or wildlife habitat. These areas will be determined based on a review by USACE, State Parks, and CDOW. Additionally, implementation of an inundation alternative would be conducted in a step-wise fashion allowing maximum water levels to be achieved only after mitigation for partial inundation was achieved or at least underway. For example, under Alternative 3, the mitigation for an intermediate pool elevation (e.g., 5,440 feet) would be allowed, but the ability to fill to the maximum elevation of 5,444 feet would not be allowed until mitigation was underway for impacts at the intermediate level of 5,440 feet. This phased or step-wise implementation is discussed in the CMP (Appendix K, Section 7.2). Once the selected alternative is fully implemented and use of the maximum pool elevation is approved and established, the tree management plan would monitor trees that are partially inundated to determine if additional trees need to be removed.

Once the annual cycle of the reservoir drawdown has been established for a few years, a successional sequence of vegetation can be expected at the upper end of the drawdown zone. This fringe of vegetation would be closely linked to a gradient of soil moisture conditions. The zone of saturated soils above the OHWM would extend for variable distances from the upper end of the drawdown zone depending on soil texture, slope, and the upgradient conditions including the normal depth of the water table. For each of the alternative pool elevation targets, the successional changes would occur in established uplands, so a complex successional sequence would include competition between established upland and pioneering riparian species. The current vegetation along the reservoir margin may probably be replicated over the long term if weedy species were controlled, and the intentional planting of target native species could accelerate this process. However, these successional changes are dependent on the many variables discussed in the preceding paragraph and long-term successional increases in riparian or wetland communities are not used to temper the estimates of vegetation community losses described in Table 4-9. An assessment of the potential future plant communities is discussed by alternative in the following sections. The potential plant communities described for Alternatives 3 and 4 (Tables 4-9, 4-10, and 4-11) are based on the current distribution of communities on the reservoir margin and an assumption that moisture will be available during the growing season for sufficient duration at or slightly above target pool elevations. This current distribution of plant communities is based on a vegetation map of Chatfield State Park prepared by CDNR in 2001. The exact new condition for each alternative is unknown due to the high fluctuation of the water levels associated with certain alternatives.

Table 4-9
Vegetation and Feature Losses due to Inundation

Dominant Vegetation Class with Species Composition[1]	Alternative 3 Inundation loss 5,432–5,444 feet msl (acres)	Alternative 4 Inundation loss 5,432–5,437 feet msl (acres)
Total Area Inundated from 5,432 feet msl to Top of Conservation Pool (includes Facilities, Ponds, and Vegetation)	587	223
Total Acres of Facilities and Ponds Inundated from 5,432 feet msl to Top of Conservation Pool	112.2	24.0
Total Acres of Vegetation Inundated from 5,432 feet msl to Top of Conservation Pool (includes the three vegetation categories below in bold)	474.8	199.0
Total Riparian/Wetland Native Forest, Woodland or Shrubland	204.0	111.4
narrowleaf cottonwood and plains cottonwood	72.3	27.5
Plains cottonwood (including mature cottonwood forest)	113.4	76.6
Plains cottonwood seedlings	0.0	0.0
Plains cottonwood, diffuse knapweed, mullein	1.2	1.2
sandbar willow	16.7	6.1
smartweed, witchgrass, cottonwood seedlings	0.1	0.1
skunkbrush, smooth sumac	0.3	0.1
Total Upland Introduced Annual and Perennial Grasslands and Forbs	257.8	80.6
Canada thistle, diffuse knapweed	0.7	0.7
cheatgrass, sand dropseed	3.6	2.4
cheatgrass, sand dropseed, mullein	66.9	21.0
cheatgrass, smooth brome, leafy spurge, diffuse knapweed	0.4	0.1
crested wheatgrass, cheatgrass, smooth brome	0.0	0.0
crested wheatgrass, sand dropseed, smooth brome, intermediate wheatgrass	9.7	6.0
diffuse knapweed	19.6	8.9
smooth brome	151.1	40.4
smooth brome, crested wheat, diffuse knapweed	4.6	0.7
mowed grass	1.3	0.4
Total Upland Native Perennial Grassland	13.0	7.0
blue grama and sand dropseed	3.6	3.2
blue grama, three awn, side oats grama, cheatgrass	1.2	0.3
needle and thread, sand dropseed	0.1	0.1
sand dropseed	2.1	0.9
sand dropseed, buffalo grass	1.2	1.0
sand dropseed, crested wheat, smooth brome	4.8	1.5

[1] Vegetation composition and existing acreages are based on CDNR (2001).

Table 4.10
Estimated Change in Acreage of Existing Vegetation Types Within 0–6 foot Elevation Band above Proposed OHWMs for Alternatives 3 and 4 (acres)

	Alternative 3			Alternative 4		
Dominant Vegetation Class with Species Composition	Increase (Decrease)	Existing Acreage	Expected New Total Acreage	Increase (Decrease)	Existing Acreage	Expected New Total Acreage
Riparian/Wetland Native Forest or Shrubland	79.2	50.1	129.2	79.3	80.8	160.1
narrowleaf cottonwood and plains cottonwood	8.0	27.9	35.9	3.2	38.5	41.8
plains cottonwood	65.0	18.2	83.2	73.7	33.0	106.7
plains cottonwood seedlings	0.0	0.0	0.0	0.0	0.0	0.0
plains cottonwood, diffuse knapweed, mullein	1.1	0.0	1.1	1.4	0.0	1.4
sandbar willow	5.1	3.7	8.8	0.9	9.1	9.9
skunkbrush, smooth sumac	(0.2)	0.3	0.1	(0.1)	0.2	0.1
smartweed, witchgrass, cottonwood seedlings	0.1	0.0	0.1	0.1	0.0	0.1
Upland Introduced Annual and Perennial Grasslands and Forbs	(59.0)	164.4	105.4	(28.7)	147.4	118.7
Canada thistle, diffuse knapweed	0.7	0.0	0.7	1.0	0.0	1.0
cheatgrass, sand dropseed	3.7	0.0	3.7	2.8	1.2	3.9
cheatgrass, sand dropseed, mullein	(21.3)	47.5	26.2	(7.4)	37.4	30.0
cheatgrass, smooth brome, leafy spurge, diffuse knapweed	(0.5)	0.6	0.1	(0.2)	0.2	0.1
crested wheatgrass and cheatgrass	(0.1)	0.1	0.0	0.0	0.0	0.0
crested wheatgrass, cheatgrass, smooth brome	(0.7)	0.7	0.0	(0.0)	0.0	0.0
crested wheatgrass, sand dropseed, smooth brome, intermediate wheatgrass	4.7	2.5	7.2	5.3	3.4	8.6
diffuse knapweed	0.2	10.9	11.1	4.0	9.0	13.0
mowed grass	0.4	0.2	0.6	(0.2)	0.8	0.6
smooth brome	(40.4)	95.3	54.9	(32.0)	92.4	60.4
smooth brome, crested wheat, diffuse knapweed	(5.5)	6.5	1.0	(2.1)	3.2	1.1
Upland Native Perennial Grassland	(2.6)	10.5	7.9	4.4	5.3	9.6
blue grama and sand dropseed	3.3	0.1	3.4	4.0	0.4	4.4
blue grama, buffalo grass, threeawn	(0.0)	0.0	0.0	0.0	0.0	0.0
blue grama, three awn, side oats grama, cheatgrass	(0.8)	1.3	0.4	(0.3)	0.7	0.5
needle and thread, sand dropseed	(4.7)	4.7	0.0	(0.1)	0.1	0.0
sand dropseed	0.5	0.6	1.2	0.1	1.1	1.2
sand dropseed, buffalo grass	1.1	0.0	1.1	1.2	0.2	1.4
sand dropseed, crested wheat, smooth brome	(1.9)	3.8	1.9	(0.6)	2.9	2.2

Table 4-11
Comparison of Estimated Changes in Acreage of Existing Vegetation Types for Alternatives 3 and 4

Dominant Vegetation Class with Species Composition	Alternative 3 - 5,444 feet msl			Alternative 4 - 5,437 feet msl		
	Inundation loss	Increase (Decrease)	Overall Increase (Decrease)	Inundation loss	Increase (Decrease)	Overall Increase (Decrease)
Total Riparian/Wetland Native Forest, Woodland or Shrubland	(204.0)	79.2	(124.8)	(111.4)	79.3	(32.1)
narrowleaf cottonwood and plains cottonwood	(72.3)	8.0	(64.3)	(27.5)	3.2	(24.3)
plains cottonwood (including mature cottonwood forest)	(113.4)	65.0	(48.4)	(76.6)	73.7	(2.9)
plains cottonwood seedlings	0.0	0.0	0.0	0.0	0.0	0.0
plains cottonwood, diffuse knapweed, mullein	(1.2)	1.1	(0.1)	(1.2)	1.4	0.2
sandbar willow	(16.7)	5.1	(11.6)	(6.1)	0.9	(5.3)
skunkbrush, smooth sumac	(0.3)	(0.2)	(0.5)	(0.1)	(0.1)	(0.2)
smartweed, witchgrass, cottonwood seedlings	(0.1)	0.1	(0.0)	(0.1)	0.1	0.0
Total Upland Introduced Annual and Perennial Grasslands and Forbs	(257.8)	(59.0)	(316.8)	(80.6)	(28.7)	(109.3)
Canada thistle, diffuse knapweed	(0.7)	0.7	(0.0)	(0.7)	1.0	0.3
cheatgrass, sand dropseed	(3.6)	3.7	0.1	(2.4)	2.8	0.4
cheatgrass, sand dropseed, mullein	(66.9)	(21.3)	(88.2)	(21.0)	(7.4)	(28.4)
cheatgrass, smooth brome, leafy spurge, diffuse knapweed	(0.4)	(0.5)	(0.9)	(0.1)	(0.2)	(0.3)
crested wheatgrss and cheatgrass	0.0	(0.1)	(0.1)		0.0	0.0
crested wheatgrass, cheatgrass, smooth brome	0.0	(0.7)	(0.7)	0.0	(0.0)	(0.0)
crested wheatgrass, sand dropseed, smooth brome, intermediate wheatgrass	(9.7)	4.7	(5.0)	(6.0)	5.3	(0.7)
diffuse knapweed	(19.6)	0.2	(19.4)	(8.9)	4.0	(5.0)
mowed grass	(1.3)	0.4	(0.9)	(0.4)	(0.2)	(0.6)
smooth brome	(151.1)	(40.4)	(191.5)	(40.4)	(32.0)	(72.4)
smooth brome, crested wheat, diffuse knapweed	(4.6)	(5.5)	(10.1)	(0.7)	(2.1)	(2.8)
Total Upland Native Perennial Grassland	(13.0)	(2.6)	(15.6)	(7.0)	4.4	(2.6)
blue grama and sand dropseed	(3.6)	3.3	(0.3)	(3.2)	4.0	0.8
blue grama, buffalo grass, three awn	0.0	(0.0)	(0.0)		0.0	0.0
blue grama, three awn, side oats grama, cheatgrass	(1.2)	(0.8)	(2.0)	(0.3)	(0.3)	(0.6)
needle and thread, sand dropseed	(0.1)	(4.7)	(4.8)	(0.1)	(0.1)	(0.2)
sand dropseed	(2.1)	0.5	(1.6)	(0.9)	0.1	(0.8)
sand dropseed, buffalo grass	(1.2)	1.1	(0.1)	(1.0)	1.2	0.2
sand dropseed, crested wheat, smooth brome	(4.8)	(1.9)	(6.7)	(1.5)	(0.6)	(2.1)

4.6.1 Alternative 1—No Action

Cottonwoods are not currently found within the normal conservation pool of 5,432 feet msl. Significant adverse impacts on trees have not been observed during past flood events that have caused short-term spikes in the pool elevation. Pool elevation data from the Tri-Lakes Office at Chatfield indicated that there were three high-water events from the period of 1975 to 2006. These occurred in 1980, 1983, and 1995. The maximum water level reached approximately 5,448 feet msl. During these events, the pool was above 5,432 feet msl for about 45 to 70 days. These events did not result in significant adverse impacts on trees (Rios, 2007; Sitoski, 2007).

Output from the hydrology model (Appendix H) indicates that there is only 1 year in the POR where the pool elevation in the growing season is above 5,432 feet msl for more than 30 days. The maximum duration above 5,432 feet msl was 37 days. The maximum pool elevation reached for more than 30 days was 5,443 feet msl, 11 feet above the normal pool elevation. The maximum pool elevation reached was 5,459 feet msl, 27 feet above the normal pool elevation. There are no years when a pool elevation of 5,432 feet is exceeded for the entire growing season.

Based on the historical data and the modeling results, adverse impacts on vegetation, especially trees, are not expected above the normal pool elevation of 5,432 feet msl. Resulting acreage loss to vegetation for Alternative 1 is not included here as it is assumed there are no impacts.

Inundation of Penley Reservoir would result in the loss of deciduous oak and mesic upland shrub plant communities. These communities are not unique to this area and occur in other regions throughout Colorado (NDIS, 2008a). Pipeline construction associated with Penley Reservoir would result in the conversion of seven land cover types including deciduous oak, mesic upland shrub, tallgrass prairie, midgrass prairie, foothills/mountain grassland, dryland agriculture, and irrigated agriculture (Figure 3-3). Because the pipeline would be buried underground, impacts to vegetation would be temporary and habitat loss would not be significant. Construction-related traffic can introduce non-native and noxious weeds into the area; thus, appropriate weed control measures would be used to avoid these types of impacts.

The downstream gravel pits are currently being mined (or are already mined out) for gravel and are therefore unvegetated. Inundation of these pits would not result in the loss of vegetation. However, temporary impacts to vegetation may occur during construction of the gravel pit infrastructure; these impacts will be minimized by revegetating with native plants as soon as practicable after infrastructure installation.

4.6.2 Alternative 2—NTGW/Downstream Gravel Pits

Under Alternative 2, reservoir levels and operations at Chatfield Reservoir would remain unchanged. Thus, vegetation at Chatfield Reservoir would not be adversely impacted. As in Alternative 1, there would be no impacts on vegetation from the conversion of downstream gravel pits to water reservoirs. However, temporary impacts to vegetation may occur during construction of the gravel pit infrastructure; these impacts will be minimized by revegetating with native plants as soon as practicable after infrastructure installation. Under Alternative 2, Penley Reservoir would not be constructed, thus vegetation in the Penley area would not be affected.

4.6.3 Alternative 3—20,600 Acre-Foot Reallocation

Under Alternative 3, there would likely be complete or significant kill of cottonwoods between pool elevations of 5,432 to 5,442 feet msl due to prolonged inundation during the growing season. The anticipated loss of existing vegetation communities due to inundation is presented in Table 4-9. This table describes 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); including 204 acres of riparian and/or wetland communities. These acreages are based on a vegetation map of Chatfield State Park prepared by CDNR in 2001.

Conversely, the higher pool levels projected in Alternatives 3 and 4 would likely enhance soil moisture in many areas that are currently at elevations too high to benefit from lateral infiltration of reservoir water. Table 4-10 describes the probable change (i.e., "Increase" or "Decrease") in vegetation communities in a 6-foot elevation band immediately above the projected pool elevation levels for Alternatives 3 and 4. A 6-foot elevation band is referenced due to GIS mapping and analysis of the vegetation communities that currently exist at the study site. Based on this analysis it is assumed that the vegetation communities immediately surrounding the reservoir (within 0 to 6 feet of the pool elevation) have a water table that is somewhat affected by the existing reservoir elevation fluctuations. This relationship is tied to the elevated water tables commonly found adjacent to reservoirs and soil composition. The existing established communities within this 6-foot band were then used as a model to estimate the future, long-term establishment (or loss) of plant communities that would be affected by implementation of Alternatives 3 or 4. Of course, this modeling and the assumptions described in Table 4-10 are hypotheses of vegetation community change above the alternative maximum pool levels and do not affect the estimated impact figures from inundation provided in Table 4-9. Likewise, the figures provided in Table 4-10 do not represent promises of mitigation and should not be the sole basis of mitigation proposals.

In order to develop the projections provided in Table 4-10, the current ratio of vegetation communities within this 6-foot band is applied to the acreage of land that would have this same relative elevation (i.e., 0-6 feet) above the alternative targeted pool elevations. When comparing impacts to vegetation as a result of inundation under Alternatives 3 and 4, it is important to realize that the vegetation losses will be somewhat offset by successional changes at the new OHWM as explained above. For example, dry grassland areas may be transformed into valuable riparian shrublands as more water becomes available at higher elevations. The impacts and offsetting successional changes do not necessarily occur in the same areas and are not typically additive or subtractive in terms of numbers of acres gained or lost. Instead, the amounts of vegetation gains and losses depends on slopes, existing vegetation, distance from the new OHWM, and future weather events and future disturbances. Therefore, values in Table 4-10 are arrived at using spatial analysis and not simple arithmetic methods.

The "Expected New Total Acreage" of vegetation communities presented in Table 4-10 is a combination of the areas of previously mapped vegetation communities located within the 6-foot bands and estimated "Increase" or "Decrease" of those same vegetation communities based on the above-mentioned spatial analysis. For example, if 100 acres of a specific vegetation community is expected above the new pool elevation, but 45 acres of that vegetation community already exist, then the change would be an increase of 55 acres in that vegetation community.

Table 4-10 indicates that implementation of Alternative 3 would affect an estimated 79.2-acre increase in riparian/wetland native forest or shrublands, a 2.6-acre decrease in native perennial grasslands, and a 59.0-acre decrease in upland annual and perennial grasslands and forbs. However, these would be long-term, not immediate, changes caused by implementation of the alternative. Table 4-11 provides a direct comparison of the projected vegetation community losses due to inundation described in Table 4-9 and the projected long-term changes described in Table 4-10 for both Alternatives 3 and 4.

The hydrology model output shows that pool elevations of greater than 5,440 feet msl are reached for the entire growing season in 10 of the 59 years (17 percent) of the POR, and there are three instances where this occurs in consecutive years. Pool elevations of greater than 5,441 feet msl are reached for essentially the entire growing season in 7 of the 59 years (12 percent) of the POR, and there is one instance where this occurs two years in a row. Pool elevations of greater than 5,442 feet msl are reached for essentially the entire growing season in four years of the POR, and there is one instance where this occurs in consecutive years. In addition, there are seven years in the POR that exceed 5,442 feet msl for at least 85 percent of the growing season. Thus, it is possible there could be significant kill of cottonwood trees at 5,442 feet msl.

There are no years in which the pool reaches more than 5,443 feet msl for the entire growing season. There is only 1 year in which this elevation is inundated for more than 90 percent of the growing season. There are two consecutive years where the area is inundated for more than 80 percent of the growing season. Because saplings are more sensitive to flooding than are mature trees, it is likely that saplings would be killed at this degree of inundation. The impact to mature trees may be less severe than at lower elevations, but it is likely that at least some mature cottonwoods would be killed. Each of these events would likely be accompanied by germination of cottonwoods, and other species, in areas with exposed saturated soil.

There are no years when 5,444 feet msl is exceeded for the entire growing season. The modeling results indicate that there is only 1 year in the POR where the pool elevation in the growing season is above 5,444 feet msl for more than 30 days. The maximum duration above 5,444 feet was 36 days. The maximum pool elevation reached for more than 30 days was 5,452 feet msl, 8 feet above the target pool elevation. The maximum pool elevation reached during this event was 5,466 feet msl, 22 feet above the target pool elevation.

Based on this assessment, the new upper limit of the drawdown zone disturbance that would prohibit the establishment of mature cottonwood would be somewhere between 5,442 and 5,444 ft. Willow shrubs would be prohibited from becoming established at a level slightly below the cottonwoods based on field observations of surviving vegetation at the current target elevation of 5,432 feet msl. It is likely that willows would become established at 5,442 feet msl and perhaps lower, given modeling results, but this would be based on the frequency of inundation from year to year. For example, if several years passed where flooding was absent or temporary (i.e., 30 days or less), willows could become established and thrive for several years, but once inundated for long durations (likely more than one growing season), they would die back and begin the establishment process over again.

Based on the average monthly pool fluctuations (Figure 4-11), the drawdown would be nearly identical with the exception of a plateau that extends from June to August. This would suggest that the hydrologic conditions at the upper edge of the pool, which would affect vegetation, would be about the same, even though the exposed area below this line would be larger.

However, reviewing year-to-year fluctuations based on changes in pool elevations during the growing season indicates that as the target pool elevation increases, the pool fluctuations increase. Based on the range of values between the 1st and 3rd quartile of data for all years combined, the fluctuation increases from approximately 4.2 feet of fluctuation under Alternative 1 or 2 (Figure 4-14), to 5.0 feet of fluctuation under Alternative 4 (5-foot rise) (Figure 4-16), and up to 7.1 feet of fluctuation for Alternative 3 (12-foot rise) (Figure 4-15). These data suggest that the shoreline water table would be available less often at the upper end of the exposed shoreline indicating that conditions along the shoreline would tend to be dryer as the target pool level increased. Therefore, conditions would favor dryer vegetation along the new shoreline due to drawdown that would be more extreme than under current conditions. This also indicates that the expected net charges in vegetation communities (Tables 4-9, 4-10, and 4-11) are at the upper end of the range of possibilities and likely overestimate future conditions.

4.6.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

In addition to the reallocation, another 5,379 acre-feet would be obtained from NTGW and\or other storage and downstream gravel pits under Alternative 4. The potential effects on vegetation from conversion of downstream gravel pits into water storage and use of NTGW are disclosed under Alternatives 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2.

Vegetation, including cottonwoods, from 5,432 up to 5,437 feet msl would likely be killed due to prolonged inundation. The anticipated loss of existing vegetation communities due to inundation is presented in Table 4-9. This table described 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); including 111.4 acres of riparian and/or wetland communities. This acreage includes approximately 15.3 acres of mature cottonwood forest. These acreages are based on the current distribution of communities on the reservoir margin and an assumption that moisture will be available during the growing season for sufficient duration at or slightly above target pool elevations. The current distribution of plant communities is based on a vegetation map of Chatfield State Park prepared by CDNR in 2001.

Table 4-10 indicates that implementation of Alternative 4 may affect an estimated 79.3-acre increase in riparian/wetland native forest or shrublands, a 4.4-acre increase in native perennial grasslands, and a 28.7-acre decrease in upland annual and perennial grasslands and forb. However, these are estimates and would be long-term, not immediate, changes caused by implementation of the alternative. Table 4-11 provides an overall summary of the inundation losses and vegetation community type changes associated with both Alternatives 3 and 4.

Output from the hydrology model (Appendix H) indicates that pool elevations of greater than 5,434 feet msl are reached for the entire growing season in 7 of the 59 years (12 percent) of the POR, including one instance where this occurs two years in a row. Above 5,435 feet msl, there are four years where essentially the entire growing season is inundated, including one instance of two consecutive years.

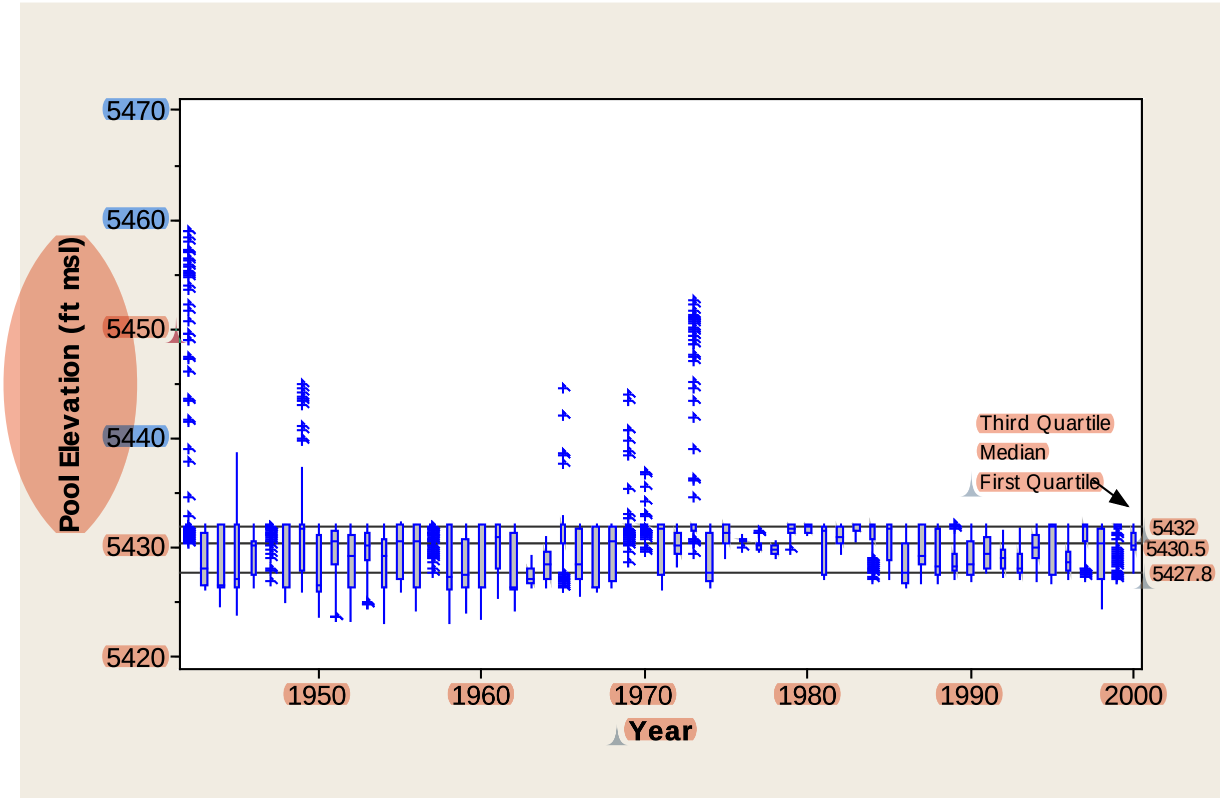


Figure 4-14
Pool Fluctuation During Growing Season Under Alternative 1 or 2

Note: Figure 4-14 is a box and whisker plot. The "box" includes the middle 50 percent of the data, and the horizontal line through the box represents the "median" value. Half of the observations are less than the median and half are greater than the median. The "+" symbols above or below the box represent extreme values for that year. The figure also shows that the variability in pool elevation is generally greater in the years before the dam was completed in 1973, as compared to the years after the dam was completed. This difference in variability occurs because the inflows to Chatfield Reservoir and the withdrawals from Chatfield Reservoir were modeled for the years before the dam was completed and were based on measured values for the years after the dam was completed. Natural variability also contributes to the difference in variability.

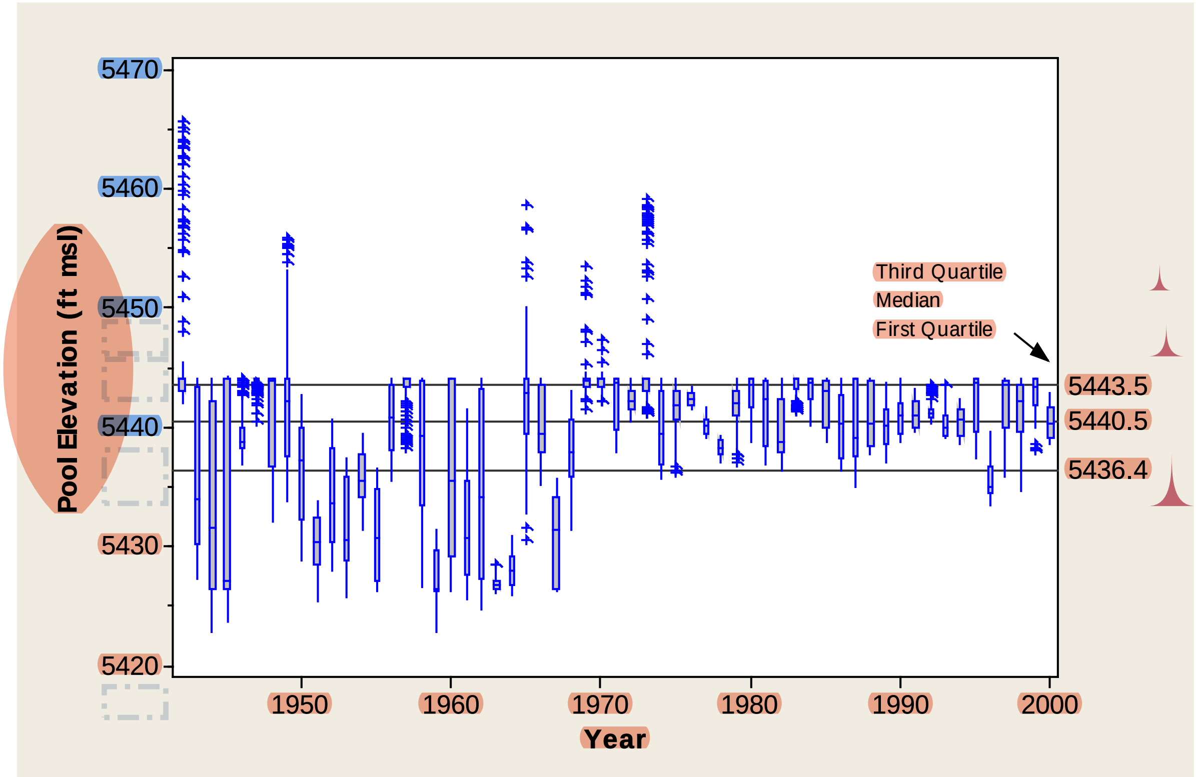


Figure 4-15
Pool Fluctuation During Growing Season Under Alternative 3

Note: Figure 4-15 is a box and whisker plot. The "box" includes the middle 50 percent of the data, and the horizontal line through the box represents the "median" value. Half of the observations are less than the median and half are greater than the median. The "+" symbols above or below the box represent extreme values for that year. The figure also shows that the variability in pool elevation is generally greater in the years before the dam was completed in 1973, as compared to the years after the dam was completed. This difference in variability occurs because the inflows to Chatfield Reservoir and the withdrawals from Chatfield Reservoir were modeled for the years before the dam was completed and were based on measured values for the years after the dam was completed. Natural variability also contributes to the difference in variability.

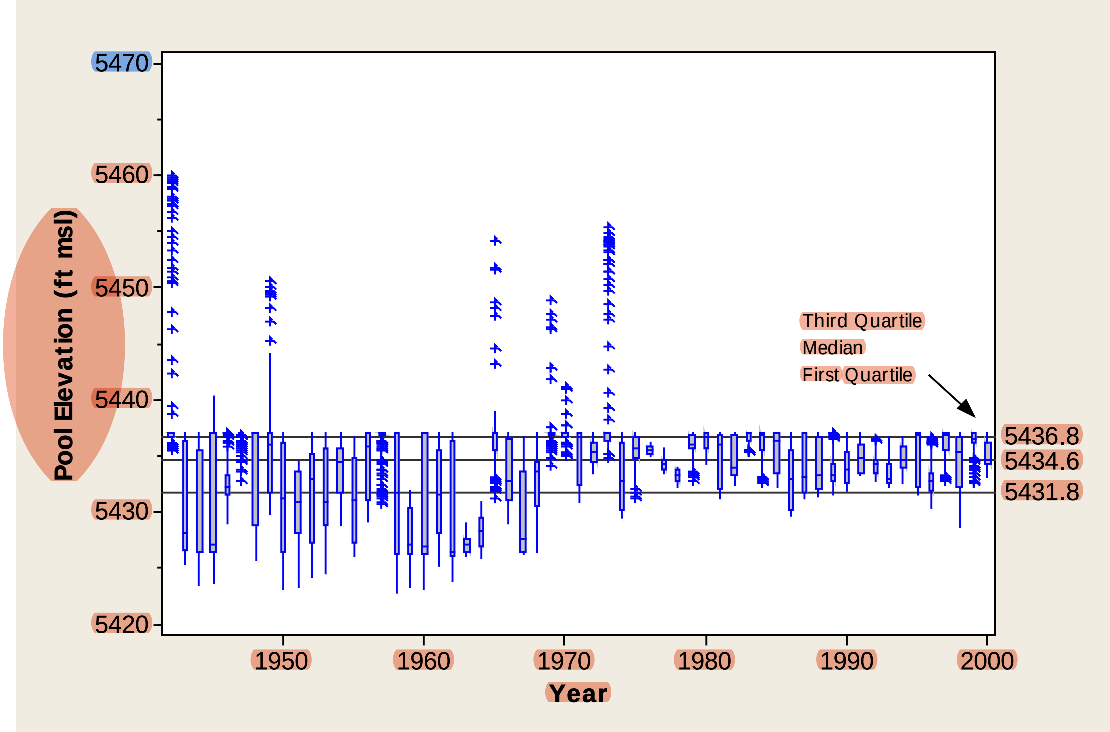


Figure 4-16
Pool Fluctuation During Growing Season Under Alternative 4

Note Figure 4-16 is a box and whisker plot. The "box" includes the middle 50 percent of the data, and the horizontal line through the box represents the "median" value. Half of the observations are less than the median and half are greater than the median. The "+" symbols above or below the box represent extreme values for that year. The figure also shows that the variability in pool elevation is generally greater in the years before the dam was completed in 1973, as compared to the years after the dam was completed. This difference in variability occurs because the inflows to Chatfield Reservoir and the withdrawals from Chatfield Reservoir were modeled for the years before the dam was completed and were based on measured values for the years after the dam was completed. Natural variability also contributes to the difference in variability.

There are no years in which the pool reaches 5,437 feet msl for the entire growing season. However, there are four years in which the area is inundated for more than 90 percent of the growing season. This includes two consecutive years when more than 94 percent of the growing season is inundated. Because saplings are more sensitive to flooding than are mature trees, it is likely that saplings would be killed to an even greater extent than mature trees. The impact to mature trees may be less severe than at lower elevations, but it is likely that a significant number of mature cottonwoods would be killed. Each of these events would probably be accompanied by germination of cottonwoods, and other species, in areas with exposed saturated soil.

The hydrology model output indicates that there is only 1 year in the POR where the pool elevation in the growing season is above 5,437 feet msl for more than 30 days. The maximum duration above 5,437 feet msl is 32 days. The maximum pool elevation reached for at least 30 days was 5,442 feet msl, 5 feet above the target pool elevation. The maximum pool elevation reached during this event was 5,460 feet msl, 23 feet above the target pool elevation. Based on this assessment, the new upper limit of the drawdown zone disturbance that would prohibit the establishment of mature cottonwood would be about 5,437 feet msl.

Based on an estimated upper limit of the drawdown zone, the lower limit of persistent vegetation is assumed to be about 5,438 feet msl. Based on this, the estimated acreage and class of vegetation anticipated for areas that would have enhanced soil moisture is presented in Table 4-10.

4.6.5 Reduction of Potential Impacts

Mitigation of the loss of the existing vegetation on the reservoir margins would have as a goal the re-establishment of similar habitat, but done in the context of mitigation for habitat of three specific resources: the Preble’s meadow jumping mouse, overall wildlife habitat represented by a diverse avian community (birds), and wetlands. The current vegetation that would be lost is a mix of both high and lower quality vegetation communities. The lower quality communities typically have a higher abundance of non-native species, and the high quality communities have more mature native cottonwoods and shrubs that are typical of riparian habitat. Reduction of potential impacts should focus on weed management and native species establishment. Therefore, the mitigation provided for impacts to Preble's meadow jumping mouse habitat, wetlands, and avifauna habitat (described in the CMP, Appendix K) also would replace the ecological functions provided by vegetation and thus mitigate for impacts to vegetation. The mitigation for impacts to Preble's meadow jumping mouse habitat, wetlands, and avifauna habitat would focus on riparian/wetland native forest or shrubland, which comprise about 43 percent of the vegetation impacts for Alternative 3 and 55 percent of the vegetation impacts for Alternative 4. These mitigation measures could include preservation and enhancement of riparian and adjoining upland habitats in nearby off-site areas, creation of wetland habitat within Chatfield State Park, and enhancement of upland, riparian, and wetland habitat within Chatfield State Park. This mitigation for wetland/riparian impacts is detailed in the CMP (Appendix K). The Corps has consulted with the EPA on how to implement operations to minimize impacts of a more highly fluctuating reservoir (see Appendix GG).

Weed Management

Weed management includes frequent monitoring of the drawdown zone for the presence of weedy species. Weed control shall employ standard IPM (Integrated Pest Management) methods with the addition of inundation as a management tool. Treatment options would be based on a monitoring and management program that responds to existing conditions (Appendix GG). Although the cyclic disturbance to the drawdown zone can be anticipated, the actual weedy species that would invade in any particular year or at a particular location cannot. Introduction of aggressive native species such as foxtail barley is one option for competing against the weedy species.

The fluctuating boundary between the drawdown zone and the persistent vegetation can be a primary source for reseeding the drawdown zone each annual cycle. Weedy species established in this area as well as the immediately adjacent zone of persistent vegetation shall be closely monitored, especially during the flowering and seed stages for the weedy species.

Weed management above the drawdown zone would not be able to use inundation as a control method. Standard weed management practices apply for these areas with special focus on weedy trees and shrubs. Simultaneous removal of non-preferred species and the planting of the preferred species, as discussed in the next section, would aid in the acceleration of habitat restoration.

Native Species Establishment

Natural community succession can be accelerated, and weed control can be assisted, by the establishment of native species. Due to a changed pool elevation, some areas would have improved soil moisture conditions that would allow the establishment of species that previously could not survive at these sites. Tree and shrub communities can be established at these locations, and intentionally planting these species can accelerate the successional process and the restoration of habitat. It may take several cycles of the pool elevation to establish the new soil moisture conditions and allow proper site evaluation for the installation of planted species. Tree species such as cottonwood need to be in contact with the water table when first planted and may need supplemental water for the first few years until roots can develop that would follow the water table down to its lowest level.

Herbaceous species can also be used at locations where vegetation is not currently established or has been removed by inundation. Some native species such as foxtail barley are adapted to the fluctuating conditions found on reservoir margins. Monitoring and adaptive management would be used to determine additional appropriate species to use as competitors for the weedy species.

4.7 Wetlands

The proposed alternatives could have potential impacts on wetlands. Specific issues include possible wetland impacts from implementing the alternatives to include inundation and transformation of specific wetland areas. These issues are evaluated by alternative in the following sections. Appendix K provides additional information on the Compensatory Mitigation Plan. This analysis of impacts on wetlands is based on the maximum level of inundation for each alternative, or the upper bound scenario. The exact new condition for each alternative is unknown due to the high fluctuation of the water levels associated with certain alternatives.

4.7.1 Alternative 1—No Action

Under Alternative 1, reservoir levels and operations at Chatfield Reservoir would remain unchanged (Table 4-2 and Figure 4-1). Wetlands in riverine, palustrine, and lacustrine systems around Chatfield Reservoir would be unaffected.

Penley Reservoir and Downstream Gravel Pits

The Penley Reservoir inundation area contains two small, isolated wetlands that total about 0.26 acres; therefore, impacts on wetlands would be limited. Conversely, inundation may potentially enhance wetland habitats, particularly if the resulting lake shoreline is vegetated with natural plant communities.

The Penley Reservoir project also would involve the construction of 32.05 miles of underground pipelines to deliver water to the reservoir and to water providers in the area. Pipelines would cross numerous wetlands and jurisdictional waters of the United States. Based on the estimated 100-foot buffer around pipelines, 12 acres of wetlands could be impacted. This is an approximate value based on approximate locations of pipelines.

The downstream gravel pits are currently being mined (or are already mined out) for gravel and are therefore unvegetated and inundation of these pits would not result in the loss of wetland vegetation. Inundation of the gravel pits could enhance wetland habitats, particularly if the shorelines were vegetated with natural plant communities. Seepage from earthen ditches also could create wetlands downgradient of ditches.

Based on information in Chapter 2, each of the three downstream gravel pits would include a diversion channel that is several feet wide and each would disturb about 2 acres of land area. If the disturbed area includes wetlands then there would be potential impacts on wetlands. The impact would be up to 2 acres per gravel pit, for a total of up to 6 acres. It is also assumed that each gravel pit would include outlet works (including distribution lines) and a pump station occupying 1 acre. If wetlands are present in these areas then up to 3 additional acres of wetlands would be disturbed. The maximum area of wetlands disturbed by the infrastructure for the three gravel pits is 9 acres.

The total area of wetland impacts from alternative 1 is up to 21.26 acres, based on 0.26 acres within the Penley Reservoir footprint, 12 acres of impacts from pipelines associated with Penley Reservoir, and 9 acres of impacts from the diversion channels and infrastructure at the gravel pits (see Tables 4-12 and 4-13).

4.7.2 Alternative 2—NTGW/Downstream Gravel Pits

Under Alternative 2, reservoir levels and operations at Chatfield Reservoir would remain unchanged. Wetlands in riverine, palustrine, and lacustrine systems around Chatfield Reservoir would be unaffected. Impacts on wetlands from the conversion of downstream gravel pits to water storage would be the same as those described under Alternative 1 (i.e., a maximum of 9 acres), (see Tables 4-12 and 4-13). However, impacts on wetlands in the Penley Reservoir area under Alternative 1 would not occur under Alternative 2 because water would be obtained from NTGW.

Table 4-12
Estimate of Acres of Wetlands Impacted by Each Alternative

Wetland Type	**Alternative 1 (a)**	**Alternative 2 (a)**	**Alternative 3 (c)**	**Alternative 4 (c)**
Submergent (Palustrine Aquatic Bed)	NA	NA	9.0	5.9
Emergent (Palustrine Emergent)	NA	NA	26.3	15.2
Seasonal (Lacustrine Emergent – nonpersistent)	NA	NA	14.7	14.7
Scrub/Shrub (Palustrine Scrub/Shrub)	NA	NA	73.0	59.2
Forested (Palustrine Forested)	NA	NA	34.2	24.8
Total	21.26	9.0	157.2 (b)	119.8

(a) "Wetland Type" is not available (NA) for Alternatives 1 and 2.
(b) Of 157.2 wetland acres for Alternative 3, 157.2 acres are also bird habitat and 137.3 acres are also habitat for Preble's meadow jumping mouse.
(c) The values in this column are based on the number of acres inundated (see text for explanation).

Table 4-13
Estimate of Acres of Wetlands Impacted by Each Alternative, Total by Drainage

	South Platte River Drainage				Plum Creek Drainage			
Wetland Type	Alternative 1(a)	Alternative 2 (a)	Alternative 3 (c)	Alternative 4 (c)	Alternative 1 (a)	Alternative 2 (a)	Alternative 3 (c)	Alternative 4 (c)
Submergent (Palustrine Aquatic Bed)	NA	NA	3.8	1.6	NA	NA	5.2	4.3
Emergent (Palustrine Emergent)	NA	NA	11.1	7.8	NA	NA	15.2	7.4
Seasonal (Lacustrine Emergent – nonpersistent)	NA	NA	10.5	10.5	NA	NA	4.2	4.2
Scrub/Shrub (Palustrine Scrub/Shrub)	NA	NA	33.7	28.0	NA	NA	39.3	31.2
Forested (Palustrine Forested)	NA	NA	4.3	3.8	NA	NA	29.9	21.0
Total	15.0 (b)	9.0	63.4	51.7	6.26 (b)	0.0	93.8	68.1

(a) "Wetland Type" is not available (NA) for Alternatives 1 and 2.
(b) The total acres for Alternative 1 assumes half of the Penley Reservoir pipeline impacts are in the South Platte Drainage (i.e., 6 acres) and half are in the Plum Creek Drainage (i.e., 6 acres).
(c) The values in this column are based on the number of acres inundated (see text for explanation).

4.7.3 Alternative 3—20,600 Acre-Foot Reallocation

Under this alternative, the infrastructure of the pool containing conservation storage would be changed to target 20,600 acre-feet of reallocated storage by allowing the water level to rise to a target pool elevation of 5,444 feet msl. This level of inundation represents a maximum level or in terms of impacts, an upper bound scenario. Based on hydrologic modeling, this maximum pool elevation would not be reached every year (see Section 4.6). Based on elevation contours generated using field survey data of the area immediately surrounding the reservoir, when reached this maximum increase in water level would inundate additional acres of land area as shown in Table 4-2 and Figure 4-1. Under Alternative 3, approximately 587 acres of additional land area would be inundated at a water level of 5,444 feet msl. Because the maximum pool elevation would not be reached every year not all acres would be inundated all years, and some acres would be inundated for only a short period.

Inundation at a water level of 5,444 feet msl would result in an inundation of approximately 157.2 acres of vegetated wetlands based on field mapping of wetlands in potential areas of inundation (Table 4-12). The greatest loss would be of scrub/shrub type wetlands. An additional 0.8 acres of wetlands (palustrine scrub/shrub) would be permanently impacted as a result of relocation of recreational facilities above 5,444 feet msl (i.e., the recreation trail across Plum Creek).

To further understand impacts to wetland resources, it is helpful to understand that the 587 acres potentially inundated by Alternative 3 include many different land types. Some of these 587 acres are areas that are currently open water, or man-made structures such as parking lots. Other acres include wildlife habitat. It is within the wildlife habitat that wetlands also exist. Therefore, it is important to note that the 157.2 acres potentially inundated by this alternative overlap with habitat for other wildlife resources (Table 4-12). This will be explained further in Section 4.8.

The process of inundating areas works to remove vegetation in the near term and to transform vegetation in the long term. As water levels inundate new areas, the soils become saturated first, and then are completely covered in water. Once water covers the soil, oxygen cannot be exchanged for plant respiration. Plants use up the available oxygen in the soil, but if inundation persists, soil conditions become anaerobic. Only plant species that can adapt to these harsh conditions would survive. If inundation lasts for extended periods, even the adapted plants would die (see Section 4.6 for additional discussion on the effects of inundation on plants especially trees). If the plants are covered completely, all respiration shuts down and the plants die rapidly (within days). If the water levels are sustained at the maximum elevation (5,444 feet msl) for an extended period, this alternative would result in converting approximately 157.2 acres of wetland (approximately 63.4 acres in the South Platte River drainage and 93.8 acres in the Plum Creek drainage; Table 4-13) to deep water habitat.

The relocation of roads and recreation facilities would impact wetland areas as well. The total impacts on specific wetland areas would include direct loss of wetlands and possibly the indirect loss or modification of wetland areas caused by increased runoff creating erosion or changing the frequency at which an area receives water.

Under Alternative 3, pool levels could fluctuate up to a maximum of 28.2 feet during the growing season, although typically the pool fluctuations within a growing season would be much less. Based on the range of values between the 1st and 3rd quartile of data for all years combined, the fluctuation increases from approximately 4.2 feet of fluctuation under Alternative 1 (Figure 4-14), to 5.0 feet of fluctuation under Alternative 4 (Figure 4-16), and up to 7.1 feet of fluctuation for Alternative 3 (Figure 4-15). These data suggest that the shoreline water table would be available less often at the upper end of the exposed shoreline, indicating that conditions along the shoreline would tend to be drier as the target pool level increased. Therefore, conditions would favor less hydrophytic vegetation along the new shoreline due to drawdown that would be more extreme than under current conditions.

It is useful to look at fluctuations during the growing season to understand the impacts on wetlands from this alternative. The vegetation growing season corresponds roughly to beginning at week 17 and ending at week 41 (i.e., late April 25 to October 11) and corresponds to a growing season of approximately 170 days (see Section 4.6 for details). During an average year, as modeled using POR data, pool levels would begin to increase prior to the onset of the growing season until reaching the peak between weeks 19 and 25. Then pool levels would recede modestly (2 to 3 feet) for a major portion of the growing season, then level off toward the end of the growing season and for the remainder of the year (Figure 4-17). Within the growing season, the POR data predict that the pool level during an average year would approximate 5,440 feet msl with fluctuations ± 2 feet (Figure 4-17). Pool levels during the majority of the growing season may also be influenced by reservoir management. During the recreation season (May 1 through September 30), pool level variations are currently restricted, and restrictions may continue under this alternative (see Section 4.17, Recreation, for details). This would aid in maintaining pool levels during the majority of the growing season. Outside of the growing season, pool levels would continue to decrease during average years to elevations approximating 5,436 feet msl in a typical year (Figure 4-15).

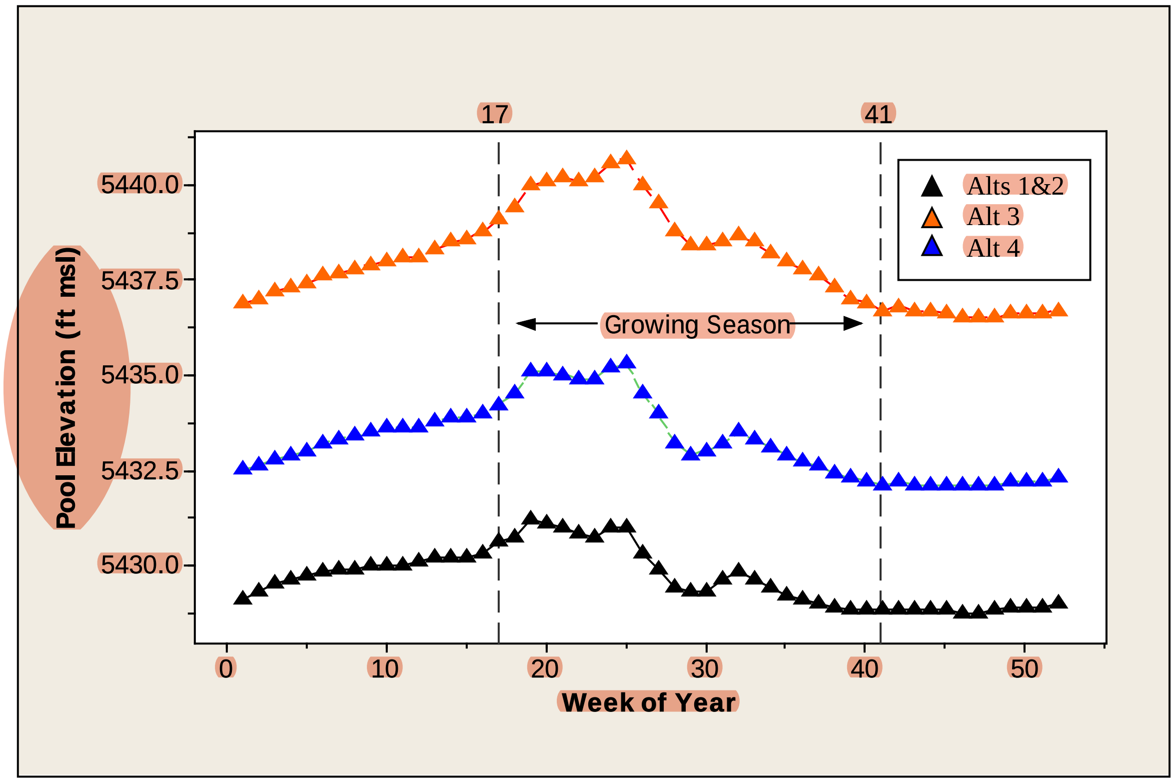


Figure 4-17
Weekly Mean Pool Elevations for the Entire Year for All Alternatives

Heavy precipitation events could raise water levels above 5,444 feet msl. Based on the POR database of pool elevations, future water levels could rise to as much as 5,465 feet msl for extended periods of time during the growing season. However, such extremes in water levels are rare from year-to-year over the POR (Figure 4-18), approximating 1 out of 10 years. Dependent on the flux of water levels, wetlands may be inundated for varying periods of time having a long-term adverse impact of changing the composition of existing wetlands (i.e., changing to more water-tolerant species such as from shrubs to cattails or from semi-aquatic habitats to aquatic) or establishing new wetlands within the new zone of fluxing inundation.

The number of wetland acres impacted in the Plum Creek drainage is over 50 percent higher than in the South Platte River drainage (Table 4-13). In both drainages the major wetland impacts are to scrub/shrub wetlands, which constitute over 50 percent of the wetland acres impacted in the South Platte River drainage. On the other hand, the percent of inundated wetland acres that are forested is nearly four times higher in the Plum Creek drainage than in the South Platte River drainage.

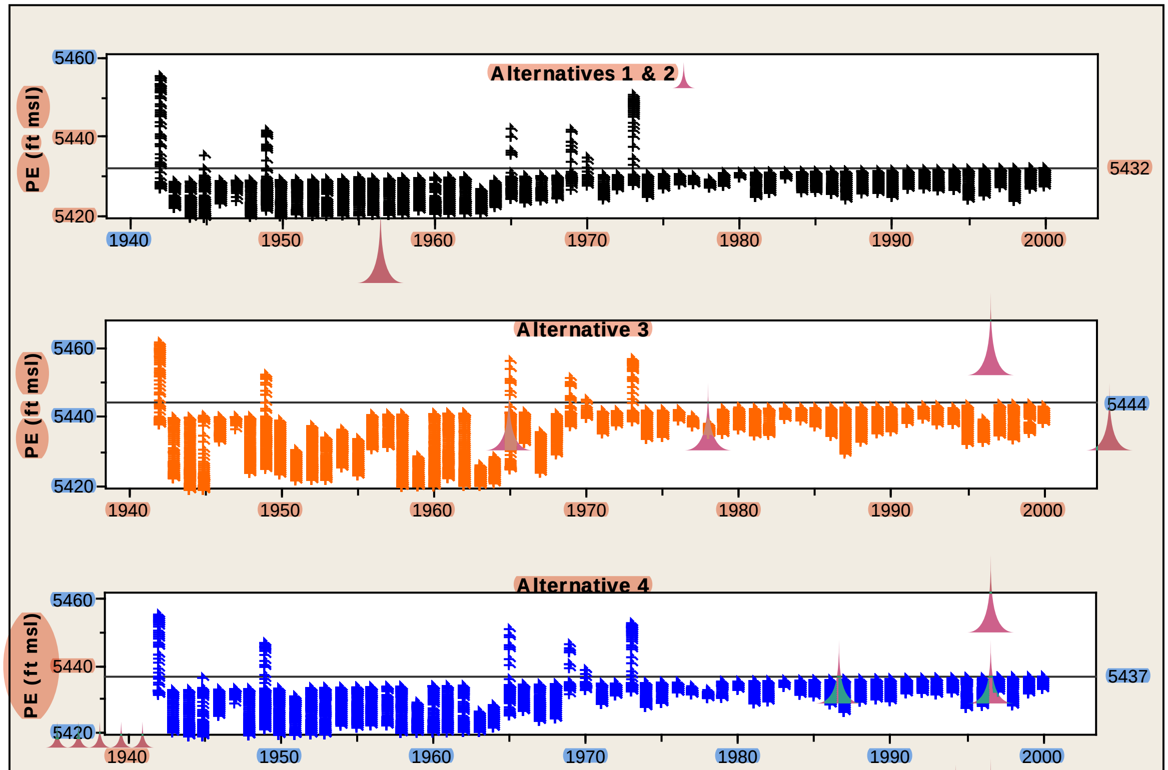


Figure 4-18
Pool Elevations over the POR by Alternative

Under Alternative 3 the Chatfield Reservoir level would fluctuate more than under the other alternatives. Over the length of an entire year, the average pool level difference would reach 6 to 7 feet; but during the growing season, it is estimated that the average pool level would peak in mid-June and would drop throughout the rest of the season, resulting in an average difference in pool elevations of only 2 to 3 feet. As a result, new wetlands could become established in areas that are inundated during a part of the growing season, including new "backwater" areas and shoreline areas on gradual slopes. However, a 2- to 3-foot drop in pool levels could also result in many areas in the flux zone being devoid of vegetation or having annual (weedy) upland communities, dependent on the slope of land at a particular site and the duration of inundation at a site. For example, areas at the peak of the elevation change would be inundated for the shortest period of time, but after the water levels drop 5 feet, are left too dry to support wetland vegetation only. Instead, these sites may be a mixture of wetland plants and upland vegetation. Wetland vegetation needs several weeks of inundation to establish itself and out-compete most terrestrial vegetation. Moreover, some sites could support upland vegetation that may be disturbed on a regular basis. In areas at the lower end of the gradient, the time of inundation would be too great for any plants (upland or wetlands) to become established and therefore would remain as bare ground or at least poorly vegetated. In between this gradient would be areas where conditions are right for wetlands.

The mitigation of potential impacts, described in the CMP (Appendix K), is guided by the development of an Ecological Functions Approach (EFA), an accounting system used to value the overlapping ecological values that wildlife habitats provide on lands surrounding Chatfield Reservoir. Ecological Functional Units (EFUs) are calculated in the CMP to capture the ecological functions provided by the individual target environmental resources as well as their overlap. The assessment of impacts is initially estimated using a conservative approach where it is assumed that the target elevation pool would be met and maintained and therefore inundate the maximum acreage. The CMP uses these acreages to compute EFUs for the combined values of the specific resources. Based on the number of acres of wetlands impacted, the CMP estimates this equates to 123 EFUs of wetlands (see Appendix K for additional details).

4.7.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

In addition to the reallocation, another 5,379 acre-feet would be obtained from NTGW and/or other storage and downstream gravel pits under Alternative 4. The potential effects on wetlands from the conversion of downstream gravel pits to water storage and the use of NTGW are disclosed under Alternatives 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2. Under Alternative 4, the maximum area of wetlands disturbed by the infrastructure for gravel pit storage is 6 acres.

Under this alternative, the infrastructure of the pool containing conservation storage would be changed to target 7,700 acre-feet of reallocated storage by allowing the water level to rise to a multipurpose pool elevation of 5,437 feet msl. Again, heavy precipitation events could raise water levels beyond 5,437 feet msl for brief periods, but this would be rare from year to year. As shown in Table 4-2, this increased water level would translate into approximately 215 acres of additional land area that would become inundated at 5,437 feet msl.

Raising water levels under this alternative would have the near-term adverse impact of eliminating approximately 119.8 acres of vegetated wetlands (approximately 51.7 acres in the South Platte River drainage and 68.1 acres in the Plum Creek drainage, Tables 4-12 and 4-13) if the water levels are sustained at 5,437 feet msl for extended periods. Plum Creek wetlands are affected more under this alternative due to the shallow nature of the Plum Creek delta at the confluence of the stream with the reservoir. More acres of land are inundated with a given rise in water level. Plum Creek impacts mainly affect scrub/shrub type wetlands. Within the South Platte River drainage, scrub/shrub type impacts are also the majority, but impacts on emergent (non-woody) wetlands are relatively large and impacts on forested wetlands are lower compared to impacts on those types in the Plum Creek drainage. An additional 0.8 acres of wetlands (palustrine scrub/shrub) would be permanently impacted as a result of relocation of recreational facilities above 5,444 feet msl (i.e., the recreation trail across Plum Creek).

As was the case under Alternative 3, the 215 acres potentially inundated under Alternative 4 are acres that are shared by multiple resources such as birds and the Preble's meadow jumping mouse as well as wetlands.

Under this alternative the Chatfield Reservoir level would fluctuate less than under Alternative 3. This may provide more areas with conditions conducive to supporting wetlands at the new water levels. However, there would likely be areas that are disturbed and weedy or lacking vegetation altogether, depending on slope and duration of inundation at specific sites.

4.7.5 Reduction and Mitigation of Potential Impacts

Potential impacts that would transform wetlands and/or reduce wetlands functions would be minimized as much as possible including changing the amount and timing of releases, seeding or plantings, and weed control. Adaptive management planning would involve an iterative process of cycling through several steps: problem assessment, design, implementation, monitoring, evaluation, adjustment, and continued cycling through earlier steps (Barnes, 2009). Mitigation for impacts associated with Alternatives 3 and 4 would be a combination of on-site and off-site enhancements of quality and functions of existing wetlands as well as wetland creation. Compensatory mitigation of wetlands would be maximized, to the extent practicable, at Chatfield State Park through the creation, enhancement, and restoration of wetlands within and/or adjacent to the park (see the CMP, Appendix K). The mitigation of impacts to wetlands would also occur as part of the mitigation provided for impacts to Preble's meadow jumping mouse and avifauna habitat. The mitigation for impacts to these resources would focus on riparian/wetland native forest or shrubland. Mitigation measures could include preservation and enhancement of riparian and adjoining upland habitats in nearby off-site areas, creation of habitat within Chatfield State Park, and enhancement of upland, riparian, and wetland habitat within Chatfield State Park. Of the 123 EFUs of wetlands impacted, 30 EFUs would be mitigated on-site and 93 EFUs would be mitigated off-site (Appendix K). The Corps has consulted with the EPA on how to implement an operations plan to minimize impacts of a more highly fluctuating reservoir (refer to Appendix GG for further details).

For Penley Reservoir, downstream gravel pits, pipelines, and other associated infrastructure, impacts to wetlands would be avoided and minimized to the extent possible and, if necessary, mitigated in accordance with Corps regulatory requirements so that the resulting net impacts to wetlands are insignificant.

The Corps has conducted coordination and informal consultations with the USFWS regarding potential impacts to wetlands and their recommendations for mitigation, including a Planning Aid Report (February 2006) and progress letter (July 2010) (see Appendix X).

4.8 Wildlife

The four proposed alternatives could have potential impacts on wildlife resources. Specific issues include possible impacts of the alternatives on habitat by inundation of wetland, riparian, and upland areas currently used by wildlife. Additionally, the relocation of recreational facilities and roads may adversely impact wildlife habitats. Potential impacts to endangered, threatened, and candidate wildlife species and wildlife species of special concern are addressed in Section 4.9. Table 4-14 presents the estimated acres of inundated wildlife habitat for all four of the alternatives, and Table 4-15 presents the estimated acres of inundated wildlife habitat for all four of the alternatives, by drainage.

Table 4-14
Estimate of Acres of Wildlife Habitats Impacted by Alternative

Habitat Type	Alternative 1 (a)	Alternative 2 (a)	Alternative 3 (b)	Alternative 4 (b)
Mature Cottonwood	0.0	0.0	43	16
Other Trees	0.0	0.0	211	162
Shrub	0.0	0.0	53	35
Upland	167	12	222	72
Wetland/Non-woody	0.0	0.0	57	43
Shoreline*	0.0	0.0	90	78
Water	0.0	0.0	1367	1296
Total (not including water)	167	12	676	406

* Shoreline habitat was calculated by determining the area of digitized polygons derived from aerial photographs.
(a) The values in this column are based on the assumption that all 12 acres of impact at the gravel pits are "Upland" habitat type.
(b) The values in this column are based on the number of acres inundated (see text for explanation).

Table 4-15
Estimate of Acres of Wildlife Habitats Impacted
by Alternative, Total by Drainage

Habitat Type	South Platte Drainage				Plum Creek Drainage			
	Alternative 1 (a)	Alternative 2 (a)	Alternative 3 (b)	Alternative 4 (b)	Alternative 1	Alternative 2	Alternative 3 (b)	Alternative 4 (b)
Mature Cottonwood	0.0	0.0	43	16	0.0	0.0	0.0	0
Other Trees	0.0	0.0	114	90	0.0	0.0	97	72
Shrub	0.0	0.0	24	20	0.0	0.0	29	15
Upland	9	9	161	45	186	0.0	61	27
Wetland/Non-Woody	0.0	0.0	37	27	0.0	0.0	20	16
Shoreline	0.0	0.0	65	53	0.0	0.0	25	25
Total	9	9	444	251	186	0.0	232	155

(a) The values in this column are based on the assumption that all 9 acres of impact at the gravel pits are "Upland" habitat type.
(b) The values in this column are based on the number of acres inundated (see text for explanation).

4.8.1 Alternative 1—No Action

Under Alternative 1, reservoir levels and operations at Chatfield Reservoir would remain unchanged (Table 4-2 and Figure 4-1). Impacts on wildlife resources at Chatfield Reservoir would not occur.

Construction of Penley Reservoir would result in the loss of 186 acres of terrestrial habitat for grassland and upland wildlife species; however, habitat for wetland and water-dependent wildlife species would increase. The entire footprint of the proposed reservoir (186 acres) includes valuable habitat for elk, mule deer, and white-tailed deer, including the following range designations per NDIS (2008b): elk winter range and severe winter range, mule deer summer range, winter concentration and severe winter range, and white-tailed deer concentration area and winter range. The footprint of the reservoir is small compared to the areas encompassed by these range designations and therefore significant adverse impacts are not expected for elk, mule deer, and white-tailed deer.

Construction of pipelines may impact wildlife resources by creating temporary adverse impacts on habitat. Roads used during construction would be temporary, and the disturbed areas would be revegetated with native plants as soon as practicable to restore native habitat. If these best management practices are followed, any impacts to wildlife resources from pipeline construction would be short term.

The downstream gravel pits are currently being mined (or are already mined out) for gravel and are therefore unvegetated and inundation of these pits would not result in the loss of terrestrial vegetation. The infrastructure associated with developing the gravel pits into water storage structures would result in habitat loss for some species, but inundation of the gravel pits would result in habitat creation for other riparian or water-dependent wildlife species. Gravel deposits are typically in or near flood plains and therefore are likely to contain high diversity of wildlife species and important habitat for birds, mammals, reptiles, and amphibians. Development of gravel pits into storage structures may impact wildlife habitat during installation of the necessary infrastructure (i.e., diversion channel, outlet works, and pump station). After inundation of the gravel pit storage areas, wildlife habitat would increase for riparian species, including amphibians, waterfowl, and riparian-associated mammal and reptile species, particularly if shorelines contained riparian vegetation. However, associated infrastructure may disrupt travel corridors for some terrestrial species. Based on information in Chapter 2, each of the three downstream gravel pits would include a diversion channel that is several feet wide and each would disturb about 2 acres of land area. The impact to terrestrial habitat from the diversion channels would be up to 2 acres per gravel pit, for a total of up to 6 acres for three gravel pits. It is also assumed that each gravel pit would include outlet works (including distribution lines) and a pump station occupying up to 1 acre of terrestrial habitat for each gravel pit. The maximum area of terrestrial habitat disturbed by the infrastructure for the three gravel pits is 9 acres (see Tables 4-14 and 4-15).

4.8.2 Alternative 2—NTGW/Downstream Gravel Pits

Under Alternative 2, reservoir levels and operations at Chatfield Reservoir would remain unchanged as in Alternative 1. Adverse impacts on wildlife resources at Chatfield Reservoir would not occur. Impacts on wildlife resources at the gravel pits would be the same as under Alternative 1, along with impacts from the construction of associated pipelines and other infrastructure. As described under Alternative 1, the maximum area of terrestrial habitat disturbed by the infrastructure for the three gravel pits is 9 acres (see Tables 4-14 and 4-15). However, impacts on wildlife from Penley Reservoir and construction of associated pipelines would not occur because water would be obtained from NTGW.

4.8.3 Alternative 3—20,600 Acre-Foot Reallocation

Under this alternative, the infrastructure of the pool containing conservation storage would be changed to target 20,600 acre-feet of reallocated storage by allowing the water level to rise as high as 5,444 feet msl. As indicated in Section 4.2.3, under Alternative 3, approximately 587 acres above the conservation pool elevation (5,432 feet msl) would be inundated at water levels of 5,444 feet msl (Table 4-2 and Figure 4-1); this includes ponds, shoreline, and non-habitat. However, the total acres of wildlife habitat inundated under Alternative 3 is greater than 587 acres (676 acres, not including "Water") because there are trees, shrubs, and wetland vegetation growing below 5,432 feet msl and these are included in the total acres of habitat inundated (see Tables 4-14 and 4-15).

It is important to note that the 676 acres potentially inundated by this alternative includes overlapping habitat for multiple resources including birds, the Preble's meadow jumping mouse (Table 4-16), and wetlands (Table 4-12). Although "shoreline" habitat is shown in Tables 4-14 and

4-15, it is not considered a loss of habitat because the present shoreline would be replaced with the same or greater amounts of new shoreline associated with reallocation. Under Alternative 3 the total acres of wildlife habitat inundated, not including shoreline, is 586 acres.

In addition, approximately 30 acres of grasslands would be permanently impacted by the footprints of relocated recreational facilities (see CMP, Appendix K).

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. This includes the following habitat types: 0.19 acres of mature cottonwood, 0.20 acres of shrub, 1.97 acres of upland, and 0.18 acres of wetland/non-woody habitat.

Impacts under Alternative 3 are substantial, converting hundreds of acres of terrestrial habitat acres to aquatic or semi-aquatic habitats. It likely would benefit fisheries and other aquatic life, but would adversely impact terrestrial wildlife species by reducing the overall acreage of wildlife habitat within the study area by reducing the available forage, protective cover, breeding sites, and nesting sites. This would occur as a result of the inundation of riparian or upland vegetation, which removes or transforms the present vegetation and corresponding wildlife habitat. The estimated losses of vegetation and wildlife habitat associated with inundation are doubly conservative because the estimated changes in acreages assume both that all wildlife habitat will be lost below 5,444 feet msl and that no successional gains will be realized in wetland and riparian habitat types. This conservative approach was taken to ensure adequate mitigation would be planned and implemented.

It is unlikely that the pool elevation of 5,444 feet msl would be maintained for long periods of time and may not be attained in some years at all. Therefore, a portion of the habitat acres listed in Tables 4-14 and 4-15 would only be inundated for short periods of time or not at all during some years. This could likely transform terrestrial habitats to wetter environments instead of eliminating them.

In Section 4.6, an estimate of vegetation gains and losses under future conditions for the inundation alternatives (i.e., Alternatives 3 and 4) is presented in Table 4-11. The estimate is based on the current ratio of vegetation communities at specific elevational increments and is applied to the acreage of land that would have these same relative elevations (i.e., 0–2 feet, 2–4 feet, 4–6 feet) above the alternative targeted pool elevations (see Section 4.6). When comparing impacts to vegetation as a result of inundation under Alternatives 3 and 4, it is important to realize that the vegetation losses will be somewhat offset by successional changes at the new OHWM. This also pertains to gains and losses of wildlife habitat. However, these successional changes are dependent on the many variables discussed in the preceding paragraph and long-term successional increases in riparian or wetland communities are not used to temper the estimates of wildlife habitat losses described in Table 4-15.

The mitigation of potential impacts, described in the CMP (Appendix K), is guided by the development of an Ecological Functions Approach (EFA), an accounting system used to value the overlapping ecological values that terrestrial wildlife habitats provide on lands surrounding Chatfield Reservoir (see Section 4.8.5). Ecological Functional Units (EFUs) are calculated in the CMP to capture the ecological functions provided by the individual target environmental resources as well as their overlap. The assessment of impacts is initially estimated using a conservative approach where it is assumed that the target elevation pool would be met and maintained and therefore inundate the maximum acreage. The CMP uses these acreages to compute EFUs for the combined values of the specific resources. Based on the number of acres of bird habitat impacted, the CMP estimates this equates to 377 EFUs of bird habitat. Mitigation of vegetation is assumed to be accomplished by mitigation for the habitat of these specific resources. Once an alternative is implemented, actual impacts would be assessed "real time" and be off-set by on-site and off-site mitigation and by tracking the gains of habitat due to increased water availability associated with newly established pool elevations (i.e., new OHWM). This accounting system would track how mitigation is progressing and whether alterations to mitigation activities are needed. See the CMP (Appendix K) for further details.

Under Alternative 3, the Chatfield Reservoir level would fluctuate more than under the other alternatives, having an average peak fluctuation of 3 feet during late spring or early summer (Figure 4-12). Modeling of maximum levels using the POR water levels illustrate that maximum pool fluctuations from year to year can be substantially more than the average fluctuations, on rare occasions changing more than 20 feet for short periods of time. Fluctuations, either average or maximum, would result in habitat transformations differing from those areas being permanently inundated. Within this zone of fluctuation, new wetlands and riparian areas would establish at higher land elevations and at lower elevations closest to shorelines; weedy areas or barren shorelines would be created, depending on the duration of inundation. These changes all have impacts on mammals, birds, reptiles, amphibians, and invertebrates.

The study area includes many different habitat types. The grasslands, shrubland, open water, rocky areas, landscaped/disturbed areas, and riparian areas in the area around Chatfield Reservoir provide habitat for a wide array of wildlife, although many habitats, especially in uplands, are of low quality, typically degraded by the presence and even dominance of non-native plant species (Table 4-10). Increasing the water level of Chatfield Reservoir, as in Alternative 3, would cause inundation of up to 587 acres of wildlife habitat (Table 4-14). The disturbance of this land would cause impacts to animal species known to reside in these areas.

Uplands (e.g., grasslands) comprise the largest amount of affected area. These areas typically provide foraging and nesting habitat for a variety of different wildlife including large mammals, small mammals, songbirds, reptiles, and invertebrates. Amphibians may also spend a portion of their life cycle in uplands, especially to forage. To submerge these lands, even intermittently, would greatly change or remove the vegetation and habitat. The area bounded by Chatfield State Park and west to the hogback has high quality habitat for mule deer and supports greater densities than the surrounding areas (NDIS, 2008b). The loss of habitat could push mule deer into adjacent grasslands and shrublands and also possibly into landscaped residential areas. Due to loss of foraging habitat, the competition for food and cover would increase and potentially place stress on individuals. The impacts of lost habitat to mule deer and other terrestrial wildlife could be exacerbated by 10-, 50-, and 100-year flood events, although these events may not have lasting effects. Raptor species would also be affected by the loss of woodland and upland habitat. Tree nesting raptors would initially benefit from the increase in dead trees for roosting, but as trees decay over time, there would be fewer roosting sites overall. Many raptors prefer grasslands when hunting. As upland areas become flooded, these forage areas would be lost, thereby reducing the available grasslands for raptors to hunt. Osprey and bald eagles would likely benefit from increased foraging areas as new aquatic habitats are created by inundation.

Riparian areas would be affected under Alternative 3 as woodlands and shrublands along Plum Creek and the South Platte River are inundated (Table 4-15). Riparian areas provide food, water, cover, and nesting areas. They also provide corridors to enable organisms to move along river systems avoiding more exposed areas and serve as resting areas for migrating songbirds. Loss of riparian habitat would have many adverse ecological impacts including local impacts on populations of breeding and migratory songbirds, many of which are already in decline. Large mammal populations, such as deer and elk, rely on riparian habitat for cover and forage.

The proposed action alternative could result in loss of up to 43 acres of mature cottonwood habitat (which is a subset of cottonwood) and up to 211 acres of other tree cover due to repeated inundation (Tables 4-14 and 4-15). Large mammals would have fewer areas at Chatfield providing thick cover and woody foraging areas. Songbirds also rely on tree habitat for nesting and foraging during the nesting season and as resting and foraging areas during migration. This includes the 43 acres of mature cottonwood trees that are a special feature of Chatfield State Park. This area of mature cottonwood forest offers habitat for birds that is rather unique within the Denver Metro area and possibly along the South Platte River. Loss of this habitat for songbirds would cause long-term adverse impacts that are not easily mitigated. Beyond loss of currently mature cottonwoods, there would be loss of additional cottonwoods that would become mature in the next 50 years. Since the development of Chatfield Lake, there have been three heronries, none of which are active today. Herons may abandon their nests due to an increased presence of humans near nesting sites (EPA, 2010) or having water levels dropping too early in the season and leaving the tree bases out of the water. The proposed addition of water into the reservoir could create a more secluded area of trees/snags surrounded by water, which the herons and cormorants prefer. These species and related bird species could potentially benefit under Alternative 3 as the proposed inundation would likely create potential nesting habitat, provided some large trees below 5,444 feet msl are not removed prior to inundation (as discussed in the Tree Management Plan, Appendix Z). Remote locations such as the mouth of Plum Creek could become future nesting areas, especially if some trees below 5,444 feet msl are left standing. The shrub habitat, including riparian shrubs, as stated in Section 3.6, tends to provide cover for many mammal species, such as deer, elk, raccoons, and also many bird species. Although similar to tree habitat, shrubs provide a differing type of cover due to the multiple stems and lower height of the vegetation. Inundating these shrublands, even temporarily, would most likely kill the vegetation and force any wildlife into surrounding habitat and eliminate some nesting areas. Although inundation would likely kill most woody plants up to the 5,439 to 5,440 foot msl elevation (see Section 4.6), some of the trees and shrubs would eventually reestablish themselves at the new water line. This would take years or even decades and push wildlife to other areas.

The loss of cottonwoods will be mitigated by a combination of providing new stands of cottonwoods that will mature over time and protecting existing stands of mature cottonwoods near Chatfield State Park. The CMP (Appendix K) calls for the following to compensate for the estimated loss of up to 43 acres of mature cottonwoods: Protect up to 22.5 acres of mature cottonwood woodlands within the defined off-site bird habitat complex near Chatfield State Park; create up to 13 acres of specifically designated cottonwood recruitment areas on-site and up to 10 acres off-site that will contribute toward the total compensatory mitigation goal of providing up to 796 EFUs (see Section 5.0 of the CMP). In total, the compensatory mitigation for mature cottonwoods involves the creation and protection of about 45 acres of cottonwoods. These acres are meant to ensure that the off-site mitigation for target resources at least includes that amount of acres specific to mature cottonwood habitat and recruitment areas.

An addition of water to the preexisting reservoir would affect many shorebird species and waterfowl. Ground nesting along shorelines by Canada geese, mallards, other waterfowl, and shorebirds currently occurs at the reservoir. Increases in water levels during the nesting season could inundate these nests. Changes to vegetation could remove protective cover important to some nesters. The amount, frequency, and timing of exposed shoreline supporting macroinvertebrates would also have a part in dictating whether shorebirds would be positively or negatively affected by the flooding actions. If exposed shoreline is available during the nesting season, then there would likely be a benefit to ground nesting shorebirds that use barren shorelines. Some adverse impacts on water birds may result due to changes in food availability; however, overall, ducks, geese, and other waterbirds would likely benefit under Alternative 3. Within newly created open water areas, inundated trees may provide temporary habitat for some bird species such as cavity nesters; however, many of these trees may be removed prior to flooding to increase boater safety, reducing this benefit to cavity nesters.

As indicated in Table 4-14, approximately 90 acres of shoreline would be inundated and transformed to aquatic habitat under Alternative 3. Shorebirds, waterfowl, reptiles, and some species of small mammals prefer shoreline habitat for nesting and foraging. High populations of invertebrates are also commonly found along shorelines and provide food for a variety of wildlife species. Flooding of 90 acres of shoreline may negatively impact wildlife species if it occurred during the nesting season, but would produce a net benefit for wildlife species that use shoreline habitat because the present shoreline would be replaced with the same or greater amounts of new shoreline associated with reallocation.

Rocky areas provide habitat for small mammals, amphibians, and invertebrates. Most rocky areas are found along the edge of the reservoir; they reduce erosion and scouring from wave action and have developed into niches for smaller wildlife species. A 12-foot rise in the current pool elevation would flood some rocky outcrops and have an adverse impact on these species; however, although the amount of rocky habitat potentially inundated was not calculated, it is thought to be minimal and habitats would be quickly reestablished at the new target pool levels. Inundating rocky areas of the reservoir would not have significant impacts on wildlife.

Significant adverse impacts on migratory birds downstream from Chatfield Reservoir would not occur under Alternative 3. Under Alternative 3, the South Platte River below Chatfield Reservoir would have minimal changes during base flow conditions and a small increase in flow during the late summer months (Figure 4-12). Figures 4-7 and 4-8 show negligible differences between Alternatives 1 and 2, 3, and 4 in winter flows at the Denver and Henderson gages on the South Platte River. Additionally, the additional discharge from various tributaries to the South Platte River through this section constitutes a large percentage of the total flow during the winter months. If flow regimes downstream are affected, limited negative impacts on water birds may result, primarily through decreased food availability and loafing areas.

Overall, Alternative 3 would have the largest adverse impact on a variety of wildlife species compared to Alternatives 1, 2 and 4. The overall impacts on migratory birds would be adverse given the variety of important habitats that would be inundated under Alternative 3 (Tables 4-14 and

4-15). Among terrestrial species, including neotropical migrants, the loss of palustrine wetlands and riparian communities through repeated inundation would cause the greatest adverse impacts. A significant area of mature woodlands would be impacted under the action alternatives, especially near the mouths of the South Platte River and Plum Creek. Inundated trees, if left standing, may provide temporary habitat for woodpeckers and other cavity nesters. Overall, terrestrial birds would be adversely impacted by Alternative 3. Mammals, reptiles, and amphibians would also lose habitat due to inundation (USFWS, 2006).

4.8.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

In addition to the reallocation, another 5,379 acre-feet would be obtained from NTGW and/or other storage and downstream gravel pits under Alternative 4. The potential effects on wildlife of converting downstream gravel pits to water storage and using NTGW are disclosed under Alternative 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2. Under Alternative 4, the maximum area of terrestrial habitat disturbed by the infrastructure for gravel pit storage is 6 acres.

Under this alternative, the infrastructure of the pool containing conservation storage would be changed to target 7,700 acre-feet of reallocated storage by allowing the water level to rise to as much as 5,437 feet. As shown in Table 4-2 and Figure 4-1, this higher water level would inundate an additional 215 acres of land adjacent to the reservoir at the target pool elevation. Under this alternative the Chatfield Reservoir level would fluctuate less than under Alternative 3, but more than under current conditions (Alternative 1).

Under Alternative 4 (7,700 acre-feet of reallocated storage), impacts on wildlife habitats would be similar to those under Alternative 3, except to a lesser extent (Table 4-14). The total acreage of wildlife habitat inundated under Alternative 4 is 406 acres (not including "Water") (Table 4-14). Only 72 acres of upland grassland would be affected by the flooding from the reservoir as opposed to the 222 acres that would be affected under Alternative 3. Mammals, birds, reptiles, invertebrates, and amphibians all use upland grassland habitat for foraging or nesting habitat and would be affected under this alternative, only to a lesser degree than under Alternative 3.

Because nearly all the shrublands, wetlands, and woody habitat are associated with riparian areas (Tables 4-14 and 4-15), they constitute about 256 acres of the riparian habitats that would be flooded at Chatfield Reservoir under Alternative 4. Riparian areas are arguably one of the most biologically diverse habitats providing food, shelter, transportation corridors, nesting sites, breeding sites, protection, and water. Most wildlife species spend at least some part of their life cycle in riparian areas. Songbirds, mammals such as deer and elk, raptors, shorebirds, reptiles, amphibians, and invertebrates are all likely to lose some important habitat. Only 16 acres of mature cottonwood habitat would be inundated under Alternative 4, compared to a total of 43 acres under Alternative 3. Approximately 162 acres of woodlands other than mature cottonwoods would be inundated, and approximately 35 acres of shrublands would be inundated under this alternative. Wetlands inundated at Chatfield Reservoir under this alternative total approximately 43 acres. Table 4-15 divides these habitat areas into the South Platte River and the Plum Creek drainages.

Open water areas would increase by less than an acre under Alternative 4. Any increase would benefit waterfowl by increasing loafing and foraging areas. Any increase also would benefit bald eagles and osprey by expanding their hunting and foraging area.

As indicated in Table 4-14, approximately 78 acres of shoreline at Chatfield Reservoir would be inundated and transformed to aquatic habitat under Alternative 4. Shorebirds, waterfowl, reptiles, and some species of small mammals prefer shoreline habitat for nesting and foraging. High populations of invertebrates are also commonly found along shorelines and provide food for a variety of wildlife species. Inundation of 78 acres of shoreline may negatively impact wildlife species if it occurs during the nesting season, but it would produce a net benefit for wildlife species that use shoreline habitat because the present shoreline would be replaced with the same or greater amounts of new shoreline associated with reallocation, and thus it is not considered a loss of habitat. Under Alternative 4 the total acres of wildlife habitat inundated, not including shoreline, is 328 acres.

In addition, approximately 30 acres of grasslands would be permanently impacted by the 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. This includes the following habitat types: 0.19 acres of mature cottonwood, 0.20 acres of shrub, 1.97 acres of upland, and 0.18 acres of wetland/non-woody habitat.

Significant adverse impacts on migratory birds downstream from Chatfield Reservoir would be unlikely under Alternative 4. Under Alternative 4, the South Platte River below the Chatfield Reservoir would have minimal changes during base flow conditions and a small increase in flow during the late summer months, and both these changes in flow are smaller than those under Alternative 3 (Figure 4-13). Alternative 4 could potentially have a slightly positive effect on waterbirds along this reach of the South Platte River.

Overall, Alternative 4 would adversely impact a variety of wildlife species by inundating a variety of wildlife habitats. Compared to Alternative 3, the area inundated would be less (Table 4-14). However, as is true with Alternative 3, these acres of inundation include habitats shared by multiple resources. Some habitats may experience gains at new elevations as is explained in the discussion of Alternative 3 above. Compared to Alternative 1, the effects on wildlife within the study area would be greater under Alternative 4.

4.8.5 Reduction and Mitigation of Potential Impacts

Prior to the implementation of an alternative, actions to reduce the level of impacts will be considered. These may include changes to the operations of the reservoir (e.g., holding water at a certain elevation at a specific time of year), or by actively managing the drawdown zone created by fluctuating water levels. For example, habitat losses along the shoreline near the new target pool elevation could be reduced by changing amounts and timing of storage and release of flows, plantings, seeding, and weed control (Appendix GG).

The mitigation of potential impacts, as described in the CMP (Appendix K), is guided by the development of an Ecological Functions Approach, an accounting system used to assign and track ecological value of overlapping terrestrial wildlife habitats provided on lands surrounding Chatfield

Reservoir. This assigning was done by a committee of local experts familiar with Chatfield Reservoir. Habitat attributes were derived and given values for specific resources: the Preble's meadow jumping mouse, overall wildlife habitat represented by a diverse avian community (birds), and wetlands. Mapped habitats for each of the three specific resources were incorporated to total across the functional values in order to provide an index of specific resource habitats. These indexes were then combined to represent the ecological function values for every acre of land that could be potentially lost to inundation. This approach provides a means to assess the value of what habitat values were lost and of potential mitigation areas. Finally, by tracking the functional values lost due to inundation, whether from Alternative 3 or 4, mitigation will be sure to account not only for the acres of habitat lost but their associated ecological function. Adaptive management by an established group would facilitate discussion of minimizing impacts by operation strategies once reallocation begins (Appendix GG). Mitigation is considered in detail in the CMP (Appendix K).

Habitat lost due to the rise in the target pool elevation would be mitigated in a combination of on-site and off-site mitigation activities. The CMP did not include open water bird habitat and shoreline bird habitat because these habitats are not considered lost as they will occur in similar or greater amounts with reallocation. Of the 377 EFUs of bird habitat impacted, 9 EFUs would be mitigated on-site and 368 EFUs would be mitigated off-site (Appendix K). Riparian habitats would be expanded on site as much as possible, and riparian habitats along Plum Creek and along the South Platte River would be preserved, enhanced, or both. In addition, in selecting mitigation sites, the CMP (Appendix K) places an emphasis on the added ecological value of the connectivity of parcels along riparian corridors. An acre of land for off-site mitigation would be credited with more EFUs if it provides a connection to other protected lands and occurs within specified areas near Chatfield State Park, thus there is an incentive to select mitigation sites with higher connectivity. All of these efforts would benefit wildlife species. Refer to the CMP (Appendix K) for further details. The Corps has conducted coordination and informal consultations with the USFWS regarding potential impacts to wildlife and their recommendations for mitigation, including a Planning Aid Report (February 2006) and progress letter (July 2010) (see Appendix X).

4.9 Endangered, Threatened, and Candidate Species, Species of Special Concern, and Sensitive Communities

The four proposed alternatives could have potential impacts on federally-threatened and endangered (T&E) species or to state-listed (threatened or endangered) species and species of special concern. Species of special concern include species tracked by the CDOW or the CNHP due to declining populations or observed risks to habitats. Collectively, these species, including federally-protected, state-protected, and species of concern, are referred to in this document as Threatened, Endangered, and Sensitive Species (TES). Specific issues include possible impacts of the alternatives on habitat by inundation of wetland, riparian, and upland areas currently used by TES species. Additionally, the relocation of recreational facilities and roads and construction of new surface storage facilities and associated infrastructure may impact TES species and their habitats. Table 4-16 lists federal and state threatened, endangered, and candidate species and species of special concern with potential to occur or be affected by the Chatfield Reservoir storage reallocation project. Consultation with USFWS on the recommended alternative is required under Section 7 of the ESA. In compliance with the ESA, a Biological Assessment (BA) was prepared, for submittal to USFWS, to address potential effects to T&E species, and their designated critical habitat, from construction, operation, and maintenance of the recommended alternative. The BA is found in Appendix V.

Table 4-16
Federal and State Threatened, Endangered, and Candidate Species and Species of Special Concern with Potential to Occur or be Affected by the Chatfield Reservoir Storage Reallocation Project

Common Name	Scientific Name	Status	
		Federal	State
Mammals			
Black-footed ferret	*Mustela nigripes*	E	E
Black-tailed prairie dog	*Cynomys ludovicianus*	-	SC
Canada lynx	*Lynx canadensis*	T	E
Preble's meadow jumping mouse	*Zapus hudsonius preblei*	T	T
Townsend's big-eared bat *(pale ssp.)*	*Corynorhinus townsendii pallescens*	-	SC
Birds			
American peregrine falcon	*Falco peregrinus anatum*	-	SC
Bald eagle	*Haliaeetus leucocephalus*	-	T
Golden eagle	*Aquila chrysaetos*	FP	-
Ferruginous hawk	*Buteo regalis*	-	SC
Greater sandhill crane	*Grus canadensis tabida*	-	SC
Interior least tern[1]	*Sterna antillarum athalossos*	E	E
Long-billed curlew	*Numenius americanus*	-	SC
Mexican spotted owl	*Strix occidentalis lucida*	T	T
Mountain plover	*Charadrius montana*	-	SC
Piping plover[1]	*C. melodius circumcenctus*	T	T
Plains sharp-tailed grouse[2]	*Tympanuchus phasianellus jamesii*	-	E
Western burrowing owl	*Athene cunicularia*	-	T
Western snowy plover	*Charadrius alexandrinus*	-	SC
White pelican	*Pelicanus erythrorhynchos*	-	SC
Whooping crane[1]	*Grus americana*	E	E
Amphibians			
Northern leopard frog	*Rana pipiens*	-	SC
Fish			
Iowa darter	*Etheostoma exile*	-	SC
Northern redbelly dace	*Phoxinus eos*		SE
Common shiner	*Luxilus cornutus*		ST
Greenback cutthroat trout	*Oncorhynchus clarki stomias*	T	T
Pallid sturgeon[1, 3]	*Scaphirhynchus albus*	E	-
Insects			
Pawnee montane skipper	*Hesperia leonardus montana*	T	CNHP
Moss' elfin butterfly	*Callophrys mossii schryveri*	-	CNHP
Plants			
American currant	*Ribes americanum*	-	CNHP
Colorado butterfly plant	*Guara neomexicana coloradensis*	T	-
Forktip three-awn	*Aristida basiramea*	-	CNHP
Ute ladies'-tresses orchid	*Spiranthes diluvialis*	T	-

Key: E = Endangered (state or federal), T = Threatened (state or federal), C = Candidate for Listing (federal), FP = Federally Protected Species (federal), SC = Special Concern (state); CNHP = Colorado Natural Heritage Program (see Table 3-5 for details)

1 Water quality or depletions may affect the species and critical habitat in downstream reaches in other states.

2 This species is not known to occur in El Paso County but occurs in adjacent Douglas County.

3 This species is not known to occur in Colorado.

4.9.1 Alternative 1—No Action

Under Alternative 1, reservoir levels and operations at Chatfield Reservoir would remain unchanged (Table 4-2 and Figure 4-1). The target pool elevation would remain at 5,432 feet msl. Impacts on TES species at Chatfield Reservoir would not occur. Water depletions at Penley Reservoir and downstream gravel pits would equal those from the Chatfield Reservoir storage reallocation project and therefore would affect Platte River T&E species. Platte River T&E species include the federally protected whooping crane (*Grus americana*), the piping plover (*Charadrius melodus*), the interior least tern (*Sterna antillarum*), and the pallid sturgeon (*Scaphirhynchus albus*).

Under the No Action Alternative, the construction and filling of Penley Reservoir and the associated pipelines could result in impacts on several T&E species. Federally-protected wildlife species known to occur within the vicinity are the threatened Preble's meadow jumping mouse (Preble's mouse) and the federally-protected bald and golden eagles. While no longer listed as threatened species under the ESA, bald and golden eagles are still protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Bald and golden eagle nest sites are now protected under the definition of "disturb" under the Bald and Golden Eagle Protection Act (50 CFR 22.3). According to the act, disturb means "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available; 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." CDOW has established the following seasonal restriction and nest site buffer guidelines for bald and golden eagles: 1) no surface occupancy beyond that which historically occurred in the area, within ¼-mile radius of active nests; and 2) seasonal restriction to human encroachment within ½-mile radius of active nests from December 15 through July 15.

Habitat loss to Preble's meadow jumping mouse could result from reservoir construction and subsequent water use along Indian Creek near Penley Reservoir. Populations may be affected directly though habitat loss, or indirectly by water diversion that would decrease the quality of habitat. Pipeline construction may impact Preble's mouse habitat unless the pipeline is routed underneath habitat areas. If directional drilling under habitat occurs, adverse impacts from pipelines would be minimal. Bald eagles may benefit from Penley Reservoir, particularly if it supports fish populations and is eventually surrounded by large trees for nesting and roosting. Bald and golden eagles nesting in the vicinity of Penley Reservoir may be affected by a loss of foraging areas and nesting could be disturbed by the initial reservoir or 48-inch pipeline construction if construction areas fall within ½ mile from an active eagle nest.

There could be a loss of habitat for plains sharp-tailed grouse if it occurs in the area of Penley Reservoir. Some of the last remaining habitat within Douglas County is found in the vicinity of Penley Reservoir. The Colorado butterfly plant and Ute ladies'-tresses orchid, both federally-listed threatened plant species, occur in riparian habitats along streams. If these plants occur at the proposed Penley Reservoir, a loss of habitat for these plant species could result from construction activities.

Fish populations including the common shiner, Iowa darter, and the northern redbellied dace may be affected by the proposed Penley Reservoir construction or the water diversion that the project creates.

Construction of buried pipelines for the proposed Penley Reservoir would result in temporary adverse impacts on habitat. The areas disturbed during construction would be revegetated to restore native habitats.

Development of gravel pits into storage structures would not likely impact TES species since these areas are already heavily disturbed from the extraction of the gravel. However, infrastructure for the gravel pits, such as pipelines, could cause additional habitat disturbance that could affect TES species if they occur in the area. The downstream gravel pits are located in close proximity to the South Platte River and contain a variety of wetland habitats. TES species that potentially occur in these areas are Preble's meadow jumping mouse, bald eagle, Ute ladies'-tresses, and Colorado butterfly plant. Inundation of these gravel pits could also increase habitat for these species, particularly if wetlands are created and shorelines are vegetated with native plant species.

4.9.2 Alternative 2—NTGW/Downstream Gravel Pits

Under Alternative 2, reservoir levels and operations at Chatfield Reservoir would remain unchanged as in Alternative 1. Impacts on Platte River T&E species would not occur. Impacts on TES species for the gravel pits would also be the same as under Alternative 1, along with impacts from the construction of associated pipelines, canals, and ditches. However, impacts on TES species in the Penley Reservoir area would not occur because water would be obtained from NTGW.

4.9.3 Alternative 3—20,600 Acre-Foot Reallocation

Under this alternative, the infrastructure of the conservation pool would be changed to target 20,600 acre-feet of reallocated storage by allowing the water level to rise to an elevation of 5,444 feet msl, up to a 12-foot increase in pool elevation. Based on elevation contours generated using field survey data of the area immediately surrounding the reservoir, this increased water level would inundate additional acres of land area adjacent to the reservoir as shown in Table 4-2 and Figure 4-1. Under Alternative 3, approximately 676 acres of wildlife habitat would be inundated at a water level of 5,444 feet msl. Tables 4-14 and 4-15 present the estimated number of acres inundated by habitat type and by drainage. It is important to understand that the total acres potentially inundated (676 acres) include overlapping habitats for multiple terrestrial resources, including habitat for birds, habitat for the Preble's mouse, and wetlands.

To better understand the inundation process and the associated impacts on TES species from changing the current target pool elevation of 5,432 feet msl by 12 feet to 5,444 feet msl, several parameters and actions surrounding the reallocation need to be explained. These include:

1. Actions to prepare the project area before inundation occurs—tree removal and relocation of road and recreation facilities

2. Estimated pool levels during average years during the growing season, both seasonally and from year to year including range of variability

3. Estimated pool levels during flood years that may raise levels above 5,444 feet msl

4. Downstream flow changes

5. Upstream flow changes

Using the POR flow and pool elevation data, these parameters and actions were analyzed and estimated. The modeling using POR data assumes that conditions of the past can predict conditions in the future. Modeling does not take into account climate change, which may result in more floods and more or longer periods of drought that cannot be accurately predicted at this time (Ray et al., 2008). Annual average streamflow volumes in the South Platte could decrease with climate change (Water Research Foundation, 2012). In addition, the inflows during the entire POR tend to be greater on average than those expected during future conditions for all alternatives. This results in a greater probability of adequate mitigation for all types of inundation-related environmental impacts. The analyses in this section were conducted to understand the potential adverse impacts on TES species.

Adverse impacts under Alternative 3 are substantial, converting hundreds of acres of terrestrial habitats to aquatic or semi-aquatic habitats. It likely would benefit reservoir fisheries, but would negatively impact terrestrial wildlife species by reducing the overall acreage of wildlife habitat within the study area by reducing the available forage, protective cover, breeding sites, and nesting sites. This would occur as a result of the inundation of upland, riparian, or wetland vegetation that kills or transforms the present vegetation and corresponding wildlife habitat. Under Alternative 3, the Tree Management Plan (Appendix Z) calls for removing the majority of trees below 5,439 feet msl prior to raising the pool elevation. Selected trees would be left in place to provide wildlife habitat, or felled and anchored to provide habitat for fish and other aquatic organisms. Visitor and dam safety will take priority in determining where trees can be retained and anchored. An adaptive management approach would be used to monitor trees that are partially inundated to determine if additional trees need to be removed to ensure visitor and dam safety (Appendices Z and GG).

The relocation of roads and recreation facilities in the park would impact riparian, wetland, and upland habitats (see Section 4.17 and Appendix M). The adverse impacts would include direct loss of habitat used by TES species, fragmentation of habitat, increase of human/wildlife interactions, and increased weed invasion. For example, the relocation of the Kingfisher Parking lot could impact Preble's meadow jumping mouse upland habitat. Plum Creek trail head and parking area relocation would also impact Preble's mouse habitat and would require mitigation.

The average pool level on an annual basis would be subject to seasonal fluctuations of up to 21 feet, although annual fluctuations of 6 to 7 feet would be typical (Figure 4-18). In terms of impacts on TES species it is useful to look at fluctuations during the growing season and fluctuations when hibernators are active or dormant and when migratory animals are present or absent. The vegetation growing season corresponds roughly to beginning at week 17 and ending at week 41 (i.e., April 25 to October 11) and corresponds to a growing season of approximately 170 days (see Section 4.6 for details). During an average year, as modeled using POR data, pool levels would begin to increase prior to the onset of the growing season until reaching the peak during weeks 19 or 20, soon after the growing season starts. Then pool levels would recede modestly (2 to 3 feet) for a major portion of the growing season, then level off toward the end of the growing season and for the remainder of the year (Figure 4-17). Within the growing season, the POR data predict that the pool level during an average year would approximate 5,440 feet msl with fluctuations equal to ±2 feet (Figure 4-15). See Figures 4-14, 4-15, and 4-16 for yearly range with quartiles during the growing season for all years in the POR for Alternatives 1 and 2, 3, and 4, respectively. Pool levels during the majority of the growing season may also be influenced by reservoir management. During the recreation season

(May 1 through September 30), pool level variations are currently restricted and restrictions may continue under Alternative 3 (see Section 4.17 for details). This would aid in maintaining pool levels during the majority of the growing season and reservoir management options are being discussed. Outside of the growing season, pool levels would continue to decrease during average years to elevations approximating 5,436 feet msl in a typical year (Figure 4-17). The modeling of average pool levels reveals that the target pool elevation of 5,444 feet msl may not be attained in a typical year. Therefore, a portion of the habitat acres listed in Tables 4-14 and 4-15 would typically not be inundated, or at least inundated for only short periods of time. Under Alternative 3, the Tree Management Plan (Appendix Z) calls for removing the majority of trees below 5,439 feet msl prior to raising the pool elevation. Vegetation between 5,439 and 5,444 feet msl would be inundated less frequently than the vegetation below 5,439 feet msl, and vegetation in this zone would not be removed prior to inundation. Vegetation in this zone would likely transform from terrestrial habitats to wetter environments instead of being completely eliminated. This could occur naturally through succession by decreasing or eliminating woody vegetation (trees and shrubs) and encouraging the growth of water-tolerant vegetation including wetland plants. As trees die and decay, they would provide habitat for raptors, herons, and cormorants as roosting areas, and provide habitat for cavity nesting birds. An adaptive management approach would be used to monitor trees in this zone to determine if additional trees need to be removed to ensure visitor and dam safety.

In Section 4.6, an estimate of vegetation gains and losses under future conditions for the inundation alternatives (i.e., Alternatives 3 and 4) is presented in Table 4-11 based on the current ratio of vegetation communities at specific elevational increments and is applied to the acreage of land that would have these same relative elevations (i.e., 0–2 feet, 2–4 feet, 4–6 feet) above the alternative targeted pool elevations (see Section 4.6). When comparing impacts to vegetation and therefore wildlife habitat as a result of inundation under Alternatives 3 and 4, it is important to realize that the losses may be somewhat offset by succession changes at the new OHWM. This also pertains to gains and losses of certain T&E species' habitat.

In terms of annual fluctuations outside of the typical conditions, what may happen to pool levels during flood years and drought years is needed to further understand impacts on TES species. Figure 4-18 presents POR modeling showing pool elevations per year over the POR for each alternative. Chatfield Reservoir's flood control function would result in periodic rises in water levels above the target pool elevation. Compared to Alternative 1, flooding occurs with the same frequency over the POR and of similar duration for each event. However, the pool elevations reached during the peak of an event is higher for Alternative 3, and therefore floods a larger area. Adverse impacts on vegetation would be minimal because the flooding, especially at the highest elevations, is for a short duration (several days). Modeling of maximum levels using the POR water levels illustrate that fluctuations in maximum water elevations from year to year can be more than the average fluctuations and on extremely rare occasions can change more than 20 feet for extended durations. For example, the largest flood recorded was in 1942 when water levels would equate to pool elevations exceeding 5,465 feet msl and flooding above 5,444 feet msl lasted for 40 days. This extreme flood event simply shows the variability of possible events and was during a time when few if any water management practices were being conducted within the watersheds. If a flood similar to 1942 occurs again, vegetation would be altered no matter what pool levels are allowed, but dams and diversions would greatly attenuate the impacts of such a flood. By reviewing Figure 4-18, flooding predicted over the POR at the new pool elevation of 5,444 feet msl would have occurred during 6 out of 59 years (10 percent). The duration of these flood events ranges widely from 30–40 days for the largest floods to 5–10 days for the more moderate floods. Currently, flooding along the South Platte River is dampened by the reservoirs upstream constructed in the 1970s. Although not quantified, the influence of the upstream reservoirs further lessens the probability of flooding along the South Platte River. Any diversions along Plum Creek likely dampen flooding on this drainage as well.

During drier years, pool levels can fall below the predicted average pool level of 5,440 feet msl and much lower than the target pool level of 5,444 feet msl. However, the frequency of these drier years occurs as frequently as flood years, about 10 percent of the time (Figure 4-18). Therefore, the majority of the time (roughly 80 percent on average) the pool levels are at an average level, about 5,440 feet msl during the growing season (and therefore during the wildlife breeding season and the Preble's mouse active season). Pool levels maintained at this elevation would help to stabilize vegetation above 5,444 feet msl and provide consistent habitat within a margin area of ± 2 feet at the average pool level of 5,440 feet msl.

Under this alternative, the Chatfield Reservoir level would fluctuate within the year more often and more widely than under the other alternatives. It is possible that the pool level could fluctuate over a distance of 21 feet under the worst conditions, likely an extended drought. The multipurpose pool level can recede to an elevation of 5,423 feet msl under Alternative 3, which is the same level as under the other alternatives including current conditions. However, under Alternative 3, the pool level can rise much more than under the other alternatives. Although the average peak fluctuation of 3 feet (Figure 4-12) during late spring or early summer is expected, over an entire year the pool level would have the potential to fluctuate 21 feet. Although the maximum pool elevation under this alternative (i.e., 5444 feet msl) is predicted to be attained at least once per year in 42 of the 59 years in the POR, the minimum levels could reach 5,423 feet msl (Figure 4-18). According to POR modeling, reservoir levels have the potential of being at this elevation during some part of the year 1 out of every 3 years. Under current conditions (Alternative 1), storage capacity is managed in an attempt not to exceed 9 feet of fluctuation annually.

Downstream impacts—Specifics of utilization of additional conservation storage capacity would determine the effect on flows below Chatfield Reservoir. Capture of up to 20,600 acre-feet appears to have the potential to decrease existing releases and alter timing of flows downstream. However, water stored and later released to downstream providers has potential to temporarily augment flows. Specific changes in flow are addressed in Section 4.5, Aquatic Life and Fisheries.

Upstream impacts—The potential for secondary impacts from additional conservation storage capacity to flows upstream of the study area on the South Platte River and Plum Creek is dependent on whether utilization of storage capacity at Chatfield Reservoir would change the current management of water in these drainages, both by providers of the reallocated storage at Chatfield Reservoir and potentially by other entities such as Denver Water. Available inflows to be stored in Chatfield by the new providers would be from both junior water rights and "free river" diversions, which would be exercised when there is available runoff for the taking ("free water"). The reallocation of storage at Chatfield simply enables waters to be stored in Chatfield that now flow downstream through and beyond the study area. Under the current understanding of how water providers would access and store water at Chatfield, there are no expected direct or indirect impacts on upstream areas outside of the study area.

Impacts on Federally-Protected Species

Preble's Meadow Jumping Mouse—The proposed increase of the target pool level to 5,444 feet msl would result in the potential inundation of approximately 454 acres of Preble's mouse habitat, including approximately 155 acres of designated critical habitat along the South Platte River and Plum Creek. Tables 4-17 and 4-18 present the estimated acres of Preble's habitat and critical habitat, respectively, that are inundated under each alternative. Acres are broken into high and low quality riparian habitat and upland habitat by drainage.

Table 4-17
Total Acres of Preble's Mouse Habitat Affected by Alternative and Drainage

	South Platte River Drainage			Plum Creek Drainage			Total		
	Alts 1 and 2	Alt 3	Alt 4	Alts 1 and 2	Alt 3	Alt 4	Alts 1 and 2	Alt 3	Alt 4
High Value Riparian Habitat	0.0	139.0	85.0	0.0	102.5	80.4	0.0	241.5	165.4
Low Value Riparian Habitat	0.0	42.5	35.7	0.0	35.3	16.6	0.0	77.8	52.3
Upland	0.0	95.2	33.9	0.0	39.3	18.3	0.0	134.5	52.2
Total Acres	0.0	276.7	154.6	0.0	177.1	115.3	0.0	453.8	269.9
Percentage of Occupied Range in Drainage Potentially Impacted	0.0	28.1%	15.7%	0.0	22.7%	14.8%	0.0	25.7%	15.3%

Notes: Acres of Total Occupied Range in Study Area = 1,764.1
Acres of Total Occupied Range in Plum Creek Portion of Study Area = 779.4
Acres of Total Occupied Range in South Platte River Portion of Study Area = 984.7

Table 4-18
Total Acres of Preble's Mouse Critical Habitat Affected by Alternative and Drainage

	South Platte River Drainage			Plum Creek Drainage			Total		
	Alts 1 and 2	Alt 3	Alt 4	Alts 1 and 2	Alt 3	Alt 4	Alts 1 and 2	Alt 3	Alt 4
High Value Riparian Habitat	0.0	79.1	40.4	0.0	44.6	30.6	0.0	123.7	71.0
Low Value Riparian Habitat	0.0	0.2	0.2	0.0	17.9	9.2	0.0	18.1	9.4
Upland	0.0	0.7	0.1	0.0	12.7	7.1	0.0	13.4	7.2
Total Acres	0.0	80.0	40.7	0.0	75.2	46.9	0.0	155.2	87.6

The entire Upper South Platte River critical habitat unit (CHU) extends from Chatfield Reservoir to Deckers many miles upstream of Chatfield Reservoir and is broken into several portions of habitat along the river and its tributaries and are designated as subunits of critical habitat [Upper South Platte critical habitat unit (SP13) (FR68(120)37276-37332)]. The Upper South Platte critical habitat unit contains approximately 43.8 miles of river and streams. Federal land along the Upper South Platte River within the USACE Chatfield property is designated as one subunit within the Upper South Platte critical habitat unit; the subunit totals 297.3 acres of critical habitat. Alternative 3 would inundate approximately 80.0 acres of Preble's mouse critical habitat within the Chatfield subunit, including 79.1 acres of high value riparian habitat, 0.2 acres of low value riparian habitat, and 0.7 acres of upland habitat (Table 4-18). Therefore, approximately 27 percent of the subunit would be inundated under this alternative. The increased storage proposed under Alternative 3 would affect the Preble's mouse in two ways, directly as water rises and indirectly through the alteration of existing habitat. Initial and subsequent rise in water to the target pool level could, depending on the season and rate of rise, drown hibernating adults or young in maternal nests, or displace individuals as water rises. Preble's mice swim well (Schorr, 2001) and it seems unlikely that active adults or self-sufficient young would be drowned. It should be noted that the current increases in water level associated with flooding within the study area have similar direct impacts on Preble's mice. In addition to direct mortality, inundation of Preble's habitat could cause secondary mortality from displacement, reduced population, and increased vulnerability based on a smaller population. Current population densities within the study area are unknown at this time, so it is difficult to determine the number of individuals that may be affected by this alternative.

The West Plum Creek critical habitat unit extends upstream from Chatfield Reservoir to include approximately 90 miles of streams in the Plum Creek Watershed (75 Federal Register 78430). The Proposed Action would inundate approximately 75.2 acres of Preble's critical habitat along 2.8 stream miles in the Plum Creek arm of Chatfield Reservoir, including 44.6 acres of high value riparian habitat, 17.9 acres of low value riparian habitat, and 12.7 acres of upland habitat (Table 4-18).

Preble's mouse habitat would be affected by direct inundation and by transformation as the new pool levels are established. The inundated acres shown in Tables 4-17 and 4-18 assume constant inundation at the target pool elevation, and therefore an estimate of maximum impacts. However, this is not how inundation is likely to occur. As discussed earlier in this section, it is more likely that during a typical year, the water level would be at 5,440 ±2 feet msl. Vegetation below this level would likely be completely lost but a ring of vegetation above this elevation may be transformed. This may result in a loss of woody vegetation or an increase in understory cover as more water becomes available closer to the surface. Additionally, at the new water level, a zone just below the area of habitat transformation may still support vegetation but due to intermittent inundation, the vegetation would be composed of annual plants including good seed producers and weedy species. This also, depending on reservoir management, may positively or negatively impact the Preble's mouse.

An additional 2.54 acres of Preble's habitat would be impacted by the relocation of the recreation trail at the Plum Creek day use area. This includes the following habitat types: 0.66 acres of high value riparian habitat and 1.88 acres of low value riparian habitat. Approximately 19 percent (0.48 acres) of this area is designated critical habitat in the West Plum Creek CHU.

Upstream or downstream conditions related to this alternative appear not to affect the Preble's mouse. Upstream conditions are thought to remain similar to baseline conditions as discussed previously in this section. Downstream conditions may change slightly but no Preble's mouse populations are known to exist downstream of Chatfield Reservoir to the Adams/Weld county line.

In conclusion, a change in the target pool elevation to 5,444 feet msl would adversely affect the Preble's mouse habitat within the study area and affect critical habitat along the South Platte River and Plum Creek.

Black-footed Ferret—The black-footed ferret has likely been extirpated from the eastern half of Colorado and is not currently found within the study area. A change in the target pool elevation to 5,444 feet msl would have no effect on the black-footed ferret.

Canada Lynx—The Canada lynx has been reintroduced to Colorado in recent years as discussed in Chapter 3. However, no habitat for the lynx is found in the study area. Therefore, a change in the target pool elevation to 5,444 feet msl would have no effect on the Canada lynx.

Bald Eagle—The bald eagle is no longer protected under the ESA, but remains federally-protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act (FR72(130)37346-37372 July 9, 2007). Bald and golden eagle nest sites are now protected under the definition of "disturb" under the Bald and Golden Eagle Protection Act (50 CFR 22.3). According to the act, disturb means "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available; 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." CDOW has established the following seasonal restriction and nest site buffer guidelines for bald and golden eagles: 1) no surface occupancy beyond that which historically occurred in the area, within ¼-mile radius of active nests; and 2) seasonal restriction to human encroachment within ½-mile radius of active nests from December 15 through July 15.

If mature trees that die in inundated areas along the shorelines are allowed to remain standing, this would reduce the loss of bald eagle perch sites in the short term since bald eagles use both live and dead trees. Ultimately, however, as trees decay, those perches would decrease below pre-inundation numbers and would eventually adversely impact the eagles by providing fewer perches for hunting and roosting. This is a temporary adverse impact and lost trees would eventually be replaced by live trees along the new pool elevation. As described in the Tree Management Plan (Appendix Z) and the AMP (Appendix GG), an adaptive management approach would be used to monitor trees below 5,444 feet msl that are not removed prior to inundation to determine if additional trees need to be removed to ensure visitor and dam safety. The Tree Management Plan attempts to minimize the amount of large trees removed by minimizing the number of trees that are removed above elevation 5,439 feet msl due to their higher likelihood of survival. In addition, the CMP identifies onsite mitigation to be the number one priority for mitigating ecological resources, thus in completing onsite mitigation, replacement of lost riparian areas will occur. Furthermore, the water providers have agreed to work with the state to provide for the reforestation of certain areas in response to State Park's concerns about preserving park aesthetics and providing shade for visitors. These additional plantings are being considered outside of the Selected Plan.

Bald eagle prey, primarily fish within and surrounding the study area, would benefit from the increased water levels proposed in Alternative 3. Section 4.5, Aquatic Life and Fisheries, provides additional details. Waterfowl would also benefit from more open water and additional acres of shoreline under Alternative 3. Because its principal prey groups (fish and waterfowl) would benefit, the bald eagle would also benefit from increased pool elevations. In conclusion, the bald eagle may be affected by Alternative 3, but this effect would likely be beneficial.

Golden eagles have been observed in the vicinity of the Lockheed Martin property west of the study area. In addition, peregrine falcons historically nested up Waterton Canyon and prairie falcons are known to nest along the hogback. However, no active nests for golden eagles, peregrine falcons, or prairie falcons are known within a ½ mile of the study area. Therefore, impacts to these species are considered minimal or non-existent.

Mexican Spotted Owl—The Mexican spotted owl is found in mature coniferous forest typically in steep mountainous canyons such as those in the Pike-San Isabel National Forest and other forests in the southwest. No habitat for the Mexican spotted owl is found within the study area and upstream portions of the South Platte River on National Forest land would not be affected by increased pool elevations at Chatfield. Therefore, there would be no adverse impact on the Mexican spotted owl.

Pawnee Montane Skipper—Pawnee montane skippers inhabit dry, open Ponderosa pine woodlands with sparse understory at 6,000 to 7,500 feet msl. Blue grama grass (*Bouteloua gracilis*), the larval food plant and prairie gay feather, the primary nectar plant, are two necessary components of the ground cover. The skipper occurs only on the Pikes Peak Granite Formation in the South Platte River drainage system in Colorado involving portions of Jefferson, Douglas, Teller, and Park counties. The total known habitat within the range is estimated to be 37.9 square miles (98.2 square kilometers). However, given the elevation restrictions of its habitat, the skipper does not occur in the study area and therefore would not be affected by a change in the pool elevation at Chatfield Reservoir as proposed under Alternative 3. Therefore, there would be no adverse impact on the Pawnee montane skipper.

Greenback Cutthroat Trout—The greenback cutthroat trout is found only in a few streams and lakes within the headwaters of the South Platte River and Arkansas River systems. Habitat requirements include clear, cold streams and lakes and clean gravel in flowing streams during spring for spawning. No habitat for the greenback cutthroat trout is found within the study area. Therefore, there would be no adverse impact on the greenback cutthroat trout.

Ute Ladies'-Tresses Orchid—Rare plant surveys for the Ute ladies'-tresses orchid were conducted at Chatfield State Park in 1998, 2004, and 2005. No orchid plants were found after intensive surveys during the correct time of year when other nearby orchid populations were in bloom. No Ute ladies'-tresses orchids are known from the study area. Therefore, the raising of the pool elevation at Chatfield Reservoir as described under Alternative 3 would have no adverse impact on the Ute ladies'-tresses orchid.

Colorado Butterfly Plant—Rare plant surveys for the Colorado butterfly plant were conducted at Chatfield State Park in 2004 and 2005. No Colorado butterfly plants were found after intensive surveys during the proper time of year. No Colorado butterfly plants are known from the study area. Therefore, the raising of the pool elevation at Chatfield Reservoir as described under Alternative 3 would have no adverse impact on the Colorado butterfly plant.

Central Platte River Species, Nebraska—Platte River species include the whooping crane (and designated critical habitat in Nebraska), the pallid sturgeon, the piping plover (northern Great Plains population), the interior least tern, and the western prairie fringed orchid. These species may be affected downstream in Nebraska by depletions resulting from the proposed Chatfield Reservoir storage reallocation project. Because these species are federally-protected, the federal action agency project proponents must seek consultation with the USFWS to ensure that no federally protected species under the ESA will be jeopardized or have their critical habitat adversely affected by the actions of the project. The whooping crane, interior least tern, and piping plover, are Platte River T&E species that occur in Nebraska; their potential to occur in the Chatfield Reservoir study area is discussed below.

The Platte River Recovery Implementation Program (PRRIP) was established to protect and recover the Central Platte River target species and to offset the depletive effects of existing and new water related activities in Colorado and the other basin states. In Colorado, individual water projects such as the Chatfield Reservoir reallocation project may rely on the PRRIP for ESA compliance purposes through the participants' membership and financial participation in the South Platte Water Related Activities Program, Inc. (SPWRAP) a water providers' organization. The SPWRAP assists in fulfilling Colorado's programmatic contributions to the PRRIP. The participants of the Chatfield project are all members of the SPWRAP (see Appendix V for certificates of membership).

Under Alternative 3, the South Platte River below Chatfield Reservoir would have minimal changes during base flow conditions and a small increase in flow during the late summer months (Figure 4-12).The projected change during winter base flow conditions is 12 cfs less than under current conditions (Alternative 1). By agreeing to participate in the PRRIP, the participants of the Chatfield Reservoir storage reallocation project, which is subject to Section 7 ESA consultation, can ensure compliance relative to the Platte River target species, can avoid the potential for prohibited "take" of these species under ESA Section 9, and can take advantage of predefined procedures and expectations going into the ESA consultation process. The PRRIP benefits Platte River species by creating offsetting measures, including measures that will substantially reduce shortages to target flows in the central Platte River, and that will obtain and restore habitat for the target species. Therefore, net impacts to these species are not expected to be significant as a result of depletions from the proposed Chatfield Reservoir reallocation project. The potential effects of project depletions on the Platte River species are addressed in the streamlined PRRIP Biological Assessment that will be submitted by the Corps (the federal action agency) to the USFWS and will be covered through a "tiered" Biological Opinion confirming the project is in compliance with the ESA based on implementation of the PRRIP. The PRRIP BA is included in the FR/EIS as Attachment 1 of the BA (Appendix V).

Two of the Platte River species can also occur in Colorado, the piping plover and the interior least tern. These two species have potential to occur in the study area during migration as they both are attracted to gravelly or sandy shorelines. Based on 10 years of observations at Chatfield Reservoir (1996 to 2006), each of these species was observed only once, the piping plover in September 2001 and the interior least tern in July 1998 (Kellner, 2006) (see Appendix V for additional information). Increased exposure of shorelines that may potentially occur under Alternative 3 may be a benefit to migrating piping plovers or interior least terns. The occurrence of whooping cranes in Colorado is extremely rare, and they have never been reported from Jefferson or Douglas Counties (Andrews & Righter, 1992) where Chatfield is located, thus direct impacts to this species are not expected. In 1975 an experiment was initiated to establish a flock of whooping cranes that would migrate from Gray's Lake Idaho to Bosque Del Apache National Wildlife Refuge in New Mexico, with stopovers in Colorado's San Luis Valley. Eggs from whooping crane nests in Canada were transferred to sandhill crane nests in Idaho, and the sandhill cranes raised the whooping cranes and taught them the migration route. The whooping cranes failed to form pair bonds and had high mortality rates. In 1989 the program was discontinued and no whooping cranes survived in this population (International Crane Foundation, 2012).

Impacts on State-Listed Species and Species of Concern

Black-tailed Prairie Dog and Associated Species—A small, isolated black-tailed prairie dog colony is found within the study area in close proximity to the radio-controlled airplane field at Chatfield State Park. This is an upland site and would not be inundated from the increase of the pool elevation as proposed in Alternative 3. Therefore, there would be no impacts on black-tailed prairie dogs.

Other species of concern are typically found in association with prairie dog colonies. Prairie dogs are considered a keystone species, meaning that they provide habitat to a variety of other animal species and enrich the environment they inhabit. These associated species include the western burrowing owl, the swift fox, the mountain plover, and the ferruginous hawk. Although these species are not totally dependent on prairie dog colonies, they typically are associated with them. Most often, these species are also associated with the shortgrass prairie of eastern Colorado and wide open spaces. Therefore, habitat for the swift fox or the mountain plover is not considered to exist within the study area and these species would not be affected by this alternative.

The western burrowing owl could be present during migration and during the breeding season. The only appropriate habitat would be the prairie dog colony described above. Because the prairie dog colony would not be affected by this alternative, the burrowing owls would also not be affected.

The ferruginous hawk, like the black-tailed prairie dog, swift fox, and mountain plover, is an eastern plains grassland species. But unlike the plover and fox, it may winter along Front Range rivers and streams and therefore may be found in the study area during migration and as a winter resident. Being a species dependent on open upland habitats, the ferruginous hawk is unlikely to be directly affected by increases to the pool elevation and marginal inundation of their preferred habitat. An indirect effect to upland habitat may be the relocation of roads and recreational facilities; however, the prairie dog colony is not identified as a location to relocate any recreational facilities. A loss of upland habitat in general, whether from inundation or relocation of recreational facilities would affect the ferruginous hawk winter habitat and potentially reduce hunting areas. Ferruginous hawks hunt over a wide area compared to the area that may be affected by inundation or relocation of facilities. Thus, the adverse impact on their hunting range would be relatively small.

Plains Sharp-tailed Grouse—The sharp-tailed grouse is found in very isolated locations in Douglas County but is not found within the study area. Therefore, the sharp-tailed grouse would not be affected by Alternative 3.

Townsend's Big Eared Bat—Townsend's big eared bat is a Colorado species of special concern and inhabits very specific habitats including caves and mine shafts that have the proper temperature for roosting and hibernating. No caves or mines are found within the study area and therefore, the Townsend's big eared bat would not be affected by this alternative.

White Pelican—The white pelican frequents Chatfield Reservoir in large groups of non-breeding summer residents. They would likely benefit, along with the bald eagle, because of an increase in fish resulting from the increase in pool elevation at Chatfield Reservoir proposed under Alternative 3 (see Section 4.5, Fisheries and Aquatic Life, for details of positive impacts on the Chatfield fishery). In addition, more exposed shoreline habitat at a variety of water levels may increase loafing and roosting sites for pelicans. Therefore, the impacts of Alternative 3 on the white pelican would likely be positive.

American Peregrine Falcon—The American peregrine falcon is a species that has recovered from past population declines. Recent surveys across North America have indicated that populations are secure (USFWS, 2003); however, it is still considered a species of special concern as its recovery has only happened recently. Peregrines may frequent the study area hunting their favorite prey, birds. Some bird habitats would be lost, such as riparian woodlands, as the pool elevations rise as proposed under Alternative 3, but other bird habitats, such as shoreline and open water habitats, would increase. Given that some habitat may actually increase, it is unlikely that the number of prey birds available to peregrines would decrease significantly enough to have an effect on peregrine falcon populations.

Greater Sandhill Crane—Greater sandhill cranes can be observed in the study area during migration. They may use the area around Chatfield Reservoir on a limited basis as a stopover site during migration. Therefore, it is unlikely that the impacts on upland and wetland habitat as projected by the implementation of Alternative 3 would have an effect on greater sandhill crane populations.

Northern Leopard Frog—This species occurs within Chatfield State Park in riparian habitats along the South Platte River and Plum Creek (Baker & Farah, 2009). Northern leopard frog habitat within areas affected by pool level increases would be at least temporarily lost. Greater variation in water levels may permanently affect wetland or shoreline habitat used by the frogs. Although new wetland areas would eventually establish and create new habitat, it is likely that there would be a period of time before these areas are established and frog habitat is available. Management of water levels during the growing season may lessen impacts to the northern leopard frog if water levels are held constant during the breeding season and if the establishment of habitat at the new water levels is enhanced by recontouring land and vegetation plantings/seeding. Therefore, the northern leopard frog may be affected by Alternative 3.

Iowa Darter—The Iowa darter, a native fish species of concern, has been sampled in Chatfield Reservoir by the CDOW; however, only two individuals have been collected over an 8-year sampling period (CDOW, 2006a). Iowa darters are more likely to be found in and associated with a limited number of streams in northeastern Colorado. Consistent with previously discussed impacts (see discussion in Section 4.5, Aquatic Life and Fisheries), it is anticipated that increased pool elevations for both Alternative 3 and Alternative 4 would enhance habitat conditions for this species in Chatfield Reservoir and would not adversely impact them.

Other Fish Species of Concern—The northern redbelly dace and the common shiner are present in the upper reaches of Plum Creek (as is the Iowa darter). Since these reaches are well upstream, only secondary impacts associated with flow alterations outside of the study area would be of concern.

Rare Plants—Two species of rare plants of concern, the American currant and the Forktip three-awn, are thought to potentially occur with the study area. Rare plant surveys for the Ute ladies'-tresses orchid and the Colorado butterfly plant were conducted at Chatfield State Park in 1998, 2004, and 2005. No American currant plants were observed during this survey work, which was conducted in much of the potential habitat for the American currant. Therefore it is unlikely that this rare plant species occurs within the study area and consequently it would not be affected by the activities associated with Alternative 3.

Forktip three-awn is an upland plant that inhabits recently disturbed sites such as old railroad grades or road right-of-ways with gravelly substrate. Such upland areas are not proposed to be inundated under Alternative 3; therefore the forktip three-awn would not be affected.

4.9.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

In addition to the reallocation, another 5,379 acre-feet would be obtained from NTGW and/or other storage and downstream gravel pits under Alternative 4. The potential effects on sensitive wildlife from conversion of downstream gravel pits to water storage reservoirs and use of NTGW are disclosed under Alternatives 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2.

Under this alternative, the conservation pool would target 7,700 acre-feet of reallocated storage by allowing the water level to rise to 5,437 feet msl. As shown in Table 4-2 and Figure 4-1, this increased water level would inundate approximately 215 acres of land adjacent to the reservoir at the target pool elevation.

Under this alternative the Chatfield Reservoir level would fluctuate less than under Alternative 3. Additionally, less terrestrial habitat would be inundated.

Impacts on Federally-Protected Species

Preble's Meadow Jumping Mouse—The proposed increase of the pool elevation to 5,437 feet msl would result in the potential inundation of approximately 270 acres of Preble's mouse habitat, including 87.6 acres of designated critical habitat along the South Platte River and Plum Creek. Tables 4-17 and 4-18 present the estimated acres of Preble's habitat and critical habitat, respectively, inundated under each alternative. Alternative 4 has much less adverse impact to Preble's critical habitat than Alternative 3 and would inundate approximately 87.6 acres of critical habitat, including approximately 40.7 acres in the Upper South Platte CHU and approximately 46.9 acres on Plum Creek in the West Plum Creek CHU. The 40.7 acres in the Upper South Platte CHU includes 40.4 acres of high value riparian habitat, 0.2 acres of low value riparian habitat, and 0.1 acres of upland habitat (Table 4-18). The 46.9 acres in the West Plum Creek CHU includes 30.6 acres of high value riparian habitat, 9.2 acres of low value riparian habitat, and 7.1 acres of upland habitat (Table 4-18).

As in Alternative 3, the reallocated storage proposed under Alternative 4 would affect the Preble's mouse in two ways, directly as water rises and indirectly through the alteration of existing habitat. Initial and subsequent rise in water to the target pool elevation could, depending on the season and rate of rise, drown hibernating adults or young in maternal nests, or displace individuals as water rises. Preble's mice swim well (Schorr, 2001) and it seems unlikely that active adults or self-sufficient young would drown. It should be noted that the current increases in water level associated with flooding within the study area have similar direct adverse impacts on Preble's mice. Current population densities within the study area are unknown at this time so it is not possible to determine the number of individuals that may be affected by this alternative.

Preble's mouse habitat would be affected by direct inundation and by transformation as the new pool levels are established. The inundated acre values in Tables 4-17 and 4-18 assume constant inundation at the target pool elevation. However, as presented in Figure 4-17, it is more likely that during a typical year, the water level would be at 5,434 ±2 feet msl. Vegetation below this level would likely be completely lost but a ring of vegetation above this elevation may be transformed to a wetter form of vegetation. This may mean a loss of woody vegetation or an increase in understory cover as more water becomes available closer to the surface. Additionally, at the new water level, a zone just below the area of habitat transformation may still support vegetation but due to intermittent inundation, the vegetation would be composed of annual plants that include good seed producers and weedy species. This also, depending on reservoir water level management and weed control, may positively or adversely impact the Preble's mouse.

An additional 2.54 acres of Preble's habitat would be impacted by the relocation of the recreation trail at the Plum Creek day use area. This includes the following habitat types: 0.66 acres of high value riparian habitat and 1.88 acres of low value riparian habitat. Approximately 19 percent (0.48 acres) of this area is designated critical habitat in the West Plum Creek CHU.

As in Alternative 3, upstream or downstream conditions related to this alternative appear not to affect the Preble's mouse. Upstream conditions are thought to remain similar to baseline conditions as discussed previously in this section. Downstream conditions may change, but no Preble's mouse populations are known to exist downstream of Chatfield Reservoir to the Adams/Weld county line.

In conclusion, a change in the pool elevation at Chatfield Reservoir to 5,437 feet msl is likely to adversely affect the Preble's mouse within the study area and affect critical habitat along the South Platte River and Plum Creek.

Bald Eagle—The bald eagle would likely benefit from a change in the pool elevation to 5,437 feet msl. As discussed in Alternative 3, the potential increase in the bald eagle's food supply (fish and waterfowl) would benefit the bald eagle.

Mature trees that did not survive in inundated areas could, if left standing, provide more available snags along shorelines and thus benefit bald eagles in the short term. Ultimately, however, as trees decay, those perches would decrease below pre-inundation numbers and would eventually adversely impact the eagles by providing fewer perches for hunting and roosting. This would be a temporary adverse impact because trees would eventually be replaced along the new target pool elevation.

Other Federally-Protected Species—Other federally-protected species including the black-footed ferret, Canada lynx, Mexican spotted owl, Pawnee montane skipper, greenback cutthroat trout, Ute ladies'-tresses orchid, and Colorado butterfly plant would not be affected by this alternative for similar reasons as discussed in the previous section for Alternative 3. These species do not exist or do not have habitat within the study area and do not exist in the areas that may be indirectly affected by the project.

Platte River Species—Platte River species include the whooping crane, the pallid sturgeon, the piping plover, and the interior least tern. These species may be affected by downstream changes in flow that Alternative 4 may cause. Because these species are federally-protected, any federal project must seek consultation with the USFWS to ensure that no federally-protected species under the ESA will be jeopardized or have their critical habitat adversely affected by the actions of the project.

The PRRIP (as discussed under Alternative 3 and in Appendix V, Attachment 1) provides streamlined procedures available to project proponents to seek ESA coverage under the PRRIP umbrella when the project actions may deplete the Platte River. Under Alternative 4, the South Platte River below Chatfield Reservoir would have minimal changes during base flow conditions and a small increase in flow during the late summer months (Figure 4-13). Managing the timing, duration, and amount of flow from the Chatfield Reservoir is an important tool in enhancing aquatic biota in the South Platte River. For example, a projected increase in flow during July would have a positive effect on aquatic biota downstream of the reservoir. The current cool- and warm-water species present experience stress during late summer months from increased water temperatures and decreased flow. Another critical aquatic stressor is base flow conditions during the winter months. The projected change during winter base flow conditions is only 11 cfs less than under Alternative 1. By participating in the PRRIP, projects resulting in Platte River depletions (which will affect, rather than "are not likely to affect," T&E species) can undergo streamlined Section 7 consultation to avoid a jeopardy opinion regarding the effect of the depletions. This means that if a project's depletions are relatively small, then they can participate in the program. By agreeing to be covered by the PRRIP, proponents of water-related projects subject to Section 7 ESA consultation can ensure compliance relative to the Platte River target species, can avoid the potential for prohibited "take" of these species under ESA Section 9, and can take advantage of pre-defined procedures and expectations going into the ESA consultation process. This is made possible by the offsetting measures being implemented during the first increment of the program, including measures which will substantially reduce shortages to target flows in the central Platte River and obtain and restore habitat for the target species. The potential effects of project depletions on the Platte River species are addressed in the streamlined PRRIP Biological Assessment that will be submitted by the Corps to the USFWS and will be covered through a "tiered" Biological Opinion confirming the project is in compliance with the ESA based on implementation of the PRRIP. The PRRIP BA is included in the FR/EIS as Attachment 1 of the BA (Appendix V).

Two of the Platte River species can also occur in Colorado, the piping plover and the interior least tern. These two species have potential to occur in the study area during migration as they both are attracted to gravelly or sandy shorelines. Based on 10 years of observations at Chatfield Reservoir (1996 to 2006), each of these species was observed only once, the piping plover in September 2001 and the interior least tern in July 1998 (Kellner, 2006) (see Appendix V for additional information). Increased exposure of shorelines that potentially would occur under Alternative 4, albeit less than Alternative 3, may be a benefit to migrating piping plovers or interior least terns. The occurrence of whooping cranes in Colorado is extremely rare, and they have never been reported from Jefferson or Douglas Counties (Andrews & Righter, 1992) where Chatfield is located, thus direct impacts to this species are not expected. In 1975 an experiment was initiated to establish a flock of whooping cranes that would migrate from Gray's Lake Idaho to Bosque Del Apache National Wildlife Refuge in New Mexico, with stopovers in Colorado's San Luis Valley. Eggs from whooping crane nests in Canada were transferred to sandhill crane nests in Idaho, and the sandhill cranes raised the whooping cranes and taught them the migration route. The whooping cranes failed to form pair bonds and had high mortality rates. In 1989 the program was discontinued and no whooping cranes survived in this population (International Crane Foundation, 2012).

Impacts on State-Listed Species and Species of Concern

Black-tailed Prairie Dog and Associated Species—A small, isolated black-tailed prairie dog colony is found within the study area in close proximity to the radio-controlled airplane field at Chatfield State Park. This is an upland site and would not be inundated from the increase of the pool elevation as proposed in Alternative 4. Therefore, there would be no impacts on black-tailed prairie dogs or species associated with prairie dog colonies including western burrowing owl, swift fox, mountain plover, and ferruginous hawk (for additional details see the discussion under Alternative 3).

American Peregrine Falcon—The American peregrine falcon is a species that has recovered from past population declines. Recent surveys across North America have indicated that populations are secure (USFWS, 2003); however, it is still considered a species of special concern. Peregrines may frequent the study area hunting their favorite prey, birds. Some bird habitats such as riparian woodlands would be lost as the pool elevations rise as proposed under Alternative 4, but other bird habitats, such as shoreline and open water habitats, would increase. Given that some hunting habitat may actually increase, it is unlikely that the number of prey birds available to peregrines would decrease significantly enough to have an effect on peregrine falcon populations.

Greater Sandhill Crane—Greater sandhill cranes can be observed the study area during migration. They may use the area around Chatfield Reservoir on a limited basis as a stopover site during migration. Therefore, it is unlikely that the impacts on upland and wetland habitat as projected by the implementation of Alternative 4 would have an adverse impact on greater sandhill crane populations.

Northern Leopard Frog— This species occurs within Chatfield State Park in riparian habitats along the South Platte River and Plum Creek (Baker & Farah, 2009). Northern leopard frog habitat within areas affected by pool level increases would be at least temporarily lost. Greater variation in water levels may permanently affect wetland or shoreline habitat used by the frogs. Although new wetland areas would eventually establish and create new habitat, it is likely that there would be a period of time before these areas are established and frog habitat is available. Therefore, the northern leopard frog may be affected by Alternative 4, but less so than under Alternative 3.

Other State Species of Concern—As previously explained under Alternative 3, the following species would not be affected by Alternative 4: sharp-tailed grouse, Townsend's big eared bat, white pelican, Iowa darter, northern redbelly dace, common shiner, American currant, and forktip three-awn.

4.9.5 Reduction and Mitigation of Potential Impacts

Generally speaking, under each alternative impact to protected species by contractors during construction activities at federal projects would be avoided or minimized by specific contract provisions for avoiding and minimizing such impacts.

Prior to the implementation of an alternative, actions to reduce the level of impacts will be considered. These may include changes to the operations of the reservoir (e.g., holding water at a certain elevation at a specific time of year), or by actively managing the drawdown zone created by fluctuating water levels.

Habitats lost due to the rise in the target pool elevation would be mitigated in a combination of on-site and off-site mitigation activities. Riparian habitats would be expanded on site as much as possible, and riparian habitats along Plum Creek and along the South Platte River would be preserved, enhanced, or both. In addition, riparian wildlife corridors would be established that connect areas where Preble's mice exist in order to aid in movement among important sites in Douglas County (see the CMP, Appendix K). Of the 210 EFUs of Preble's non-critical habitat impacted, 43 EFUs would be mitigated on-site and 167 EFUs would be mitigated off-site. The 65 EFUs of critical habitat in the West Plum Creek CHU would all be mitigated within that unit, and likewise the critical habitat in the Upper South Platte CHU would all be mitigated within that unit. The mitigation of potential impacts is guided by the development of an Ecological Functions Approach, an accounting system used to assign and track the ecological values of the overlapping terrestrial wildlife habitats. This assigning was done by a committee of local experts familiar with Chatfield Reservoir. Habitat attributes were derived and given values for specific resources: the Preble's meadow jumping mouse, overall wildlife habitat represented by a diverse avian community (birds), and wetlands. Mapped habitats for each of the three specific resources were incorporated to total across the functional values in order to provide an index of specific resource habitats. These indices were then combined to represent the total ecological function values for every acre of land that could be potentially lost to inundation. The assessment of impacts is initially estimated using a conservative approach where it is assumed that the target elevation pool would be met and maintained and therefore inundate the maximum acreage.

This approach provides a means to track ecological values lost and those gained on future mitigation areas or by gains realized at or above the future OHWM. Once an alternative is implemented, actual impacts would be assessed "real-time" and be off-set by on-site and off-site mitigation. This accounting system will track how mitigation is progressing and if alterations to mitigation activities are needed. Finally, by tracking the functional values lost due to inundation, whether from Alternative 3 or 4, mitigation will be sure to account not only for the acres of habitat lost but their associated ecological function. Mitigation is considered in detail in the CMP (Appendix K).

Habitat losses along the shoreline near the new target pool elevation would be reduced through adaptive management measures including changing amounts and timing of release flows, plantings, seeding, and weed control. Adaptive management planning would involve an iterative process of cycling through several steps: problem assessment, design, implementation, monitoring, evaluation, adjustment, and continued cycling through earlier steps (Barnes, 2009).

Specifically, management of water levels during the growing season may lessen impacts to the northern leopard frog if water levels are held constant during their breeding season and if the establishment of habitat at the new water levels is enhanced by recontouring land and vegetation plantings/seeding. Operational Management options are being considered in mitigation implementation. Adaptive management by manipulation of water levels beyond what is dictated by water providers' needs would lessen impacts to vegetation and hence a wide variety of wildlife species including TES species.

The removal of trees killed by inundation has the potential to affect many wildlife species by removing a potential environment currently not found within the study area. The increase of snags (standing dead trees) and downed trees could provide valuable habitat for raptors, cavity nesting birds, herons, and aquatic life. They could also benefit aquatic life including warm-water fisheries, macroinvertebrates, and amphibians, and could be used to offset impacts to terrestrial wildlife on the basis of ecological value and services. In addition, some of the removed trees could be scattered in Preble's habitat within the Park to enhance the habitat for Preble's. Woody debris has been found to be a component of Preble's mouse high use areas (Trainor et al., 2007). Trees to be retained for aquatic and wildlife habitat, or removed and used for woody debris would be reviewed by resource managers to ensure visitor and dam safety.

Reduction of winter flows, albeit minor, in the South Platte River and the Chatfield SFU could be offset by water providers providing needed flows when Denver Water exercises its senior rights and sweeps water from the river and the SFU. As the Chatfield SFU was originally considered mitigation for the reservoir project, the amount of water needed to adequately run the facility should be seriously considered to lessen impacts of reallocation.

All of these efforts would benefit wildlife species, including TES species. Impacts to ecological functions of wetlands, riparian habitat (and mature cottonwoods), bird/wildlife terrestrial habitat, Preble's meadow jumping mouse habitat, and shoreline habitat are evaluated in Appendix K, which also proposes priority measures that will ensure full, cost-effective compensatory mitigation. Adaptive management by an established group would facilitate discussion of minimizing impacts by operation strategies once reallocation begins. Refer to the CMP (Appendix K) and the AMP (Appendix GG) for further details.

The Corps has conducted coordination and informal consultations with the USFWS regarding potential impacts to T&E species and their recommendations for mitigation and the CMP for Preble's mouse (see Appendix X).

In addition to these measures, the water providers, in coordination with State Parks and CDOW, may pursue other measures to provide ecological benefits above and beyond where the CMP has planned to replace lost ecological functions. While not considered part of the Selected Plan, the state may require the water providers to fund these features prior to entering into contracts for water supply at Chatfield. Beyond the measures described in the CMP, the water providers propose to fund stream habitat improvements on up to 0.7 miles of the mainstem of the South Platte River above Chatfield Reservoir. Also, while this analysis does not suggest a significant loss of habitat downstream, to allay CDOW concerns, the water providers have agreed to pursue stream habitat improvement on up to 0.5 miles of the mainstem of the South Platte River downstream of Chatfield Reservoir. The specific sites and project designs for these measures will be selected in coordination with CDOW.

4.10 Land Use

This section describes the impacts of the alternatives on land use within the park, as well as outside of the park, where applicable.

4.10.1 Alternative 1—No Action

Under Alternative 1, the water levels at Chatfield Reservoir would remain unchanged from existing conditions. Water would be stored in alternate locations that include Penley Reservoir and three downstream gravel pits. Pipelines would be built to transfer water to Penley Reservoir (Figure 2-1).

Impacts on downstream agricultural users were raised as a specific issue during the scoping meetings under the No Action Alternative. However, under the No Action Alternative the water providers would obtain water from other locations, as discussed below.

Penley Reservoir

If the No Action Alternative was chosen, the proposed Penley Reservoir would be built and the proposed storage volume would be 12,725 acre-feet. Approximately 368 acres (approximately 186 acres disturbed by the reservoir and 182 acres disturbed by the infrastructure) of land would be disturbed during construction and operation of the project. Associated infrastructure would include outlet works, a pipeline, and a pump station. The outlet works would be 1,100-feet long. The 48-foot diameter, 8-mile long buried pipeline would extend from the South Platte River at the downstream end of Waterton Canyon near the Platte Canyon Reservoir and Highline Canal to Penley Reservoir. Additionally, a pump station would be located near the water diversion. Water diversions could be different depending on the water provider as discussed below:

- Most water providers would use the same pipeline that carries water to the reservoir, and the water would be delivered back to the South Platte River and Chatfield Reservoir. This would include about 97 acres of disturbance.
- Castle Pines Metropolitan District and the town of Castle Rock would construct new buried pipelines and would pump the water to the Plum Creek Reservoir, which would include about 85 acres of disturbance. The pipeline's total length would be approximately 7 miles.

Downstream South Platte River Gravel Pits

In addition to the proposed Penley Reservoir, the water providers would use three gravel pits to store water if the No Action Alternative was selected. These gravel pits 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. Assuming that the diversion channels are relatively small (i.e., only a few feet wide), the channels to the gravel pits would require less than 2 acres for each channel. Again, assuming that the outlet works and pump stations are relatively small, an additional 1 acre would be required for each gravel pit. The proposed storage volume at these gravel pits is estimated to be about 7,835 acre-feet, and would disturb a total of 427 acres (418 acres for the reservoirs and another 9 acres would be disturbed for associated infrastructure).

4.10.2 Alternative 2—NTGW/Downstream Gravel Pits

Similar to Alternative 1, under Alternative 2 the water levels would remain unchanged from their existing levels at Chatfield Reservoir. Water would be stored in the same downstream gravel pits as described under Alternative 1. Additional water needs for upstream providers would be met through NTGW.

Using underground water sources could affect farming (changing from irrigated land to non-irrigated land), if pumping rates declined to the point that agricultural lands irrigated by NTGW could no longer produce sufficient water from existing wells. However, most agricultural users rely on alluvial groundwater and not on NTGW, so this impact is not likely to be significant. If gravel pits were converted to water storage reservoirs, impacts on land use would be the same as described for gravel pits under Alternative 1.

4.10.3 Alternative 3—20,600 Acre-Foot Reallocation

Under this alternative, the reallocated storage capacity of Chatfield Reservoir would be 20,600 acre-feet. The water providers would use existing infrastructure to divert water, so no pipelines would be constructed under this alternative. The land affected by construction and operation of the project would be land immediately around Chatfield Reservoir, including lands within Chatfield State Park.

4.10.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

In addition to the reallocation, another 5,379 acre-feet would be obtained from NTGW and/or other storage and downstream gravel pits under Alternative 4. The potential effects on land use from conversion of downstream gravel pits to water storage reservoirs and use of NTGW are disclosed under Alternatives 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2.

Under this alternative, the reallocated storage capacity would be 7,700 acre-feet. The water providers would use existing infrastructure to divert the water, so no pipelines would be constructed under this alternative. As under Alternative 3, the land affected by construction and operation of the project would be land immediately around Chatfield Reservoir.

4.10.5 Reduction and Mitigation of Potential Impacts

Some land would be consumed for project construction and operation of the pipelines. However, most adverse impacts would be temporary, and the disturbed areas would be revegetated with native plants. Potential adverse impacts to land use during construction and operation of the project can be minimized through implementation of BMPs such as clearing only the amount of land needed to build the pipelines.

4.11 Hazardous, Toxic, and Radiological Wastes

This section describes the impacts of each alternative on hazardous, toxic, and radiological wastes within the park, as well as the impacts of the No Action Alternative outside of the park.

4.11.1 Alternative 1—No Action

Environmental concerns pertaining to hazardous, toxic, or radiological wastes have not been identified for Penley Reservoir, pipeline areas, or downstream gravel pits under the No Action Alternative. Construction activities would be monitored to avoid spills of potentially hazardous materials (e.g., fuel, hydraulic fluid). It is anticipated that there would be no short- or long-term, insignificant or significant, adverse or positive impacts on hazardous, toxic, or radiological wastes as a result of implementing the No Action Alternative.

4.11.2 Alternative 2—NTGW/Downstream Gravel Pits

Impacts are not expected on hazardous, toxic, or radiological wastes under Alternative 2. Similar to Alternative 1, construction activities related to new well installation or conversion of gravel pits would be monitored to avoid spills of potentially hazardous materials (e.g., fuel, hydraulic fluid).

4.11.3 Alternative 3—20,600 Acre-Foot Reallocation

Under Alternative 3, some lift stations and transformers would be removed and relocated prior to raising the water levels in the reservoir. No spills, reported releases, or underground tanks have been identified in the affected area. Therefore, with these best management practices, activities associated with reallocation implementation would not result in adverse impacts from hazardous, toxic, and radiological wastes.

4.11.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

In addition to the reallocation, another 5,379 acre-feet would be obtained from NTGW and/or other storage and downstream gravel pits under Alternative 4. The potential effects on hazardous, toxic, and radiological wastes from conversion of downstream gravel pits to water storage reservoirs and use of NTGW are disclosed under Alternatives 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2.

Under this alternative, some lift stations and transformers may need to be removed and relocated prior to raising the water levels in the reservoir. As under Alternative 3, no spills, reported releases, or underground tanks have been identified in the affected area. Therefore, with these best management practices, activities associated with reallocation implementation would not result in adverse impacts from hazardous, toxic, and radiological wastes.

4.11.5 Reduction of Potential Impacts

Measures to prevent spills of potentially hazardous materials are described under Section 4.4, Water Quality.

4.12 Air Quality

This section addresses potential impacts on air quality from the study alternatives. Air quality was not raised as a specific issue during the scoping meetings. The analysis addresses construction activities that could result in short-term adverse impacts on air quality, and impacts on air quality associated with changes in pool fluctuation that result in drying of exposed soils/sediments around the reservoir. These impact levels are influenced by the wind speed, which can erode unvegetated soil and increase particulate levels. Spring is the windiest season in the Denver area. Wind speeds are greatest from March through May (Figure 4-19).

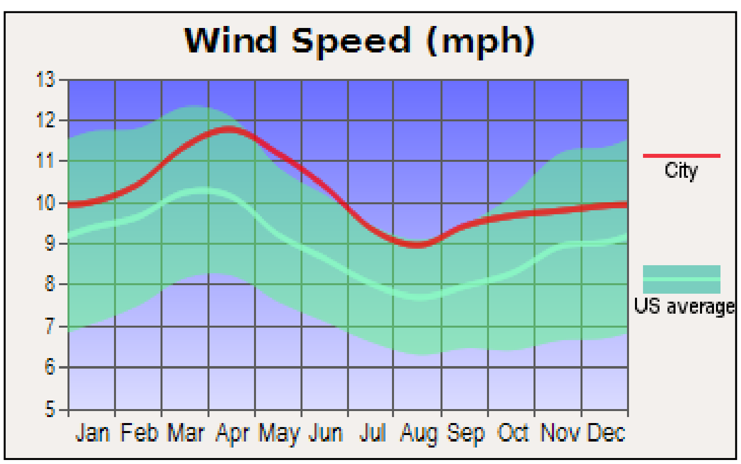


Figure 4-19
Average Wind Speeds in Denver, Colorado, Based on Data from 4,000 Weather Stations (from City-Data.com, 2007)

4.12.1 Alternative 1—No Action

The construction of Penley Reservoir and the associated pipelines would likely result in short-term adverse impacts on air quality during the period of construction. There would also be short-term adverse impacts on air quality from infrastructure constructed at the gravel pits. No long-term adverse impacts on air quality are expected under Alternative 1. Relatively little energy would be needed over the long term to maintain water storage at the gravel pits under Alternative 1. In the short term, fossil fuels would be combusted to run construction equipment under Alternative 1. Overall, this alternative would result in relatively little energy consumption or greenhouse gas emissions.

4.12.2 Alternative 2—NTGW/Downstream Gravel Pits

Alternative 2 would have fewer short-term adverse impacts on air quality than Alternative 1 because of the lack of major construction. Like Alternative 1 there would be short-term adverse impacts due to construction of infrastructure at the gravel pits. More energy would be needed to drill and operate additional wells with larger pumps and motors. Depending on future energy sources, long-term impacts to air quality could include greenhouse gas emissions and other air pollution from coal-fired power plants that would supply the larger energy requirements needed to produce the same water under Alternative 2 as under the other alternatives. However, if other energy sources were used, including renewable or nuclear energy, these indirect impacts to air quality would not occur.

4.12.3 Alternative 3—20,600 Acre-Foot Reallocation

Alternative 3 would require construction to relocate recreational facilities and realign the park road that crosses the South Platte (see Section 4.17 and Appendix M for details). Air quality could be adversely impacted due to construction traffic and dust generated by earth moving and other construction activities. Adverse impacts on air quality from construction are considered short-term and would not be significant. In the short term, fossil fuels would be combusted to run construction equipment under Alternative 3. This alternative would result in relatively little energy consumption or greenhouse gas emissions.

Alternative 3 would result in changes in the timing and extent of pool fluctuation at the reservoir. This would result in changes in the area of soils that are exposed to inundation and drying, and thus a change in the "bathtub ring" (see Section 4.14, Aesthetics, for details.) As described in Section 4.2.3, the inundated area between 5,432 and 5,444 feet msl has soils with an average wind erodibility index of 87. This rating indicates that these soils have a relatively low potential for surface soil erosion by wind. The two soils types that could be inundated under Alternative 3 that are rated with the highest wind erodibility indices, 134 and 180, represent a total of 8 percent of the inundated area. Thus, the potential for wind erosion in the inundated area is relatively low. Vegetative growth would vary according to the degree of fluctuations of the pool levels. More vegetation would protect soils from erosion by wind and reduce airborne particulates. If vegetation were removed from the inundated areas, the potential for wind erosion would increase, and these areas could be considered at moderate to moderately high risk for wind erosion.

The bathtub ring that would be exposed with fluctuations in pool elevations under Alternative 3 could be as much as 587 acres larger than the current bathtub ring (under Alternative 1). The maximum bathtub ring area would be exposed if pool levels dropped from the target elevation of 5,444 feet msl to the minimum elevation predicted by the hydrologic model of 5,423 feet msl. This full 21-foot fluctuation would not occur every year. Even in the wettest of years, the model predicts that the pool would reach the target elevation in over 50 days of the year. The minimum pool elevations also would be higher during wet years. In the driest of years, the target pool elevation would not be reached at all.

According to the hydrology model, the pool elevation of 5,444 feet msl would be reached in 42 of the 59 years modeled. In 17 years, this pool elevation would never be reached. In years where the pool elevation was reached, the model output indicates that it would never be maintained throughout the entire spring (March through May), Denver's windiest season. Only in 10 of the 59 years modeled would the target pool elevation be reached for more than half of the days in the spring months (March through May). Based on this analysis, particulate matter (PM10) concentrations would not increase on a continuous basis. As a result, wind erosion of exposed shoreline would likely be more of a nuisance issue than an air quality issue.

4.12.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

In addition to the reallocation, another 5,379 acre-feet would be obtained from NTGW and/or other storage and downstream gravel pits under Alternative 4. The potential effects on air quality from conversion of downstream gravel pits to water storage reservoirs and use of NTGW are disclosed under Alternatives 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2. Relatively little energy would be needed over the long term to maintain water storage at gravel pits under Alternative 4. In the short term, fossil fuels would be combusted to run construction equipment. Some energy would be required over the long term to drill and operate additional wells to capture NTGW. This alternative would result in some energy consumption and, depending on energy sources, some greenhouse gas emissions. However, less energy and fewer greenhouse gases are anticipated than under Alternative 2 which would rely on more extensive NTGW development.

Alternative 4, like Alternative 3, would require construction to relocate recreational facilities. However, under Alternative 4, the road would not be realigned over the South Platte (see Section 4.17, Recreation, and Appendix M for details). Thus, construction-related adverse impacts on air quality would be less than under Alternative 3. Air quality could be adversely impacted due to construction traffic and dust generated by earth moving and other construction activities. Adverse impacts on air quality from construction are considered short-term and would not be significant. Construction traffic is described in Section 4.16 Transportation.

Alternative 4, like Alternative 3, could have an increase in the bathtub ring that would increase the potential for wind erosion. The soils in the susceptible area generally have low potential for wind erosion. Vegetative growth would vary according to the degree of fluctuations of the pool levels. More vegetation would protect soils from erosion by wind and reduce airborne particulates. If vegetation were removed from the areas to be inundated, then the potential for wind erosion would increase.

Potential adverse impacts on air quality for Alternative 4 would be less than for Alternative 3 because the amount of exposed soil would be less and the magnitude of pool fluctuations would be less. The bathtub ring that could be exposed with fluctuations in pool elevations under Alternative 4 could be as much as 215 acres larger than the current bathtub ring (under Alternative 1). The maximum area would be exposed if pool levels dropped from the target elevation of 5,437 feet msl to the minimum elevation predicted by the hydrologic model of 5,423 feet msl. This full 14-feet fluctuation would not occur every year. Even in the wettest of years, the model predicts that the pool would reach the target elevation 40 days of the year. The minimum pool elevations also would be higher during wet years. In the driest of years, the target pool elevation would not be reached at all.

According to the hydrology model, the pool elevation of 5,437 feet msl would be reached in 51 of the 59 years modeled. In years where the pool elevation was reached, the model output indicates that it would never be maintained throughout the entire spring period (March through May), Denver's windiest season. Only in 19 of the 59 years modeled would the target pool elevation be reached for more than half of the days in the spring months. Based on this analysis, particulate matter (PM10) concentrations would not increase on a continuous basis. As a result, wind erosion of exposed shoreline would likely be more of a nuisance issue than an air quality issue.

4.12.5 Reduction of Potential Impacts

Implementation of BMPs would reduce the potential short-term adverse impacts during construction activities, so that impacts on particulate levels during construction are not significant.

If vegetation were removed from the inundated areas to mitigate adverse impacts to other resources (such as nutrients as described under water quality), the potential for wind erosion would increase. Leaving the vegetation intact would reduce potential adverse impacts to air quality from windblown sediments. As part of the adaptive management strategy to minimize adverse impacts, vegetation on the banks of Chatfield Reservoir below the target elevation would be removed only as needed, and vegetation growing below but near the new target elevation may not be removed (Appendix GG), so that impacts of reallocation on particulate levels are not significant.

4.13 Noise

This section describes the effects of the alternatives on noise levels within the park. Noise was not raised as a specific issue during the scoping meetings, although short-term direct adverse impacts would occur within the park under Alternatives 3 and 4 and outside of the park to varying degrees under all alternatives. These noise-related issues include use of existing roads for construction traffic, and operation of equipment during the road rebuilding and moving of facilities phase of the project. Noise from construction is unavoidable but considered short-term and not predicted to be significant. Current noise levels at Chatfield State Park are typically within the 40 to 94 decibel (dBA) range, or moderate to high (when motorized boats pass within 50 feet). Current noise levels at the gravel pits (Alternatives 1 and 2) are in the 88 to 106 dBA range, or high. Indirect adverse impacts are not anticipated. No significant long-term adverse impacts from noise are anticipated.

No mitigation or monitoring activities are identified based on the assumptions used to analyze noise. If assumptions regarding construction and relocation of facilities change, the anticipated noise levels would need to be reviewed with respect to the noise standards and guidelines.

4.13.1 Alternative 1—No Action

The No Action Alternative assumes that road construction and relocation of associated facilities would not occur within the park. Increases or decreases in noise levels occur during various times of the year, typically coinciding with the amount of recreational use and traffic at the time. These noise variations would continue to occur under the No Action Alternative.

Under the No Action Alternative, the proposed Penley Reservoir and other gravel pits in the Denver Metro area would be used to store water. Construction impacts similar to those listed in Alternative 3 would occur; however, construction would occur in a shorter period of time and would not be constructed in phases since there would be no recreation at this reservoir and associated gravel pits. Noise levels at the converted gravel pits would be reduced under this alternative, and construction noise would be short-term rather than long-term.

4.13.2 Alternative 2—NTGW/Downstream Gravel Pits

Impacts under Alternative 2 would be similar to impacts under Alternative 1 for the gravel pits. Reliance on NTGW could result in the need for additional water wells, which would result in temporary increases in noise during construction.

4.13.3 Alternative 3—20,600 Acre-Foot Reallocation

This alternative would include short-term construction, including road rebuilding and relocation of some facilities. Table 3-6 identifies the percentage of recreation and electrical facilities and/or utilities potentially affected by a raise in the reservoir's target elevation to 5,444 feet msl. This temporary construction (3 to 5 years) would be expected to generate noise levels within the park, including use of existing roads for construction traffic and operation of equipment during the construction phase of the project. This potential increase in noise levels would be due to road construction of segments of the park road that would be inundated unless rebuilt on higher elevations. Additionally, the removal of recreation facilities such as park benches and trees would generate short-term noise. These increased noise levels would decline to the current noise levels after construction was complete. These direct adverse impacts are not considered significant since they are short-term and would occur during the winter months when recreational use is not heavy. Winter construction was included in the EDAW report (EDAW, 2010) because Colorado State Parks wants to minimize impacts on visitors. It may not be realistic for some facilities and would increase costs due to the need for periodic remobilization and higher costs during out-years.

The numbers, types, and manner of use of equipment proposed to relocate facilities and rebuild the road are summarized below. Assumptions for analysis of on-site construction noise include:

- Construction would occur during weekday shifts of 8 to 10 hours per day during the construction period.
- Access to the construction areas would be restricted to maximize public safety and proximity to equipment operation.
- Earthmoving equipment such as loaders, backhoes, scrapers, and heavy trucks would be used to rebuild the road.
- Other stationary and materials hauling equipment such as concrete mixers would be used to rebuild the road.

- Construction equipment used by contractors is assumed to function as designed and would conform to applicable noise emission standards.

Off-site construction-related noise would include traffic using site access roads, such as C-470 and Highway 121 (Wadsworth Boulevard). Residential areas may be affected by construction traffic during weekday, daytime hours. Projections for estimated peak hour construction trips are described in Section 4.16, Transportation. Assumptions for the analysis of off-site construction noise include:

- Types of traffic making daily or regular trips to the site, such as construction worker vehicles, concrete mixers to rebuild the road, and earthmoving equipment to help relocate facilities

- Access roads most frequently used, which include C-470 and Highway 21 (Wadsworth Boulevard)

No significant short- or long-term adverse impacts are anticipated from on- or off-site construction noise. On-site construction noise may periodically exceed the EPA noise threshold of 70 dBA for public exposure, but the public would not be exposed to these levels on a continuous basis. The noise levels described are predicted at distances of less than 50 feet from the source and would be temporary and remote from the general public. Above this distance, noise levels diminish rapidly. The noise impacts from off-site construction traffic would contribute to the overall background noise levels. The degree that background noise levels may increase would be consistent with the normal variation currently experienced in the area. Construction traffic noise would comply with county ordinances. The proposed activities are not predicted to exceed relevant standards or guidelines.

4.13.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

In addition to the reallocation, another 5,379 acre-feet would be obtained from NTGW and/or other storage and downstream gravel pits under Alternative 4. The potential effects on noise from conversion of downstream gravel pits to water storage reservoirs and use of NTGW are disclosed under Alternatives 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2.

This alternative would be similar to Alternative 3 but includes a shorter (2 to 4 years) construction period. Construction equipment needs are similar to those in Alternative 3, but fewer facilities would be relocated. The existing road would not be inundated, and therefore it would not be moved and rebuilt. Noise levels from all sources would be either similar to or less than those analyzed for Alternative 3. No significant short- or long-term adverse impacts from Alternative 4 are anticipated.

4.13.5 Reduction of Potential Impacts

No mitigation or monitoring activities are identified based on the assumptions used to analyze noise. If assumptions regarding construction and relocation of facilities change, the anticipated noise levels would need to be reviewed with respect to the noise standards and guidelines.

4.14 Aesthetics

This section describes the impacts of the alternatives on visual quality within and outside of the park. The main aesthetic issue identified during scoping was the potential impact of the reservoir's water fluctuation on visual quality. Fluctuation would create a wider shoreline area without vegetation and could have an adverse impact on aesthetics. Changing water levels may positively or negatively affect aesthetics. High water levels versus exposing reservoir rings or mudflats can result in visual impacts. Mudflats are visually displeasing, whereas high water levels are visually pleasing.

For this analysis, it was assumed that minimizing exposed reservoir bottoms and shoreline ring effects resulting from lower pool levels would help maintain or enhance the positive scenic character and attractiveness of Chatfield Reservoir. Table 4-19 provides a summary of the shoreline ring analysis for each alternative based on anticipated pool elevations relative to the target pool elevations over a 59-year POR at Chatfield Reservoir (based on the hydrologic modeling results in Appendix H). Figure 4-20 shows the target pool elevations of each alternative in relation to facilities at the park. The analysis focuses on two aspects of pool fluctuation: 1) the frequency at which the pool is below the target pool elevation, and 2) the magnitude by which the pool fluctuates from the target pool elevation. Alternatives 1 and 2 do not involve any changes to operations at Chatfield Reservoir and thus the pool elevations at Chatfield would be the same under these alternatives. Under Alternatives 1 and 2, Chatfield Reservoir is below the target pool elevation (5,432 feet msl) for 69 percent of the time (or 14,948 days in the modeled POR of 21,550 days). Under Alternative 3, the reservoir would be below the target pool elevation (5,444 feet msl) about 82 percent of the time (17,674 days in the POR); and under Alternative 4, the reservoir would be below the target pool elevation (5,437 feet msl) 75 percent of the time (16,232 days in the POR).

Table 4-19
Summary Statistics for Shoreline Ring Analysis

Parameter	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Target Pool Elevation (feet msl)	5,432	5,432	5,444	5,437
Number of years in POR (1942–2000) with at least 1 day below the target pool elevation	59	59	59	59
Number of days in POR below the target pool elevation	14,948	14,948	17,674	16,232
Percent of days in POR below the target pool elevation	69%	69%	82%	75%
Minimum number of days per year below the target pool elevation	33	33	56	40
Maximum number of days per year below the target pool elevation	366	366	366	366
Mean (average) days per year below the target pool elevation	253	253	300	275
Mean (average) of values below the target pool elevation (feet)	3.5	3.5	7.3	5.0
Maximum of values below the target pool elevation (feet)	9.1	9.1	21.3	14.3
Minimum pool elevation based on the maximum feet below the target pool elevation (feet msl)	5,422.9	5,422.9	5,422.7	5,422.7

Note: "Percent Equal or Exceed" is based on nearest value.

At baseline (Alternatives 1 and 2), the pool elevation is below its targeted pool elevation a minimum of 33 days annually, up to a maximum of 366 days annually. Under Alternative 3, the minimum number of days per year the pool elevation is below target is 56 days and the maximum number of days is the same as baseline, at 366 days annually. Under Alternative 4, the minimum number of days per year the pool elevation is below target is 40 days and the maximum number of days is the same as baseline at 366 days annually. On average, at baseline the pool is below its targeted pool elevation

253 days annually, and would increase to 300 days annually under Alternative 3, and 275 days annually under Alternative 4.

In addition to understanding the frequency at which the pool is below the target pool elevation, it is also important to understand the magnitude (in vertical feet) by which the pool deviates from the target pool elevation. Under Alternatives 1 and 2, when the pool is below the target pool elevation, it is on average a distance of 3.5 vertical feet, with the maximum being 9.1 feet below the target pool elevation. Under Alternative 3, when the pool is below the target pool elevation, it is on average a distance of 7.3 vertical feet below the target pool elevation, with a maximum of 21.3 feet below the target pool elevation. Under Alternative 4, when the pool is below the target pool elevation, it is on average a distance of 5.0 vertical feet below the target pool elevation, with a maximum of 14.3 feet below the target pool elevation.

The summary statistics for the "Bathtub Ring" evaluation are based on the Corps' modeling results (Appendix H) and the evaluation performed in Minitab.

4.14.1 Alternative 1—No Action

Under the No Action Alternative, no changes would occur at Chatfield Reservoir and the water levels would continue to fluctuate. Generally, during the summer months the reservoir stays at a minimum of 5,427 feet msl, and the remainder of the year the reservoir is typically drawn down to a minimum of 5,423 feet msl. The existing scenic integrity levels would continue to be a component of the viewed landscape.

The scenic views would not be impacted by the construction of Penley Reservoir in as much as nearby high ridges and peaks, raising about 500 feet above the plains, would still be visible as would the more distant but much higher Rocky Mountain foothills to the west. No major disruption of rangeland, pastureland, or grassland would result.

The aesthetic quality at Penley Reservoir and the gravel pits would stay intact if these projects were to be built. The water-filled reservoirs may, in fact, add an element of scenery that was not there before, especially at the gravel pits. The associated pipeline routes would not significantly impact views. During construction, the ground would be bare and construction vehicles would be on site. However, the area would be revegetated after construction and visual impacts would be minimal.

4.14.2 Alternative 2—NTGW/Downstream Gravel Pits

Alternative 2 would be similar to Alternative 1, but it would not include the Penley Reservoir. Impacts under this alternative potentially could be positive to the area surrounding the gravel pits. The area around the Penley Reservoir site would not be affected.

4.14.3 Alternative 3—20,600 Acre-Foot Reallocation

Under Alternative 3, the water would fluctuate the most; therefore, mudflats and shoreline rings would be more visible than with any other alternative. During construction, the ground would be bare and construction vehicles would be on site. However, the area would be revegetated after construction and visual impacts would be short-term.

The view of the Rocky Mountain Front Range will not be affected by reallocation. Much of the existing vegetation next to the lake would be killed as a result of the raised water table. The current view would be degraded to some extent by the reduced concentration of trees and shrubbery for a period of years. The trees and other vegetation would return following the stabilization of the higher pool level. Riparian shrubs and herbaceous plants would be replaced rapidly; but trees lost, including many mature cottonwoods, would take significantly longer to grow to pre-reallocation heights. Accordingly the views near the lake would be affected for a period of years.

Although some land will be acquired for environmental mitigation, no disruption of rangeland, pastureland, or grassland would result.

4.14.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

In addition to the reallocation, another 5,379 acre-feet would be obtained from NTGW and/or other storage and downstream gravel pits under Alternative 4. The potential effects on aesthetics from conversion of downstream gravel pits to water storage reservoirs and use of NTGW are disclosed under Alternatives 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2.

The potential impacts described for the 20,600 acre-foot Chatfield reallocation would be experienced, but to a lesser extent. These impacts are described under Alternative 3. Under Alternative 4, the water would fluctuate more so than at baseline, but less than Alternative 3. Similar to Alternative 3, the mudflats and shoreline rings would be more visible than at baseline. During construction, the ground would be bare and construction vehicles would be on site. However, the area would be revegetated after construction and visual impacts would be short-term.

4.14.5 Reduction of Potential Impacts

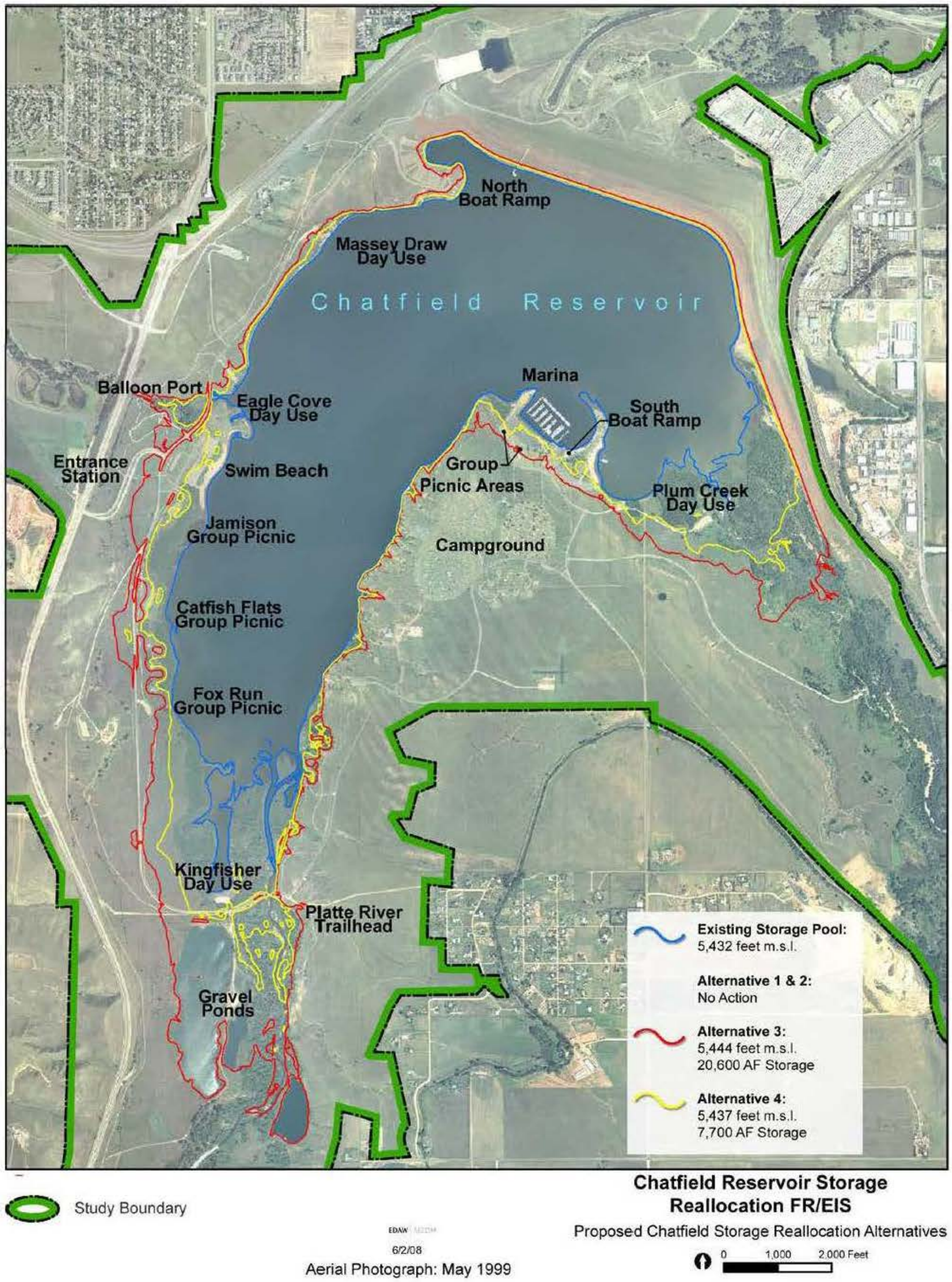
The project could alter the views at Chatfield Reservoir. If either Alternative 3 or 4 were selected, the water would fluctuate more than under current conditions or the other alternatives. However, some measures that would reduce potential impacts could include planting trees and shrubbery to help reduce the adverse effects.

4.15 Socioeconomic Resources

The four proposed alternatives could result in impacts on socioeconomic resources. This section considers the potential social and economic impacts of the four alternatives.

There would be no difference in flood damages among the four alternatives because the peak flood flows downstream of Chatfield are not significantly different among the alternatives, based on the results of certified/approved hydrologic and hydraulic engineering models described in Appendices H and I and elsewhere in the FR/EIS (e.g., Section 4.3) and the water control operating rules in the Water Control Plan (Appendix B). Documentation of concurrence dated May 11, 2010 from the Corps' Flood Risk Management Planning Center of Expertise and from engineers on the Corps' Agency Technical Review team for this FR/EIS is included in Appendix BB, Policy Waivers, as it waives the need for an economic flood damage analysis (HQUSACE Policy Guidance Memorandum, June 22, 2009, paragraph 6).

Figure 4-20
Target Pool Elevations and Park Facilities (from WebbPR, rev. 2-2010)



4.15.1 Alternative 1—No Action

Recreation Visitation Losses

No changes to recreation are expected under Alternative 1.

Employment Impacts

No changes to park activities are expected under Alternative 1. No jobs would be lost under this alternative.

During gravel pit conversion under Alternative 1, it is anticipated that an average of 19 construction workers would be needed each day for approximately two years based on other gravel pits in the area that were converted into water storage reservoirs (Rick McLoud, Centennial WSD, personal communication, 2007b). It is assumed that these workers would commute from existing residences in the Denver Metro area. Construction worker relocation is expected to be minor.

According to the "Chatfield Reservoir Reallocation Project Regional Economic Development and Other Social Effects Analyses" report prepared by BBC Research and Consulting (2010), implementation of Alternative 1 would generate direct, indirect, and induced jobs. This alternative would temporarily support a labor force hired to physically construct the proposed elements, as well as for construction management and oversight services. In addition to construction, there would be ongoing annual employment to operate the proposed facilities and delivery systems. In total, the employment benefits of Alternative 1 are estimated to be approximately 4,376 person-years of employment over the 50-year analysis period in the study area. More than half of that total is attributable to ongoing operations expenditure. These additional jobs per year (Exhibit 1V-2, Appendix U), averaging approximately 88 jobs annually are approximately 0.007 percent of the 1,214,448 jobs in the five-county Denver metropolitan area in 2009 (Exhibit II-2, Appendix U). More information is available in Appendix U.

Agricultural Land Conversion

Under the No Action Alternative, no irrigated land would be converted to dryland agriculture for the downstream gravel pits.

Project Costs

The FY 2013 financial cost of this alternative is estimated at $283.4 million. The participants will raise the funds for this alternative. The project costs include the capitalized construction, operation and maintenance, and rehabilitation and replacement costs for NTGW and the gravel pits using an interest rate of 3.75 percent and a study period of 50 years. The NTGW component includes costs from the SMWSS and operation and maintenance costs associated with the 111 wells required over the 50-year horizon for providing water.

According to BBC (2010), Alternative 1 is expected to generate a total of $623.1 million in economic output in the region. Implementation of this alternative would result in substantial construction-related expenditures and generate demand for construction labor and support services, which would generate a positive short-term impact to the regional economy. Expenditures on construction materials and equipment that are made within the region would generate additional economic benefits as spending flows through the local economy through industry linkages. As described above, implementation of this alternative would temporarily support a labor force. Labor income earned by construction-related workers would be re-spent, in part, in the local economy, generating additional economic activity. In addition to construction, there would be ongoing annual expenditure to operate the proposed facilities and delivery systems.

4.15.2 Alternative 2—NTGW/Downstream Gravel Pits

Recreation Visitation Losses

As under the No Action Alternative, no changes to recreation are expected under Alternative 2.

Employment Impacts

No jobs would be lost under this alternative.

During gravel pit conversion under Alternative 2, it is anticipated that an average of 19 construction workers would be needed each day for approximately two years based on other gravel pits in the area that were converted into water storage reservoirs (Rick McLoud, Centennial WSD, personal communication, 2007b). It is assumed that these workers would commute from existing residences in the Denver Metro area.

According to BBC (2010), implementation of Alternative 2 would generate direct, indirect, and induced jobs. This alternative would temporarily support a labor force hired to physically construct the proposed elements, as well as for construction management and oversight services. In addition to construction, there would be ongoing annual employment to operate the proposed facilities and delivery systems. In total, the employment benefits of Alternative 2 are estimated to be approximately 2,742 person-years of employment over the 50-year analysis period in the study area. About half of that total is attributable to ongoing operations expenditure. These additional jobs per year (Exhibit 1V-2, Appendix U), averaging approximately 55 jobs annually are approximately 0.005 percent of the 1,214,448 jobs in the five-county Denver metropolitan area in 2009 (Exhibit II-2, Appendix U). More information is available in Appendix U.

Agricultural Land Conversion

The long-term use of NTGW could reduce the pumping rates for water wells in the area. Agricultural lands that rely on NTGW could be affected under this alternative. Under this alternative no irrigated land would be converted to dryland agriculture for the downstream gravel pits.

Project Costs

The FY 2013 financial cost of this alternative is estimated at $186.1 million. The participants will raise the funds for this alternative. The project costs include the capitalized construction, operation and maintenance, and rehabilitation and replacement costs for NTGW and the gravel pits using an interest rate of 3.75 percent and a study period of 50 years. The NTGW component includes costs from the SMWSS and operation and maintenance costs associated with the 111 wells required over the 50-year horizon for providing water.

According to BBC (2010), Alternative 2 is expected to generate a total of $391.5 million in economic output in the region. As in Alternative 1, implementation of this alternative would result in substantial construction-related expenditures and generate demand for construction labor and support services, which would generate a positive short-term impact to the regional economy.

Expenditures on construction materials and equipment that are made within the region would generate additional economic benefits as spending flows through the local economy through industry linkages. Labor income earned by construction-related workers would be re-spent, in part, in the local economy, generating additional economic activity. In addition to construction, there would be ongoing annual expenditure to operate the proposed facilities and delivery systems.

4.15.3 Alternative 3—20,600 Acre-Foot Reallocation

Recreation Visitation Losses

Under this alternative, potential impacts to visitation, concessionaire revenues, and Colorado State Parks revenues could occur as outlined in BBC (2010). Based on the report, impacts were calculated by estimating visitation loss and associated decline in visitor spending within Chatfield State Park and at local retailers and service providers. The estimates also included a portion of lost visitor spending recovered through substitute recreation sites. The full report is available as Appendix U.

According to the BBC report (2010), Colorado State Parks is estimated to lose approximately $217,000 annually as a result of visitation reduction at Chatfield during the construction period and approximately $107,000 annually during the incremental reallocation period. Additionally, Colorado State Parks is estimated to lose approximately $57,000 annually when park management stabilizes at Chatfield. Colorado State Parks is expected to lose about $3.4 million over the 50-year analysis period, including revenue associated with concessionaire agreements. Net Colorado State Parks revenue loss includes direct revenue loss from reduced visitation, loss revenue from the concessionaire share, and a recovery of a portion of lost revenue through substitute recreation site provisions (BBC, 2010).

In addition, USACE prepared a report entitled "Recreation Benefit Analysis Using the Corps' Unit Day Value Methodology to Determine the Effect of Reallocation of Storage at Chatfield Reservoir on National Economic Development (NED) Recreation Benefits at Chatfield State Park" (2011a). This report addresses the impacts to recreational enjoyment in dollars under the proposed alternatives. USACE used the Unit Day Value (UDV) method which is typically prepared for projects where the maximum annual visits are less than 750,000. Chatfield State Park visitor counts are activity-based, and the effects of reallocation would be expected to differ among recreational activities. Therefore, USACE (2011a) calculated UDVs for individual activities, each of which met the criterion of a maximum of 750,000 annual visits.

USACE conducted recreation assessment workshops for assigning UDV points. Approximately 69 members of the recreating public, including two marina owners, four horse stable operators/wranglers, and the campground hosts were contacted by USACE and invited to participate in one of two workshops held at Chatfield State Park. Information on the proposed recreation modifications was presented at the workshops and then the park users were asked to complete UDV assessments of recreation at Chatfield State Park. Of those asked to join one of the workshops, only a few declined the invitation. Invitees were contacted primarily because of their participation in one particular activity, but many volunteered to assign UDV points for additional activities that they participate in at Chatfield State Park. The goal was to obtain at least four or five UDV ratings for each activity, to achieve a robust statistical analysis. To meet this goal for certain activities that would otherwise have had relatively low sample sizes, Chatfield State Park and USACE Tri-Lakes staff that are knowledgeable about these activities completed UDV assessments for these activities. Workshop attendees who assigned UDV points included: 43 Chatfield State Park recreationists, two marina owners, seven Chatfield State Park staff, and two USACE Tri-Lakes staff. Assumptions used in assigning point values to the five criteria (accessibility, carrying capacity, environmental, recreation experience, and availability of opportunity) for the three alternatives and two time periods were based on the information (PowerPoint slides), responses to questions and general instructions received from USACE, and the individual perspectives of the raters.

A spreadsheet was compiled for each of the 29 recreational activities chosen by USACE to calculate the annual recreation benefits for ten scenarios (including no action at Chatfield, 7,700 acre-foot reallocation, and 20,600 acre-foot reallocation). The UDV points assigned to each of the five criteria were added, and this sum was converted to fiscal year 2013 dollars per day for that activity in accordance with Economic Guidance Memorandum 13-03, Unit Day Values for Recreation, Fiscal Year 2013, dated February 13, 2013. The present value of NED recreation benefits foregone during the 2-year construction period prior to reallocation is about $1.5 million for Alternative 3. The 12-foot reallocation (Alternative 3) shows a reduction in NED recreation benefits of approximately $15.6 million over 50 years. The present value of recreation benefits over 50 years for Alternative 3 is about $216.7 million, compared to about $232.4 million without the reallocation (Alternatives 1 and 2). More details on the UDV analysis can be found in Appendix T.

Employment Impacts

According to the BBC report (2010), Alternative 3 would generate direct, indirect, and induced jobs. In addition to the approximate 324 construction jobs per year directly supported by this alternative over the first two years of construction, an additional 292 annual jobs would be generated in the study area, for a total of about 615 annual jobs in the study area per year during the first two years of project construction. Payment associated with water storage leaving the region represents a loss of about 154 total jobs (i.e., direct, indirect, and induced jobs) during the first year of construction under Alternative 3. Ongoing operational spending is estimated to support about 22 total jobs per year. In total, the employment benefits of project construction and operations are estimated to be approximately 2,257 person-years of employment over the 50-year analysis period in the study area under Alternative 3. About half of that total is attributable to ongoing operations expenditure. These additional jobs per year (Exhibit 1V-2, Appendix U), averaging approximately 45 jobs annually are approximately 0.004 percent of the 1,214,448 jobs in the five-county Denver metropolitan area in 2009 (Exhibit II-2, Appendix U).

Agricultural Land Conversion

No irrigated land would be converted to dryland agriculture to provide water storage under Alternative 3. The socioeconomic impacts on agricultural land would be insignificant based on its percentage of irrigated acres in the six-county area, as illustrated in Tables 3-10 and 3-12.

Project Costs

The FY 2013 financial cost of this alternative is estimated at $178.7 million. This includes the capitalized cost of storage, operation and maintenance, rehabilitation and replacement costs, and recreation and environmental mitigation pits using an interest rate of 3.75 percent and a study period of 50 years.

The participants would raise the funds for this alternative. The cost of storage would be paid to the U.S. Treasury so it would not be spent in the region.

According to BBC (2010), Alternative 3 is expected to generate a total of $318.0 million in economic output in the region, which includes the direct impact of the project ($186.4 million) and the resulting economic activity generated in response to project demands for goods and services (indirect impacts) and spending attributed to direct and indirect labor earnings (induced impacts), which total an additional $131.6 million. Implementation of this alternative would result in substantial construction-related expenditures and generate demand for construction labor and support services, which would generate a positive short-term impact to the regional economy. Expenditures on construction materials and equipment that are made within the region would generate additional economic benefits as spending flows through the local economy through industry linkages. Labor income earned by construction-related workers would be re-spent, in part, in the local economy, generating additional economic activity. In addition to construction, there would be ongoing annual expenditure to operate the proposed facilities and delivery systems.

4.15.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

In addition to the reallocation, another 5,379 acre-feet would be obtained from NTGW and/or other storage and downstream gravel pits under Alternative 4. The potential effects on socioeconomic resources from conversion of downstream gravel pits to water storage reservoirs and use of NTGW are disclosed under Alternatives 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2.

Recreation Visitation Losses

According to the BBC report (2010), Colorado State Parks is estimated to lose approximately $278,000 annually as a result of visitation reduction at Chatfield during the construction period. After construction, the facilities would reopen and would be expected to recover. Colorado State Parks is expected to lose about $2.7 million over the 50-year analysis period, including revenue associated with concessionaire agreements. Net Colorado State Parks revenue loss includes direct revenue loss from reduced visitation, loss revenue from the concessionaire share, and a recovery of a portion of lost revenue through substitute recreation site provisions (BBC 2010). As described under Alternative 3, USACE (2011a) addresses the impacts to recreational enjoyment in dollars using the UDV method. Based on input gathered during recreation assessment workshops, a spreadsheet was compiled for each of the 29 recreational activities chosen by USACE to calculate annual recreation benefits. The UDV points assigned to each of the five criteria were added and this sum was converted to fiscal year 2011 dollars per day for that activity in accordance with Economic Guidance Memorandum 13-03, Unit Day Values for Recreation, Fiscal Year 2013, dated February 13, 2013. The present value of NED recreation benefits foregone during the 2-year construction period prior to reallocation is about $1.3 million. The 5-foot reallocation (Alternative 4) shows a reduction in NED recreation benefits of approximately $13.2 million over 50 years. The present value of recreation benefits over 50 years for Alternative 4 is about $219.2 million, compared to about $232.4 million without the reallocation (Alternatives 1 and 2). More details on the UDV analysis can be found in Appendix T.

Employment Impacts

The number of jobs lost under this alternative would be a total of two jobs due to dryland farming.

According to the BBC report (2010), Alternative 4 would generate direct, indirect, and induced jobs. In addition to the approximate 542 construction jobs per year directly supported by this alternative over the first two years of construction, an additional 488 annual jobs would be generated in the study area, for a total of about 1,030 annual jobs in the study area per year during the first two years of project construction. Payment associated with water storage leaving the region represents a loss of about 57 total jobs (i.e., direct, indirect, and induced jobs) during the first year of construction under Alternative 4. Ongoing operational spending is estimated to support about 15 total jobs per year. In total, the employment benefits of project construction and operations are estimated to be approximately 2,946 person-years of employment over the 50-year analysis period in the study area under Alternative 4. About half of that total is attributable to ongoing operations expenditure. These additional jobs per year (Exhibit 1V-2, Appendix U), averaging approximately 59 jobs annually are approximately 0.005 percent of the 1,214,448 jobs in the five-county Denver metropolitan area in 2009 (Exhibit II-3, Appendix U).

Agricultural Land Conversion

No irrigated land would be converted to dryland agriculture under this alternative. The long-term use of NTGW could reduce the pumping rates for water wells in the area. Agricultural lands that rely on NTGW could be affected under this alternative.

Project Costs

The FY 2013 financial cost of this alternative is estimated at $180.2 million. This includes the capitalized construction, operation, maintenance, repair, rehabilitation and replacement costs for NTGW and the gravel pits using an interest rate of 3.75 percent and a study period of 50 years. The NTGW component includes costs from the SMWSS and operation and maintenance costs associated with the 42 wells required over the 50-year planning horizon. Additionally, the cost includes the capitalized cost of storage, operation and maintenance, rehabilitation and replacement, and recreation modifications and environmental mitigation for the 7,700 acre-foot Chatfield reallocation.

The participants would raise the funds for this alternative. The cost of storage would be paid to the U.S. Treasury so it would not be spent in the region.

According to BBC (2010), Alternative 4 is expected to generate a total of $419.4 million in economic output in the region, which includes the direct impact of the project ($237.0 million) and the resulting economic activity generated in response to project demands for goods and services (indirect impacts) and spending attributed to direct and indirect labor earnings (induced impacts), which total an additional $182.3 million. Implementation of this alternative would result in substantial construction-related expenditures and generate demand for construction labor and support services, which would generate a positive short-term impact to the regional economy. Expenditures on construction materials and equipment that are made within the region would generate additional economic benefits as spending flows through the local economy through industry linkages. Labor income earned by construction-related workers would be re-spent, in part, in the local economy, generating additional economic activity. In addition to construction, there would be ongoing annual expenditure to operate the proposed facilities and delivery systems.

4.15.5 Reduction and Modification of Potential Impacts

The USACE and State Parks have agreed to allow the swim beach and marina to remain open from May through September during the entire construction period to minimize impacts to park visitors and the marina operators. In addition, while it is outside of the Selected Plan, the water providers would reimburse Colorado State Parks and the marina operators on an annual basis for lost revenues that result as a consequence of reallocation, as well as any increased costs that Colorado State Parks incurs.

Because flood damages along the South Platte downstream from Chatfield would remain essentially the same under all four Alternatives, no modification is anticipated.

4.15.6 Environmental Justice

Although it has been shown that some Census tracts in the impacted area have varied concentrations of minority and low income populations, these variations are small compared with the concentration of low income and minorities in individual counties and in the six-county area. Additionally, it cannot be shown, and it is not reasonable to assume that minority and low income populations in the middle and upper middle class suburbs surrounding the impact area are affected by any of the alternatives to any greater degree than the rest of the population. The impacts are primarily to the physical environment with no secondary health or welfare impacts. These would be shared by the surrounding communities and, in the case of Chatfield Reservoir, by project users. No impacts to the health of residents of any race or to subsistence fishing, hunting, or food gathering are known or likely. Accordingly none of the alternatives are evaluated further.

4.16 Transportation

This section describes the impacts of the alternatives on transportation within the park. Transportation was not raised as a specific issue during the scoping meetings, although short-term direct adverse impacts would occur inside and outside of the park during construction. Potential impacts on transportation on roadways in the study area are associated with temporary construction traffic and ongoing maintenance and recreation traffic in the vicinity of Chatfield State Park.

4.16.1 Alternative 1—No Action

The No Action Alternative assumes that road construction and relocation of associated facilities would not occur at Chatfield State Park. Increases or decreases in visitor access occur during various times of the year, typically coinciding with the amount of recreational use and traffic at the time. These access variations would continue to occur under the No Action Alternative.

Instead, Penley Reservoir and the gravel pits would be built, and after their construction these would not require any new roads, nor would transportation be greater than it is now. The gravel pits would likely result in less traffic than what is currently operating in the area during active mining.

4.16.2 Alternative 2—NTGW/Downstream Gravel Pits

The NTGW/Downstream Gravel Pits Alternative is similar to the No Action Alternative above. However, only the gravel pits would be constructed, not Penley Reservoir, and again, this would decrease operation traffic to the area.

4.16.3 Alternative 3—20,600 Acre-Foot Reallocation

Under Alternative 3, a portion of the entrance road would be realigned and a major segment of the main park road would have to be located farther away from the reservoir. Realignment of the main park road would require a new bridge crossing over Deer Creek. Under this alternative, traffic would temporarily increase during the construction periods, which would be implemented in phases over a 2- to 5-year period. Assuming that the construction period does not conflict with the high-use recreation times, transportation would not be a significant factor.

Short-term access issues would occur. Road rebuilding and associated facility relocation would take approximately 3 to 5 years to complete. During construction of the road, the volume of traffic would increase. At times, construction traffic may be heavy during each phase of the project. For example, earth moving equipment and bulldozers may be needed during facility relocations, and asphalt paving machines and concrete trucks may be needed during road building activities. Delivery trucks may be required to deliver certain items to the park, and additionally, construction worker traffic would be required for the approximately 50 construction workers working in the area (see Section 4.15, Socioeconomic Resources).

New roads projected in the recreation study (EDAW, 2010) are just a few feet in elevation above the reallocation levels. When floods occur, much damage occurs to the road base, as has been demonstrated in previous floods at the park. Access to and within the park would not be significantly impacted by the long-term increases in pool elevations under Alternatives 3 or 4.

4.16.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

In addition to the reallocation, another 5,379 acre-feet would be obtained from NTGW and/or other storage and downstream gravel pits under Alternative 4. The potential effects on transportation from conversion of downstream gravel pits to water storage reservoirs and use of NTGW are disclosed under Alternatives 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2.

Under Alternative 4, the road would not be realigned and reconstructed. However, some facilities would be relocated, which would require construction vehicles in the park. Similar to Alternative 3, it is anticipated that the traffic would temporarily increase during the facility relocation which could be implemented in phases over a 2- to 4-year period. Assuming that the facility relocation/ construction period does not conflict with the high-use recreation times, transportation would not be a significant factor. Transportation from all sources would be either similar to or less than those analyzed for Alternative 3. No significant short- or long-term adverse impacts from this alternative are anticipated.

Short-term access issues would occur under Alternative 4 that are similar to those described under Alternative 3. The duration of impacts on access and traffic would be slightly shorter under Alternative 4 than under Alternative 3. Long-term impacts to access are not anticipated.

4.16.5 Reduction of Potential Impacts

To minimize impacts, construction periods would be limited to certain times of the year when recreation use is low. Construction should also occur during daylight hours, per Colorado law, so that it does not disturb nearby residences. This would also reduce disturbance to wildlife at night.

During the construction period, construction would meet the applicable noise standards for Colorado, as provided in Section 25-12-103, Colorado Revised Statutes (C.R.S). The Colorado absolute noise limits are assessed at the facility property line, but no closer than 25 feet from the noise source (i.e., worst-case scenario would be if construction were to occur within 25 feet of a property line). In residential areas, from 7 a.m. to 7 p.m., the absolute noise limits are 55 A-weighted dBA, and from 7 p.m. to 7 a.m., the absolute noise limits are 50 dBA, according to state stature. Table 4-20 illustrates the maximum noise limits as follows:

Table 4-20
Maximum Noise Limits

Zone	7:00 a.m. to next 7:00 p.m.	7:00 p.m. to next 7:00 a.m.
Residential	55 dBA	50 dBA
Commercial	60 dBA	55 dBA
Light Industrial	70 dBA	65 dBA
Industrial	80 dBA	75 dBA

The Colorado statute states that, "Construction projects shall be subject to the maximum permissible noise levels specified for industrial zones for the period within which construction is to be completed pursuant to any applicable construction permit issued by proper authority or, if no time limitation is imposed, for a reasonable period of time for completion of project." Therefore, during construction only, the project area construction noise is required to be at or below the 80/75 dBA limit. This section may not be applicable to the use of property by this state, or a political subdivision of this state.

4.17 Recreation

This section describes the impacts of the four alternatives on recreation. Adverse impacts on recreation resources at Chatfield State Park, such as the swim beach, marina, and boat ramps may occur as a result of increased water levels in Chatfield Reservoir. Direct short-term adverse impacts may result from road construction and relocation/installation of new facilities development at the park. Direct long-term adverse impacts may occur at the Swim Beach area if visitors are required to walk longer distances to access the beach. No indirect adverse impacts would occur. Most information in this section comes from the "Chatfield Reservoir Recreation Facilities Modification Plan" (EDAW, 2010), which is included in this FR/EIS as Appendix M. Impacts on visitation and revenue at Chatfield State Park are discussed in more detail in Section 4.15.

4.17.1 Alternative 1—No Action

The No Action Alternative assumes that relocation of recreation facilities would not occur because portions of the park would not be inundated with water under normal operating conditions. The average recreational season (June through September) water surface elevation under historic operations is 5,432 feet with 4.8 feet of fluctuation. Under the No Action Alternative, there would not be an increased frequency of larger, seasonal water surface fluctuations (measured June 1 through September 30 over a 59-year period). The associated pipeline infrastructure would be outside of the park and would not affect recreation resources in the park. Chatfield State Park's authority under the LWCF Act would not apply because relocation of recreation facilities would not occur.

No recreation would occur at Penley Reservoir, nor would it occur at the gravel pits.

4.17.2 Alternative 2—NTGW/Downstream Gravel Pits

The NTGW/Downstream Gravel Pits Alternative is similar to Alternative 1 in that no recreation would occur at the gravel pits, and there would be no impacts at Chatfield State Park.

4.17.3 Alternative 3—20,600 Acre-Foot Reallocation

Under Alternative 3, the raised water surface in Chatfield Reservoir would increase the average recreational season (June through September) pool fluctuation to approximately 12 feet, an increase of 5.2 feet. A more significant operations challenge may be presented by larger fluctuations that occur infrequently but regularly. Over the 59-year period (1942 to 2000) that was modeled, historic operations (5,432 feet msl) had five years with more than 15 feet of fluctuation during the primary recreational use season. In contrast, the 5,444 feet msl alternative had 20 years when the water surface elevation fluctuation was greater than 15 feet (EDAW, 2010, Appendix M).

The discussion that follows focuses on the affected use areas at Chatfield State Park and provides an area-by-area description of what facilities would have to be relocated or redeveloped. Areas that would not be influenced are not considered in this discussion. The main areas that would be affected include the North Boat Ramp, Massey Draw, Swim Beach area (including Eagle Cove, Deer Creek, and Jamison areas), Catfish Flats and Fox Run group use areas, the Kingfisher/Gravel Ponds/Platte River Trailhead areas, Marina area (including Marina Point, South Boat Ramp, Riverside Marina, and Roxborough day use areas), and Plum Creek area (EDAW, 2010, Appendix M). These areas are discussed below in more detail.

The North Boat Ramp would be partially inundated under Alternative 3. Facilities affected include two boat ramps, paved parking, and a variety of support facilities, including trails and day use shelters (see Table 2.2 and Map 2.3 in EDAW 2010, Appendix M). Additionally, this alternative requires a substantial amount of fill to raise a portion of the parking area (EDAW, 2010).

The recreation capacity of Massey Draw would be reduced but the parking area would not be inundated. The service tank for the existing vault restroom is below 5,444 feet msl; therefore, it would need to be relocated (see Table 2.3 and Map 2.4 in EDAW, 2010, Appendix M).

Under Alternative 3, adverse impacts on the Swim Beach area are the most substantial of all facilities located along the shoreline. The entire swim beach site and associated parking area, including a number of other facilities (e.g., trails, restrooms, concession building, first aid station, volleyball, and horseshoe pits) would be inundated (see Tables 2.6 and 2.7 and Map 2.5 in EDAW, 2010, Appendix M). The gravel parking area and portable restroom at Eagle Cove would be inundated, while approximately half of the Deer Creek area would be inundated at this level (see Tables 2.4 and 2.5 and Map 2.5 in EDAW, 2010, Appendix M). The Jamison area also would be inundated (see Table 2.7 and Map 2.5 in EDAW, 2010, Appendix M). In addition to adverse impacts on recreation facilities, a portion of the entrance road would be realigned and a major segment of the main park road would have to be located farther inland (EDAW, 2010). Impacts on roads are discussed further in Section 4.16, Transportation.

The majority of entrance roads, parking areas, shelters, restrooms, and utilities at the Catfish Flats and Fox Run group use areas would be inundated at 5,444 feet msl (see Tables 2.8 and 2.9 and Map 2.6 in EDAW, 2010, Appendix M). Specifically, the parking area, restroom, and picnic shelters would be inundated at the Catfish Flats area, while the entrance to the parking area at the Fox Run group use area would be reconstructed due to the new location of the main park road (EDAW, 2010).

The Kingfisher and Gravel Ponds areas would be entirely inundated if Alternative 3 were implemented. The Platte River Trailhead restroom, parking area, and trailhead would not be inundated; however, inundation of existing trails that lead to the river would be inundated (see Tables 2.10, 2.11, and 2.12 and Map 2.7 in EDAW, 2010, Appendix M). Modification measures are discussed in Section 4.17.5.

Recreation facilities at the Marina area would be significantly affected under this alternative (see Table 2.13 and Map 2.8 in EDAW, 2010, Appendix M; JJR 2011, Appendix N). The increase in average pool level fluctuation would affect the operations of Riverside Marina. The existing anchors are not capable of handling the increase in pool elevation and they would need to be replaced to operate correctly. At Marina Point the parking area, group day use area, volleyball and horseshoe pits, and the accessible fishing pier would all be inundated, as would the south boat ramp. Additionally, the Roxborough day use area would be entirely inundated at a water elevation of 5,444 feet msl (EDAW, 2010).

The Plum Creek area facilities include a trailhead and a day use area with picnic tables, a restroom, and parking (see Table 2.14 and Map 2.9 in EDAW, 2010, Appendix M). Under Alternative 3, the Plum Creek day use area would be entirely inundated.

As stated above, Chatfield State Park must remain in outdoor recreation uses pursuant to Section 6(f) of the LWCF Act because LWCF assistance was used by the Colorado Division of Parks and Outdoor Recreation to obtain water for Chatfield Reservoir. According to David Giger, Colorado State Parks, (personal communication, 2008), there are presently several LWCF grants at Chatfield. One LWCF grant is used for water in the reservoir. The other LWCF grants (approximately four to five grants) were used to purchase facilities that could be inundated under Alternative 3. If these facilities are inundated under this alternative, they must be replaced elsewhere in the park, and Colorado State Park staff must submit a formal letter to the National Park Service recognizing the changes and stating that the park is not in default. If the facilities are removed and not relocated, then the state would be in default. However, all facilities are planned to be relocated, so this should not be a conflict with the LWCF Act and the state of Colorado.

As described in Section 4.15, the USACE prepared a report entitled "Recreation Benefit Analysis Using the Corps' Unit Day Value Methodology to Determine the Effect of Reallocation of Storage at Chatfield Reservoir on National Economic Development (NED) Recreation Benefits at Chatfield State Park" (2011a). This report addresses the impacts to recreational enjoyment under the proposed alternatives. To estimate visitation loss at Chatfield State Park during construction, surveys were distributed to representatives of Chatfield recreation user groups, who were specifically assembled by the USACE on April 16, 2009 to review the reallocation and facility modification plan for Alternative 3. As described in Section 4.15, the information gathered during the meeting forms the basis of the NED analysis completed by the USACE and the Regional Economic Development (RED) prepared by BBC.

Attendees were asked to describe their primary, secondary, and tertiary (if applicable) recreation activity at the park. Attendees reported the number of days they use the park per activity and if there were any local substitute sites for their primary recreation activity. The attendees were then shown graphics that depicted the new facilities and water levels that would exist under Alternatives 3 and 4. To gauge visitation loss, respondents were asked to review the reallocation plan and estimate the extent to which their usage may change during construction, one to five years after construction when water is incrementally reallocated to the reservoir conservation storage pool, and when park and water management practices stabilize. Attendees were aware that they were providing responses as a representative of a broad user group.

Forty-five individuals completed the survey reporting 88 activities, indicating each respondent was involved in nearly two activities at the park. Among all responses, 22 types of activities were identified. The breadth of activities suggests that all visitation groups were represented. In this analysis, uses were aggregated into like categories. For instance, "water dog training," "scuba diving," and other like uses were placed in the category "Gravel Pond Use" because these groups exclusively use that facility and would likely have similar reactions to park facility changes. Detailed results are presented in Appendices T and U.

Results are calculated based on total days among all survey respondents. For example, trail hikers, joggers, and walkers will have an estimated loss of 23.3 percent of visitation during construction. All of the visitors who specified this activity in the survey were asked to estimate the number of days they visit the park each year. Respondents were then asked by how many days they would reduce their visits during construction. All of the respondents' visitor days were summed (total visitor days) and all respondents' reduced days were summed (total decreased days). The total number of reduced days was divided by the total number of visitor days yielding the percent visitation loss.

Reported sightseers at the park are reduced by the average reduction of all other recreation users. Sightseers are defined as participating in no particular recreation activity and most often accompany other recreators at the park.

Visitors who indicated they would not visit Chatfield during and after construction may choose to recreate at other parks and recreation areas in the study area. Many survey respondents indicated they would substitute their visit to Chatfield with a visit to another local recreation site, either at another state park or municipal or county recreation area. For example, trail users reported substitute sites including Bear Creek Trail, Washington Park, and the Platte River Trail. State Parks has indicated that nearby substitute parks, especially Cherry Creek State Park, reach capacity during summer weekends.

Under Alternative 3, overall visitor use at Chatfield is 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.

4.17.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

In addition to the reallocation at Chatfield Reservoir, another 5,379 acre-feet would be obtained from NTGW and/or other storage and downstream gravel pits under Alternative 4. The potential effects on recreation from conversion of downstream gravel pits to water storage reservoirs and the use of NTGW are disclosed under Alternatives 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2.

Recreation facilities at Chatfield State Park would be adversely impacted under Alternative 4, as discussed in the following sections and in Appendix M. The discussion that follows focuses on the affected use areas at Chatfield State Park and provides an area-by-area description of what facilities would have to be relocated or redeveloped. Areas that would not be influenced, such as the campgrounds, are not considered in this discussion. The areas that would be affected include the North Boat Ramp, Massey Draw, and the Swim Beach, Kingfisher, Marina, and Plum Creek areas (EDAW, 2010). These areas are discussed below in more detail.

Under this alternative, the North Boat Ramp would be partially inundated, making it inoperable. Facilities affected include the two boat ramps (see Appendix 5 in EDAW, 2010, Appendix M). Remaining areas, including most of the parking, the picnic shelters, and circulation roads, would remain above the normal high water line.

The recreation capacity of Massey Draw would be reduced but the existing parking area and restroom would not be inundated (see Appendix 5 in EDAW, 2010, Appendix M).

Under Alternative 4, adverse impacts on the Swim Beach area are the most substantial of all facilities located along the shoreline. The entire swim beach site and associated parking area, including a number of other facilities (e.g., trails, restrooms, concession building, first aid station, volleyball, and horseshoe pits) would be inundated (see Appendix 5 in EDAW, 2010, Appendix M). Unlike Alternative 3, this would not adversely impact the road.

The Kingfisher area would be entirely inundated under this alternative. However, unlike Alternative 3, the gravel ponds would not be inundated at this level (see Appendix 5 in EDAW, 2010, Appendix M).

In the Marina area there is significantly higher topography, which somewhat limits the impacts to the shoreline facilities. However, most of the parking areas would be inundated under this alternative which results in impacts to the use of most of the facilities. Thus all of the facilities would need to be relocated, or rebuilt on filled areas, in order to maintain the same recreational benefits (see Appendix 5 in EDAW, 2010, Appendix M).

Under this alternative, the Plum Creek day use area and trailhead would be entirely inundated at the proposed water elevation. Some segments of the Plum Creek trail would also be inundated (see Appendix 5 in EDAW, 2010, Appendix M).

As stated above, Chatfield State Park must remain in outdoor recreation uses pursuant to Section 6(f) of the LWCF Act because LWCF assistance was used by the Colorado Division of Parks and Outdoor Recreation to obtain water for Chatfield Reservoir. According to David Giger, Colorado State Parks (personal communication, 2008), there are presently several LWCF grants at Chatfield.

One LWCF grant is used for water in the reservoir. The other LWCF grants (approximately four to five grants) were used to purchase facilities that could be inundated under Alternative 4. If these facilities are inundated under this alternative, they must be replaced elsewhere in the park, and Colorado State Park staff must submit a formal letter to the National Park Service recognizing the changes and stating that the park is not in default. If the facilities are removed and not relocated, then the state would be in default. However, all facilities are planned to be relocated, so this should not be a conflict with the LWCF Act and the state of Colorado.

In the UDV survey (described under Alternative 3 above), respondents were asked to state their visitation responses to Alternative 3 only. Because Alternative 4 would have similar but less severe effects on facilities at the park during and post-construction, BBC (2010) estimated impacts for Alternative 4 using Alternative 3 as an estimate boundary.

Under Alternative 4, overall visitor use at Chatfield is expected to decrease by 14.1 percent (from 1.66 million to 1.43 million visitors) during construction, by 8.0 percent (to 1.53 million visitors) 1 to 5 years after construction, and by 3.3 percent (to 1.61 million visitors) 6+ years after construction. Detailed information is available in Appendices T and U.

4.17.5 Reduction and Modification of Potential Impacts

Modification measures proposed under Alternatives 3 and 4 are discussed for each of the affected recreation use areas in Chatfield State Park. More detailed information can be found in Appendix M (EDAW, 2010). In addition to the modification measures discussed below, the water providers continue to work with staff of Colorado State Parks to identify additional recreational features that could be implemented in order to enhance the recreational experience beyond what is captured within the federal plan. These features, while not considered part of the Selected Plan, may be required by the state of the water providers prior to entering into contracts for water supply at Chatfield. These additional features provide additional assurance to State Parks that a like-kind recreational experience at Chatfield State Park would occur following a reallocation of storage space, as well as to ensure Colorado State Parks is compensated for any lost revenue or increased costs incurred as a result of this project. These additional measures are summarized at the end of this section, following modifications proposed as part of the Selected Plan.

According to BBC (2010), the USACE and State Parks plan to minimize visitation loss under Alternative 3 by developing a construction schedule with minimal impact during high season (May 1 to September 30) and extensive impact during low season. The USACE and State Parks have agreed to allow the swim beach and marina to remain open from May through September during the entire construction period. Construction would begin in mid-September of year 1 and continue, uninterrupted, until mid-May of year 4. The overall construction period is estimated at 32 months. The construction period for recreation related economic impacts is estimated to occur over two years, as all facility closures would take place within the first 24 months of construction. EDAW (2010) documents an analysis that was performed to determine the best construction concept to minimize impacts to the public and to operations by State Parks and the Corps, balancing time and cost to complete the proposed recreation modifications. Six different construction schedules were evaluated. After careful consideration of the factors influencing the use and operation of the park, a combination of off-season and high-use season construction phasing was proposed. Under this option, construction would occur over a two-year, 8-month period, beginning in September of the first year. Construction activities would be sequenced to fit into 7-month, off-season (September 16 to May 14) periods. The north boat ramp, swim beach area, and marina area would remain open during the high-use season (May 1 through September 30). The portion of the park under construction would be closed during the off-season. Multiple crews would work 8- to 10-hour days simultaneously at multiple locations. Some activities would be performed during double-shifts to fit the proposed facility replacement into the 7-month off-season window. Smaller facilities would be reconstructed (in alternative locations) during the high-use season.

For any of the recreation modification facilities that would require fill placed within the flood control pool above elevation 5,444 feet msl, an equal amount of excavation would be required at similar elevations. For gently sloping areas, proper signage and marking of hazards will be used to minimize boating hazards in shallow waters during implementation.

As a modification measure for the North Boat Ramp, the boat ramps would be reconstructed to extend to the elevation of the existing ramps in order to operate at lower water levels. The slope on the new ramps would be reduced and day use shelters, furniture, and trails would be relocated (see Map 3.1 in EDAW, 2010, Appendix M).

Modification to the Massey Draw area would include importing fill material to raise the elevation above 5,444 feet msl and create a useable recreational area in the same location with a similar amount of useable area that currently exists. Existing beach volleyball and horseshoe pits would be rebuilt. Furniture would be stored and relocated to the future area. Additionally, the service tank for the vault restroom would be relocated (see Map 3.2 in EDAW, 2010, Appendix M).

Given Colorado State Park's goal of replacing affected facilities and use areas "in kind," the EDAW (2010) report (Appendix M) is based on maintaining current walking distances at the swim beach. To construct a new swim beach, the existing facilities would be demolished and excavated EDAW (2010) Sand would be saved and imported to create the new swim beach environment. The excavated material could be used to fill low areas that would be inundated at 5,444 feet msl to increase the amount of useable area. Additionally, the current buildings, lawn area, and recreational facilities would be rebuilt in the new location (Figure 4-21, also Map 3.3.1 in EDAW, 2010, Appendix M). The proposed location would require a segment of the main park road to be relocated (see Appendix 2 in EDAW, 2010, Appendix M). Costs associated with redevelopment and relocation of recreation facilities are presented in Appendix M.

As an additional modification measure, construction in the Swim Beach area would not occur between June and September of each year until complete. Redesigning the swim beach would carefully consider options that allow visitors to walk less distance to access the shoreline.

As part of the swim beach area, the Eagle Cove gravel parking area would be redeveloped in the same general area. Additionally, all affected existing facilities at the Deer Creek area would be redeveloped within the same area (EDAW, 2010). The Deer Creek hot air balloon launch site would not be relocated. Instead, fill would be brought into the area to raise the balloon launch site to ensure that the area would not be inundated throughout the year (EDAW, 2010). The Jamison day use area would be relocated south of its current location and parking and restroom facilities would be replaced (EDAW, 2010).

The Catfish Flats and Fox Run group use areas would be modified slightly. The Catfish parking area, restroom, and picnic shelters would be relocated, while the Fox Run entrance to parking area would be reconstructed due to the new location of the main park road (see Map 3.4 in EDAW, 2010, Appendix M).

To protect the Kingfisher area and gravel ponds that would be entirely inundated if Alternative 3 were implemented, one modification measure would include creating a berm and raising the park road in its current location (see Appendix 3 in EDAW, 2010, Appendix M). A new bridge would be constructed across the South Platte River. A cross section and more detail are presented in Appendix M. This avoidance modification measure would ensure that the gravel ponds are not inundated, and therefore, the ponds still would be used for a variety of recreational uses. Additionally, new parking areas would be developed and existing trail connections and concrete trails would be redeveloped above the high waterline to provide similar recreation opportunities (see Map 3.5 in EDAW, 2010, Appendix M).

Modification to the Riverside Marina would include constructing new breakwaters and placing earth fill on an elevated surface (Figure 4-22, also Map 3.6.1 in EDAW, 2010, Appendix M). Below the Riverside Marina, the reservoir floor would be excavated down to a depth of 5,412 feet msl to enable it to operate at extreme low water levels. This excavated material could be used to raise the breakwater elevations and provide fill for other locations. The marina would operate close to the existing location. Due to a potential increase in water fluctuations, the existing cable and winch system would be replaced with a modern electronic winch system. The marina would be developed on a flotation system designed for the occurrence of water above 5,444 feet msl. The parking areas, day use shelters, group use area, and recreational areas associated with the south boat ramp areas in their present locations would be rebuilt on fill areas in the same general location where they currently exist. Trails and walkways in the inundated area would need to be rebuilt. Additionally, the Roxborough day use area would need to be relocated to a new location close to the existing one, where easy access to the shoreline, which it currently enjoys, would remain (EDAW, 2010).

As a modification measure, construction in the marina area would occur between November and March of each year. This would ensure that park visitors and concessionaires (discussed more in Section 4.15, Socioeconomic Resources) are not significantly impacted.

For the purpose of this feasibility-level report and NEPA disclosure, Appendix M, "Recreation Facilities Modification Plan" includes the EDAW report and Appendix N, "Chatfield Marina Reallocation Impact Assessment Report" includes the JJR report each depicting alternative designs and configurations for the marina. Each report presents different proposed relocation/modification measures and cost estimates. Future studies and final design work will assist with developing necessary details along with updated cost estimates for marina facility modification. Estimated costs from the EDAW report were originally included in the overall financial analysis and economic feasibility considerations by the federal sponsor. No parties are bound by either cost estimate, and they are included for informational purpose of scale and range only. The actual relocation/modification may take an alternative form reflecting additional factors which may result in actual costs that differ from those presented in this document.

Figure 4-21
Swim Beach Area Modification Plan (5,444 ft) under Alternative 3

Source: Map 3.3.1 from Appendix M.

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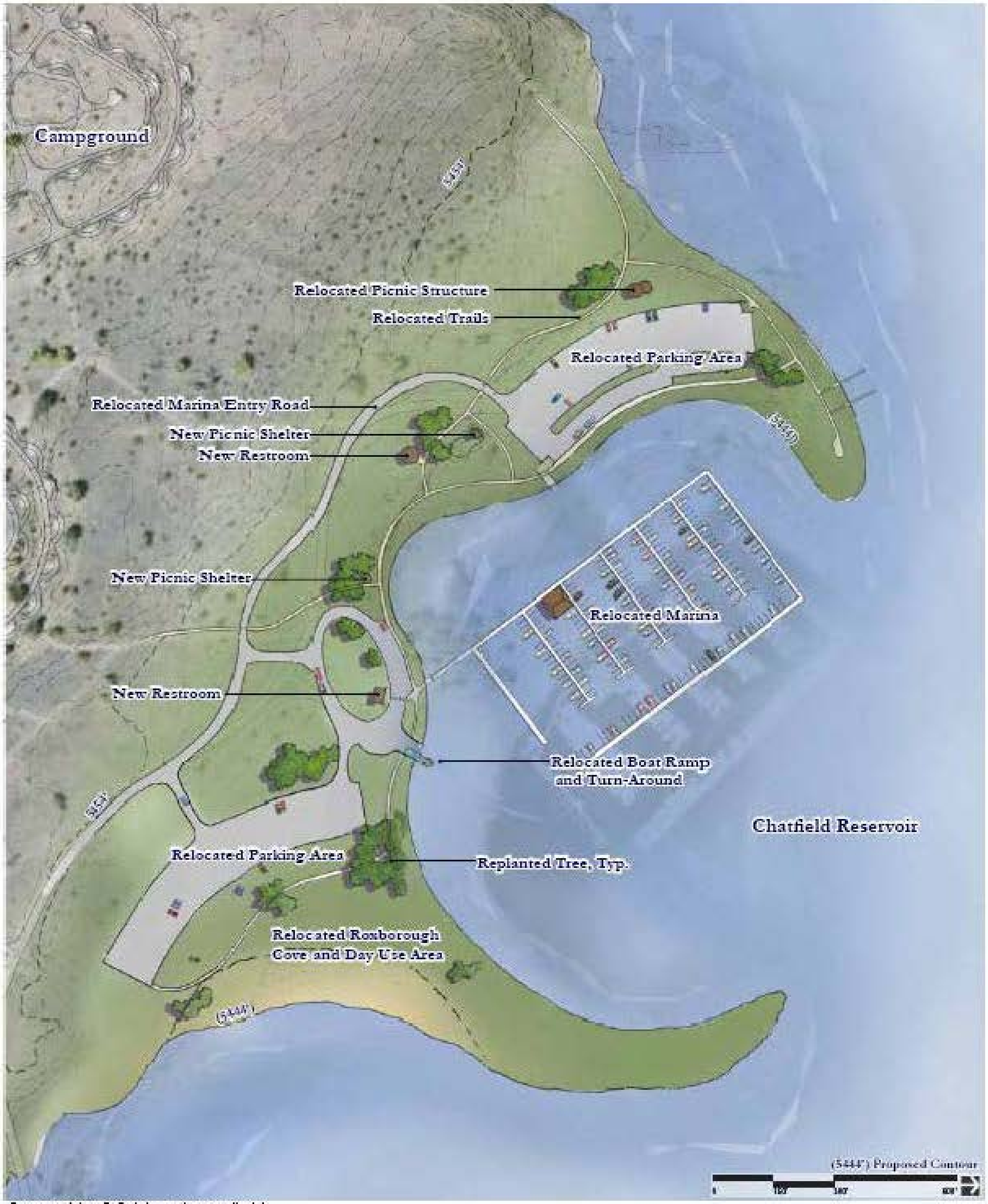
Figure 4-22
Marina Area Modification Plan (5,444 ft) under Alternative 3



Source: Map 3.6.1 from Appendix M

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Regardless of the final design details and construction cost estimates, the water providers affirm their support of the continued operation of a quality marina at Chatfield State Park and to keep the marina operator financially whole. The water providers are committed to the costs of planning, design, engineering, permitting, and construction of in-kind replacement facilities to ensure the quality of the marina recreational experience remains the same, to the extent possible. The continuation of park and marina services will be planned to continue before, during, and following reallocation construction activities at Chatfield. Planning for the sequence of actions has begun with the initial EDAW report in the FR/EIS, and has continued with the funding and delivery of the JJR report in late 2010.

A more specific plan will be developed by the involved parties including the current lessee, North Shore Marina Chatfield, Inc., CWCB, Colorado State Parks, and the water providers and submitted to the Corps of Engineers for approval. The plan will address the marina relocation in its entirety, including elements identified in both the EDAW report and JJR report.

Modification measures to the Plum Creek area would include relocating the day use area to the southern edge of the reservoir. The recreational facilities would be replaced at this location and a new restroom would be built. Additionally, Plum Creek trailhead would be relocated to this area and inundated trail segments would be replaced (see Map 3.7 in EDAW, 2010, Appendix M). A new trail bridge would be built to span the creek. Adaptive management by an established group would facilitate discussion of minimizing impacts by operation strategies once reallocation begins (Appendix GG). Costs associated with redevelopment and relocation of recreation facilities are presented in Appendix M.

In addition, several features are being pursued by the water providers and the state outside of the Selected Plan. One feature is grading, where not completed as a result of implementing the Recreation Modification Plan. Specifically, water providers have agreed to fund re-contouring along the south shoreline, portions of the west shoreline, and potentially other select sites to minimize the appearance of a "bathtub ring." To deal with recreation density issues, the water providers propose to work with State Parks and landowners adjacent to Chatfield State Park to maximize buffer areas (via easements) to offset the loss of usable land. Where the Recreation Modification Plan, Tree Management Plan, and CMP do not provide immediate replacement of natural shade for park visitors, the water providers have agreed to work with the state to provide for the reforestation of certain areas where State Parks feels it would help preserve park aesthetics and provide shade. In addition, as described in Section 4.15.5, while it is beyond the requirements of the Selected Plan, the water providers will reimburse Colorado State Parks and the operators of the marina on an annual basis for lost revenues that result as a consequence of the reallocation.

4.18 Cultural Resources

This section describes the impacts of the study alternatives on cultural resources within the proposed APE. Adverse impacts on a significant cultural resource may occur as a result of pipeline construction under Alternative 1.

The APE would include a sufficient buffer around the lake to account for all needed facility relocations and would also include a 50-foot buffer around all construction areas. Additionally, the APE would include a 50-foot buffer around the downstream gravel pits and the proposed Penley

Reservoir and pipelines. No downstream adverse impacts are anticipated because modeling results show that flooding discharges downstream would be less than the current baseline conditions. The river stages resulting from these flows would also be reduced from the current baseline.

Archaeological Inventoried and Identified Sites

An online review of the Colorado Office of Archaeology and Historic Preservation Site Files System (COMPASS) resulted in the identification of 117 cultural properties that are listed in, eligible for listing, or potentially eligible for listing in the NRHP, within one mile of the APE for all study alternatives. Of these recorded sites and districts, one NRHP-eligible property could be affected within the project APE of Alternative 1 (Table 4-21).

Table 4-21
NRHP-Eligible Cultural Resources within Project APE

Site #	Site Name	Site Type	Site Age	National Register Status	Project Segment	Alternative	Township	Range	Section	Quarter
5DA922.1	Atchison, Topeka & Santa Fe Railroad (ATSF)	Trans-portation	1887	eligible	Plum Creek Reservoir Pipeline	1	7S	68W	19/20	SE/SW

The project was initially coordinated with fourteen potentially interested Tribes by letter on October 13, 2005 (see Attachment 4 in Appendix S). The Corps requested comment from Tribes on the proposed alternatives and any future necessary studies. No comments or requests for consultation regarding the study were received.

The project was initially coordinated with the Colorado State Historic Preservation Office (SHPO) by letter on December 12, 2005 and later revised on July 10, 2006 once the hydrologic study for the project was completed, which determined the maximum storage increase needed and downstream impacts for the project. On February 29, 2008 a third letter was sent, as project alternatives further expanded (see Attachment 2 in Appendix S).

In the December 2005 letter, the Corps addressed three possible pool raise alternatives. The Corps also coordinated a 300- foot buffer along both sides of the South Platte River downstream from the dam to the Adams/Weld County line to ensure that any potential impacts were considered. In a letter dated December 19, 2005, the SHPO concurred with the Corps Area of Potential Effect (APE) recommendations and requested continued consultation as stipulated in 36 CFR 800.4(a).

In the July 2006 letter, the Corps coordinated the exclusion of the 300-foot buffer along both sides of the South Platte River downstream from the dam to the Adams/Weld County line, as well as the inclusion of a 50-foot buffer around the lake to account for needed facility relocations. In a letter dated July 24, 2006, SHPO concurred with the Corps APE recommendations and requested involvement in any continued consultation as stipulated in 36 CFR 800.3.

The most recent cultural resources survey was conducted by RMC Consultants/4G Consulting on 3,605 acres within Chatfield State Park (Dominguez et al., 2007), and this information was utilized in the formulation of additional alternatives. In a letter dated March 20, 2008 SHPO concurred with the Corps APE recommendations and requested involvement in any continued consultation as stipulated in 36 CFR 800.3.

4.18.1 Alternative 1—No Action

Review of state site files indicate that pipeline and infrastructure installation would adversely impact the Atchison, Topeka & Santa Fe Railroad (ATSF), a cultural resource that is eligible for NRHP listing. The ATSF was chartered in 1859 and was a major rail link between the Plains and the Rocky Mountain regions. A segment of the ATSF built in 1887 east of the town of Sedalia, Colorado, would be adversely affected by the proposed construction of the Plum Creek Reservoir Pipeline near the proposed Plum Creek Reservoir (Figure 2-1). The High Line Canal was constructed in 1883 for water control purposes. The Denver & Rio Grande Railroad was built in 1871, just two years after the completion of the first transcontinental railroad. After review of state site files, no NRHP-listed, eligible, or potentially eligible sites were identified in the proposed Penley Reservoir or the gravel pit locations associated with this alternative.

4.18.2 Alternative 2—NTGW/Downstream Gravel Pits

Alternative 2 proposes using NTGW and four downstream gravel pits for storage. No NRHP-listed, eligible, or potentially eligible cultural resources would be affected by this alternative.

4.18.3 Alternative 3—20,600 Acre-Foot Reallocation

The implementation of Alternative 3 would result in the inundation of 587 additional acres around the lake (Table 4-2). The effects of shoreline erosion are anticipated to be slight as changes to the target pool would occur slowly over a period of seasonal variation. Previous archeological investigations have identified 10 prehistoric and historic sites that are located within the zone of potential inundation. The proposed change in pool elevation associated with Alternative 3 would not adversely affect any NRHP-listed or potentially eligible properties.

4.18.4 Alternative 4—7,700 Acre-Foot Reallocation/NTGW/Downstream Gravel Pits

In addition to the reallocation, another 5,379 acre-feet would be obtained from NTGW and/or other storage, and downstream gravel pits under Alternative 4. The potential effects on cultural resources from conversion of downstream gravel pits to water storage reservoirs and use of NTGW are disclosed under Alternatives 1 and 2, respectively. Fewer and/or smaller gravel pit reservoirs would be needed under Alternative 4 than under Alternative 1 or 2.

Alternative 4 would result in the inundation of 215 additional acres of shorefront around the lake. As in Alternative 3, alterations in the target pool would occur slowly, minimally affecting shoreline erosion during seasonal drawdown and filling. Based upon the results of Dominguez et al. (2007), it is concluded that no significant cultural resources would be adversely affected by the proposed change in pool level.

4.18.5 Reduction and Mitigation of Potential Impacts

It is recommended that project-generated adverse impacts on the linear NRHP-eligible property (the ATSF) be avoided by direct-drill installation of proposed pipelines beneath the affected property. If adverse impacts on the properties cannot be avoided in this manner, then mitigation of adverse impacts should be undertaken by thorough documentation of the affected property in accordance with the Colorado State Historic Preservation Office (SHPO) guidelines and standards.

4.19 Cumulative Impacts

This section describes the potential cumulative impacts that would result from the proposed alternatives combined with other projects and activities. In general, discussions emphasize the alternatives that would affect each resource. Alternatives that would not affect a resource are generally not addressed in the cumulative impacts discussions.

The CEQ regulations for implementing NEPA define cumulative impacts as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions and regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7).

The cumulative impacts of a proposed alternative can be viewed as the total impacts on a resource, ecosystem, or human community of the actions included in that alternative and all other activities affecting that resource. In many ways, scoping is the key to analyzing cumulative impacts; it provides the best opportunity for identifying important cumulative impact issues, setting appropriate boundaries for analysis, and identifying relevant past, present, and future actions.

Past, present, and reasonably foreseeable future projects that may have cumulative impacts on the resources in Chatfield State Park, and downstream of Chatfield are presented in this section. These projects and their relationships to the Chatfield FR/EIS study and each resource are described below.

In addition, the best available scientific evidence based on observations from long-term monitoring networks indicates that climate change is occurring and will continue to occur (Brekke et al., 2009). Climate change affects water availability, water demand, water quality, stormwater and wastewater infrastructure, flood infrastructure, wildland fires, and ecosystem functioning. These factors affect the water resources projects operated by the Corps, many of which were designed and constructed before climate change was recognized as a potential influence (USACE, 2010d). Potential climate change impacts affecting water availability include changes in precipitation amount, intensity, timing, and form (rain or snow); changes in snowmelt timing; and changes to evapotranspiration (Brekke et al., 2009). Water supplies in the southwestern United States are projected to become increasingly scarce, calling for trade-offs among competing uses (Karl et al., 2009). Four overlapping areas with unresolved issues are climate models, research specific to Colorado, drought, and reconciling hydrologic projections (Ray et al., 2008).

The results from several general circulation models agree that the southwestern United States is likely to experience precipitation and evapotranspiration changes that result in less runoff and water availability (Brekke et al., 2009). The consistent projections for a substantial temperature increase across Colorado have important implications for water management (Ray et al., 2008). Increases in temperature imply more evaporation and evapotranspiration leading to higher water demands for agriculture and outdoor watering. Temperature-related changes in the seasonality of streamflows (e.g., earlier runoff) may complicate prior appropriation systems and interstate compact regimes; and modify the interplay among forests, hydrology, wildfires, and pests (e.g., pine beetles) (Ray et al., 2008). The wide range of Colorado precipitation projections makes it difficult to assess likely changes in annual mean precipitation by mid-21st century. However, a synthesis of findings (Ray et al., 2008) suggests a reduction in total water supply by then. Limitations imposed on water supply by projected temperature increases are likely to be made worse by reductions in rain- and snow-fall in spring months when precipitation is most needed to fill reservoirs to meet summer demand (Karl et al., 2009). Furthermore, there is potential for increased drought severity in the region due to higher temperatures alone. The Front Range Climate Change Vulnerability Study confirmed these forecasts, indicating that annual average streamflow volumes in the South Platte could decrease with climate change (Water Research Foundation, 2012).

4.19.1 Project Descriptions

The following 20 projects were identified based on comments during scoping, as well as discussions with the water providers as past, present, or reasonably foreseeable future projects that could have a cumulative impact on the resources evaluated under the Chatfield FR/EIS study. Table 4-22 provides a summary of the projects, along with references for additional information.

Table 4-22
Past, Present, and Foreseeable Future Projects Considered As Part of the Cumulative Impacts Analysis

Project	County	Timeframe	Reference
Chatfield Reservoir Drought Drawdown	Arapahoe, Douglas, Jefferson	Reasonably foreseeable future	Denver Water and USACE - Reference not available
Halligan-Seaman Water Management Project	Larimer	Reasonably foreseeable future	City of Fort Collins and city of Greeley - http://www.halligan-seaman.org
Northern Integrated Supply Project	Larimer, Weld	Reasonably foreseeable future	Northern Colorado WCD - http://www.northernwater.org/WaterProjects/NISP.aspx
Denver Water Moffat System Improvement Project	Boulder, Clear Creek, Douglas, Gilpin, Jefferson, Park, Summit, Teller	Reasonably foreseeable future	Denver Water - http://www.denverwater.org/StudyPlanning/WaterSupplyProjects/Moffat
Rueter-Hess Reservoir Project	Douglas	Past	Parker WSD - http://www.pwsd.org/projects.html
Issuance of Permit for Incidental Take of Preble's Mouse	Boulder, Douglas, Jefferson	Past	EPA - http://www.epa.gov/fedrgstr/EPA-IMPACT/2003/February/Day-10/i3133.htm and http://www.epa.gov/fedrgstr/EPA-SPECIES/2003/June/Day-03/e13783.htm
Last Chance Water Diversion to Conduit 20 at Kassler	Arapahoe, Douglas, Jefferson	Past	Denver Water (Bob Peters)
Denver Water Temporary Chatfield Pump Station	Arapahoe, Douglas, Jefferson	Past	Denver Water (Bob Peters)
Wastewater System Improvements/Wastewater Interceptor Project for the Roxborough Wastewater Treatment Plant	Douglas	Past	Roxborough Water and Sanitation District - http://www.roxwater.org/downloads/Summary%20MP-2012%20Report_Part1.pdf and http://www.cenews.com/print-magazinearticle-fourteen_mile_pipeline_enables-7665.html
Re-routing of Sewer across Plum Creek	Douglas	Past	Chatfield State Park and USACE - Roberts & Johnson, 2003
CDOT Projects – Widening U.S. 85/Santa Fe Drive	Douglas	Present	CDOT - http://www.coloradodot.info/business/grants/tiger2grants/CDOT%20I25%20Santa%20Fe%20App.pdf/at_download/file
CDOT Projects: Widening I-25/ Castle Rock	Douglas	Present	CDOT – http://www.coloradodot.info/about/AboutCDOTandFacts/CDOTHistory/50th-anniversary/interstate-25/i-25-major-projects

Table 4-22
Past, Present, and Foreseeable Future Projects Considered As Part of the Cumulative Impacts Analysis

Project	County	Timeframe	Reference
CDOT Projects: 2035 Metro Vision	Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson	Present/ Reasonably foreseeable future	CDOT - http://www.drcog.org/index.cfm?page=regionaltransportationplan%28rtp%29
CDOT Projects: C470 Corridor Plan	Jefferson	Present/ Reasonably foreseeable future	CDOT - http://co.jefferson.co.us/ planning/planning_T59_R12.htm
CDOT Projects: South Jefferson County Community Plan	Jefferson	Present/ Reasonably foreseeable future	CDOT - http://co.jefferson.co.us/planning/ planning_T59_R24.htm
Lockheed Martin Wetland Projects	Jefferson	Past/Present	Colorado Parks and Wildlife - http://www.parks.state.co.us/Parks/Chatfield/Nature/Pages/ChatfieldNature.aspx
South Platte Reservoir Project	Arapahoe	Past	Centennial WSD - http://www.deereault.com/ damandreservoir.html#2
Gravel Pits	Multiple	Present/ Reasonably foreseeable future	Multiple water providers
Residential Development Projects	Douglas, Jefferson	Present/ Reasonably foreseeable future	Multiple Developers - http://www.douglas.co.us/planning/planning-projects/ and http://www.jeffco.us/planning/
Plum Creek Reservoir	Douglas	Reasonably foreseeable future	Town of Castle Rock, Castle Pines Metropolitan District, and Castle Pines North Metropolitan District

4.19.1.1 Project 1—Chatfield Reservoir Drought Drawdown

A draft proposal by Denver Water for the Chatfield Reservoir Drought Drawdown is being considered to operate a pump station at the outlet works of Chatfield Reservoir to access its stored water below 5,423 feet msl. The reservoir has not been below 5,423 feet msl since the reservoir first filled in 1979. The pump station could be used to manage water levels during normal conditions and for municipal water supply needs during drought conditions. This pumping would allow use of water in the drought pool, between 5,423 and 5,385 feet msl. This drought drawdown proposal is conceptual and has not been approved.

In addition to the proposed action described in the previous paragraph, the draft proposal also analyzes a No Action Alternative. Under this alternative, no efficient means to move water out of storage below the 5,423 feet msl exists. To meet customers' water needs during a drought, another source of water and additional pipelines would need to be developed. Information about the location or total length of pipeline that would be necessary is unavailable.

4.19.1.2 Project 2—Halligan-Seaman Water Management Project

The Halligan-Seaman Water Management Project has been proposed by the cities of Fort Collins and Greeley and six other water providers. Plans involve two water supply projects designed to provide drought protection for existing and future water demands, more efficiency in managing the existing or future water rights of the six other water providers, some operational redundancy, and possibly environmental benefits. The project involves enlarging two existing reservoirs: Halligan Reservoir and Milton Seamen Reservoir, resulting in approximately 88,592 acre-feet of additional storage capacity in the Cache la Poudre River Basin. Fort Collins and Greeley have proposed a preferred configuration of the project(s), which involves the construction of new, larger dams immediately downstream of the existing Halligan and Seaman Dams. Preliminary analyses by the cities indicate that the enlarged reservoirs would fill primarily during the summer and fall months from North Fork Poudre River flows. Milton Seaman Reservoir also would fill via a pump station on the Poudre River mainstem near the dam site. Small releases are proposed throughout the year on a periodic basis to maximize operational efficiency. Fort Collins and Greeley anticipate that both reservoirs are expected to remain mostly full except during drought periods. The Halligan-Seaman Water Management Project would be a non-federal project constructed, owned, and operated by the cities and/or other water providers.

4.19.1.3 Project 3—Northern Integrated Supply Project

The Northern Integrated Supply Project (NISP) is a collaborative regional water supply project between 12 water providers and the Northern Colorado WCD acting by and through the Northern Integrated Supply Project Water Activity Enterprise. The project would provide approximately 37,000 acre-feet of new reliable water supply, which would meet a portion of the estimated 2025 additional water supply needs of the 12 water providers. Currently, most of the providers predominantly rely on Colorado-Big Thompson units to meet their growing water supply needs. The proposed project would occur in Larimer and Weld Counties in Colorado. It would include a proposed Glade Reservoir with a capacity of approximately 177,000 acre-feet. Associated with Glade Reservoir are a forebay, pump station, and canal upgrade to convey water diverted from the Cache la Poudre River to the proposed reservoir. A pipeline connecting the proposed Glade Reservoir to the existing Horsetooth Reservoir is proposed. Glade Reservoir would inundate a section of U.S. Highway 287 and require the relocation of about 7 miles of the highway. Additionally, Glade Reservoir would inundate a section of the North Poudre Supply Canal and a portion of the canal would need to be rerouted. The proposed project also would include a proposed Galeton Reservoir with a capacity of approximately 30,000 acre-feet. Associated with Galeton Reservoir are a forebay, pump station, and pipeline to deliver South Platte River water to Galeton Reservoir. Water exchanges between the Galeton Reservoir and Glade Reservoir diversion locations are proposed. NISP would be a non-federal project constructed, owned, and operated by the Northern Integrated Supply Project Water Activity Enterprise.

4.19.1.4 Project 4—Denver Water Moffat System Improvement Project

The Denver Water Moffat System Improvement Project was proposed by the city and county of Denver, acting by and through its Board of Water Commissioners (Denver Water). Denver Water identified four needs in the Moffat Collection System that have to be solved. First, existing water demands served by Denver Water's Moffat Collection System exceed available supplies from the Moffat Collection System during a drought, causing a water supply reliability problem. Second, Denver Water's collection system is vulnerable to manmade and natural disasters because 90 percent of available reservoir storage and 80 percent of available water supplies rely on the unimpeded operation of Strontia Springs Reservoir and other components of Denver Water's South System. Third, Denver Water's treated water transmission, distribution, and water collection systems are subject to failures and outages caused by routine maintenance, pipe failures, treatment plant problems, and a host of other unpredictable occurrences that are inherent in operating and maintaining a large municipal water supply system. These stresses to Denver Water's ability to meet its customers' water demands require a level of flexibility within system operations that is not presently available. Finally, Denver Water's near-term water resource strategy and water service obligations that have occurred since the Integrated Resources Plan was developed in 1997 and updated in 2002, has resulted in a need for 18,000 acre-feet of new near-term water supplies. Denver Water has proposed meeting those needs by enlarging Gross Reservoir in Boulder County. Denver Water is in the process of amending the FERC license and drafting an EIS for the project. In fall 2008, the Corps completed the Preliminary EIS and the Draft EIS was released October 30, 2009. The Final EIS is expected to be published in 2014.

4.19.1.5 Project 5—Rueter-Hess Reservoir Project

The Rueter-Hess Reservoir is an existing reservoir located east of Chatfield Reservoir. The Parker WSD expanded the Rueter-Hess Reservoir to provide sufficient storage of Denver Basin groundwater, and the associated reuse water from initial Denver Basin use, for selected South Metro Denver area water providers, and to assist in sustaining the Denver Basin aquifers. The project was conceived to allow the reservoir to serve as a regional water management facility for multiple water providers in northern Douglas County; enable them to meet peak demands; greatly enhance water management in the region; and help extend the yield of the Denver Basin aquifers, a non-renewable water source and the primary source of water for the South Metro area. Expansion of the reservoir has resulted in direct impacts on an additional 0.21 acres of wetlands and 4 miles of intermittent stream channel (in addition to the 6.7 acres of wetlands and 5 miles of other waters of the U.S. permitted as part of the 16,200 acre-foot reservoir).

Parker WSD enlarged the Rueter-Hess Reservoir from the currently permitted design of 16,200 acre-feet by 55,800 acre-feet for a total storage capacity of approximately 72,000 acre-feet. This is considered the site's maximum storage capacity based on the site's topography. The expanded reservoir pool inundated approximately 1,140 acres (an additional 672 acres). Parker WSD will maintain a 5,000 acre-feet emergency reserve pool in the reservoir (elevation 6,110 feet msl) to be used as needed to provide a reliable water supply for its customers. The design involved raising the currently permitted dam (embankment) by 60 feet, to a crest elevation of 6,219 feet, using a downstream raise concept. In addition to the expanded reservoir, new pipelines were installed to deliver the water to and from the new project participants (town of Castle Rock, Castle Pines North Metropolitan District, and Stonegate Metropolitan District).

Groundbreaking for the dam expansion began on September 5, 2008. The dam expansion was completed in March 2012.

4.19.1.6 Project 6—Issuance of Permit for Incidental Take of Preble's Mouse

In February 2003, the city and county of Denver, acting by and through its Board of Water Commissioners (Denver Water) applied to the USFWS for an Incidental Take Permit (ITP) pursuant to Section 10(a)(1)(B) of the ESA of 1973, as amended. The permit authorized the loss and modification of habitat associated with Denver Water's Operations and Maintenance (O&M) activities and the incidental take of Preble's meadow jumping mouse, federally listed as threatened. In June 2003, the USFWS issued a permit for incidental take of threatened species. The permit is in effect for 30 years from the date of issuance. The application included a proposed Habitat Conservation Plan (HCP) and Environmental Assessment (EA) for the Preble's meadow jumping mouse on Denver Water properties.

The applicant's plan to conduct O&M activities necessary for Denver Water to meet its mission of providing a safe and high quality water supply to its customers covers properties that may constitute Preble's mouse habitat in Boulder, Jefferson, and Douglas Counties in Colorado. Such activities would include repair and maintenance of infrastructures and facilities (e.g., conduits, siphons), ditch/canal maintenance, road repair and maintenance, construction of new conduits, burial of pipeline, and other activities necessary for municipal water supply. The planning area for the permit application covers approximately 6,000 acres of properties that may constitute Preble's mouse habitat. The O&M activities would permanently alter no more than 10 acres of potential Preble's mouse habitat, but are estimated to only permanently impact 1 acre. Additionally, up to 74 acres of potential Preble's mouse habitat would be temporarily impacted, with total impacts not to exceed 75 acres (either 1 acre permanent and 74 acres temporary or ranging up to no more than 10 acres permanent and 65 acres of temporary disturbance).

Alternatives considered were: No Action; individual ITPs on a site-by-site or project-by-project basis, as needed; waiting for approval of and participating in three separate countywide HCPs; waiting for and participating in a single statewide HCP; and the Preferred Alternative–a single ITP held by Denver Water, achieved through the proposed HCP. None of these alternatives, except No Action, eliminated potential take of Preble's mouse.

4.19.1.7 Project 7—Last Chance Water Diversion to Conduit 20 at Kassler

While the Kassler Water Treatment Plant was in operation (prior to 1985), Conduit 20 was used as part of the plant's water distribution system. This pipeline originates in Waterton Canyon approximately three miles upstream from the Waterton Canyon entrance and is still used as part of the water distribution system in this area. In 2002 Denver Water constructed a pipeline to carry water from the South Platte River in the former Last Chance Ditch to a pump located at the Kassler Plant. The pump delivers the water diverted to Conduit 20. Denver Water is required to maintain flow in the South Platte River below the Last Chance Ditch diversion to Chatfield. From mid-September to mid-May, a minimum of 15 cfs must be maintained. During the rest of the year, flows are maintained at 60 cfs, unless Denver Water has implemented water use restrictions. As water restrictions become more severe, the amount of water that Denver Water allows to flow downstream can be reduced.

4.19.1.8 Project 8—Denver Water Temporary Chatfield Pump Station

Denver Water installed submersible pumps in Chatfield Reservoir that can be operated while the reservoir is between 5,432 feet msl and 5,427 feet msl. Water is pumped to Conduit 20, which goes to Marston Reservoir.

4.19.1.9 Project 9—Wastewater System Improvements/Wastewater Interceptor Project for the Roxborough Wastewater Treatment Plant

The Roxborough Wastewater Treatment Plant was proposed to connect Roxborough to the Littleton/Englewood Wastewater Treatment Plant. TST, Inc. designed a lift station and seven miles of force main pipeline to connect the district to the Littleton/Englewood Wastewater Treatment Plant. The proposed project crossed the South Platte River, a Chatfield Watershed Authority Section 404 jurisdictional water and lands managed by the USACE for flood storage in the Chatfield Reservoir pool. TST, Inc., with assistance from ERO Resources, completed an EA for the area affected by the proposed lift station and force main pipeline. Potential adverse impacts on protected and sensitive species (bald eagles, Preble's meadow jumping mouse, and black-tailed prairie dogs) were specifically considered as part of the report. Wetlands, 100-year flood plains, surface and groundwater quality and quantity, cultural and historical resources, air quality, and geology were also assessed in the NEPA document. The EA included development of a GIS database with numerous resource layers facilitating impact assessment. Construction of facilities was completed in August 2007 and was operational in November 2007.

4.19.1.10 Project 10—Re-routing of Sewer across Plum Creek

In October 2002, the USACE issued a Nationwide Permit for the construction of a 5,960-foot sewer force main pipeline near Plum Creek on Chatfield State Park. During the planning process, the project was determined to have potential temporary adverse impacts on 0.75 acres of wetland and Preble's mouse habitat. Two acres of off-site Preble's mouse habitat enhancement and restoration were proposed as mitigation and approved by regulatory agencies after the completion of ESA Section 7 consultations. In January 2003 the USFWS approved a 2.00-acre mitigation site located approximately 250 feet south of the pipeline restoration area. Conditions of the Section 404 permit included stockpiling and redistributing topsoil; reseeding with native species and herbaceous, shrub, and tree species; planting to minimize erosion; implementing weed control to limit coverage of noxious weeds to less than 5 percent of the construction and mitigation area; avoiding construction during the active season for Preble's mouse; monitoring revegetation; and protecting plantings in the mitigation area from large herbivore browsing.

4.19.1.11 Project 11—CDOT Projects: Widening U.S. 85/Santa Fe Drive

The Colorado Department of Transportation (CDOT) proposed to widen U.S. 85/Santa Fe Drive just north of Sedalia. Work included widening the highway in concrete from two to four lanes (0.5 miles), new median construction, drainage improvements, landscaping, signing, and striping. CDOT also completed earthwork and relocating utilities just south of Sedalia. Sema Construction Inc. of Centennial, Colorado, was the contractor for the $2.8 million project, which was completed in 2007.

4.19.1.12 Project 12—CDOT Projects: Widening I-25/Castle Rock

Construction to widen I-25 through Castle Rock, from 5th Street to Meadows/Founders Parkway, started on August 28, 2006. This project involves expansion of I-25 to three lanes in each direction, and flattening the existing curves in this section. Construction has been completed on the major interchanges in this segment.

4.19.1.13 Project 13—CDOT Projects: 2035 Metro Vision

The 2035 Metro Vision Regional Transportation Plan (2035 MVRTP) addresses the challenges and guides the development of a multimodal transportation system over the next 25 years. It is an element of the overall Metro Vision 2035 Plan adopted by the DRCOG. To meet current and future challenges, the 2035 MVRTP includes plans to enhance the relationship between transportation and land use development, provide for maintenance of the existing system, incorporate transportation management actions to increase the existing system's efficiency, include travel demand management efforts to slow the growth of single-occupant vehicle trips, identify transit and roadway improvements to increase the system's people-carrying and freight movement capacity, add bicycle and pedestrian facilities, prioritize improvements considering limited resources, integrate plan components to result in a connected and complete system, encourage coordination between neighboring communities and between agencies, and support the Metro Vision urban center, extent of development, environmental quality, and freestanding community elements.

4.19.1.14 Project 14—CDOT Projects: C-470 Corridor Plan

A 1999 Jefferson Economic Council (JEC) study revealed that only 4,000 acres of developable commercial and industrial land remained within Jefferson County. The Jefferson County Planning Commission directed JEC and the Planning and Zoning Department to write Land Development Policies to remedy this shortage. Approved policies were incorporated into the county's Policy and Procedures Manual in 2002 by the Board of County Commissioners.

In 2001, the Planning Commission and the Board of County Commissioners directed staff to develop a plan for the C-470 corridor to identify and designate locations for employment-generating land uses. Three prime locations for employment-generating land uses along the C-470 corridor were identified: Bowles, Belleview, and Ken-Caryl. The C-470 Corridor Plan is intended to encourage the development of job opportunities along the C-470 corridor to improve the county's jobs-to-population imbalance. This plan provides land use recommendations for office development and smaller-scale retail that would support office development. This plan includes the C-470 area adjacent to Chatfield Reservoir.

4.19.1.15 Project 15—CDOT Projects: South Jefferson County Community Plan

The South Jefferson County Community Plan is a set of policy recommendations developed for the southeastern portion of Jefferson County. Its purpose is to serve as a guide for land use and service decisions now and in the future. Included in the plan are guidelines for land use activities, including activity centers, arterial/arterial intersections, open spaces, trails, parks, utilities and services, and redevelopment to encourage the reuse of existing facilities. In addition, subareas are identified within the plan as areas west of the Hogback and in the rural plains, and guidelines are laid out specific to these areas to maintain their unique character. This plan includes the area around Chatfield Reservoir.

4.19.1.16 Project 16—Lockheed Martin Wetland Projects

The Chatfield Wetlands were created in the mid-1990s by Martin Marietta, the predecessor to Lockheed Martin, in partnership with Colorado State Parks, the USACE, and Ducks Unlimited. Approximately 13 acres of wetlands were constructed in Chatfield State Park west of the South Platte River near the southern boundary of the park. The wetlands contain many cells of varying sizes that filtered effluent from Lockheed Martin. The effluent reached the wetlands by flowing through a ditch located close to a viewing platform and interpretive area. Usage was discontinued prior to 2007 by order of the CDPHE when water quality testing showed one of the components of the effluent exceeded state of Colorado standards. The effluent now flows through a pipeline that was installed across Chatfield State Park near the wetlands and is discharged into the South Platte River.

Lockheed Martin also discharges effluent to the South Platte River upstream of Chatfield Reservoir. The water quality of the effluent is monitored under the Colorado Discharge Permit System and must meet applicable water quality standards.

4.19.1.17 Project 17—South Platte Reservoir Project

The South Platte Reservoir Project was built over a 13-year timeline and completed in 2007 by Centennial WSD. This former gravel pit, which was condemned for the reservoir, provides raw water storage to the district, which provides water service to Highlands Ranch. This reservoir covers approximately 215 acres and is about 60-feet deep. Water is taken out using a pump station and a 48-inch, 60-cfs pipeline to McLellan Reservoir or the district's water treatment plant. A Section 404 permit was required to build the project. To mitigate the 0.45 acres of wetlands disturbed by construction, the permit required that all disturbed wetlands plants be replaced. Specific numbers of plants and types of plants are listed as follows: 110 shrubs, 15 cottonwoods, and 360 bulrush plants. Surveys were conducted for Preble's meadow jumping mouse and Ute ladies'-tresses orchid, and none were found. The reservoir was operational in spring 2008, and the capacity is 6,400 acre-feet of raw water storage for domestic use. The reservoir site will not be available for public use.

4.19.1.18 Project 18—Gravel Pits

Approximately 41 gravel pits located north of Denver have been built or are planned to be converted into reservoirs, similar to the South Platte Reservoir Project above (Table 4-23). About half of these gravel pits have been built or are under construction, and the remaining half are planned to be built in the future. The gravel pits are or would be located along the South Platte River from Denver to Brighton and possibly even farther downstream. Based on the available information, the largest gravel pit (Lupton Lake) would hold approximately 11,000 acre-feet of water, and the smallest gravel pit (Tanabe) would hold approximately 700 acre-feet of water (Table 4-21). These gravel pits would have pipeline facilities; however, information about these pipelines was not available at the time of the study.

Table 4-23
Existing or Planned Gravel Pit Reservoirs North of Denver

No.	Name	Owner	Built or Under Construction	Planned	Size (acre-feet)	Surface Area (acres)	Year Put into Service
1	Cat	Denver Water (DW)/ South Adams County Water and Sanitation District (SACWSD)	X		1,700		2009
2	Miller	Denver Water/SACWSD	X		2,100		2009
3	South Tani Reservoir	Thornton	X		7,241	237	1988
4	East Gravel Lake #4	Thornton	X		2,807	112	1988
5	South Dahlia	Thornton	X		1,777	86	1998
6	West Gravel (3)	Thornton	X		2,840	100	1990
7	North Dahlia	Thornton	X		2,568	104	2002
8	Sprat Platte Ranch aka East Sprat Platte	Thornton	X		1,700	87	2002
9	West Sprat Platte	Thornton	X		1,900	62	2002
10	Cooley Lake West (3)	Thornton	X		4,400	200	2008
11	Cooley Lake East	Thornton	X		5,100		2013
12	Tanabe	DW/SACWSD		X	700		
13	Howe Haller A&B	DW/SACWSD		X	6,350		
14	Hazeltine/Rd Runn II	DW/SACWSD		X	5,600		
15	Dunes	DW/SACWSD		X	5,200		
16	Mann Lake So (3)	Adams County	X		5,000		
17	Brannon	FRICO/United	X	X	6,000		
18	Worthing			X			
19	Tower			X	2,100		
20	So. Hammer	Thornton	X				
21	No. Hammer	Thornton	X		1,600		
22	Bromley Lakes (3) aka Ken Mitchell Lakes	Brighton	X	X	9,000		Partially 2007

Table 4-23
Existing or Planned Gravel Pit Reservoirs North of Denver

No.	Name	Owner	Built or Under Construction	Planned	Size (acre-feet)	Surface Area (acres)	Year Put into Service
23	Rogers	Thornton	X		2,500		
24	Wattenburg	Westminster	X		1,200		
25	Platte Valley			X			
26	Fort. Lupton (3)	Thornton	X		2,700		
27	Walker	Aurora	X				
28	Stillwater/Brighton Resources	Aurora		X			
29	Lupton Lake	Denver		X	11,000		2020
30	Koenig	Central Colorado WCD	X		1,300		2001
31	124th Ave (Brighton)	Brighton	X		1,000		2004
32	Tucson	Aurora	X				
33	Arvada Pit	Arvada	X				
34	120th Avenue/Hwy 85	120th Estate Partners	X	X	1,300	41	
35	Erger Pond	Ready-Mixed/Boral	X	X	1,600	94	
36	Crabb Trust Pond	Crabb Family		X			
37	E-470 Pond	E-470 Authority		X		33	
38	Front Range Agg.	Front Range Agg.		X			
39	Aggregate Ind.	Aggregate Ind.					
40	Aggregate Ind.	Aggregate Ind.					
41	Albert Frei (2)						

Source: McLoud, 2007a

4.19.1.19 Project 19—Residential Development Projects: Jefferson/Douglas Counties

Residential development is happening around Chatfield, mostly to the south of the reservoir. This development is removing wildlife habitat by building housing communities in the area. Currently, the open spaces of undeveloped land to the south of the park are ad-hoc wildlife habitats.

The U.S. Census Bureau (2006) data indicate that there are a total of 226,195 housing units in Jefferson County and a total of 95,511 housing units in Douglas County. In 2005, a total of 3,671 housing units were built in Jefferson County, and another 6,902 housing units were built in Douglas County. These data are not site-specific, so the locations where the houses were built within each of the counties could not be determined. However, there are some undeveloped properties located near Chatfield that could be developed in the future, as illustrated by the Jefferson and Douglas County zoning maps (see discussion below).

Jefferson County

The Jefferson County zoning map identifies a few pockets of open space around Chatfield State Park. The portion of Jefferson County south of C-470 and east of Wadsworth is zoned Agriculture-One Zone District (A-1). The A-1 district is "intended to provide for limited farming, ranching and agriculturally related uses while protecting the surrounding land from any harmful effects. A revision in March 1972 increased the minimum land area for this district to 5 acres. Contained in this section are the allowed land uses, building and lot standards (including minimum setbacks) and other general requirements specified for this zone district" (Zoning Resolution). The Lockheed Martin property is zoned Industrial-One Zone District (I-1). The I-1 district is "intended to provide areas for medium industrial development. Contained in this section are the allowed land uses, building and lot standards (including minimum setbacks) and other general requirements specified for this zone district" (Zoning Resolution). South and west of the Lockheed Martin property, it is zoned

Agriculture-Two Zone District (A-2) but there are several small pockets of residential development scattered throughout that area (it appears those subdivision pockets were rezoned). The A-2 district is intended to provide for general farming, ranching, intensive agricultural uses and agriculturally related uses while protecting the surrounding land from any harmful effects. A revision in March 1972 increased the minimum land area for this district to 10 acres. Contained in this section are the allowed land uses, building and lot standards (including minimum setbacks) and other general requirements specified for this zone district" (Zoning Resolution). The Chatfield Green (owned by the city of Littleton) is the subdivision just north of Lockheed Martin on the west side of Wadsworth. It is surrounded by open space. The city of Littleton has numerous subdivisions on the north side of C-470.

Douglas County

Everything south of Chatfield State Park is currently zoned, planned, or zoned A-1. North of Titan Road and south of Chatfield State Park, there are several subdivisions. Also, east of Santa Fe Drive, there are multiple subdivisions and industrial areas. There are some planned (urban and non-urban) developments in these areas too. Industrial developments are abundant along Santa Fe Drive. South of Titan Road and west of Santa Fe Drive, development against the mountain range is planned. The east side of Santa Fe Drive is being developed heavily at this time, down to Castle Rock and I-25.

4.19.1.20 Project 20—Plum Creek Reservoir

The town of Castle Rock, Castle Pines Metropolitan District, and Castle Pines North Metropolitan District are considering constructing the Plum Creek Reservoir in Douglas County. The proposed location is about 3 miles southeast of Sedalia, CO and is shown in Figure 2-4. The reservoir would have a capacity of 1,200 to 1,700 acre-feet. Studies are being conducted regarding the size and economic feasibility of the reservoir. Castle Pines Metropolitan District and Castle Pines North Metropolitan District jointly have applied for Water Court Decrees allowing storage in Plum Creek Reservoir of existing and applied-for conditional East Plum Creek water rights. The districts also seek rights of exchange from Chatfield Reservoir to Plum Creek Reservoir and would store recaptured reusable water rights in the Plum Creek Reservoir if the Chatfield Reallocation project were approved. However, as indicated in Section 2.4.1.1, the reservoir will be constructed regardless of whether the Chatfield reallocation is approved. Currently, there is not a firm construction schedule, but the parties expect that construction likely will occur within the next five to ten years.

4.19.2 Geology and Soils

Current and projected land development would not result in significant cumulative impacts on geological hazards (i.e., potential slope failure, seismicity, and stability). Cumulative impacts on geologic resources are considered negligible. Land and transportation development unavoidably involves disturbance to soils during construction. Inundation of soils with water storage projects would also result in long-term commitment of soils. Short- and long-term adverse impacts on soils include excavation, removal, erosion, inversion of soil layers, compaction, and covering by buildings and pavement. These activities result in soil loss, mixing or burial of topsoil, reduction in surface soil quality, and arresting of normal soil development. Soils that are located under buildings or pavement can be considered to be permanently lost. Soils that become irrigated lawns or gardens may be improved through tillage, soil amendment, and fertilization. Erosion would be limited because of state requirements for stormwater management and fugitive dust control plans. For soils with high shrink-swell potential, this limitation should be considered in foundation design and home landscaping. Soil impacts would generally be confined to the individual construction areas and are considered minor. There would be no interaction between impacts in different parts of the study area (impacts would be additive and not synergistic).

4.19.3 Hydrology

Cumulative impacts on NTGW relate to the increased population growth and related demand for Denver Basin aquifer NTGW. Under Alternative 2 the cumulative impact of relying on NTGW would be to significantly reduce the pressure in the NTGW aquifers, which would result in significantly lower production rates (Black & Veatch et al., 2003). Few of the listed activities would further rely on NTGW.

In terms of surface water, the South Platte River Basin was considered for potential cumulative impacts on hydrology. Previous water storage and water diversion projects have historically impacted the study area by altering the amount and duration of flows. Historically, flows in the Platte River were estimated at about 2.6 million acre-feet annually, or approximately 3,590 cfs (Sidle & Faanes, 1997). Mean annual flows in the Platte River at Overton, Nebraska, have ranged from 320.9 to 2,622 cfs in the past 10 years (USGS, 2008). The scale of the proposed alternatives, in combination with the list of past, present, and foreseeable future water development projects, would not significantly alter the hydrologic regime of this river basin. The Chatfield Reservoir Drought Drawdown, the Denver Water Moffat System Improvement Project, the Rueter-Hess Reservoir Project, the Last Chance Water Diversion to Conduit 20 at Kassler, the Denver Water Temporary Chatfield Pump Station, and the gravel pit reservoirs could each affect the amount and timing of water in the South Platte River locally. For many of these projects, quantitative analyses of their potential impacts on local South Platte flows are not available. The Final Supplemental EIS for the Rueter-Hess Reservoir Expansion indicates that the project will not result in flow depletions in the South Platte River. Given the scale of the flows in the river system, the overall cumulative impact of these projects on the river's hydrologic regime would not likely be significant.

The analyses in Appendices H, I and R included assessment of potential changes to downstream flows in the South Platte River under Alternative 3. Alternative 3 would result in more available water storage in Chatfield Reservoir, which could reduce flows downstream. Under Alternatives 3 or 4, the Downstream Users (defined in Appendix R) would release their water right allocations from the reservoir and divert the water further downstream on the South Platte River. The Upstream Users would divert their water directly from Chatfield Reservoir and not release it downstream. The net effect of Alternative 3 on flows immediately downstream of the reservoir is small (a maximum of 2.8 to 7.3 percent). Furthermore, all water projects with the potential to affect streamflows in the South Platte River downstream of Colorado in Nebraska are addressed under the South Platte Water Related Activities Program (SPWRAP) (see Appendix V, Attachment 1), which prevents detrimental cumulative impacts by evaluating each project. The lack of significant effects under Alternatives 3 and 4, combined with the broader consideration of the SWRAP, makes the potential for cumulative effects on downstream flows of Alternatives 3 or 4 with other water projects unlikely.

The proposed alternatives, in combination with the list of past, present, and foreseeable future water development projects, may result in acquisition and transfer of water rights; however, changes in water rights are not anticipated to alter the hydrologic regime of this river basin. As described in Section 4.3, when flows enter the reservoir, the first commitment would be to meet senior water rights needs. Once those needs were met, any excess flow would be retained in the available storage of the reservoir (below the maximum elevation of the pool containing conservation storage). After the water levels reached the base elevation of the exclusive flood control pool, any excess flows would be released downstream. Any project that may potentially impact the Platte River system would be permitted and operated in accordance with the Platte River Recovery Implementation Program (see Appendix V, Attachment 1). The overall cumulative impacts of flow depletions on the Platte River system would not likely be significant.

Several of the listed cumulative actions could impact water levels in Chatfield Reservoir, including the Chatfield Reservoir Drought Drawdown, the Last Chance Water Diversion to Conduit 20 at Kassler, and the Denver Water Temporary Chatfield Pump Station. The Chatfield Reservoir Drought Drawdown involves use of stored water below 5,423 feet msl. During drought conditions, pumping would allow use of water in the drought pool, between 5,423 and 5,385 feet msl. Similarly, the Last Chance Water Diversion project would divert water from Chatfield Reservoir only during drought conditions. The Temporary Chatfield Pump Station would allow Denver Water to pump water from their existing water storage rights (between 5,432 feet msl and 5,427 feet msl). These projects could decrease pool levels related to water storage at or below 5,432 feet msl. Implementation of Alternatives 3 or 4 would not impact pool levels until water storage reached 5,437 ft msl, higher than the levels at which other proposed projects would affect pool levels. Pool level changes at Chatfield Reservoir under Alternatives 3 and 4 would not be additive with pool level changes from other potential projects.

The proposed transportation and development projects could increase the flashiness (i.e., shorten the time between a storm event and the rising of stream waters, as in a flash flood) of this portion of the South Platte River Basin by reducing infiltration and routing water directly to the river. The activities under the proposed alternatives would not increase the imperviousness of the area.

Climate change may result in less runoff and water availability in the Southwest (Brekke et al., 2009). Projected increases in temperature over Colorado could translate into increased water demands and earlier snowpack runoff. Total water supplies in Colorado may be reduced by mid-century (Ray et al. 2008). The Front Range Climate Change Vulnerability Study confirmed these forecasts, indicating that annual average streamflow volumes in the South Platte could decrease with climate change (Water Research Foundation, 2012).

4.19.4 Water Quality

Cumulative impacts from the proposed alternatives and land development projects include indirect adverse impacts along the Plum Creek drainage causing a possible increase in sedimentation and nutrient levels, particularly phosphorus. Future land development along the Plum Creek drainage could impact water quality but the cumulative impact would be minor because most of this river reach is already developed. An increase in nutrient loading and sediment levels in Plum Creek could also affect water quality in Chatfield Reservoir and the South Platte River downstream of the reservoir. Prolonged levels of drawdown in Chatfield Reservoir, such as from the Chatfield

Reservoir Drought Drawdown, could also increase temperatures in the bottom of the reservoir, creating possible eutrophication and algal issues in Chatfield and also in downstream sections of the South Platte River.

Cumulative impacts from sedimentation would be minimized by state and local regulations requiring BMPs and stormwater management controls for construction activities and non-point sources. Increased sedimentation from the proposed alternatives would have only short-term, adverse impacts. The incremental effect with the degree of development in the area would be insignificant. Alternatives 3 and 4 do not contribute directly to phosphorus loads in Chatfield Reservoir but could indirectly increase the phosphorus loading in the reservoir through changes in reservoir operations. Other development activities upstream of the reservoir that could mobilize sediments could contribute to phosphorus and other mineral levels. However, as noted in Regulation No. 38, to date, eutrophication of Chatfield Reservoir has been averted through the control of phosphorus loads from the watershed, despite development activities. For example, there has been no trend for increasing phosphorus in Plum Creek, where most development has occurred. In Regulation No. 38, the Water Quality Control Division recognizes domestic dischargers for their role in minimizing impacts to Chatfield Reservoir.

4.19.5 Aquatic Life and Fisheries

Cumulative impacts from Alternatives 3 and 4 and land development projects include indirect adverse impacts along the riparian buffers of the Plum Creek drainage causing a possible increase in sedimentation and nutrient levels, particularly phosphorus. Future land development along the Plum Creek drainage could adversely impact the native fish species present (see Section 4.19.9 for a list of protected species). There would be little cumulative impact from land development downstream of Chatfield Reservoir, as a large majority of this river reach is already developed. An increase in nutrient loading and sediment levels in Plum Creek could not only affect the aquatic community in Plum Creek but also the Chatfield Reservoir and South Platte River species downstream of the reservoir.

Cumulative impacts from Alternatives 3 and 4 and water-related projects could impact the study area in various ways. Previous water storage and water diversion projects have historically impacted the study area by altering the amount and duration of flows as well as fish species composition and range throughout the South Platte River. Increased base flows in the South Platte River for water demands both upstream and downstream of Chatfield Reservoir would benefit in-stream aquatic life and fisheries. Decreases in water levels below current low water levels in Chatfield Reservoir, such as from the Chatfield Reservoir Drought Drawdown, could have an adverse impact on successful spawning of warm water fish species that inhabit the reservoir. Prolonged levels of drawdown could also increase temperatures in the bottom of the reservoir, creating possible eutrophication and algal issues in Chatfield and also in downstream sections of the South Platte River.

4.19.6 Vegetation

Cumulative impacts from Alternatives 3 and 4 and land development projects include unavoidable loss of large areas of native prairie grassland vegetation and smaller areas of shrubland, riparian, and wetland communities. Native vegetation would be replaced by pavement, lawns, other horticultural plants, buildings, and other structures. Some of the existing riparian plant community including riparian wetlands, throughout the South Platte River Basin below 7,600 feet, is within federal lands, state lands, or public open space and is generally protected from development. As the Front Range Urban Corridor becomes more urbanized, this trend continues. Low-lying areas, including wetlands and riparian areas, tend to be selected for open space and preservation by local governments. Alternative 3 would increase protected areas or enhance riparian vegetation in Plum Creek and the Upper South Platte and also involve habitat improvements in the Chatfield Lake project area. The federal protection provided to the Preble's mouse, a riparian obligate species, greatly aids in the protection of riparian habitat and adjacent uplands. The cumulative impacts of Alternatives 3 and 4 and land development may slightly decrease the amount of riparian vegetation but would increase protected areas.

The combined effects of past, present, and foreseeable future projects that involve alluvial groundwater pumping and discharge of treated water are likely to increase stream base flows. The increased base flow may increase the amount and density of wetland riparian vegetation adjacent to the active South Platte River channel.

Alternatives 3 and 4 and other water-related projects would adversely impact grasslands, shrublands, riparian, and wetland communities, including direct loss of vegetation communities, conversion of some communities (such as grassland to shoreline), or temporary loss of vegetation communities due to construction and installation of infrastructure. Additionally, most water-related projects have some federal nexus and therefore must consider the loss of all vegetation communities including wetlands. Sensitive communities such as relic tallgrass prairie, shortgrass prairie, riparian areas, and wetlands should be avoided or mitigated. Federal projects must also address the functional loss of wetlands. If wetland functions are changed or lost, federal projects would be required to mitigate for this loss. Therefore, losses to all vegetation communities resulting from the cumulative impacts of water-related projects would not be expected to increase if storage in Chatfield Reservoir is reallocated.

4.19.7 Wetlands

Cumulative impacts from Alternatives 3 and 4 and land development projects include unavoidable loss of large areas of native prairie grassland vegetation and smaller areas of shrubland, riparian, and wetland communities. Land development projects would replace native vegetation with pavement, lawns, other horticultural plants, buildings, and other structures. Much of the existing riparian plant community including riparian wetlands, throughout the South Platte River Basin below 7,600 feet, is within federal lands, state lands, or public open space and is generally protected from development. Alternatives 3 and 4 would increase the area of protected or enhanced riparian vegetation in Plum Creek and the Upper South Platte River and also involve habitat improvements in the Chatfield Lake Project area.

Impacts on wetlands that are under the jurisdiction of the Corps' permitting for Section 404 of the Clean Water Act would have to be avoided, minimized, or mitigated. Non-jurisdictional wetlands including isolated wetlands may be lost due to development projects, especially those outside of riparian and floodplain areas.

4.19.8 Wildlife

Land development projects would affect several thousand acres of native wildlife habitats upstream and downstream of Chatfield Reservoir. Depending on housing densities after land development, existing wildlife would be displaced and likely replaced by species characteristic of or compatible with urban and suburban habitats. The quality of wildlife habitat within the study area may decline as lands adjacent to the Chatfield Lake Project area are developed. Adverse impacts would be greatest for species inhabiting prairie grassland, such as grassland birds, because upland areas are typically where most of the development would take place. Adverse impacts would be lower for shrublands and riparian areas due to the greater likelihood that some natural vegetation would be preserved for open space and flood control. Human activities and hunting by roaming cats and dogs would adversely affect wildlife beyond the limits of developments. New roads and higher traffic volumes would cause more fragmentation of habitat and mortality from collisions with vehicles.

Alternative 3 would affect over 500 acres of wildlife habitat. Off-site mitigation would preserve or enhance hundreds of acres within Plum Creek and the Upper South Platte River with a special effort to preserve areas that provide linkages to existing preserved areas to enhance wildlife corridors (see the CMP, Appendix K). Furthermore, county planning departments including Douglas, Boulder, and Larimer Counties have developed open space programs that seek to preserve riparian areas and emphasize wildlife corridors. Therefore, implementation of Alternative 3 and the accompanying compensatory mitigation plan would not be expected to increase cumulative adverse impacts on wildlife and their habitats and will, in fact, preserve wildlife movement corridors.

Cumulative impacts from other water-related projects would permanently alter some wildlife habitat areas and have temporary impacts on others. Developing new reservoirs from gravel pits or enlarging pre-existing reservoirs would displace terrestrial wildlife in these specific areas. Aquatic species and water birds would benefit from such activities. Corresponding infrastructure for water projects would create temporary disturbances for underground pipelines and fragment habitat with new roads and facilities. Increased base flows in the South Platte River Basin would benefit aquatic and riparian species. However, decreased magnitude of flooding may reduce establishment of new riparian shrubs and trees on terraces above the stream. As older trees on higher terraces die from natural causes, the width of the non-wetland riparian zone may be decreased over a span of many decades. This would have a long-term effect on riparian wildlife species and other species that use riparian habitat for some part of their life cycle.

4.19.9 Endangered, Threatened, and Candidate Species, Species of Special Concern and Sensitive Species

Land development and highway projects include direct and indirect adverse impacts of native vegetation communities and wildlife habitat in numerous locations throughout the South Platte River Basin below 7,600 feet msl elevation. Land development projects must address potential impacts on federally-protected species and must mitigate for adverse impacts. Activities covered under an ITP would be subject to compliance with Section 10 of the ESA. Furthermore, project activities permitted under Section 404 of the Clean Water Act (impacts on wetlands) also must avoid, minimize, or mitigate wetland areas and must address federally-listed species under Section 7 of the ESA. Therefore, cumulative impacts on federally-listed species from land development and the proposed alternatives would not adversely affect federally-listed species as impacts would be minimized or mitigated given the current regulatory framework. Habitat improvement projects and land preservation efforts resulting from Preble's mouse impact mitigation, including Alternative 3, would benefit other riparian/wetland species of concern including the northern leopard frog and American currant. Land development projects would adversely affect some other species of special concern, especially the northern red-bellied dace, Iowa darter, common shiner, sharp-tailed grouse, and if present, black-tailed prairie dog, burrowing owl, and forktip three-awn. These species are found in drier habitats or in streams and would be directly impacted from development in upland areas or indirectly by increased runoff and sedimentation into streams. Additionally, species of special concern in drier habitats generally would not benefit from Preble's mouse impact mitigation projects. Furthermore, development projects can indirectly affect species of special concern by habitat fragmentation and isolation as no statewide planning or regulations guide development outside of the NEPA process. Generally, landscape-level planning does not occur outside of the level of county planning departments and counties are free to analyze for landscape-level impacts on wildlife or to focus efforts elsewhere. Additionally, planning among counties is not required for landscape-level impacts from development projects by any state regulations.

There would be minimal cumulative impacts from land development downstream of Chatfield Reservoir to the Weld County boundary, as a large majority of land along this river reach is already developed and federally-protected species or species of special concern generally do not occur within this area. For example, this area is not thought to contain Preble's mice and is excluded through a block clearance agreement with the USFWS.

Cumulative impacts from Alternatives 3 and 4 and other water-related projects could occur in or near areas of Preble's mouse habitat and potential habitat for bald eagles, Ute ladies'-tresses orchid, Colorado butterfly plant, and other species of special concern. Activities permitted under Section 404 of the Clean Water Act would be subject to compliance with Section 7 of the ESA. Adverse impacts on these species would be mitigated and there would be no net adverse cumulative impacts to federally-listed species. Adverse impacts on species of special concern would generally be temporary, and these species would likely benefit from habitat improvement projects resulting from Preble's mouse impact mitigation.

Projects involving water depletions would be required to mitigate those depletions, so there would be no net adverse cumulative impacts on endangered and threatened species in the Central and Lower Platte River Valley.

4.19.10 Land Use

Minimal cumulative impacts on land use are anticipated as a result of the proposed alternatives and other projects. As discussed above, about 55 acres would be required for Alternative 3. However, projects located in the vicinity of Chatfield Reservoir (e.g., Chatfield Reservoir Drought Drawdown, Last Chance Water Diversion to Conduit 20 at Kassler, Denver Water Temporary Chatfield Pump Station) have either already occurred in the past, or could occur in the reasonably foreseeable future. Residential development projects are still occurring around the study area; however, there are pockets of open space located near Chatfield Reservoir. Therefore, few cumulative impacts are anticipated to be associated with land use. Implementation of Chatfield storage reallocation may actually have a beneficial cumulative effect on land use if it results in fewer acres of agricultural land drying up after acquisition of irrigation water rights for conversion to municipal and industrial water uses.

4.19.11 Hazardous, Toxic, and Radiological Wastes

The cumulative impacts of the proposed alternatives and the other past, present, and reasonably foreseeable future activities in the area on hazardous, toxic, and radiological wastes are likely to be negligible. Although various hazardous materials, including fuels and hydraulic fluids, would be used during construction under the alternatives and other projects, their storage, use, and disposal would be subject to local, state, and federal regulations. Individual construction areas would require monitoring of fuels and other hazardous materials. Over the long term, the proposed alternatives would have little to no adverse impact on hazardous, toxic, and radiological wastes. Any short-term impacts would generally be confined to the individual construction areas and are considered minor. There would be no interaction between impacts in different parts of the study area (impacts would be additive and not synergistic).

4.19.12 Air Quality

The proposed water storage reallocation project and alternatives would occur in a rapidly developing area of Jefferson and Douglas Counties. Short-term construction emissions for the project and alternatives may be noticeable above ongoing emissions. Construction of the proposed reservoir (under Alternative 1), pipeline areas (under Alternatives 1), and conversion of gravel pits (under Alternatives 1 and 2) could affect air quality in the short term. However, these and other residential, transportation, and water development projects in the area would be required to implement dust control measures that would reduce construction-related dust emissions. In addition, exhaust emissions from heavy-duty construction equipment would be reduced by measures that decrease nitrogen oxide (NO_x) emissions from heavy-duty construction equipment. Furthermore, increasing use of low-sulfur diesel fuel would reduce sulfur dioxide (SO_2) emissions.

Long-term cumulative adverse impacts on air quality are not expected from the implementation of the alternatives, including emissions from gravel pit reservoir and pipeline area maintenance and fugitive dust. Vehicle emissions are expected to be insignificant, particularly in comparison with regional emissions and with emissions resulting from the additional residential and transportation development in the area. Fugitive dust emissions may occur because of increasing levels of fluctuation in water levels at Chatfield Reservoir under Alternatives 3 and 4. Unvegetated land would be exposed when water receded. However, fugitive dust emissions from wind erosion would be relatively low.

4.19.13 Noise

Minimal cumulative impacts of noise are anticipated as a result of the proposed alternatives and other projects. As discussed above, minor, short-term temporary increases to noise volumes are expected as result of the construction and associated pipeline facilities under different alternatives. However, projects located in the vicinity of Chatfield Reservoir (e.g., Chatfield Reservoir Drought Drawdown, Last Chance Water Diversion to Conduit 20 at Kassler, Denver Water Temporary Chatfield Pump Station) have either already occurred in the past, or could occur in the reasonably foreseeable future. Construction schedules of these projects likely would not overlap with the project. The remaining projects are located farther away from Chatfield and would not affect noise in or around Chatfield Reservoir. Therefore, few (if any) cumulative impacts on noise are anticipated. State noise regulations would be followed during construction at Chatfield, most of which would occur in the winter months to minimize noise impacts on visitors. As a result, Chatfield reallocation activities would not be expected to add significantly to cumulative noise impacts.

4.19.14 Aesthetics

Aesthetic impacts of the proposed alternatives would occur within the context of landscape modifications associated with past, current, and reasonably foreseeable future uses in the Chatfield Reservoir. As discussed above, the existing environment includes the dam and its infrastructure, as well as fluctuations in water levels. The area has been substantially modified since the 1970s when the reservoir was first built (creating a dam on what was once naturally flowing water). Since the dam was built, and in more recent years, other projects have been implemented near the reservoir (e.g., Last Chance Water Diversion to Conduit 20 at Kassler, Denver Water Temporary Chatfield Pump Station) that may have further altered the visual appearance. Alternative 3 would further alter the visual appearance of the lake because of fluctuating water levels, and the addition of another potential project (e.g., Chatfield Reservoir Drought Drawdown) could increase the visual impact even more. There could be a noticeable change near the water level which would be viewed by users within the park, primarily users along in boats and near the shoreline. It is not anticipated that these additional cumulative impacts would substantially alter the nearby views.

4.19.15 Socioeconomic Resources

Regarding socioeconomic resources, the biggest concern for flooding potential would be that of the reasonably foreseeable future projects that are planning on distributing their water into the South Platte River. It is unknown at this time how much more or less water would be coming from these other projects and running into the South Platte River. If they are similar to Alternative 3, then cumulative impacts would not be expected. Because any monetary losses to State Parks or concessionaires would be fully compensated by the Chatfield Reservoir storage reallocation project proponents, and construction activities at Chatfield would have a beneficial cumulative effect on jobs available for Denver-area residents, no significant increases in cumulative socioeconomic impacts would be expected from implementation of storage reallocation at Chatfield Reservoir.

NTGW is a component of Alternatives 1, 2, and 4. Operation and maintenance costs are expected to increase over time as water levels decline and threaten the viability of this water source. The SWSI report (CWCB, 2004), portrays this with this statement: "In the South Metro Denver area, it is anticipated that aquifer production will decline by 40 to 85 percent by the year 2050, and that municipal wells in this part of the Denver Basin that can produce even 100 gpm will be considered to be a good producing well. Current production rates average 540 gpm for the Arapahoe Aquifer and 120 gpm for the Lower Dawson. To maintain current production, an increase in the number of wells would be needed. It is estimated that it will cost $2.7 to $4 billion for infrastructure by 2050 for supplies provided by the non-tributary sources."

The SMWSS (Black & Veatch et al., 2003) states: "The results of this study indicate that continued reliance on the ground water aquifers to meet urban demands in the South Metro Area will result in very large increases in the production costs in the foreseeable future, and the eventual loss of the ground water as an economically viable resource. Therefore, the measures identified to maintain the aquifers by reducing the rate of water withdrawals should be implemented. The results of the study indicate that the problem faced through intensive development of the Denver Basin aquifers is not one of depleting the non-renewable supply, but rather reducing the production of the supply to a point where it is no longer economically feasible to product the supply."

4.19.16 Transportation

Overall positive cumulative impacts regarding transportation are anticipated as a result of the proposed alternatives and other projects. As discussed above, minor, short-term temporary increases to traffic volumes are expected as a result of the construction and associated pipeline facilities under different alternatives. However, projects located in the vicinity of Chatfield Reservoir (i.e., Chatfield Reservoir Drought Drawdown, Last Chance Water Diversion to Conduit 20 at Kassler, Denver Water Temporary Chatfield Pump Station) have either already occurred in the past, or could occur in the reasonably foreseeable future. Construction schedules of these projects are not expected to overlap with the proposed project. The CDOT projects are likely to improve the transportation system and ease traffic congestion near Chatfield Reservoir. The remaining projects are located farther away from Chatfield and would not affect transportation in or around Chatfield Reservoir. Construction equipment would be using State Park roads during the winter months when park visitation is relatively low, thereby minimizing potential road use conflicts and traffic delays in and near Chatfield State Park. Therefore, cumulative impacts regarding transportation are not anticipated to increase significantly as a result of implementation of reallocation at Chatfield.

4.19.17 Recreation

No cumulative impacts on recreation facilities or activities are anticipated to occur based on Alternative 3 and the other projects mentioned above because these impacts will be mitigated. Recreation users may be slightly impacted by the visual quality of the reservoir when they are on boats or near the shoreline. None of the other nearby projects is expected to affect recreation significantly. Although the reservoir projects in Weld and Larimer Counties (Table 4-22) may increase opportunities for fishing and boating locally, they are located outside of the scope of analysis for the cumulative impacts on recreation. Although there may be short-term impacts on enjoyment for some recreation activities, because of the new facilities and subsequent maturing of vegetation mitigation plantings, long-term increases to cumulative impacts on recreation are not anticipated.

4.19.18 Cultural Resources

The expansion of water control and delivery infrastructure and improvements to transportation systems in the 12-county region of north-central Colorado, from Fort Collins to Colorado Springs, creates the potential for changes to land use patterns that could generate cumulative adverse impacts on recorded cultural resources within the region and on properties that have the potential to contain cultural resources.

The principal cause of these impacts is likely to be new residential development. Because most residential and commercial development does not take place on federal land or with federal funding, federal involvement often occurs through Section 404 of the Clean Water Act, which requires permitting of certain activities involving wetlands impacts. Once a federal nexus is identified, properties potentially eligible for listing on the NRHP must be identified, avoided, or mitigated. Without a federal nexus, these steps are not required, which may result in some form of adverse impact upon cultural resources by potential developments. As a number of local communities and counties throughout the state have enacted historic preservation ordinances, cultural resources affected by construction impacts might fall within the jurisdiction of one or more of these administrative actions, even in the absence of state or federal regulations upon a specific project.

Road and highway construction projects are not likely to result in cumulative impacts on cultural resources. In general, cultural resources may be affected as new residential and commercial developments are linked to established zones of economic activity in towns and cities. However, as the recipient of federal funds, CDOT must comply with a variety of federal environmental laws. Two of these laws focus on cultural resources: Section 106 of the National Historic Preservation Act and Section 4(f) of the U.S. Department of Transportation (USDOT) Act. Through Section 106, the department takes into account project effects on historic and archeological resources through consultation with the Colorado Office of Archaeology and Historic Preservation. Section 4(f) requires that the Federal Highway Administration, a USDOT agency and principal source of CDOT's federal funds, avoid the use of land from these resources unless "no feasible and prudent alternative" can be identified. Through implementation of these two sections of federal environmental acts, cumulative impacts on recorded and potential cultural resources, in general, can be avoided or mitigated.

4.20 Collective Operational Scenario that Could Reduce Environmental Impacts

The water providers participating in the Chatfield Reallocation study have worked with representatives from the EPA and the CWCB to develop and evaluate a range of potential mitigation scenarios for operating the reallocated storage in a manner that has the goals of minimizing impacts to environmental resources while meeting the needs of the water providers for use of the reallocated storage. After evaluating a variety of operational scenarios, the EPA, the CWCB, and the water providers focused on one potential operational scenario that appears to come closest to meeting these goals. The following is a description of this potential operational scenario, the benefits it could provide, and the steps needed to determine the feasibility of implementing the scenario.

The operational scenario under consideration is intended to cooperatively manage water stored in the reallocated space at a potentially higher reservoir level. Per a 1979 agreement with the state of Colorado, Denver Water makes its "best efforts" to manage its water stored in Chatfield Reservoir to maintain a minimum storage level goal of 20,000 acre-feet between May 1 and August 31 to benefit reservoir recreation. Management of these water levels has also benefited the target environmental resources of wetlands and riparian habitat. Denver Water's commitments under the 1979 agreement would be unchanged by the potential future operational scenario being proposed.

The historical management of Chatfield Reservoir has led to the development of wetlands and riparian habitats, including extensive cottonwood woodlands, around the upper portions of the reservoir. The historical management and Denver Water's best efforts under the 1979 agreement have accomplished two key management objectives during the summer season: 1) maintained relatively high reservoir levels, and 2) minimized fluctuation. The EPA and the water providers are hopeful that more frequent higher reservoir levels during the summer season in the reallocated space should lead to the development of similar resources in the future.

As proposed, the operational scenario would involve all of the water providers implementing "collective operations" of the reallocated storage using the water providers' best efforts to maintain water levels at or above a new target water level elevation, during the same summer season of May 1 to August 31. Since the water rights for the water that would be stored by the water providers in the reallocated storage space have a relatively junior priority for storage (i.e., the water providers would on average be able to fill the entire reallocated space less than 50 percent of the time), there would be years when the water providers would not have either the legal priority and/or physical availability of water to store water in the reallocated space.

In order to potentially keep water levels higher during the summer season, other water sources and storage capabilities would be needed to supplement the water providers' ability to store water in the reallocated space. The only entity capable of providing this supplemental storage water is Denver Water. The Chatfield water providers have had discussions with Denver Water regarding a possible cooperative operational scenario where Denver Water would store water in unused reallocated storage space when it has water available that cannot otherwise be managed and would withdraw its water when needed. For instance, Denver Water has a minimum flow requirement on the South Platte River between Strontia Springs Reservoir and Chatfield Reservoir. Occasionally, Denver Water's existing pool in Chatfield is insufficient to manage the minimum flows. During those conditions, Denver Water could store its minimum flows in available reallocated space. Denver Water also has a 1977 storage right for Chatfield, which is senior to the storage rights of the water providers participating in the Chatfield Reallocation study. There would be occasional opportunities to store water in available space using Denver Water's 1977 Chatfield storage right. These operations would be on an "as available" basis; there would be no requirement for Denver Water to store water in the reallocated space and no expectation as to how or when the water would be withdrawn.

This cooperative operational scenario, which would increase water levels during the summer season in some years, while meeting the needs of those storing water in the reallocated space, would require cooperation among the water providers and Denver Water. In preliminary discussions between Denver Water and the water providers, Denver Water officials have determined that they may be open to participating in the operational scenario, but need to perform further analysis to ensure that participation in the operational scenario would have no adverse impact on Denver Water, and to discuss Denver Water's role in the scenario with the CDNR. The water providers are in discussions with State Parks that could also shape this operational scenario.

If the cooperative operational scenario were implemented and successful at reducing impacts to environmental resources, implementation of the CMP would need adjustment to compensate for fewer impacts to the target environmental resources. The water providers would be responsible for any adjustment of the CMP associated with the operational scenario (Appendix, Section 7.5.2.2., for additional details on how the CMP would be adjusted).

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