Alternatives Screening Report

for the

Halligan Water Supply Project Environmental Impact Statement

Prepared for

U.S. Army Corps of Engineers

Omaha District

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## Abbreviations and Acronyms

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<td>AF</td>
<td>acre-feet</td>
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<tr>
<td>Corps</td>
<td>United States Army Corps of Engineers</td>
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<tr>
<td>EIS</td>
<td>Environmental Impact Statement</td>
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<td>Halligan Reservoir Water Supply Project</td>
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<td>MGD</td>
<td>Million Gallons per Day</td>
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1 Introduction

The Halligan Water Supply Project (Halligan Project) involves the proposed expansion of Halligan Reservoir on the North Fork of the Cache La Poudre River (North Fork). North Poudre Irrigation Company (NPIC) owns the Halligan Reservoir while the City of Fort Collins (Fort Collins) owns a right to enlarge the reservoir. The existing reservoir has a storage capacity of 6,400 acre-feet (AF). The expansion of this reservoir is proposed by Fort Collins to help provide a reliable water supply for anticipated 2065 municipal and industrial water demands. Fort Collins proposes to enlarge Halligan Reservoir by 8,125 AF to a total capacity of 14,525 AF.

The proposed expansion of Halligan Reservoir would result in the discharge of dredge and/or fill material into waters of the United States (U.S.) and require authorization under Section 404 of the Clean Water Act by the United States Army Corps of Engineers (Corps) Regulatory Branch of the Omaha District. The National Environmental Policy Act (NEPA) requires consideration of potential environmental effects of, and reasonable alternatives to, any major federal action. To comply with NEPA and the Council on Environmental Quality (CEQ) regulations, which implement NEPA, the Corps is required to prepare an environmental analysis. The Corps determined that an Environmental Impact Statement (EIS) was necessary to evaluate the potential impacts to human health and the environment of each of the identified alternatives. In accordance with Regulatory Guidance Letters Nos. 87.05, 88-15, and 05-08; the 1988 NEPA Implementation Procedures for the Regulatory Program (appendix B, 33 Code of Federal Regulations [CFR] 325); and the 1997 memorandum Guidance on Environmental Impact Statement Preparation, Corps Regulatory Program, this report was prepared by DiNatale Water Consultants and CDM Smith as part of a team of Third-Party Contractors paid by Fort Collins but working for and accountable to the Corps. The Corps (rather than Fort Collins) was responsible for directing the Third-Party Contractor team and ensuring that the information they provided was consistent with Corps statutory requirements to take a hard, objective look at the public interest and environmental factors. The Corps also regularly participated in the preparation of the document and independently evaluated the information to ensure that it is technically adequate and not biased. The Corps had the final determination of whether the data provided is adequate and accurate and takes full responsibility for the scope and contents of the EIS.

When the NEPA process initiated in 2005, two additional entities were involved and the proposed expansion of Halligan Reservoir was 33,462 AF. One of the entities, known as the Tri-Districts, is a group of three water supply districts that withdrew from the project in 2009. More recently in 2013 the second entity, NPIC, withdrew from the project. After the Tri-Districts and NPIC withdrew from the project, the proposed expansion of Halligan Reservoir was reduced to 8,125 AF, which is the capacity needed by Fort Collins.
The NEPA analysis of the Halligan Project was previously combined with the analysis of the City of Greeley’s proposed expansion of Seaman Reservoir. Together the projects were known as the Halligan and Seaman Water Supply Projects (HSWSPs) and the Corps was working toward one combined EIS. In early 2015, the Corps granted a request by Fort Collins and the City of Greeley to separate the analysis of the two projects into two EISs; the Halligan Project and the Seaman Reservoir Project. The Corps performed a significant amount of work and analysis prior to the separation of the two projects that will continue to be used in the Halligan Project and Greeley’s Seaman Reservoir Project EIS. Some documents cited in this report may refer to the HSWSPs, and any such reference related to Fort Collins should be understood to refer to the Halligan Project portion of the cited material.

In addition, the Corps was developing another EIS for the Northern Colorado Water Conservancy District’s (Northern Water) proposed Northern Integrated Supply Project (NISP). NISP is a regional water supply project proposed in the same river basin as both the Halligan Project and the Seaman Reservoir Project. In order to ensure that the impacts of the cumulative actions are adequately addressed as set forth in NEPA (40 CFR 1508.25(a)(2)), the Corps required a Common Technical Platform approach for the analysis for several key resources potentially affected by the proposed projects. As a part of the Common Technical Platform the Third-Party Contractor teams for the three projects and the Corps developed a hydrology model so they could compare impacts of the three projects using the same baseline conditions and assumptions. Additional information about the Common Technical Platform hydrology modeling is provided in the hydrologic modeling report (CDM Smith et al. 2015). Although sharing the same technical basis for analysis, all three projects are now individual EIS projects seeking individual permits from the Corps.

1.1 Objective of the Report

NEPA requires that the Corps identify a reasonable range of alternatives to the applicant’s proposed project that meet defined criteria, are economically and technically feasible, and would meet the proposed project’s purpose and need. The Clean Water Act Section 404(b) (1) Guidelines (40 CFR 230.10a) require the Corps to only approve the least environmentally damaging practicable alternative (LEDPA). Practicability is based upon costs, logistics, and technology in light of the proposed project’s overall purpose. The specific details regarding the alternative development and screening processes are documented in this Halligan Water Supply Project Alternatives Screening Report and associated appendices. The Corps directed the screening process and the preparation of this report that documents the identification of potential alternatives, screening methods, and results while ensuring the requirements of NEPA and Clean Water Act Section 404 are addressed. The final alternatives identified through this screening process will be analyzed in detail in the EIS.
1.2 Overview of the Halligan Project

Fort Collins proposed the Halligan Project to meet its specific water supply needs for the future. In addition to this primary purpose, the project is designed to achieve a number of other objectives, including drought protection, firming of existing supplies, increasing system operational flexibility, and optimizing the management of water rights acquisitions. However, these benefits are not specific needs that must be addressed by any alternative.

In 2016 the Third-Party Contractor team completed the Purpose and Need Report for the Halligan Water Supply Project (Western EcoSystems Technology Inc. [WEST] et al. 2016), under the direction of the Corps. The report states the purpose of Fort Collins’ proposed Halligan Project, as defined by the Corps, is to provide additional system firm yield for Fort Collins in order to satisfy an additional need of approximately 7,900 AF per year to meet its projected approximate 2065 municipal and industrial demands with water of a quality comparable to the water now delivered to its customers.

The process for screening alternatives originated in 2007. However, because of the Corps decision in 2009 to develop a Common Technical Platform, the screening process was delayed until the Third-Party Contractor teams completed the Common Technical Platform hydrology modeling in October 2012. The alternatives screening process, which is described in the subsequent chapters of this report, was based in part on these estimated needs. In 2013, the demand values for the purpose and need report were updated resulting in a slight decrease in the need for Fort Collins from 8,100 to 7,900 AF (WEST et al. 2013). The demands were updated again in 2015 (WEST 2016) and resulted in an adjustment to the time horizon from 2050 to 2065, but no change to the need of 7,900 AF. The Corps and Third Party Contractor team reviewed the alternatives screening process with the reduced need for Fort Collins and determined that the reduction from 8,100 AF to 7,900 AF would not change the outcome of the process. Therefore, while the current project need is 7,900 AF, the Corps determined that the alternatives screening process conducted with the original project need of 8,100 AF was valid for the purpose of identifying alternatives to take through a more detailed review in the EIS.

A draft version of this report through the development of preliminary alternatives (Section 1) was provided to Fort Collins in April 2013. The Corps granted Fort Collins’ request to perform the final modeling for the alternatives, with the modeling process reviewed by the Third-Party Contractor. The Third-Party Contractor team provided all screening and preliminary alternative development work performed in support of the April 2013 draft to Fort Collins. In that draft, the preliminary alternatives described in Section 1 were numbered. The numbering has been removed from this final draft of the report. However, the Fort Collins Alternatives Report (MWH 2015) refers to the preliminary alternatives numbering used in the draft. Table 1-1 shows the correlation between the names used in the preliminary alternatives in this final version of the report and the numbering used in the draft version. The numbering does not reflect any order of preference or ranking of any kind, and the order of alternatives presented in final version of this report changed since the draft version.
Table 1-1. Correlation of preliminary alternative names with numbering used in 2013 draft.

<table>
<thead>
<tr>
<th>Preliminary alternative names in this final report</th>
<th>Preliminary alternative numbers in the April 2013 draft version and Fort Collins alternatives report (MWH 2015)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fort Collins' Proposed Action (Expanded Halligan Reservoir)</td>
<td>1</td>
</tr>
<tr>
<td>Expanded Glade Reservoir</td>
<td>5</td>
</tr>
<tr>
<td>Overland Gravel Pits Expansion and Pipeline to the Pleasant Valley Pipeline with Other Operations</td>
<td>2</td>
</tr>
<tr>
<td>Mountain Reservoir Utilization with Other Operations</td>
<td>3</td>
</tr>
<tr>
<td>Alternative Agricultural Transfer Methods</td>
<td>4</td>
</tr>
</tbody>
</table>

1.3 Supplemental Documents

The Third-Party Contractor developed the following documents used in the preparation of this alternative screening report.

- **Purpose and Need Report for the Halligan Water Supply Project** (WEST et al 2016) – This report described the Corps’ purpose and need for the proposed project and outlines Fort Collins’ purpose and need, provided an independent evaluation of the estimated current and future water requirements, and provided supporting material for use in the preparation of the purpose and need statement and chapter of the EIS.

- **Draft NISP and HSWSPs Common Technical Platform Hydrologic Modeling Report** (CDM Smith et al. 2015) – This report provided documentation on the construction and assumptions for each component of the Common Technical Platform hydrologic model sequence. The Common Technical Platform hydrologic modeling included the Halligan Project, the Seaman Reservoir Project and NISP. The Common Technical Platform hydrologic modeling platform included simulation of current and future condition baseline without proposed projects, current and future conditions with proposed projects, a cumulative effects model run with all three projects combined, and firm yield modeling used for sizing infrastructure associated with each proposed project and alternatives, including the no action alternatives.

- **Fort Collins Alternative Descriptions: Action Alternatives Report** (MWH 2015) – Provided detailed technical information on Fort Collins’ Proposed Action and alternatives. This report was prepared by Fort Collins based on the preliminary alternatives developed in Section 1 of this report.

1.4 Alternatives Screening Approach

The Corps was required to consider a range of alternatives in addition to Fort Collins’ proposed action that meet criteria defined by the Corps, are economically and technically feasible and would meet the proposed project’s purpose and need. There are a variety of ways of providing additional water to meet Fort Collins’ need. The approach to identify water supply options was to
identify infrastructure options (elements) and water source options (concepts). We identified elements including reservoirs, groundwater aquifers, gravel pits (reclaimed mined gravel pits), and pipelines that could be constructed, expanded, rehabilitated, or operated in a different manner. We identified concepts including potential water sources for the project available through various water supply strategies, such as the purchase of agricultural water rights or full use of existing water rights. Alternatives were then constructed as combinations of concepts and elements that would meet the entire project need for Fort Collins as specified in the *Purpose and Need Report for the Halligan Water Supply Project* (WEST et al. 2016). In summary, the alternatives screening for the Halligan Project EIS consisted of a four-part process involving the identification and screening of water supply elements, concepts, combination into preliminary alternatives, and additional refinement into final alternatives (Figure 1-1).

The screening process for the elements and concepts began with the development of long-lists of potential elements and concepts to be considered, which were then screened to shorter lists for subsequent analysis. The results from the element and concept screening processes were combined to form the long-list of concept-element combinations used in the preliminary alternatives formulation process. Additional detail was developed and modeling was performed on each of five preliminary alternatives, resulting in a further screening and refinement of the preliminary alternatives into a set of four final alternatives.

At each stage in the process, specific criteria were developed to screen the elements, concepts, and combinations of elements and concepts. Any remaining elements, concepts, and concept-element combinations were then subjected to a best fit analysis to determine those that would move on to the next step in the alternatives formulation process. The best fit analysis was only applied when multiple remaining elements, concepts, or combinations had no identifiable or discernible difference in impact to aquatic resources, in accordance with direction from the Corps and EPA (August 23, 1993 Memorandum to the field; subject: appropriate level of analysis required for evaluating compliance with the Section 404(b)(1) guidelines alternatives requirements. Corps and EPA 1993). The best fit analysis selected one option from a group of similar elements, concepts, or concept-element combinations based on proximity to Fort Collins’ existing systems features and potential impacts to other resources. Elements, concepts or combinations not selected through a best fit analysis were eligible for reconsideration in the event the selected element, concept or combination was screened out at a later stage in the alternatives formulation process.

The development and screening of the long-list of concepts and elements, and combining concepts-elements into preliminary alternatives, and the preliminary screening of alternatives was conducted by the Third Party Contractor team and the Corps. The preliminary alternatives were provided to Fort Collins so that the City could develop operational and engineering configurations for each alternative. The Corps and the Third Party Contractor reviewed Fort Collins’ configurations during the development of the final alternatives. Fort Collins documented and submitted any suggested modifications in advance to the Corps for consideration and approval. Once the final alternatives were approved by the Corps, Fort Collins conducted the
hydrology modeling for each of the approved final alternatives. The No Action Alternative was developed and modeled by Fort Collins, independent of, but verified by the Third Party Contractor team and the Corps. The final alternatives will be evaluated in the EIS.

**Figure 1-1. Alternative screening process flow chart showing the screening process in four stages.**

### 1.5 Regulatory Requirements

The approach and the screening criteria selected for the element, concept, and alternative screening processes are consistent with the Section 404(b)(1) Guidelines (40 CFR Part 230), the NEPA requirements of the CEQ (40 CFR Part 1500 through 1508), and regulatory requirements of the Corps (33 CFR Parts 320-330 and Appendices) for the development of alternatives. The criteria applied to the screening of the concepts, elements, and alternatives meet the following standards:
• **Environmental** – Section 404(b)(1) Guidelines states that "no discharge of dredged or fill material will be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences" (40 CFR 230.10(a)). The screening criteria were developed to identify and eliminate concepts, elements, and alternatives that would result in relatively high adverse effects to aquatic resources and other natural environmental factors. Consequently, the final-list of alternatives carried forward into the comparative analysis in the EIS document would result in lower impacts to aquatic resources and other natural environmental factors, relative to other alternatives considered in the screening process.

• **Purpose and Need** – Alternatives developed must be capable of meeting the conditions set forth in the overall purpose and need statement (Section 8, WEST et al. 2016). The No Action Alternative was developed by Fort Collins to represent actions it is likely to pursue in an effort to satisfy all or part of the purpose and need if none of the action alternatives are permitted or it chooses to not proceed with the permitted alternative.

• **Practical and Practicable** – A reasonable range of alternatives is defined by the CEQ guidance (1981) as "those that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant." Practicable alternatives are defined in the Section 404(b)(1) Guidelines as those alternatives that are "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes." The final alternatives identified for the comparative analysis in the EIS document are reasonable and practicable.
2 Elements

A long-list of elements was developed and included both surface and underground options. Elements were classified as a reservoir, gravel pit, underground element, or an operational element. Surface structural options included the construction of new reservoirs, expansion of existing reservoirs, rehabilitation or reoperation of existing reservoirs, and gravel pit storage, and associated inlet and outlet, treatment and distributions infrastructure. Underground elements included aquifers in the region and associated wells, water treatment and distribution infrastructure. This section provides an overview of the element development and screening approach and results (outlined in red in Figure 2-1). The element screening process (Figure 2-1) resulted in a list of final elements carried forward into the preliminary alternatives formulation process. The following appendices provide additional details on the element development and screening.

- **Appendix A – Long-List of Elements and Screening:** Provides the element long-list and detailed screening results for each of the elements in the long-list. This includes the identification of the screening criterion responsible for the elimination of an element and the results of quantitative evaluations.

- **Appendix B – Geographic Information System Analyses:** Describes the specific geographic information system (GIS) procedures used for the element evaluation and screening.
Figure 2-1. Alternative screening process flow chart showing the screening process in four stages with the element screening stage outlined in red.

2.1 Reservoir Elements

Reservoir elements included the rehabilitation or expansion of existing reservoirs and construction of new reservoirs. The rehabilitation of reservoirs applies to existing reservoirs that cannot be filled to full capacity in their current condition. For example, capacity limitations have been placed on reservoirs impounded by a dam with geotechnical or spillway capacity issues where the filling of these reservoirs to full capacity could raise safety concerns. The rehabilitation of these dams could enable these reservoirs to be filled to full capacity. Expansion of reservoirs involves raising the existing dam(s) or constructing a new dam(s) downstream of an existing dam that will impound a larger volume of water and raise the maximum surface elevation of the existing reservoir. Construction of new reservoirs involves construction of a new dam(s) that would impound water either on a stream or at an off-channel location.

Several water supply EIS processes are being conducted along the Colorado Front Range, including Denver Water's Moffat Collection System Project, the Windy Gap Firming Project, NISP, and the Seaman Reservoir Expansion Project. All storage options included in NISP and
Windy Gap Firming Project's long-lists were incorporated into the Halligan Project element long-list. Reservoir sites selected for NISP final alternatives were evaluated both as stand-alone sites, assuming that NISP was not developing that site and as expansions of the NISP alternative facility to include additional storage for Fort Collins. Moffat storage options located in the South Platte River Basin (including tributaries) upstream of the Weld-Morgan County line, but downstream of the confluence of the South Platte River and St. Vrain River were included in the Halligan Project long-list of reservoir elements. The Halligan Project reservoir element long-list resulted in a total of 220 reservoir elements. These reservoir elements were conveyed through the two-tiered screening process shown in Figure 2-2. Reservoir elements not meeting a specific screening criterion were eliminated while the remaining elements were retained for screening using the next criterion.
Figure 2-2. Reservoir element screening process showing the two-tiered screening process and best fit analysis.
2.1.1 Tier 1 Reservoir Element Screening

The Tier 1 reservoir element screening included the following screening criteria: geographic area, perennial streams, special designated land use, and whether or not the reservoir element was integral to other development plans. GIS was used to identify reservoir element locations and eliminate elements based on these screening criteria. These GIS analyses coupled with information provided from NISP, Windy Gap Firming Project, and Moffat EIS alternative evaluation processes were used to conduct the evaluations needed for the geographic, perennial stream, and land use screening criteria.

2.1.1.1 Geographic Area

The long-list of elements included a variety of reservoir elements throughout northeastern Colorado and on the Western Slope (Table A-1 in Appendix A). Although many of these reservoir elements had sufficient capacity to provide storage for Fort Collins, they did not provide any discernible advantages compared to other elements relative to impacts to aquatic resources and their location would require a greater amount of infrastructure and its associated impacts to convey water to Fort Collins when compared to closer reservoir elements.

For purposes of the reservoir element screening, the South Platte River Basin (including tributaries) upstream of the Weld-Morgan County line and downstream of the confluence with the St. Vrain River was considered to be within a practical distance from Fort Collins’ service area. This area includes the Poudre River Basin, Big Thompson River Basin, Crow Creek Basin, Lone Tree-Owl Creek Basin, and portions of the South Platte River Basin, some of which currently provide water to Fort Collins (Figure 2-3). The location of the reservoir elements evaluated in NISP, the Windy Gap Firming Project, and the Moffat EIS processes were imported into GIS for analysis. All reservoir elements within this geographic area were retained for further analysis. Reservoir elements outside of the geographic area were eliminated. Eliminated elements were located within the following hydrologic basins: Western Slope, Saint Vrain River, Clear Creek, South Platte River above the confluence with the St. Vrain River, and South Platte River downstream of the Weld-Morgan county line. This criterion eliminated 138 of the 220 reservoir elements, and 82 reservoir elements were retained.

2.1.1.2 Perennial Streams

This criterion qualitatively evaluated the potential of aquatic habitat impacts associated with the various types of reservoir elements. The construction of a new reservoir on perennial streams could result in higher impacts than enlarging an existing reservoir on a perennial stream, and much higher than the construction of new reservoirs on ephemeral streams or off-channel reservoirs. Consequently, all new reservoir elements on perennial streams were eliminated. New off-channel reservoirs, new reservoirs on ephemeral streams, on-channel reservoir expansions, and rehabilitated reservoir elements were retained. This criterion eliminated 31 of the 82 reservoir elements, and 51 reservoir elements were retained.
2.1.1.3 Special Designated Land Uses

The development of reservoir elements located near or on Superfund Sites, Designated Hazardous Material Sites, Landfill Locations, and Mine Site Locations could increase the risk of drinking water contamination. Because toxic chemicals and materials could potentially leach into the reservoir causing significant water quality issues, developing reservoir elements near or on these designated sites is considered contrary to the project purpose of providing a public water supply. Permitting elements near or on these sites would likely be difficult.

Other sites with significant or adverse environmental consequences or other logistical constraints were considered infeasible. Wilderness Areas and National and State Parks have been preserved for the high recreational, aesthetic, and environmental values. Development of reservoir elements on or near these special designated land uses could result in significant adverse environmental consequences to high functioning and highly valued preserved habitat. Development within these areas would likely meet significant public opposition as well as face agency and legal barriers. Development on or near interstate highways would likely require significant effort (e.g., Congressional approval) and funding to relocate.

GIS was used to determine whether any of the remaining reservoir elements were located on or immediately adjacent to such designated land uses (Table 2-1). Our evaluation indicated that there are no reservoir elements passing the geographic area screening criteria within close proximity to or within the boundaries of the special designated land use areas. No reservoir elements were eliminated using this special designated land use criterion.

Table 2-1. Land use GIS coverage and sources used for the special land use designation screening.

<table>
<thead>
<tr>
<th>GIS Coverage</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superfund Site Locations</td>
<td>Colorado Department of Public Health and Environment (CDPHE)</td>
</tr>
<tr>
<td>Designated Hazardous Material Sites</td>
<td>CDPHE</td>
</tr>
<tr>
<td>Landfill Locations</td>
<td>CDPHE</td>
</tr>
<tr>
<td>Mine Site Locations</td>
<td>CDPHE</td>
</tr>
<tr>
<td>Parks and Open Space</td>
<td>Larimer County</td>
</tr>
<tr>
<td>Wilderness Area</td>
<td>National Atlas</td>
</tr>
<tr>
<td>National and State Parks</td>
<td>National Parks Service and Colorado State Parks</td>
</tr>
<tr>
<td>Near and Interstate or Highway</td>
<td>Colorado Department of Transportation</td>
</tr>
</tbody>
</table>

2.1.1.4 Integral to Other Development Plans

A variety of water development plans are currently undergoing environmental review or are in other planning stages along the Colorado Front Range. If a remaining reservoir element was the
same as a reservoir that was also being considered for other development projects, then we assumed that conflict, logistical issues, and significant delays would likely arise.

Information obtained from conversations with representatives of various Colorado Front Range water providers with respect to regional water development plans was used to identify reservoir elements that are incorporated in other water development plans in the region. Reservoir elements integral to other regional water development plans were eliminated except for reservoir elements where the other involved parties expressed an interest in discussing a mutual project with Fort Collins. For example, Northern Water has previously discussed the possibility of enlarging its proposed Glade Reservoir to accommodate Fort Collins’ storage needs, and therefore the Glade Reservoir expansion was not eliminated through this criterion. This criterion eliminated eight of the 51 reservoir elements, and 43 reservoir elements were retained.

2.1.1.5 Tier 1 Reservoir Element Screening Results

The Tier 1 reservoir element screening resulted in the elimination of 177 of the 220 reservoir elements and retaining 43 of the potential reservoir elements, including the proposed expansion of Halligan Reservoir (Table 2-2 and Figure 2-3).

Table 2-2. List of reservoir elements retained through the Tier-1 screening process.

<table>
<thead>
<tr>
<th>ID</th>
<th>Element</th>
<th>Element Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Big Kammerzell Reservoir</td>
<td>Reservoir Rehabilitation</td>
</tr>
<tr>
<td>13</td>
<td>Big Windsor Reservoir</td>
<td>Expanded Reservoir</td>
</tr>
<tr>
<td>15</td>
<td>Black Hollow Reservoir</td>
<td>Reservoir Rehabilitation</td>
</tr>
<tr>
<td>17</td>
<td>Box Elder Reservoir</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>26</td>
<td>Cactus Hill Reservoir with NISP</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>27</td>
<td>Cactus Hill Reservoir without NISP</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>36</td>
<td>Cobb Lake</td>
<td>Expanded Reservoir</td>
</tr>
<tr>
<td>43</td>
<td>Douglass Reservoir</td>
<td>Expanded Reservoir</td>
</tr>
<tr>
<td>45</td>
<td>Dry Creek Reservoir</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>47</td>
<td>Elder Reservoir</td>
<td>Reservoir Rehabilitation</td>
</tr>
<tr>
<td>51</td>
<td>Empire Reservoir</td>
<td>Reservoir Rehabilitation</td>
</tr>
<tr>
<td>56</td>
<td>Galeton Reservoir with NISP</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>57</td>
<td>Galeton Reservoir without NISP</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>59</td>
<td>Glade Reservoir with NISP</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>60</td>
<td>Glade Reservoir without NISP</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>66</td>
<td>Green Ridge Glade Reservoir</td>
<td>Expanded Reservoir</td>
</tr>
<tr>
<td>72</td>
<td>Halligan Reservoir</td>
<td>Expanded Reservoir</td>
</tr>
<tr>
<td>76</td>
<td>Hertha Reservoir</td>
<td>Expanded Reservoir</td>
</tr>
<tr>
<td>77</td>
<td>Highland Reservoir No. 2</td>
<td>Expanded Reservoir</td>
</tr>
<tr>
<td>79</td>
<td>Hillsboro Reservoir</td>
<td>Reservoir Rehabilitation</td>
</tr>
<tr>
<td>ID</td>
<td>Element</td>
<td>Element Type</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>102</td>
<td>Little Kammerzell Reservoir</td>
<td>Reservoir Rehabilitation</td>
</tr>
<tr>
<td>107</td>
<td>Lone Tree Creek Reservoir</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>111</td>
<td>Lower Latham Reservoir</td>
<td>Reservoir Rehabilitation</td>
</tr>
<tr>
<td>117</td>
<td>Meadow Hollow Reservoir</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>121</td>
<td>Mountain Supply Reservoir No. 1</td>
<td>Reservoir Rehabilitation</td>
</tr>
<tr>
<td>122</td>
<td>Mountain Supply Reservoir No. 8</td>
<td>Reservoir Rehabilitation</td>
</tr>
<tr>
<td>131</td>
<td>NPIC Reservoir No. 4</td>
<td>Reservoir Rehabilitation</td>
</tr>
<tr>
<td>132</td>
<td>NPIC Reservoirs Nos. 5&amp;6</td>
<td>Expanded Reservoir</td>
</tr>
<tr>
<td>137</td>
<td>Park Creek Reservoir</td>
<td>Expanded Reservoir</td>
</tr>
<tr>
<td>142</td>
<td>Pinewood Lake</td>
<td>Expanded Reservoir</td>
</tr>
<tr>
<td>144</td>
<td>Point of Rocks Reservoir</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>156</td>
<td>Rawhide Creek (Rawhide, North and West) Reservoir</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>157</td>
<td>Rawhide East A1 Reservoir</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>158</td>
<td>Rawhide East B1 Reservoir</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>159</td>
<td>Rawhide North Reservoir</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>166</td>
<td>Riverside Reservoir</td>
<td>Reservoir Rehabilitation</td>
</tr>
<tr>
<td>171</td>
<td>Sandborn Reservoir</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>185</td>
<td>Spomer Reservoir</td>
<td>Reservoir Rehabilitation</td>
</tr>
<tr>
<td>186</td>
<td>Sprenger Ranch Reservoir</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>187</td>
<td>Spring Creek Reservoir</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>200</td>
<td>Trap Lake Reservoir</td>
<td>Expanded Reservoir</td>
</tr>
<tr>
<td>205</td>
<td>Upper Black Hollow Reservoir</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>220</td>
<td>NPIC Reservoir No. 15</td>
<td>Expanded Reservoir</td>
</tr>
</tbody>
</table>
Figure 2-3 Map of reservoir elements retained through the Tier-1 screening process.
2.1.2 Tier 2 Reservoir Element Screening

The Tier 2 reservoir element screening criteria includes the storage capacity, inundated wetlands, and a refined geographic location screen.

2.1.2.1 Storage Capacity

The objective of this screening criterion was to eliminate reservoir elements that would not provide the full amount of storage needed to meet the project need of 7,900 AFY of additional firm yield for Fort Collins by 2065. The amount of storage needed to provide firm yield depends on a variety of factors including the availability and seniority of water rights. For purposes of this study, it was assumed that the amount of storage needed within the Poudre Basin to meet the purpose and need firm yield requirements for all Halligan Project alternatives was equivalent to the amount of storage required for the proposed project (8,125 AF). This is because the same amount of water diverted and stored in the proposed project could also be diverted downstream in other elements (all storage elements are downstream of the proposed Halligan Reservoir expansion). Fort Collins could use the same water rights portfolio anticipated for Fort Collins’ Proposed Action and obtain approximately the same storage to yield ratios at other downstream locations.

Due to the seniority and amount of water rights in Fort Collins’ water rights portfolio, it can obtain nearly one AF of firm yield for every one AF of storage (1:1 storage to yield ratio). Fort Collins’ storage needs outside of the Poudre Basin are higher than their storage needs inside the Poudre Basin, due to generally fewer available senior water rights as compared to Fort Collins’ Poudre River water rights portfolio. We assumed that Fort Collins’ total storage needs outside of the Poudre Basin were three times the firm yield specified in the purpose and need (3:1 storage to yield ratio), resulting in a total required storage of 24,375 AF. Storage to yield ratios typically range from 1.4:1 to 4:1 for senior agricultural water rights and 6:1 to 10:1 for more junior water rights. The 3:1 storage to yield ratio was applied for these screening purposes representative of a storage to yield ratio for agricultural water rights.

Due to the abundance of high capacity reservoir elements, the relatively low amount of storage needed, and the likelihood of greater aquatic resource impacts from multiple reservoir elements and their associated infrastructure, the Corps determined it was reasonable that a reservoir element must be able to meet 100 percent of the total storage needed to meet the firm yield specified in the purpose and need. The maximum storage capacity of the majority of reservoir elements was estimated using information provided in NISP, Windy Gap, and Moffat EIS alternative evaluation reports. However, the maximum storage capacities of nine reservoir elements were estimated using GIS topographic data (refer to Appendix B for details). Reservoir elements within the Poudre Basin were retained if their maximum storage capacity exceeded the minimum needed capacity of 8,125 AF. Reservoir elements located outside of the Poudre Basin were retained if their capacity exceeded the minimum needed capacity of 24,375 AF. This
criterion eliminated 15 of the 43 remaining reservoir elements, and 28 reservoir elements were retained.

2.1.2.2 Inundated Wetlands

Wetlands are special aquatic sites within the aquatic ecosystem as defined by the Section 404(b)(1) Guidelines (40 Code of Federal Regulations 230.41). The CWA Section 404(b)(1) Guidelines state that "no discharge of dredged or fill material will be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences" (40 Code of Federal Regulations [CFR] 230.10(a)). Our purpose for this analysis was to identify and retain reservoir elements that would inundate the least amount of wetlands, ensuring compliance with 40 CFR 230.10(a).

The extent to which wetlands would be inundated by a reservoir element depended on the inundation footprint of the element. GIS was used to develop reservoir footprints for each of the reservoir elements with the minimum needed capacity of 8,125 AF for Poudre Basin elements, and 24,375 AF for elements outside the Poudre Basin.

The US Fish and Wildlife Service maintains GIS coverage of wetlands in the National Wetlands Inventory (NWI). The NWI is comprised of digitized maps that indicate locations and types of wetlands for the nation. The NWI mapped and classified wetlands from aerial imagery interpreted by trained image analysts to provide biologists and others with information on the distribution and type of wetlands to aid in conservation efforts. The NWI is not sufficiently precise and accurate to be used to determine jurisdiction and evaluate wetland impacts under Section 404 of the Clean Water Act, but is adequate to compare inundated wetlands among reservoir elements. GIS was used to compare the reservoir element footprints with the NWI to estimate the acreage of inundated wetlands for each reservoir element.

Numerous elements are available that could provide 8,125 AF of additional storage while resulting in zero acres of wetland inundation, therefore a zero-acre wetland inundation screen was utilized and comports with 40 Code of Federal Regulations 230.10(a). Elements that involved the expansion of the NISP Glade or Galeton reservoirs only considered any additional acres of wetlands inundated due to the expansion to accommodate Fort Collins’ storage. The NISP Glade Reservoir would inundate approximately 40 acres of wetlands, but these inundated acres associated with the NISP site were previously evaluated in NISP and not included as a wetlands impact for the Fort Collins expansion of the NISP Glade alternative as this was an existing impact of NISP. With the exception of Halligan Reservoir expansion, reservoir elements inundating any wetlands were eliminated. Halligan Reservoir would inundate approximately seven acres, which is more than the screening limit of wetlands. However, because Halligan Reservoir is part of Fort Collins’ proposed action, it was not eliminated through the screening process. This criterion eliminated 20 of the 28 remaining reservoir elements, and eight reservoir elements were retained.
2.1.2.3 Refined Geographic Location

Although all elements passing the storage capacity requirement and wetland inundation screen could provide a firm supply of water, potential adverse environmental consequences to other natural resources associated with reservoir elements from outside the Poudre Basin might be increased (i.e., more extensive conveyance infrastructure, acquiring an increased amount of water rights that may have higher storage to yield ratios, removing or adding water from or to a non-native basin). Due to an adequate number of feasible, in-basin elements passing the storage capacity and wetlands inundation screens, all remaining out-of-basin reservoir elements were eliminated. This criterion eliminated two of the eight remaining reservoir elements, and six reservoir elements were retained. This refined geographic screening criterion essentially narrows the Tier 1 geographic screening criterion. While the same result would have been achieved by first applying the refined geographic screening criterion, it was important to determine if any out-of-basin reservoirs had less impacts to the aquatic environment than the in-basin reservoirs. The process demonstrated that none of the out-of-basin options had less aquatic impacts compared to the remaining in-basin reservoir sites, making the refined geographic screen appropriate at the later stage. This criterion eliminated two of the eight remaining reservoir elements, and six reservoir elements were retained.

2.1.2.4 Tier 2 Reservoir Element Screening Results

The Tier 1-List consisted of 43 reservoir elements. The Tier 2 reservoir element screening eliminated 37 reservoir elements for Fort Collins and retained six reservoir elements (Table 2-3 and Figure 2-4).

<table>
<thead>
<tr>
<th>ID</th>
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</tr>
</thead>
<tbody>
<tr>
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<td>New Reservoir</td>
</tr>
<tr>
<td>59</td>
<td>Glade Reservoir with NISP</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>72</td>
<td>Halligan Reservoir</td>
<td>Expanded Reservoir</td>
</tr>
<tr>
<td>159</td>
<td>Rawhide North Reservoir</td>
<td>New Reservoir</td>
</tr>
<tr>
<td>205</td>
<td>Upper Black Hollow Reservoir</td>
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</tr>
<tr>
<td>220</td>
<td>NPIR Reservoir No. 15</td>
<td>Expanded Reservoir</td>
</tr>
</tbody>
</table>
Figure 2-4. Map of reservoir elements retained through the Tier 2 screening process.
2.1.3 Best Fit Analysis

The Tier 2 Reservoir Element Screening resulted in five remaining elements as alternatives to Halligan Reservoir. The remaining five elements have identical impacts to the aquatic environment at the reservoir sites. None include a new dam on a perennial stream and none would inundate any wetlands. Due to the identical impacts to aquatic environment at these five reservoir sites, we used a best fit analysis to select a reservoir element that is most practicable from the Applicant’s perspective and that would be carried forward into the preliminary alternatives formulation process. These five elements were individually evaluated and compared to each other based on practicability aspects. Reservoir elements not selected through this best fit analysis remained available for use in the event the selected reservoir element was determined not to be viable through further analysis. Enlarging Halligan Reservoir is Fort Collins’ proposed action and therefore will be evaluated in the EIS and was not subjected to the best fit analysis.

- **Glade Reservoir with NISP** – Glade Reservoir is a new reservoir that is part of the proposed action in the NISP EIS. If Glade Reservoir is constructed as a result of the decision for the NISP EIS, it could be expanded to meet Fort Collins’ purpose and need. The elevation of an expanded Glade Reservoir (at the toe of the dam) is approximately 70 feet higher than and six miles from the Fort Collins water treatment plant. Deliveries from an expanded Glade Reservoir could flow by gravity to the treatment plant. Fort Collins has two other water supply pipelines located near the proposed Glade Reservoir dam site. A connection from the Glade Reservoir outlet to one or both of these pipelines could be utilized to deliver water from Glade Reservoir and could reduce the amount of new pipeline significantly if water quality is compatible. If the existing pipelines are shared, some pumping may be required to regulate pipeline hydraulics. A new separate pipeline would be approximately seven miles long to supply water to the Fort Collins water treatment plant. Water quality from Glade Reservoir is anticipated to be relatively good due to the diversion point in the Poudre Canyon, upstream of most agricultural and urban runoff into the Poudre River, but may require pre-treatment to ensure similar water quality in the existing pipelines that divert water directly from the Poudre River higher in the Poudre Canyon.

- **Cactus Hill Reservoir with NISP** – Cactus Hill Reservoir is a new reservoir that is part of several alternative actions in the NISP EIS. Cactus Hill Reservoir, if constructed as a result of the decision for the NISP, could be expanded to meet Fort Collins’ purpose and need. Because Cactus Hill Reservoir is not the proposed action in the NISP EIS, the opportunity to enlarge Cactus Hill Reservoir is less likely than is the opportunity to enlarge Glade Reservoir and is impracticable at this time. The Cactus Hill Reservoir site is approximately 60 feet lower than and 14 miles from the Fort Collins water treatment plant and would require pumping and approximately 16 miles of new pipeline to supply water to the Fort Collins water treatment plant. Diversions into Cactus Hill could potentially use a new pipeline or existing ditch capacity. If deliveries are made through an existing ditch, water quality would be expected to degrade through the delivery canal as it passes through agricultural areas and intercepts runoff from these lands. Delivery losses by ditch to Cactus Hill would be expected to be large.
• **NPIC Reservoir No. 15** – NPIC Reservoir No. 15 is an existing reservoir that could be expanded to meet Fort Collins’ purpose and need. The reservoir is approximately 260 feet higher than and 13 miles from the Fort Collins water treatment plant and would require approximately 14 miles of new pipeline to supply water to the Fort Collins water treatment plant. Deliveries from the reservoir to the water treatment plant could flow by gravity, but pumping may be required to deliver water to the reservoir, depending on the point of diversion.

• **Rawhide North Reservoir** – Rawhide North Reservoir is a new reservoir that could be constructed to meet Fort Collins’ purpose and need. The reservoir is approximately 340 feet higher than and 17 miles from the Fort Collins water treatment plant and would require approximately 20 miles of new pipeline to supply water to the Fort Collins water treatment plant. Deliveries from the reservoir to the water treatment plant could flow by gravity, but pumping may be required to deliver water to the reservoir, depending on the point of diversion. Deliveries into the reservoir could be accomplished by gravity if diverted at the North Poudre Canal, located on the North Fork just below the existing Halligan Reservoir.

• **Upper Black Hollow Reservoir** – Upper Black Hollow Reservoir is a new reservoir that could be constructed to meet Fort Collins’ purpose and need. The reservoir is approximately 190 feet higher than and 14 miles from the Fort Collins water treatment plant and would require approximately 18 miles of new pipeline to supply water to the Fort Collins water treatment plant. Deliveries from the reservoir to the water treatment plant could flow by gravity, but pumping may be required to deliver water to the reservoir, depending on the point of diversion. If deliveries are made through an existing ditch, water quality would be expected to degrade through the delivery canal as it passes through agricultural areas and intercepts runoff from these lands. Delivery losses by ditch to Upper Black Hollow would be expected to be large.

The Glade Reservoir with NISP element was selected as the best fit of the remaining reservoir elements due to several practicability considerations and was retained for the Fort Collins preliminary alternatives formulation process. The Glade Reservoir with NISP element would be located significantly closer to the Fort Collins water treatment plant and may be able to use existing pipelines to the treatment plant, thereby decreasing the infrastructure costs and ground disturbance impacts associated with the longer pipelines to other reservoirs. All other reservoir elements would require more than 10 miles of new pipelines most would require pumping to deliver water either into or out of the reservoir. Of the remaining reservoirs, water quality is likely better at the Glade Reservoir with NISP element due to the diversion point from the main stem in the Poudre Canyon, and a shorter conveyance distance that does not pass through large amounts of agricultural areas. Furthermore, both the Glade Reservoir with NISP and Cactus Hill Reservoir with NISP elements rely on that reservoir to be used for NISP. Since Cactus Hill is not the proposed action for NISP, it is less likely to be constructed because it is not the NISP proposed action. The Glade Reservoir with NISP element could provide services to Fort Collins water supply systems similar to the Halligan Reservoir with no additional wetlands inundated and the least amount of additional pipeline construction and pumping required compared to the other four reservoir elements.
2.2 Gravel Pits Elements

The gravel pit element type is comprised of storing water in pits created by the mining of sand and gravel within close proximity of a stream. These mining pits are sealed with an impermeable barrier (e.g., slurry wall or clay liner) so they may be used for water storage. Gravel pit storage has been developed by many water providers along the Colorado Front Range. Gravel pit storage is useful in particular for storing any unused wastewater effluent that a water provider has the right to reuse, or to regulate other changed water rights near the point of diversion. By capturing unused effluent or other changed water rights near their source, water providers are sometimes able to develop firm yield with relatively low storage volumes.

A database of Colorado mine sites registered with the Colorado Division of Reclamation Mining and Safety (DRMS) was used to identify potential gravel pits within the state. Approximately 6,431 mine sites in Colorado that were registered with DRMS as of May 2010 were incorporated into the gravel pit element long-list. The DRMS is responsible for the administration of mining permits and maintains a database with a variety of information on registered mines including mine site locations, permit status and type, commodities mined, mine type, and approximate permit area. Based on this information, gravel pits were evaluated through two tiers and then a best fit analysis was applied (Figure 2-5). Tier 1 criteria included geography, mine type, permit status and commodity, while Tier 2 was a practicability screen. The practicability screen eliminated gravel pit elements that could not effectively store reusable effluent or regulate Fort Collins’ changed water rights due to administration of water rights on the Poudre River.

A wetland inundation screening criterion was not applied to gravel pit elements because any wetland or stream impacts from the mining operation would have been evaluated under the mining permit. The Corps’ experience is that non-abandoned and to-be-reclaimed gravel pits typically have no wetlands associated with them and in most cases are not considered waters of the United States. Therefore, it was assumed that the gravel pit elements identified in this analysis fall within those conditions and the direct impact to waters of the U.S. and the aquatic environment for the purposes of the Section 404(b)(1) Guidelines are minimal or non-existent. Gravel pits are typically used to maximize the use of reusable effluent and changed water rights and may provide a portion of the purpose and need in combination with other concepts and help maintain a wide range of reasonable alternatives so gravel pits were not required to meet 100 percent of the needed storage.

Gravel pit elements that passed the Tier 1 and Tier 2 screening were subjected to a best fit analysis. The best fit analysis was appropriate because the remaining elements passed through the various Tier 1 and Tier 2 screening and have indistinguishable effects on the aquatic environment. The best fit analysis evaluated the gravel pit elements based on proximity to Fort Collins’ existing infrastructure. Gravel pit elements nearer to Fort Collins’ existing infrastructure were considered a better fit than other gravel pit elements further away.
Figure 2-5. Gravel pit element screening process showing the two-tier screening process and best-fit analysis.
2.2.1 Tier 1 Gravel Pits Elements Screening

The Tier 1 gravel pit element screening involved the elimination of gravel pit elements that are not within the South Platte River Basin (including tributaries) upstream of the Weld-Morgan county line and downstream of the confluence with the St. Vrain River and are not gravel pit mines. The Tier 1 screening criteria included the following: geographic area, mine type, permit status, and commodity.

2.2.1.1 Geographic Area

The long list of potential gravel pit storage elements included approximately 6,431 mine sites in Colorado registered with DRMS. The DRMS database included approximate coordinates of mining sites, which were imported into GIS. The mines located in the South Platte River Basin (including tributaries) upstream of the Weld-Morgan county line and downstream of the confluence with the St. Vrain River were identified and retained for further screening analyses. A total of 6,074 mine sites were eliminated through the geographic area screen, and 357 sites were retained.

2.2.1.2 Mine Type

Gravel pit mines generally involve surface mining using heavy equipment for excavation. The DRMS mine type designations provide a general indication of the type of mining that is permitted for a site. Generally, sites with DRMS designations other than surface mining (e.g., groundwater mining and in situ mining) are not gravel pit mining sites. Gravel pit elements with DRMS designations other than surface mining were eliminated. This criterion eliminated 25 of the 357 remaining sites, and 332 were retained.

2.2.1.3 Permit Status

A gravel pit element with the DRMS permit status of not mining, denied, application withdrawn, illegal-pending application, incomplete application, or revoked and terminated suggested a low probability of the gravel pit being mined to a level sufficient to provide water storage. Sites that included at least one of these statuses were eliminated. This criterion eliminated 201 of the 332 remaining sites, and 131 were retained.

2.2.1.4 Commodity

Alluvial sediments such as sands, gravels, and stone material are typically excavated from gravel pit mines for construction and landscaping materials. Generally, sites mining commodities other than these alluvial sediments are not gravel pit mining sites. DRMS commodity data were used to eliminate gravel pit elements permitted to mine commodities not typical of gravel pits. This criterion eliminated eight of the 131 remaining sites, and 117 were retained.
2.2.1.5 Tier 1 Gravel Pits Element Screening Results

Tier 1 gravel pit element screening resulted in the elimination of all but 117 gravel pit elements. The remaining 117 gravel pit elements were carried forward into Tier 2 Practicability Screen.

2.2.2 Tier 2 Gravel Pits Element Screening

We determined that gravel pits at locations far from Fort Collins’ reusable effluent or changed water rights were not practicable because of the City’s limited ability to use the storage and to regulate the relatively small flows. Delivery of relatively small amounts of reusable effluent or changed water rights to distant storage facilities may incur significant conveyance losses or face other delivery challenges associated with administration of other water rights on the Poudre River. For example, the Larimer and Weld Canal has water rights that are senior enough to divert the entire flow of the Poudre River at certain times of the year and is known as a dry-up location on the Poudre River. It would be difficult for Fort Collins to deliver small flow rates from a changed water right past a river headgate like the Larimer and Weld Canal or other dry-up point that is legally able to divert the entire flow of the river. Fort Collins currently owns a gravel pit near its Drake Wastewater Reclamation Facility that can capture and regulate reusable effluent. Additional gravel pit storage near the wastewater treatment plant would add little yield to Fort Collins system. However, additional gravel pits located near Fort Collins’ changed water rights could enhance the ability of Fort Collins to fully utilize its changed rights.

Fort Collins has changed several agricultural water rights to municipal use in the Arthur Ditch, the New Mercer Canal, the Larimer County Canal No. 2, and the Pleasant Valley and Lake Canal. These four ditches are often referred to as the South Side Ditches because they all divert water to the south side of the Poudre River and historically irrigated lands near or within the current Fort Collins city limits. All of the South Side Ditches are diverted upstream of the Larimer and Weld Canal dry-up location. In addition to downstream dry-up locations, upstream water rights were also considered in the practicability criteria. Any diversion of the changed water rights at upstream locations by Fort Collins would require a river exchange. An exchange allows diversion at locations upstream of the original water right, but requires that no injury occur to intervening water rights. The Watson Fish Hatchery is located upstream of three of the four South Side Ditches and has an instream flow water right that could prevent diversion of the three downstream South Side Ditch water rights upstream of the Watson Fish Hatchery.

A practicability screen was applied to the remaining 117 gravel pit elements requiring the gravel pits to be located in an area where Fort Collins could efficiently divert and regulate changed water rights. This function is more important than capturing reusable effluent because Fort Collins has limited reusable effluent available (see Section 3.2.9). The practicability screen for gravel pits required gravel pits to be located near the Poudre River upstream of the Larimer and Weld Canal headgate dry-up location and downstream of the Watson Fish Hatchery. This screen eliminated 111 gravel pit elements and retained six practicable gravel pit elements for Fort Collins (Table 2-4).
Table 2-4. Remaining gravel pit elements after applying the practicability screen.

<table>
<thead>
<tr>
<th>ID #</th>
<th>DRMS ID</th>
<th>Gravel Pits Element</th>
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<td>Cache La Poudre</td>
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<tr>
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<td>Stegner Farms</td>
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<td>M2001051</td>
<td>North Taft Hill Expansion Site</td>
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<td>305</td>
<td>M2002081</td>
<td>Overland Ponds</td>
<td>Cache La Poudre</td>
</tr>
<tr>
<td>314</td>
<td>M2003069</td>
<td>Timberline Resource</td>
<td>Cache La Poudre</td>
</tr>
<tr>
<td>357</td>
<td>M2011049</td>
<td>Treiber Lakes</td>
<td>Cache La Poudre</td>
</tr>
</tbody>
</table>

2.2.3 Best Fit Analysis

The remaining six gravel pit elements had no identifiable or discernable difference in impact on aquatic resources based on the Tier 1 and Tier 2 screening. A best fit analysis compared the locations of the six remaining gravel pit elements with respect to the location of existing infrastructure, and infrastructure that would need to be constructed. The Timberline Resources site (ID 314) and the North Taft Hill Expansion Site (ID 296) are located farther from the Poudre River and would each require approximately a one-mile pipeline and pumping from the river. The remaining four gravel pit elements are all located in the area near a group of mine sites, collectively called the Overland Gravel Pits. Because of their geographic proximity, we aggregated these four elements into a single Overland Gravel Pits gravel pit element. Water storage in the four individual mines could be used in any combination to achieve the same results.

The Overland Gravel Pits are located two miles northeast of the Fort Collins Water Treatment Plant on the Poudre River. The diversion points for South Side Ditches are in the vicinity and the Overland Gravel Pits potentially could be filled from the Larimer County Canal No. 2 or the New Mercer Canal. A portion of the site is currently being mined for use by the City of the Greeley and the Tri-Districts to support their water supply operations. In order for Fort Collins to utilize the Overland Gravel Pits in its storage reserve safety factor, a pipeline from the Overland Gravel Pits to the water treatment plant would be required. Fort Collins may be able connect a shorter pipeline from the Overland Gravel Pits to one of the two raw water supply lines serving its water treatment plant in the vicinity of the Overland Gravel Pits in order to reduce cost and earth disturbance impacts. Although Fort Collins may exchange water from the Overland Gravel Pits to its upstream intakes in the Poudre River Canyon, a pipeline connection would be needed to satisfy the Fort Collins storage safety reserve criteria of a direct connection to the treatment...
system. The Overland Gravel Pits site was the only gravel pit element selected for the preliminary alternatives formulation process.
Figure 2-6. Location of gravel pit elements retained through Tier 2 screening.
2.3 Underground Elements

The underground element type included potential storage capacity in bedrock and alluvial aquifers. Alluvial and bedrock aquifers are permeable geologic formations capable of storing and yielding usable quantities of water. Bedrock aquifers in the region are generally fully saturated and are bound above and below by impermeable layers. Alluvium is the material deposited adjacent to and under a flowing stream, typically consisting of silts, sands and gravels. Alluvial aquifers are near the surface and may be hydraulically connected to a nearby stream. The bedrock and alluvial aquifer elements could be used for aquifer storage and recovery. In aquifer storage and recovery, an aquifer is recharged through either permeable infiltration basins or injection wells. The water stored in the aquifer would be extracted (pumped) from the aquifer at a later date.

Water stored underground in an unlined alluvial aquifer does not remain in the same location over time like a surface water reservoir. Storage and subsequent extraction of water in alluvial aquifers requires additional technical analysis of the rate and direction of groundwater flow in order to effectively use the stored water. Under Colorado water law, water stored in an alluvial aquifer is considered in-transit to the nearest surface water stream and will accrete to the stream over time as lagged (at a later time) stream accretions. Similarly, taking water out of storage in an alluvial aquifer by pumping results in lagged depletions to the stream by intercepting water that would have otherwise flowed to the stream. The lagged accretions that result from storing water in the alluvial aquifer can be used to offset pumping depletions caused by removing the water from storage. Some aquifers have sufficient natural recharge to allow pumping without first storing water in the aquifer. In either scenario, a groundwater pumper must replace the lagged pumping depletions to the stream with either lagged accretions caused by storage in the aquifer or other sources that can be delivered to the stream in the amount, time and location of the pumping depletion. This arrangement of meeting pumping depletions with other water sources or lagged accretions is referred to as an augmentation plan in Colorado water law. Several municipal water providers and agricultural water users in the region rely on augmentation plans to pump water from alluvial aquifers.

The Colorado Water Conservation Board's (CWCB) Senate Bill 06-193 Underground Water Storage Study (SB06-193 Study) provides delineations of the Denver Basin bedrock aquifers and different portions of the South Platte Basin alluvial aquifer. Aquifers located at least partially within the South Platte River Basin (including tributaries) upstream of the Weld-Morgan County line, and downstream of the confluence with the St. Vrain River were incorporated into the long list of underground elements. For evaluation in this alternatives analysis, we subdivided the Poudre Alluvial aquifer in the SB06-193 study into six alluvial aquifer elements, to correspond with the Poudre River tributary hydrologic sub-basins. Figure 2-7 and Figure 2-8 show the delineation of the bedrock and alluvial aquifer elements.

These underground elements were evaluated through a two-tiered screening process (Figure 2-9). Underground elements that did not meet a specific screening criterion were eliminated while the
remaining elements were retained for screening using subsequent criteria. Infrastructure associated with underground storage elements (e.g., well heads, pump houses, pipelines, etc.) can be located such that impacts to aquatic resources are completely avoided or minimized to such a level that direct impacts to aquatic resources are not identifiable or not discernible. Therefore, best fit principals were applied after the second tier of the screening process to select an underground element for use in the alternatives formulation process.
Figure 2-7. Map of bedrock aquifer elements retained through the designated geographic area screen.
Figure 2-8. Map of alluvial aquifer elements retained through the geographic area screen.
Figure 2-9. Underground element screening process showing the three-tier screening process including the best fit analysis
2.3.1 Tier 1 Underground Element Screening

We used the geographic location of each of the underground and alluvial aquifer elements in Tier 1 screening of underground elements. Many of the alluvial and bedrock aquifer elements presented in the underground element long-list have sufficient capacity to provide storage for Fort Collins; however, their distant location would require an extensive amount of infrastructure to deliver water to Fort Collins when compared to closer elements. We eliminated all underground elements with more than 50 percent of their footprint area located outside of the South Platte River Basin (including tributaries) upstream of the Morgan-Weld county line, and downstream of the confluence with the St. Vrain River.

The underground element long-list consisted of a total of 36 underground elements. The application of the Tier 1 screen process resulted in the elimination of 21 underground elements, leaving 15 underground elements (Table 2-5).

Table 2-5. List of underground elements retained through the Tier-1 screening process.

<table>
<thead>
<tr>
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<td>27</td>
<td>Rawhide Creek</td>
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</tr>
<tr>
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<td>South Platte-Greeley to Ft. Morgan</td>
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<tr>
<td>32</td>
<td>South Platte-Metro to Greeley</td>
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</table>

2.3.2 Tier 2 Underground Element Screening

We used various hydrogeologic properties of the alluvial and bedrock aquifer elements in the Tier 2 screening of underground elements. We used hydrogeologic property data from the SB06-193 Study to evaluate the following screening criteria: hydraulic conductivity, transmissivity,
residence time, total available pore space, and total aquifer storage capacity. SB06-193 Study GIS shapefiles were used to depict the spatial distribution of these properties with respect to the groundwater elements. Figure 2-10 to Figure 2-14 show the hydrogeologic properties used in the Tier 2 groundwater screening criteria.

These figures were used to assess the underground elements' hydrogeologic properties in relation to each screening criteria threshold. Underground elements that did not meet the screening criteria were eliminated, while underground elements that met the screening criteria were retained for additional evaluation using a best fit analysis among underground elements.

2.3.2.1 Transmissivity and Hydraulic Conductivity

Both alluvial and bedrock aquifers have widely varying transmissivity and hydraulic conductivity. Transmissivity and hydraulic conductivity are indicative of the ability of an aquifer to accept water infiltration and produce extracted water to a well. Sufficient infiltration and extraction rates are necessary for aquifer storage and recovery, where an aquifer is recharged with water supplies and the water is recovered later when needed. Aquifers with a low hydraulic conductivity and transmissivity are not able to be recharged easily and may not allow for extraction of water at a sufficient rate to meet demands.

For purposes of this screening, we assumed that an alluvial aquifer element with a hydraulic conductivity exceeding 50 ft/day and bedrock aquifers with a transmissivity exceeding 300 ft²/day could provide sufficient recharge and extraction rates. These were the same threshold values applied in the SB06-193 Study used to evaluate the storage capacity of aquifers.

While there are bedrock aquifers in the southern Denver metro area with transmissivity rates more suitable for aquifer recharge and extraction, all of the bedrock aquifer elements in the South Platte River Basin (including tributaries) upstream of the Morgan-Weld county line and downstream of the confluence with the St. Vrain River had a transmissivity lower than the 300 ft²/day threshold value (Figure 2-10) and, therefore, all bedrock aquifer elements were eliminated. In contrast, the hydraulic conductivity of all alluvial aquifer elements exceeded the 50 ft/day threshold (Figure 2-11) and therefore no alluvial aquifer elements were eliminated with this criterion. This criterion eliminated four of the 15 remaining underground elements and 11 were retained.
Figure 2-10. Transmissivity of the bedrock aquifer elements.
Figure 2-11. Hydraulic conductivity of the alluvial aquifer elements.
2.3.2.2 Residence Time

Groundwater gradually travels through an aquifer and over time and will eventually flow out of the aquifer. The alluvial aquifer elements are all hydraulically connected to the local stream system, which are typically gaining reaches throughout the region. Water recharged into the alluvial aquifer will eventually result in seepage to the stream and will increase the streamflow. Similarly, water pumped from the alluvial aquifer element will eventually result in a depletion to the stream by intercepting groundwater that would have otherwise accrued to the stream. The residence time of an alluvial aquifer represents the amount of time a recharged volume of water remains stored in an aquifer.

For purposes of this analysis, we selected a 480-day stream depletion factor as the screening criterion threshold. This value was also used by the SB06-193 Study to represent a reasonable amount of sub-surface storage time and allows for water to be carried over from one year to the next within the alluvial aquifer. Alluvial aquifer elements that exhibited a stream depletion factor less than 480 days in any portion of the element were eliminated (Figure 2-12). This criterion eliminated four of the 11 remaining underground elements, and seven elements were retained.

2.3.2.3 Total Available Pore Space Capacity

The total available pore space capacity represents the available unsaturated void space of the alluvium. This volume of void space is equivalent to the amount of water that an aquifer can store.

We evaluated the total pore space capacity of each alluvial aquifer element provided in the SB06-193 Study (Figure 2-13) to identify elements that do not have the available unsaturated void space to sufficiently store the minimum allowable storage capacity. Alluvial aquifer elements within the Poudre Basin were retained if their maximum storage capacity exceeded the minimum allowable capacity of 8,125 AF. Alluvial aquifer elements outside of the Poudre Basin were retained if their capacities exceeded the minimum allowable capacity of 24,375 AF for Fort Collins. These storage amounts are the same amounts used in the reservoir element screening (Section 2.1). This analysis eliminated alluvial aquifer elements that would not be able to meet the storage capacity needed to meet the purpose and need. This criterion eliminated two of the seven remaining underground elements and five were retained.
Figure 2-12. Residence time of the alluvial aquifer elements.
Figure 2-13. Total available pore space capacity of the alluvial aquifer elements.
2.3.2.4 Aquifer Storage Capacity

The storage capacity of an aquifer represents the volume of storage available per unit of surface area (e.g., AF/acre). Aquifers with high storage capacities are able to store relatively large volumes of water per unit area and are, therefore, better storage candidates than aquifers that would require more surface land area to achieve the same volume of storage.

We selected an aquifer storage capacity of two AF/acre as the threshold aquifer storage capacity value for the purposes of this analysis. This value was also used by the SB06-193 Study to characterize conditions conducive for aquifer storage and recovery. Aquifer storage capacities below two AF/acre were considered to provide an inefficient amount of storage per area, requiring the disturbance of a relatively large amount of land area to develop infiltration basins and/or injection wells. Alluvial aquifer elements with an aquifer storage capacity less than two AF/acre were eliminated (Figure 2-14); no elements were eliminated using this criterion.

2.3.2.5 Tier 2 Underground Element Screening Results

The Tier 1-List consisted of 15 underground elements. The Tier 2 underground element screening resulted in the elimination of all four of the bedrock aquifer element types and six of the alluvial aquifer element types, retaining five alluvial aquifer elements for the best fit analysis (Table 2-6).

Table 2-6. List of underground elements retrained through the Tier 2 screening process.

<table>
<thead>
<tr>
<th>ID</th>
<th>Element</th>
<th>Underground Element Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Crow Creek</td>
<td>Alluvial</td>
</tr>
<tr>
<td>19</td>
<td>Lone Tree Creek</td>
<td>Alluvial</td>
</tr>
<tr>
<td>23</td>
<td>Lower Lost Creek</td>
<td>Alluvial</td>
</tr>
<tr>
<td>25</td>
<td>Old Alluvium Lone Tree Creek</td>
<td>Alluvial</td>
</tr>
<tr>
<td>27</td>
<td>Rawhide Creek</td>
<td>Alluvial</td>
</tr>
</tbody>
</table>
Figure 2-14. Aquifer storage capacity of the alluvial aquifer elements.
2.3.3 Best Fit Analysis

The Tier 2 Underground Element Screening resulted in five remaining alluvial aquifer elements for preliminary alternatives development. Bedrock and alluvial aquifers are not part of the aquatic environment protected under the Clean Water Act or considered in the Section 404(b)(1) Guidelines. However, the Guidelines would have us consider the effects of discharges from those aquifers into wetlands, rivers, and streams which are part of the aquatic environment. Under Colorado water law, an aquifer storage and recovery plan for any of the alluvial aquifers would be required to replace any depletions to the stream with either lagged accretions caused by storage in the aquifer or other sources that can be delivered to the stream in the amount, time and location of the pumping depletion. Therefore, impacts from depletion on the aquatic environment in any of the alluvial aquifers would be minimal and the differences are not discernible. Infrastructure associated with underground storage elements (e.g., well heads, pump houses, pipelines, etc.) can be located such that impacts to the aquatic environment are completely avoided or minimized to such a level that direct impacts associated with some infrastructure are very minor and differences are not discernible. Differences to impacts to the aquatic habitat at the different remaining alluvial aquifers could result from the location where water is diverted from the river and delivered into recharge facilities. At this stage in the alternatives formulation process, the source of recharge water is not yet determined. The source of recharge water will in part determine the point of diversion. Therefore, since the five elements remaining after the Tier 2 screen have no identifiable or discernible impacts to the aquatic environment as well as design characteristics, the best fit among the remaining alluvial aquifer elements for Fort Collins was identified by qualitatively evaluating big-game habitat, urban development, continuous alluvial width, and water quality of the alluvial aquifer elements.

2.3.3.1 Big-Game Habitat

Since there is a potential to use spreading basins as a form of recharge, we evaluated the extent to which the habitat of a big-game species would be disturbed by the potential method of recharge. GIS data for the bighorn sheep (Ovis canadensis), elk (Cervus canadensis), mule deer (Odocoileus hemionus), pronghorn (Antilocapra americana), and white-tailed deer (Odocoileus virginianus) big-game species and associated habitats was provided by the Natural Diversity Information Source, Colorado Division of Wildlife (CDOW, now Colorado Parks and Wildlife). We used GIS to compute the number of acres of big-game habitat that lay within the boundaries of each alluvial aquifer footprint.

Two of the five remaining alluvial aquifer elements, Crow Creek and Lower Lost Creek, were overlain with severe winter habitat of mule deer, pronghorn, and white-tailed deer. Two-thirds of the total surface area of each of these alluvial aquifer elements was covered by the big-game habitat designation. Conducting alluvial aquifer recharge using spreading basins on lands designated as severe winter habitat would result in greater environmental impacts than other seasonal big-game habitat types and were therefore not selected as the best fit. The remaining three elements – Rawhide Creek, Old Alluvium Lone Tree, and Lone Tree Creek – were either
not covered with the big-game habitat or only small portions were covered, which would result in very small impacts to big-game.

2.3.3.2 Urban Development

We examined urban development because this land use would limit the potential to use spreading basins as a form of recharge to the aquifer and thus would limit the area where alluvial groundwater recharge could occur. An urban development GIS coverage for all of Colorado was available through Colorado Department of Transportation. We mapped this GIS coverage and the boundaries of the remaining alluvial aquifer elements (Figure 2-15). We identified alluvial aquifer elements that did not have a large portion of urban development within their boundaries. These elements would allow for greater flexibility when deciding the placement of infrastructure associated with use of an underground element.

Urban development was present overlying portions of three of the alluvial aquifer elements – Rawhide Creek, Old Alluvium Lone Tree Creek, and Lone Tree Creek (Figure 2-15). Although the presence of urban development would limit the possible location availability of the spreading basins, none of the elements were completely urbanized and spreading basins are possible in some locations. Therefore, none of the underground elements were selected as the best fit based on urban development.

2.3.3.3 Water Quality

We evaluated water quality of the alluvial aquifer element's groundwater because quality of the current groundwater would directly affect the quality of the injected/recharged water as the two sources blend underground.

In general, the surface water in the Poudre River Basin and groundwater in the alluvial aquifers along the Poudre River can be impacted by return flow from urban run-off, municipal wastewater discharges, and surface and groundwater agricultural returns. The water quality within both the channel of the Poudre River and alluvium degrades as the water flows downstream from the mouth of the canyon. Generally, the concentrations of nutrients, organics, pathogens, total dissolved solids, and other pollutants increase.

We assumed that any water extracted from the alluvial aquifer elements would require some form of water treatment to meet aesthetic and drinking water standards. Some level of advanced water treatment would be required after it was extracted, even if relatively high quality water were injected or recharged into the alluvial aquifer elements located further downstream in the basin. Treatment would be necessary because high quality water injected to an alluvial aquifer would mix with the lower water quality already present and be subject to influences of nearby or overlying urban and agricultural land uses and discharges.
Figure 2-15. Spatial distribution of urban development and Tier 2 alluvial aquifer elements.
Since contaminants from runoff and discharges increase downstream, alluvial aquifer elements further upstream along the Poudre River, such as Rawhide Creek, would in general have relatively better groundwater quality. Once the groundwater is retrieved from this alluvial underground element, the higher quality water may not require the same level of additional advanced treatment processes as the alluvial elements farther downstream such as Old Alluvium Lone Tree Creek, Lone Tree Creek, Crow Creek, and Lower Lost Creek. Groundwater extracted from these areas would require additional advanced treatment processes than would be required to treat water withdrawn from alluvial aquifer elements further upstream.

Water quality in the more downstream alluvial elements may have higher total dissolved solids that would not meet Fort Collins purpose and need without reverse osmosis treatment. Reverse osmosis removes total dissolved solids by passing water through membranes and concentrating the total dissolved solids in a brine solution. One of the most significant challenges to implementing reverse osmosis in Colorado is the brine disposal. Currently, some water providers who use reverse osmosis dispose of the brine through high pressure, very deep injection wells.

2.3.3.4 Proximity to Fort Collins’ Infrastructure

As part of the best fit analysis, we evaluated the proximity of the alluvial aquifer element to Fort Collins’ existing infrastructure and water treatment facilities because an aquifer with groundwater of higher quality that would require less water treatment infrastructure to meet aesthetic and water quality standards would be more advantageous to Fort Collins. We used GIS shape files showing the location of water treatment plants, transmission lines, and water intake locations obtained from Fort Collins and depicted the spatial distribution of these items with respect to the groundwater elements. We did not select alluvial aquifer elements further away that would require development of significant new infrastructure for conveyance and water treatment. We selected the Rawhide Creek alluvial aquifer element because it is in closest proximity to Fort Collins’ water treatment facility and existing raw water supply lines. Depending on the water quality in the aquifer, the retrieved groundwater may require some level of treatment before being blended into the current water supply system and could be delivered to Fort Collins utilizing some of the current transmission infrastructure.

2.3.3.5 Best Fit Analysis Results

The Tier 2 list consisted of five underground elements with non-identifiable or indiscernible impacts to the aquatic environment. The best fit analysis indicated that three elements – Rawhide Creek, Old Alluvium Lone Tree, and Lone Tree Creek – were either not covered with the big-game habitat or only small portions were covered, which would result in very small impacts to big-game. These three elements are experiencing urban development over a portion of their area but none of the elements are completely urbanized, which would not eliminate the possibility of utilizing spreading basins in some locations. Impacts to aquatic habitat at the recharge facilities and well heads could be avoided by locating those facilities away from riparian areas. Due to the non-identifiable or indiscernible impacts to aquatic habitat at the three sites, the best fit analysis
selected the Rawhide Creek aquifer to be carried through to the next step in the alternatives formulation process due to its proximity to Fort Collins’ infrastructure.

2.4 Operational Elements

Operational elements are a fourth type of element that can increase Fort Collins’ firm yield without requiring new storage facilities. Operational elements are facilities that currently exist and do not need to be constructed or expanded to provide firm yield to Fort Collins. Firm yield would be developed at these facilities through changes to existing operations. We identified two operational elements that could not be screened using the same methods used for reservoirs, gravel pits, or underground screening processes because these are not new or expanded facilities. The operational elements included existing storage facilities that would be operated differently to meet a portion of the Fort Collins purpose and need. These elements were tied directly to specific proposed re-operation water supply concepts that are described in more detail in Sections 3.2.7 and 3.2.8.

- **Joe Wright Reservoir** – Fort Collins owns Joe Wright Reservoir and the Michigan Ditch system. Joe Wright Reservoir is located in the headwaters of the Poudre River Basin. The Michigan Ditch system brings water from the Michigan River basin into the Poudre River Basin above Joe Wright Reservoir. Joe Wright Reservoir has a capacity of 6,474 AF, but the existing outlet works has an operational limitation that requires that winter storage be reduced to approximately 3,200 AF. Fort Collins performs a water trade with NPIC by releasing water from Joe Wright Reservoir to NPIC in the late summer in exchange for NPIC’s water in Horsetooth Reservoir from the Colorado-Big Thompson Project (C-BT). Modifications to the outlet works would allow for higher winter carryover storage that could increase firm yield to Fort Collins. In addition, Fort Collins could modify its water trade with NPIC to increase its firm yield.

- **Pro-Rata Agricultural Storage** – Fort Collins owns shares in several ditches, including the NPIC system, which has nearly 38,000 AF of storage. Fort Collins projects that it will own approximately 37 percent of the shares in the NPIC system in the future. If Fort Collins were able to control and use 37 percent of the NPIC system storage through its ownership of NPIC shares (pro-rata storage), it could gain 14,000 AF of storage in plains agricultural reservoirs. This operational element would change operations at the agricultural reservoirs to allow Fort Collins independent use of its portion of storage in agricultural reservoirs to meet its demand during years with shortages. Fort Collins also owns shares in the Water Supply & Storage Company, which operates two reservoirs located in the headwaters of the Poudre River Basin, Chambers Reservoir and Long Draw Reservoir. If Fort Collins were able to use its pro-rata capacity in these reservoirs independently from Water Supply & Storage Company, it could meet a portion of the purpose and need. Ownership of shares in a ditch company does not guarantee a shareholder the right to independent use of its pro-rata ditch company storage capacity. Agreements would have to be made with the ditch companies to operate in this manner.
2.5 Element Screening Summary of Results

The element screening classified four different types of infrastructure: reservoir elements, gravel pit elements, underground elements, and operational elements. The screening process subjected long lists of each element type to multiple screening criteria. When there were no identifiable or discernible differences in impacts to the aquatic ecosystem, we employed a best fit analysis to select between elements of the same type. In total, six elements were selected through the screening by element type.

2.5.1 Best Fit Analysis between Element Types

After the screening process for each type of element was complete, it was apparent that two of the elements would have the same aquatic impacts. The Rawhide alluvial aquifer element and the pro-rata agricultural storage operational element using NPIC plains reservoirs had no identifiable or discernible difference in impacts on the aquatic ecosystem. Both elements would divert water at the same location because the aquifer and the NPIC reservoirs are located in approximately the same area. Alternatives using either element would divert approximately the same volume of water. Direct impacts to aquatic habitat at the aquifer site or the existing reservoir site are anticipated to be minimal or non-existent. The Rawhide alluvial aquifer element, like a reservoir, was not considered a new source of water, because water would have to be recharged into the aquifer to provide the water supply. This need was evidenced by the lack of center pivot irrigation wells up-gradient of the Munroe Canal, indicating a lack of sufficient supply of naturally occurring water in the upper portions of the aquifer. The increase in the number of wells below the Munroe Canal indicated it (and other ditches that cross the aquifer) provide a source of recharge. The water that would be recharged and stored in the aquifer would be diverted from the stream in a similar manner as water that would be stored in the reservoir pro-rata agricultural storage operational element.

Neither element would have direct impacts to wetlands, and conveyance infrastructure required to deliver water to Fort Collins would be nearly identical since the elements are located in nearly the same area. Although evaporative losses would likely be less for the Rawhide alluvial aquifer compared to an agricultural reservoir, aquifer storage and recovery plans incur some evaporative loss during infiltration, other losses associated with a timing mismatch between lagged stream accretions from recharged water, and lagged stream depletions from well pumping, and potentially other water treatment losses, depending on groundwater quality.

Based on these factors, we considered the difference in impacts to the aquatic habitat to be non-identifiable or indiscernible between the Rawhide alluvial aquifer underground element and the pro-rata agricultural storage operational element. This determination allowed us to use a best fit analysis and select one of these elements for further analysis in the alternatives formulation process by considering factors other than criteria specified in the 404(b)(1) Guidelines, such as cost and complexity.
Delivering water into a surface water reservoir for storage and subsequent release is a relatively straightforward and common operation for water providers, although obtaining independent pro-rata storage in NPIC reservoirs may present some legal challenges or require an agreement with NPIC. Storage in an alluvial aquifer, in contrast, is significantly more complicated by Colorado water law. Under Colorado water law, all water in an alluvial aquifer is considered tributary to the stream system, and water cannot be stored in the aquifer as one considers storage in a reservoir. Water introduced into an aquifer immediately begins to travel towards the stream. The recharged water accrues to the stream over a lagged period of time. The travel time can be characterized by a unit response function developed based on the location of recharge and aquifer characteristics. Extraction wells that would take water out of storage from the aquifer create a lagged stream depletion based on the location of the wells and aquifer characteristics in a similar manner to the lagged accretions of the recharge. It is difficult to exactly align timing and amounts of the lagged accretions from recharge with the lagged depletions from the wells that would be necessary to approximate a release from a storage facility.

In addition, water stored in and then extracted from the Rawhide alluvial aquifer may be of lower quality with high levels of dissolved solids compared to water stored in the agricultural reservoirs. Groundwater may require an advanced water treatment process such as reserve osmosis. A byproduct of reverse osmosis is a concentrated brine that must be disposed of properly. Brine disposal is one of the chief hurdles to effectively using reverse osmosis in Colorado. In coastal areas, the brine can simply be discharged into the ocean. In Colorado, water providers have been able to dispose of brine through significant dilution or through high-pressure, deep well injection. Other methods of disposal are under investigation, but no technology has emerged as the preferred cost-effective alternative.

The accounting, permitting, water rights and water treatment issues associated with the alluvial aquifer element are significantly more complex than using an existing surface water facility. The best fit analysis between the two elements led to selection of the pro-rata agricultural element for use in the preliminary alternatives screening. As with other best fit analyses, in the event the pro-rata agricultural storage element is determined to be infeasible through additional, more detailed analysis, the Rawhide alluvial aquifer element may be re-introduced into the alternatives formulation process.

### 2.5.2 Final-List of Elements

The element screening resulted in the following:

- **Reservoir Elements** – Four new reservoir elements and one expanded reservoir element were retained after the screening process. Through the best fit analysis, Glade Reservoir with NISP was selected along with the proposed expansion of Halligan Reservoir for the preliminary alternatives formulation process.
• **Gravel Pits Elements** – From the elements passing the screening, the Overland Gravel Pits gravel pit elements were selected through the best fit analysis for the preliminary alternatives formulation process.

• **Underground Elements** – All bedrock aquifer elements were eliminated following the Tier 1 screening. Following additional screening of the remaining alluvial aquifers, the Rawhide Creek alluvial aquifer was selected through a best fit analysis among other alluvial aquifers, but was subsequently eliminated through a best fit analysis when compared to the Joe Wright Reservoir and Pro-Rata Agricultural Storage operational elements.

• **Operational Elements** – The Joe Wright Reservoir and Pro-Rata Agricultural Storage operational elements were retained for the preliminary alternatives formulation process.

The long lists of elements and detailed screening results for each individual element are provided in Appendix A. Details on GIS and calculation processes can be found in Appendix B. Table 2-7 summarizes the number of elements screened out (or not selected in a best fit analysis) throughout the various stages of the screening process.

Table 2-7. Summary of screening process results.

<table>
<thead>
<tr>
<th>Element Type</th>
<th>Reservoirs</th>
<th>Gravel Lakes</th>
<th>Underground</th>
<th>Operational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Long List</td>
<td>220</td>
<td>6431</td>
<td>36</td>
<td>2</td>
</tr>
<tr>
<td>Remaining after Tier 1 Screening</td>
<td>43</td>
<td>123</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Eliminated through Tier 2 Screening</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Capacity</td>
<td>15</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Inundated Wetlands</td>
<td>20</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Refined Geographic Area</td>
<td>2</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Ability to Capture Reusable Effluent</td>
<td>n/a</td>
<td>117</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Transmissivity</td>
<td>n/a</td>
<td>n/a</td>
<td>4</td>
<td>n/a</td>
</tr>
<tr>
<td>Residence Time</td>
<td>n/a</td>
<td>n/a</td>
<td>4</td>
<td>n/a</td>
</tr>
<tr>
<td>Pore Space</td>
<td>n/a</td>
<td>n/a</td>
<td>2</td>
<td>n/a</td>
</tr>
<tr>
<td>Remaining After Tier 2</td>
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<td>6</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Not Selected through Best Fit</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Number of Final Elements</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Name of Final Elements</td>
<td>Halligan Reservoir, Glade Reservoir with NISP</td>
<td>Overland Gravel Pits</td>
<td>n/a</td>
<td>Joe Wright Reservoir, Pro-Rata Agricultural Storage</td>
</tr>
</tbody>
</table>
3 Concepts

A concept is defined as a potential operational or water supply strategy that is able to contribute to Fort Collins’ water supply firm yield. The development and screening of concepts recognized that concepts must often be matched with a storage element to produce firm yield (Section 1.4).

This section provides a description of the concepts development and screening process results. Concepts that passed the screening advanced to the preliminary alternatives formulation process (Section 1). Appendix C provides additional details on the concept development and screening processes. The concept screening process is a component of the overall alternatives screening process (Figure 3-1).

Figure 3-1. Alternative screening process flow chart showing the screening process in four stages with the concept screening stage outlined in red.
3.1 Concept Screening Criteria

Concepts were screened to meet the regulatory requirements of the NEPA and Section 404(b)(1) Guidelines. The screening criteria focus on ensuring that the concepts meet purpose and need and practicability standards, with several specific criteria within each standard. Concepts that passed the screening were retained for the preliminary alternatives formulation process (Section 1). Some criteria described in the NEPA and Section 404(b)(1) Guidelines, such as special land use designations and environmental considerations such as wetlands and impoundments on perennial streams, were initially applied to concepts but had no effect on the concept screening, and were already applied in the element screening. Cost can be evaluated as an aspect of practicability but was not used as a screening criterion for the Halligan Project at this stage. A concept had to satisfy all of the criteria in order to advance to the preliminary alternatives formulation process.

3.1.1 Purpose and Need Screening Criteria

The purpose of Fort Collins’ proposed Halligan Project, as defined by the Corps, is to provide additional system firm yield for Fort Collins in order to satisfy an additional need of approximately 7,900 AF per year to meet its projected approximate 2065 municipal and industrial demands with water of a quality comparable to the water now delivered to its customers (WEST et al. 2016).

3.1.1.1 Firm Yield

The firm yield screening criterion required that a concept must be capable of providing a reasonable amount of firm yield either as a stand-alone concept or when combined with a storage element. While developing the long list of alternatives, the Third Party Contractor team identified several potentially viable system efficiency concepts that would be relatively simple to implement, but produced small amounts of firm yield when considered individually. The firm yield criterion for the concept screening process was set to 600 AF, which is the firm yield that was developed from the system efficiency concept that required the least amount of infrastructure (Section 3.2.7.1). While this threshold is small compared to the overall firm yield need of 7,900 AF, it screens concepts that develop less firm yield with more infrastructure, and allows some concepts with a relatively small firm yield to be further evaluated with other concepts that together form an alternative that meets the full need of 7,900 AF.

In accordance with the purpose and need statement, firm yield for Fort Collins requires that the concept-element combination can provide a supply of water through the design drought. Fort Collins defined firm yield as an amount of water that can be supplied through the 1-in-50-year critical drought while still meeting the reliability criteria (WEST et al. 2015). The design drought was developed using a statistical process based on historical data in the Poudre Basin. Because many concepts cannot produce firm yield without accompanying storage facilities, the firm yield...
criterion was sufficiently broad to allow for concepts that alone produce no firm yield, but may be viable options when combined with an element.

3.1.1.2 Recipient

The recipient criterion required that the concept must be capable of delivering water to Fort Collins. Fort Collins would prefer that water from a project have a quality comparable to current supplies. The Purpose and Need Report for the Halligan Water Supply Project (WEST et al. 2016) clarified that water quality considerations under this criterion apply to the treated water delivered to customer taps and does not refer directly to source water quality. Therefore, water sources with lower water quality than the current water source were considered in the concepts analysis because existing technology can be used to treat lower quality water to the desired standard. Concepts that were not able to deliver water to Fort Collins failed the recipient criteria.

3.1.2 Practicable Screening Criteria

The following practicable screening criteria were developed in accordance with the 404(b)(1) guidelines definition for practicable stated in Section 1.5.

3.1.2.1 Institutional

The institutional criterion stated that a concept must conform to federal, state, and local laws, rules, and ordinances. The concept must not have any known or unacceptable legal or institutional issues. Examples of unacceptable concepts included concepts that are contrary to Colorado water law or other related state or federal water quality laws, or contrary to established policies of governmental agencies.

3.1.2.2 Integral to Others

The integral to others criterion stated that a concept must not utilize lands or specific concepts known to be currently used by others. However, this limitation did not apply to instances where the concept expanded on another entity's planning but would not interfere with those plans. The conflicts and costs associated with pre-empting or displacing an already planned development should be avoided. Such conflicts and costs increase as the time and effort already devoted to the concept by others increases.

3.1.2.3 Existing Technology

The existing technology criterion stated that a concept must be able to utilize existing and proven technology for construction, operation, and maintenance to reduce the risk in obtaining the firm yield. Concepts that did not rely on existing technology failed the concept screening.
3.2 Concept Development and Screening

The Corps and the Third Party Contractor developed a long list of concepts in 2007 to identify potential water supply and operational strategies for Fort Collins. Once the Common Technical Platform hydrology model process was near conclusion, the purpose and need statement was updated, and the alternatives screening process resumed. The initial long-list of concepts was supplemented based on knowledge acquired through the Common Technical Platform hydrology modeling process.

The long list was developed using insight gained through several meetings with Fort Collins that provided an in-depth understanding of its water supply system and operations, identification of strategies and water sources used by other water providers in the region, and review of other EIS projects in the region (NISP, Windy Gap Firming Project, and Moffat Collection System Project). Concepts were limited to the South Platte River Basin (including tributaries) upstream of the Weld-Morgan County line and downstream of the confluence with the St. Vrain River. No concepts involving water sources located in other states were considered due to the wide range of potential concepts available within the study area in Colorado and the substantial challenges associated with interstate water compacts. Concepts may need to be combined with a storage element to produce firm yield, and such combination occurred at later stages in the screening process.

We categorized concepts into similar concept classes (Table 3-1). Each long list concept was evaluated in the concept screening process. Descriptions of the concepts and the screening are presented in the following sections, organized by concept class. Additional information about some concepts is provided in Appendix C.

**Table 3-1. Concept classes and the number of concepts evaluated within each concept class.**

<table>
<thead>
<tr>
<th>Concept Class</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation Strategies</td>
<td>3</td>
</tr>
<tr>
<td>Hydrologic Alteration</td>
<td>3</td>
</tr>
<tr>
<td>Other Water Rights</td>
<td>4</td>
</tr>
<tr>
<td>C-BT Options</td>
<td>8</td>
</tr>
<tr>
<td>Traditional Agricultural Transfers</td>
<td>6</td>
</tr>
<tr>
<td>Alternative Agricultural Transfers</td>
<td>3</td>
</tr>
<tr>
<td>System Efficiency</td>
<td>5</td>
</tr>
<tr>
<td>Re-regulation of Agricultural Reservoirs</td>
<td>1</td>
</tr>
<tr>
<td>Reuse</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>35</strong></td>
</tr>
</tbody>
</table>

To develop concepts, we used the Fort Collins need for an additional 7,900 AF of firm yield. Analysis of the results of the Common Technical Platform hydrology modeling (including results from the Fort Collins System Model) revealed that Fort Collins requires this amount only in the
critical drought year. Often the project need implies delivery of a set quantity of additional water every year. However, Fort Collins defines firm yield as the amount of water that can be delivered in the critical drought year. Fort Collins is able to meet its future demands in most years without the project. It is during the most critical years that Fort Collins must rely on the additional supply developed by the project. Therefore, we focused on alternatives that address the project need through the critical dry years. A portion of the firm yield requirement for Fort Collins is to maintain 15 percent of annual demand in storage, which Fort Collins calls the storage reserve safety factor. For future conditions, the storage reserve safety factor is approximately 5,800 AF. Maintaining water in storage to satisfy the storage reserve safety factor represents nearly two-thirds of the Fort Collins need. Therefore, many of the following concepts involve preserving additional water in storage through the critical drought.

3.2.1 Conservation

This concept class included agricultural conservation for both C-BT and non-C-BT agricultural water use, and the foothills/plains storage transfer concept. Conservation by municipal and industrial customers of Fort Collins was considered as a need reducer rather than as a source of water that could meet the purpose and need. For more information on conservation considerations for municipal and industrial, please see Section 5 of the Purpose and Need Report for the Halligan Water Supply Project (WEST et al. 2016). All three concepts were evaluated for the NISP EIS (HDR 2007) and our analysis relied on that work.

3.2.1.1 Agricultural Conservation – Non-C-BT

The non-C-BT agricultural conservation concept relied on the idea that by reducing losses within agricultural water systems, the savings could be transferred to other uses. Appendix G to the NISP Alternatives Report (HDR 2007) has a significant amount of detail related to agricultural water conservation as a potential supply of water. The content of Appendix G in the NISP Alternatives Report was also valid for the purposes of the Halligan Project alternatives screening because it dealt primarily with long-standing water law, policy and hydrologic understanding. The major points of the appendix are summarized in the bulleted list below, followed by a discussion of certain aspects applicable to the Halligan Project that were not part of the NISP analysis.

- There is a large amount of water used for agriculture in Colorado (approximately 90 percent of stream diversions)
- The agricultural water budget includes losses from conveyance, on-field losses and other non-beneficial use, and beneficial consumptive use by the crops
- Some of the losses result in return flows to the stream system through deep percolation into tributary aquifers, spills from the distribution system, and tailwater or unused water that runs off the fields.
Return flows are often diverted by other water users who have come to rely on the continuance of upstream return flows as part of their water right appropriation. In the South Platte Basin, return flows may be re-diverted and used multiple times before leaving the state.

The State of Colorado has set precedent through case law and legislation that any salvaged water or saved water that results from conservation efforts is subjected to the prior appropriation system, and establishes that such water is not directly appropriable by the entity effecting the salvaging or saving, with the exception that saved water may be used to meet shortages within the original water right appropriation.

The concept of non-C-BT agricultural water conservation produced no firm yield and failed to meet the firm yield and recipient criteria due to the legal precedent that requires salvaged or saved water to be returned to the river for distribution in order of priority and cannot be made available exclusively to Fort Collins.

### 3.2.1.2 Agricultural Conservation – C-BT

The concept of C-BT agricultural water conservation is similar to the concept of non-C-BT agricultural water conservation described in the previous section in that it relied on the assumption that increases in agricultural water use efficiency could make water available for use by Fort Collins. The salient difference from non-C-BT water is that C-BT water originates from a transbasin source, and as such would be subject to different requirements regarding maintenance of historical return flows. C-BT agricultural water conservation was also considered as a NISP concept, and analysis of its feasibility was described in Appendix H to the NISP Alternatives Report (HDR 2007). The analysis in Appendix H is also applicable to the Halligan Project because it focused on general legal and hydrological reasoning not specific to the NISP participants.

- Conservation measures could be undertaken to reduce the demand for C-BT water by agricultural entities, thereby making those C-BT units available for purchase by Fort Collins
- There could be logistical difficulties in negotiating the terms of a C-BT agricultural water conservation program between Fort Collins and ditch companies. Complexities could also foreseeably arise due to negotiations internal to the ditch companies.
- Current Northern Water policies prohibit the transfer of C-BT units from agricultural to municipal use without showing immediate need.
- All C-BT water must be consumed within the boundaries of Northern Water, and owners of units of C-BT water are only allowed to use their allotted water exactly once. All return flows must return to the stream for the benefit of downstream water users within the Northern Water boundaries.
• C-BT water conservation programs carried out on a ditch with both native and C-BT water sources (all major regional ditches carry both C-BT and non-C-BT water) can lead to injurious reductions of native water return flows from the ditch, because the common conveyance systems for C-BT and non-C-BT water prohibit the selective application of conservation measures. These injurious return flow reductions would need to be augmented with a new firm supply.

The concept of C-BT agricultural conservation failed to meet the institutional criterion for Fort Collins because it is currently subject to the C-BT municipal cap and cannot directly acquire additional C-BT units, and also because it is not able to show the immediate need required by Northern Water for an agricultural-to-municipal transfer. This concept failed to meet the firm yield criterion due to the necessity of developing another source of firm supply to augment for the injurious reduction of return flows of non-C-BT water that would result from implementation of this concept.

3.2.1.3 Foothills/Plains Storage Transfer

The foothills/plains storage transfer concept relied on the assumption that evaporative losses can be reduced by storing water in higher-elevation foothills reservoirs rather than plains reservoirs, and that the volume of water by which the evaporative losses are reduced could be used by Fort Collins. Differences in free water surface evaporation rates between the foothills and plains, as well as differences between the typical geometry of reservoirs located in the foothills and plains both contribute to relatively lower evaporative losses for reservoirs located in the foothills as compared to those located on the plains. Foothills reservoirs have lower free water surface evaporation rates, because evaporation rates tend to decrease as altitude increases. Foothills reservoirs tend to have less surface area for the same volume of storage compared to plains reservoir because of the generally steeper terrain of the foothills region as compared to the plains.

The annual free water surface evaporation rate for the expanded Halligan Reservoir, expanded Seaman Reservoir, and Glade Reservoir (foothills reservoirs) used in the Common Technical Platform hydrology modeling was 37.5 inches, while annual free water surface evaporation rate for Timnath, Terry, and Big Windsor reservoirs (plains reservoirs) was 40 inches. These annual rates were reduced by average monthly effective precipitation and distributed monthly in accordance with the Colorado State Engineer’s Office in the General Administration Guidelines for Reservoirs (CDWR 2011).

The potential firm yield that could be developed by the foothills/plains storage transfer concept was estimated by comparing the volumes of evaporation for the same volume of stored water at different foothills reservoirs and plains reservoirs. Historical storage levels for Timnath, Terry, and Big Windsor reservoirs for the period December 1951 through October 2008 were obtained from the State of Colorado’s hydrologic database HydroBase. The historical storage levels for these plains reservoirs were used along with their area-volume curves (obtained from the Common Technical Platform hydrology modeling) to determine a time series of surface area for
each reservoir. Evaporation was computed by multiplying the surface area by the monthly evaporation rate. The monthly storage volume and evaporation volume for the three plains reservoirs were then summed together to produce a hypothetical amount of storage water to transfer to a foothills reservoir. The maximum storage of the combined plains reservoirs is approximately 36,000 AF. Using the combined storage volume from the plains reservoirs, a corresponding area was computed assuming the entire volume was stored in a foothills reservoir (note area-volume information was available for the foothills reservoir exceeding 36,000 AF). The foothills evaporation rates were applied to the surface area of the foothills reservoir. This process was repeated for all three foothills reservoirs.

The time series of annual reduction in evaporation from the analysis described above was computed (Figure 3-2). The yield from reduction of evaporation was lowest in dry years, such as the 1950’s drought, 1977 and 2002 because less water was stored in those years. Fort Collins firm yield is defined as delivery through the 1-in-50 year drought and, thus the maximum theoretical firm yield of this concept is approximately 1,000 to 1,600 AF.
In order to provide an upper-bound estimate of the evaporation volume savings from storage in a reservoir further into the foothills, the analysis above was repeated using an annual free water surface evaporation rate of 30 inches for the foothills reservoir evaporation calculations. The same precipitation data and method of calculation as used for the plains reservoirs were used for the foothills reservoirs. The results are similar to those shown in Figure 3-2, but the magnitudes are somewhat larger, with the dry-year maximum theoretical firm yield approximately 1,200 AF to 1,600 AF depending on site-specific conditions.

To obtain this yield from evaporation savings requires a 36,000 AF reservoir in the foothills, such as the Halligan Reservoir site. 36,000 AF is larger than the proposed expansion of Halligan Reservoir and the reduction in evaporation provides only a fraction of the firm yield of the proposed expansion when combined with other water sources owned by Fort Collins. The storage to yield ratio for this concept is approximately 36 to one, as compared to nearly one to one for the Halligan Reservoir expansion, and five to one for NISP. Therefore, while this concept has a maximum theoretical firm yield above the 600 AF firm yield criterion threshold, the concept requires a bigger expansion of the reservoir than Fort Collins’ Proposed Action.
Other than the firm yield issue discussed above, there are still significant technological and logistical problems with this concept. The calculation of savings from reduced evaporation that relates to the site-specificity of actual evaporation rates. Significant deviations from local average evaporation rates can exist at reservoir sites due to higher or lower than average wind speeds, and other site-specific factors such as shading. Due to the site-specificity of actual evaporation rates, a study would need to be carried out to determine the actual evaporation rate at a proposed reservoir site before an accurate estimate of the volume of savings could be obtained. In addition, flow rates and conveyance losses in river channels and canals is not an exact science and measurement errors may be a significant fraction of the maximum theoretical reduction in evaporative losses. For example, a USGS stream gage is rated as ‘excellent’ if the actual flow is within 5 percent of the measured flow (Berris 2012). In the analysis above, a 36,000 AF reservoir would be required to achieve savings of approximately 1,000 to 1,600 AF. In a year in which the entire 36,000 AF is stored and delivered from the foothills reservoir, 5 percent measurement error in an excellent stream gage exceeds the maximum theoretical evaporative savings. Conveyance losses are often estimated by water commissioners as a certain percent per mile based on experience with the river system. However, conveyance losses are rarely measured on a continual basis. It would be difficult if not impossible to accurately track the delivery of the conserved evaporation to end users.

There are further administrative complications that would pose significant obstacles to being able to deliver any water developed through a reduction in evaporation. In order to store the water at a foothills location, the water would be exchanged to the location from the original point of diversion. Depending on the flows between the original points of diversion and the foothills reservoir, this may limit the amount of water that could be stored. Delivery from the foothills facility to the recipients of the plains reservoirs would need to accurately account for conveyance losses between the foothills facility to the recipients. There are conveyance losses between the original point of diversion and the plains reservoir that would have to be maintained to prevent injury to other water users, reducing the amount of water available to store at the foothills facility. Upon delivery of the water, there may additional conveyance losses.

The measurement error associated with common methods of measuring or estimating conveyance losses, actual evaporation rates at the plains and foothills facilities, and flow rates may be approximately the same magnitude as the potential reduction in evaporation. Therefore, the foothills/plains storage transfer concept cannot be operated with available measurement technology and could not reliably deliver water to Fort Collins and was eliminated from consideration for failure to meet the existing technology and recipient criteria.

**3.2.2 Hydrologic Alteration**

This concept class included options for the alteration of local hydrologic processes with the goal of making water available to Fort Collins. The concepts of cloud seeding, forest management and phreatophyte removal described herein have previously been investigated as part of the NISP.
EIS (HDR 2007), and this previous analysis is frequently referenced here, along with comments as to the applicability of that analysis to the Halligan Project.

### 3.2.2.1 Cloud Seeding

Cloud seeding, also known as weather modification, has been used in Colorado since 1951. The process is designed to stimulate the formation of ice crystals and snowflakes by introducing a silver-iodide and acetone vapor into clouds (Vonnegut 1947). The vapor is produced by ground-based generators that burn a mixture of silver iodide and acetone. Cloud seeding has been conducted in Colorado to increase precipitation to benefit ski areas, municipalities, and for hail suppression (HDR 2007). It is difficult or impossible to distinguish the volume of rainfall caused by cloud seeding because of the complexities and uncertainties of global and regional atmospheric processes, and therefore this concept produced no firm yield and failed the firm yield criterion.

Any increases in stream runoff from precipitation developed from cloud seeding would be administered according to the prior appropriation system and could not be directly claimed by the entity performing the cloud seeding. The Colorado Weather Modification Act of 1972 specifically stated that any additional precipitation and subsequent runoff generated by cloud seeding activities will be considered property of the people of Colorado and allocated under the existing prior appropriation system. Therefore, water generated under a cloud seeding program by Fort Collins would not be directly available to Fort Collins and therefore failed the firm yield and recipient criteria and was eliminated from further consideration.

### 3.2.2.2 Forest Management

This concept relied on the assumption that an increase in runoff volume could be achieved by thinning trees from the forests of a watershed, and that this increase in runoff volume could be made available to Fort Collins. The concept of forest management was analyzed as a part of the NISP EIS, and the results of that analysis were presented as Appendix M to the NISP Alternatives Report (HDR 2007). The conclusions of the NISP analysis are entirely applicable to the Halligan Project.

- The effects of forest management practices on water yield and water quality have been studied in Colorado for over 50 years by the US Forest Service.
- Removal of trees from a watershed can possibly increase streamflow in the watershed due to reductions in evapotranspiration and canopy interception.
- The most significant increase in runoff due to forest management occurs on the rising limb of the snowmelt hydrograph.
- Successful forest management programs require at least 18-19 inches of annual precipitation (MacDonald and Stednick 2003) and there is only a small area of the Poudre watershed that has average annual precipitation in this range.
Increased streamflow attributable to forest management would likely fall under the category of salvaged water, and as such it would not be exclusively available to the party carrying out the forest management, but rather would be available to all water users in order of priority.

Adverse impacts to water quality, channel morphology, and reservoir sedimentation rates are associated with the removal of trees from a watershed.

The concept of forest management produced no firm yield and failed to meet the firm yield and recipient criteria because any quantity of increased streamflow attributable to forest management would be available to all water users in order of priority and not directly to Fort Collins. Additionally, the concept of forest management would be unlikely to be selected as the least environmentally damaging practicable alternative considering the adverse effects on water quality associated with its implementation.

### 3.2.2.3 Phreatophyte Removal

Phreatophytes are plants and trees that grow in riparian areas and consume water from the shallow groundwater aquifer. Common phreatophytes in Colorado include cottonwoods (*Populus spp*), willows (*Salix spp*), and salt cedars (*Tamarix ramosissima*). Removal of native phreatophytic plants such as cottonwoods and willows would constitute removal of habitat that would likely raise Endangered Species Act compliance issues. Salt Cedar (also known as tamarisk) is an invasive phreatophytic plant whose removal might be considered favorable. Removal of such plants and trees would reduce the amount of consumption of water from the shallow groundwater aquifer. However, similar to the cloud seeding and forest management concepts, any increases in flow due to removal of phreatophytes would be considered salvaged or saved water under Colorado water law and would revert to administration under the prior appropriation system and would not be available directly to Fort Collins. Increases in flow would be difficult to quantify and would accrue to all water users in the basin, not just to Fort Collins. Therefore, the concept produced no firm yield and failed the firm yield and recipient criteria and was eliminated from further consideration.

### 3.2.3 Other Water Rights

This concept class included transbasin projects, development of groundwater, purchasing conditional water rights and new water rights appropriations. All of the concepts discussed in this concept class were reviewed as part of the NISP EIS (HDR 2007), and the following discussion refers to the analysis carried out for the NISP EIS.

#### 3.2.3.1 Transbasin Projects

Transbasin water is diverted from one river basin for use in another basin. Fort Collins already makes use of transbasin water through the C-BT system and Windy Gap project, which divert water from the Upper Colorado River. Fort Collins also obtains transbasin water from the Michigan Ditch system that brings water into the Poudre Basin near Joe Wright Reservoir from
the headwaters of the North Platte River. In addition, Water Supply & Storage Company obtains approximately half of its source from transbasin supplies, and Fort Collins owns shares of Water Supply & Storage Company.

New transbasin projects could be developed to provide additional water supply to Fort Collins. The feasibility of several larger scale transbasin projects, including the Colorado River Return Project (also known as “The Big Straw”), the Yampa River Pumpback Project, and the Flaming Gorge Pipeline Project, was described in Appendix I to the NISP Alternatives Report (HDR 2007). All three projects were speculative and outside of the Halligan Project study area and were therefore eliminated from further consideration due to their speculative nature and the wide range of practicable concepts within the study area.

The two neighboring basins most suitable for transbasin projects capable of providing additional firm yield to Fort Collins are the Laramie and North Platte basins. Transbasin diversions from the Laramie and North Platte Rivers are governed by several U.S. Supreme Court decisions that allocate water between Colorado and Wyoming.

Five transbasin ditches currently carry water from the Laramie Basin to the Poudre Basin. The U.S. Supreme Court’s decision in the case of Wyoming v. Colorado limited annual transbasin exports from the Laramie Basin to other basins in Colorado to a maximum of 19,875 AF. This annual maximum export did not take into account the actual availability of flow, and in some drought years, the full 19,875 AF may not be available for diversion given collection system constraints. For the period 1957-2004 there was an annual average of 17,361 AF of Laramie Basin exports. For 24 of the 48 years in the period 1957-2004 there was less than an additional 1,000 AF available for export from the Laramie Basin. The annual maximum export was realized in 1959 and in more than 15 subsequent years, suggesting that any additional flow would not be available in priority to a new junior water right that could be exported to the Poudre Basin.

Two transbasin ditches currently carry water from the North Platte Basin to the Poudre Basin. The U.S. Supreme Court’s decision in the case of Nebraska v. Wyoming and Colorado limited transbasin exports from the North Platte Basin to other basins in Colorado to a maximum of 60,000 AF in any 10-year period. Based upon the last 10 years of diversion data, there is an estimated 1,000 to 2,000 AF of remaining available annual diversions from the North Platte Basin.

The potential additional transbasin diversion amount available from the Laramie and North Platte basins under the U.S. Supreme Court decisions was evaluated in the NISP alternatives report (HDR 2007). The average annual amount was estimated between 3,500 and 4,500 AFY. However, this estimate was based on historical diversions compared to the legal maximum amount and did not consider the historical availability of the water. Diversions from the North Platte and Laramie Basins were below the legal limit in the drought years of the early 2000s, falling from previous years’ diversions (HDR 2007). This indicates that water was not available to these transbasin diversions in drought years with the existing collection systems and would not
provide yield to Fort Collins in dry years. If existing collection systems could be expanded, the increased dry year yield would likely be low or non-existent because diversions into the expanded collection system would be made under a new junior priority that would likely not be in priority in dry years. In many average and wet years, the diversion limit is met by existing diversions and no additional diversions could be made by Fort Collins. Therefore, new transbasin projects produced no new firm yield and failed the firm yield criterion and were eliminated from further consideration.

3.2.3.2 Groundwater Development

This concept relied on the assumption that development of groundwater sources from either unconfined shallow alluvial aquifers underlying the Poudre basin, or the deeper Denver Basin bedrock aquifers, could be expanded to provide additional water for Fort Collins. Development of groundwater supplies from both the alluvial aquifers underlying the Poudre Basin and the Denver Basin bedrock aquifers were investigated as part of the NISP EIS, and the results of this investigation are presented in Appendix N to the NISP Alternatives Report (HDR 2007). The analysis of groundwater development carried out as a part of the NISP EIS is also applicable for the Halligan Project because the groundwater aquifers to be considered are the same since Fort Collins is located in the same region as the NISP Participants.

There has been significant development of groundwater sources in the Poudre Basin for irrigation purposes, with over 1,800 decreed ground water rights. The shallow groundwater aquifer in the Poudre Basin is hydrologically connected to the river and, as a result of this connection, pumping of groundwater causes depletions to the stream. When out of priority, these depletions would cause injury to senior surface water rights, requiring a firm supply to augment depletions in time, location, and amount to offset the depletions, in accordance with Colorado water law. Due to the junior water rights priority that new wells would obtain, stream depletions would be out of priority most of the time. Thus, development of water sources from shallow aquifers would not produce a firm yield since the water pumped from the aquifer would have to be augmented with other firm supplies. Fort Collins does not hold groundwater rights, and the wells would be pumped under new junior water rights. In order to replace the depletions caused by pumping, this concept essentially becomes equivalent to the new water right appropriation concept described in Section 3.2.3.4.

The deeper Denver Basin bedrock aquifers in the region are not hydrologically connected to the stream system to the degree that the alluvial aquifers are. Thus, the majority of water pumped from the Denver Basin bedrock aquifers would not require a full augmentation plan as is required for an alluvial aquifer. However, the Denver Basin aquifers near Fort Collins may produce only a few hundred AFY (HDR 2007). Furthermore, water providers who have relied on the Denver Basin bedrock aquifers in the productive regions in the south Denver metro area are in the process of developing surface water supplies to reduce the draw on the aquifer due to concerns about long-term sustainability of the aquifer. Thus development of the Denver Basin...
bedrock aquifer groundwater produced no firm yield and failed the firm yield criterion and was eliminated from further consideration.

### 3.2.3.3 Purchase Conditional Rights

This concept relied on the assumption that Fort Collins could purchase conditional water rights to provide for its future supply. Fort Collins proposed to acquire one sixteenth of the Grey Mountain conditional right that has a 1980 priority date. In addition, Fort Collins intends to use the Halligan Reservoir expansion water right with a 2013 priority date. Both of these conditional water rights were incorporated into Fort Collins' proposed alternative. A review of the State of Colorado's water rights database indicated that there are no significant conditional rights that could be acquired by Fort Collins in the Poudre Basin that are senior to the Grey Mountain right. The yield of the Grey Mountain right was quantified through the Common Technical Platform hydrologic modeling process. Any water right junior to this water right would yield less frequently than the Grey Mountain right and only in wetter years. Modeling also shows that Fort Collins would not be able to utilize all of its one-sixteenth share of the Grey Mountain right when it does yield, even under Fort Collins’ proposed action. Therefore, a more junior right would not provide additional yield that could reasonably be used as a dry year water supply. Thus, purchasing of additional conditional water rights produced no firm yield and failed the firm yield criterion and was eliminated from further consideration.

### 3.2.3.4 New Water Right Appropriation

This concept relied on the yield generated from a new water right appropriation. The Poudre and Big Thompson Rivers currently have many water rights dating back to the 19th century. A new water right would be junior to the conditional water rights described in the previous section and would therefore have a yield less reliable than the conditional water rights Fort Collins already anticipates acquiring in its proposed action. Therefore, a new water right appropriation produces no firm yield and failed the firm yield criterion and was eliminated from further consideration.

### 3.2.4 C-BT Options

This concept class included options for changing C-BT operations or for long-term leasing of Windy Gap Project water. Both re-operation of C-BT facilities and Windy Gap leases were considered as part of the NISP EIS (HDR 2007) and the analysis carried out as part of the NISP is applicable for the Halligan Project as well.

#### 3.2.4.1 C-BT Re-operation

Re-operation of C-BT facilities for the purpose of increasing water supply to NISP participants was discussed in Appendix K to the NISP Alternatives Report (HDR 2007). The content of Appendix K is applicable to the Halligan Project because it discussed the same facilities and operating procedures relevant to re-operation of C-BT facilities for Fort Collins. The concept relied on reoperation of C-BT facilities to create capacity for a new West Slope water right to be
used to supply Fort Collins, using C-BT facilities to convey the water. Fort Collins does not currently hold any West Slope water rights that could be used for this purpose and would have to adjudicate new Western Slope water rights. Furthermore, the C-BT system does not have the capacity to convey additional water as is evidenced by the need for the Windy Gap Firming Project. The Windy Gap Project uses excess capacity in the C-BT system to divert water from the West Slope to the East Slope. However, capacity in the C-BT system is often limited when the Windy Gap Project water rights are in priority. A similar situation would likely emerge if Fort Collins attempted to use any excess C-BT capacity after Windy Gap Project water. The junior status of the necessary new water rights, along with the lack of a Western Slope storage location combined to make the feasibility of realizing a firm yield from C-BT re-operation practically zero for Fort Collins. Therefore, the concept failed the firm yield criterion and the recipient criterion and was eliminated from further consideration.

### 3.2.4.2 Lease of Excess Windy Gap Shares

This concept relied upon the assumption that leases of Windy Gap Project water could be made available for use by Fort Collins once the Windy Gap Firming Project was completed. The purpose and need statement for the Windy Gap Firming Project stated that no long-term yield from the Project would be available for non-Windy Gap participants. Fort Collins is not a Windy Gap participant (although it uses Windy Gap water in its Reuse Plan; see Reuse Plan in Appendix C), so this concept could not be considered to provide long-term yield to Fort Collins. Permanent leases are also not permitted under Windy Gap policies (Gibbens 2003). Any lease would be a temporary lease while long-term reliability and permanency is inherent in the definition of firm yield. Therefore, the concept of Windy Gap leasing produced no firm yield and failed to meet the firm yield and was eliminated from further consideration.

### 3.2.4.3 Permanent Lease of C-BT Units

This concept relied on securing a permanent lease of C-BT units from current C-BT unit allottees. A majority of C-BT unit allotment contracts are currently owned by municipalities and the rate of acquisition of C-BT units by municipalities was estimated by Northern Water at 2,000 units per year (Northern Water 2009). Acquisition of additional C-BT units was evaluated for the NISP EIS and in response to an alternative proposed during public comments on the NISP draft EIS by an organization named “Save the Poudre: Poudre Waterkeeper,” and was determined to be limited (MWH 2010 and Hydros 2012). Municipalities have obtained C-BT supplies to meet their own demands during periods of drought and are unlikely to lease C-BT supplies to Fort Collins through a drought. It was also not clear that there would be a sufficient number of current agricultural C-BT unit allottees who would lease to Fort Collins through a dry year. Furthermore, a permanent lease may be viewed by Northern Water as similar to ownership of allotment contracts. Northern Water has a cap on C-BT units held by individual municipal and industrial providers and may treat a permanent lease the same as a sale and restrict Fort Collins’ future acquisition of C-BT units. Therefore, this concept produced no firm yield and failed the concept firm yield and institutional criteria and was eliminated from further consideration.
3.2.4.4 Permanent C-BT Carryover Program

Northern Water currently has a C-BT carryover program in place that allows C-BT unit holders to carryover up to 20 percent of a full allocation from year to year (for Fort Collins, 6,166 AF maximum). Northern Water also applies a 10 percent storage loss factor on the volume of water carried over. We analyzed a future conditions model run for Fort Collins used to determine the Fort Collins system yield to evaluate the potential firm yield that could be developed through the C-BT carryover program (Table 3-2). The model run did not include the ability to carryover excess C-BT at the end of a water year (October) and the amounts shown in Table 3-2 indicate the amount of water that would be available for use in a carryover program through the 7-year design drought. The analysis shows that Fort Collins would carry-over the full 6,166 AF from drought year four to drought year 5. At the end of drought year 5, the excess amount (assuming all other operations equal) would be 5,093 plus the 6,166 amount carried over from drought year 4, less a 617 AF (10 percent) loss, for a total excess of 10,642 at the end of drought year 5. Of this amount, Fort Collins would carryover the full amount of 6,166 AF and would begin drought year six with 5,549 AF (6,166 AF, less the 10 percent storage loss factor) of additional storage. This amount of additional storage would meet approximately 71 percent of the Fort Collins purpose and need.

The carryover program was not considered a permanent program because the program is subject to the decisions by the Northern Water Board of Directors and can be modified or terminated by the Board. Although Northern Water personnel have indicated that there are no plans to terminate the program, Northern Water has also indicated that the program cannot be made permanent because the program is at the discretion of the Board of Directors. Because Northern Water has no plans to terminate the carryover program, it was considered a reasonably foreseeable future action (RFFA) for the impacts modeling runs of the Common Technical Platform hydrology model. However, because the program is not and cannot be made permanent it was not considered in the Halligan Project firm yield runs of the Common Technical Platform hydrology model that was used to determine the need (CDM Smith 2015). Therefore, if permanent, this concept would produce a significant portion of the firm yield. This concept failed the firm yield criterion because the program cannot be made permanent and is not a permanent source of firm yield. It also failed the institutional criterion because the program is at the Northern Water Board of Directors' discretion and which is beyond Fort Collins’ institutional authority and was eliminated from further consideration.
Table 3-2. Fort Collins’ simulated excess C-BT through design drought, without C-BT carryover program.

<table>
<thead>
<tr>
<th>Year of Design Drought</th>
<th>Excess Fort Collins C-BT (lost at end of water year) (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14,179</td>
</tr>
<tr>
<td>2</td>
<td>14,204</td>
</tr>
<tr>
<td>3</td>
<td>13,213</td>
</tr>
<tr>
<td>4</td>
<td>9,396</td>
</tr>
<tr>
<td>5</td>
<td>5,093</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>6,590</td>
</tr>
</tbody>
</table>

Carryover program maximum is 6,166 AF for Fort Collins

3.2.4.5 Acquire Additional C-BT Units Directly

As discussed in the permanent lease of C-BT concept in Section 3.2.4.3, the current and future availability of C-BT units is limited and likely not sufficient to supply Fort Collins with an increase in firm yield. In addition, Fort Collins exceeds the municipal cap limit set by Northern Water on the number of C-BT units that can be owned outright by a municipal water provider and is therefore prohibited from purchasing more C-BT units directly. The municipal cap was adopted by Northern Water Resolution D-962-02-95 which identifies two methods for computing the municipal cap. The cap is the lower of the two methods.

Method 1) (Demand x 2) - Average Yield of Native Water Supplies = Max No. of C-BT Units Allowed to be Owned

Method 2) Demand - Firm Yield of Native Water Supplies = Max Volume of Firm Yield C-BT Water Allowed to be Owned

The firm yield of a C-BT unit is 0.5 AF per unit for variable quota units (all of Fort Collins units are variable quota units). Fort Collins’ Michigan Ditch water and Windy Gap water (received from Platte River Power Authority through the Reuse Plan) is not considered native water in most contexts because it is imported from the Western Slope. Northern Water verified that ‘native water’ in the context of the calculation of the C-BT cap in the Northern Water resolution refers to all non-C-BT supplies (A. Pineda personal communication 1/21/13). Northern Water also confirmed that the C-BT shares associated with a share of NPIC stock are excluded from the number of units allowed to owned, but are included in the native yield. The calculations of the municipal cap for both the Fort Collins current (2010) and future (2065) portfolio using Method 2 with Common Technical Platform hydrology model run outputs for average and firm yield values of Fort Collins’ other supplies showed that the 18,855 C-BT units owned outright by Fort Collins exceeded the cap (Table 3-3). No additional C-BT shares could be acquired directly by...
Fort Collins and therefore this concept failed the firm yield and institutional criteria and was eliminated from further consideration.

Table 3-3. Fort Collins municipal C-BT units cap calculation for current and future conditions (Method 2).

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>Future</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td>28,923</td>
<td>38,572</td>
<td>Run 1 demand for 2010, Run 8 demand for 2050</td>
</tr>
<tr>
<td>Average Yield of</td>
<td>20,730</td>
<td>25,976</td>
<td>Run 1 for current, Run 8 without Halligan for future. Average 'from pipeline' plus 4,200 AF Windy Gap</td>
</tr>
<tr>
<td>natives (exclusive of NPIC)</td>
<td></td>
<td></td>
<td>C-BT portions of NPIC shares</td>
</tr>
<tr>
<td>Average Yield of NPIC</td>
<td>16,841</td>
<td>17,737</td>
<td>4.74 AF/share average NPIC yield per Northern (A. Pineda email Jan 2013)</td>
</tr>
<tr>
<td>Firm Yield of</td>
<td>19,244</td>
<td>24,075</td>
<td>Run 1 for 2010, Run 8 w/o Halligan for 2050, tab results, minimum year through critical drought plus 4,200AF Windy Gap</td>
</tr>
<tr>
<td>natives (exclusive of NPIC)</td>
<td></td>
<td></td>
<td>C-BT quota</td>
</tr>
<tr>
<td>Firm Yield of NPIC shares</td>
<td>9,948</td>
<td>10,478</td>
<td>2.80 AF/share average NPIC yield per Northern (A. Pineda email Jan 2013)</td>
</tr>
<tr>
<td></td>
<td>20,275</td>
<td>33,431</td>
<td>Method 1; max number of C-BT units</td>
</tr>
<tr>
<td></td>
<td>(539)</td>
<td>8,039</td>
<td>Method 2; max number of C-BT units</td>
</tr>
<tr>
<td></td>
<td>18,855</td>
<td>18,855</td>
<td>2010 owned units; 2050 projected C-BT units</td>
</tr>
</tbody>
</table>

3.2.4.6 Acquire Additional C-BT Units via Purchases of NPIC Shares

Each share of NPIC stock includes the use of four C-BT units. On average, NPIC assesses approximately a 20 percent conveyance loss on these units to non-agricultural shareholders. Thus, the amount of C-BT water delivered per share of NPIC stock is 3.2 times the C-BT quota. The firm yield C-BT quota used for NISP was 50 percent for some applications and 60 percent for others (NISP DEIS, Corps 2008). Fifty percent was the appropriate value for incorporation into the Fort Collins system. Thus, each NPIC share resulted in 1.6 AF of firm yield. Approximately 85 percent of NPIC shares are projected to be owned by non-agricultural water providers in the future. Acquisition of the remaining 15 percent, if possible, would result in additional firm yield of approximately 2,700 AF. However, Fort Collins has stated that it did not believe any of the last 15 percent of the shares could reasonably be acquired based on its historical acquisition experience with other ditch companies. During its previous participation in the Halligan Project, NPIC expressed its intent to keep a portion of the service area in agricultural production. Given the competition for water rights in the Poudre Basin and NPIC’s intent to preserve agricultural production within its service area, the ability to acquire all remaining shares is improbable. Therefore, the concept failed the firm yield criterion and was eliminated from further consideration.
3.2.4.7 Require Developers to Bring C-BT Units

The Northern Water municipal cap on the purchase of C-BT units permits developers to dedicate C-BT units to the municipal and industrial providers even if the provider is already over the municipal cap. As discussed in Section 3.2.4.6, it is not clear that there are sufficient C-BT units left that could be acquired by developers to form a substantial portion of the firm yield. Therefore, this concept failed the firm yield criterion and was eliminated from further consideration.

3.2.4.8 Store Excess C-BT Water in Available Storage at the End of the Irrigation Year

For the firm yield evaluation, Fort Collins loses any remaining C-BT water at the end of the irrigation year (end of October) because the carryover program is not a permanent program and therefore was not implemented in the Common Technical Platform hydrology model firm yield run. Many C-BT unit holders release any excess C-BT water to other storage reservoirs to avoid losing any unused water and to avoid the loss charge assessed by Northern Water under the carryover program. The Fort Collins system model is not configured to release any excess C-BT water to its storage facilities for the Common Technical Platform hydrology model runs. This is due to the fact that Fort Collins' storage is limited to Joe Wright Reservoir and the Overland Gravel Pits and South Gravel Pits. C-BT water cannot be used for augmentation purposes and therefore cannot be used by Fort Collins to meet any return flow obligations. In the Common Technical Platform hydrology model configuration of the Fort Collins system, the Overland Gravel Pits and South Gravel Pits are used exclusively for meeting return flow obligations. However, in connection with other concepts discussed below (see System Efficiency, Section 3.2.7), storing excess C-BT water in these sites or other final storage elements can produce a reasonable contribution to the system firm yield in excess of the 600 AF firm yield threshold if the gravel pits can be filled with C-BT water at the end of the irrigation year. Delivery of C-BT water to non-C-BT storage facilities is already common practice in the Poudre Basin and therefore the practicable criterion is satisfied. Thus this concept satisfies all concept criteria and is retained for the preliminary alternatives formulation process.

3.2.5 Traditional Agricultural Transfers

This concept class included various methods of utilizing water transferred from irrigation use to municipal use. To assist in evaluating agricultural transfers, the Third-Party Contractor team compiled a list of the ditch companies in the Poudre River basin that identifies the number of shares in each ditch, known municipal and industrial share owners, projected share ownership by Fort Collins and other municipal and industrial entities (Table C-10 in Appendix C). Fort Collins provided input regarding the number and owners of shares in the various ditch companies. Under the NISP preferred alternative, NISP intends to exchange on approximately one-third of the shares in the Larimer and Weld Canal and New Cache Irrigation Company. This exchange by NISP would not require ownership of those shares, but it was assumed that those shares would
not be available for future acquisition by other municipal and industrial providers because they
would be needed for the NISP exchanges. The maximum estimated additional shares available
for municipal and industrial acquisition was computed as the total company shares less the
estimated future share ownership of municipal and industrial providers and NISP use.

The future conditions yield of water rights associated with each ditch were estimated using the
future conditions firm yield model results (Common Technical Platform Run 8). Modeled C-BT
deliveries were subtracted from the river headgate diversions since C-BT units are not typically
associated with a ditch share. The model results were used to quantify river headgate diversions,
farm headgate delivery and transferrable consumptive use for average year, dry year and the
critical year of the synthetic design drought for each ditch. The river headgate diversions, farm
delivery and consumptive use shown in Table C-10 of Appendix C are not observed historical
values – they are model results. Conveyance losses and on-field efficiency parameters from the
Common Technical Platform hydrology model were used to estimate farm delivery amounts and
consumptive use for each ditch. The ditch-wide yields were then divided by the total number of
ditch company shares to develop an average per-share yield. The per-share yield was then
multiplied by the estimated maximum additional shares available for municipal and industrial
acquisition to quantify the total amount of additional water potentially available for agricultural
transfers under the alternatives. Actual yields that would be realized after a water court transfer
will vary by ditch and within the same ditch, but the values in this table represented reasonable
estimates of the transferrable yield.

In Table C-10 of Appendix C, the average diversions were computed using the simulated
diversions during the historical hydrology of 1950 to 2005. The dry year diversions were the
minimum annual diversion through the 1950 to 2005 period including the 2002 drought year
which is considered more severe than the 1-in-50 design drought simulated in the synthetic
hydrology. The critical year of the synthetic drought corresponded to the fifth year of the seven-
year synthetic hydrology drought because this is the year that Fort Collins experiences shortages.
The modeling process appends the 30-year synthetic hydrology sequence to the historical
hydrology beginning in 2006, thus, the critical drought year through the synthetic period
corresponds to year 2023 in the hydrology model.

Table C-10 of Appendix C also includes estimates of return flow obligations per share,
calculated as the difference between the farm headgate delivery per share and the consumptive
use per share. This assumes that all ditch conveyance losses are not part of any transfer to
municipal use, as is customary. The return flow locations and percentages of the total return
flows simulated in the PBN are also identified on the far right side of Table C-10 of Appendix C.

The list was developed to evaluate the firm yield and integral to others criteria by quantifying the
remaining water available after accounting for known future acquisition projections. Reliable
information was not received for ditches in the Big Thompson Basin. To satisfy the recipient
criterion, only Poudre Basin ditches were considered in this listing.
Agricultural transfers have been successfully implemented throughout Colorado and are therefore considered an existing technology and conform to Colorado water law, thereby satisfying two of the practicable criteria. The following sections describe different methods and operations associated with agricultural transfers that could be pursued by Fort Collins. There is approximately 13,500 AF of consumptive use supply available from agricultural water rights in the critical year of the synthetic drought (Table C-10 of Appendix C), which satisfies the firm yield criterion threshold. Any water rights changes will require storage to meet the storage reserve safety factor that is part of the Fort Collins need, or combined with other concepts that preserve water in storage in earlier months by using transferred water instead of stored water.

### 3.2.5.1 Transfer New Agricultural Water to Intakes or Reservoirs

The concept of acquiring and transferring new agricultural water rights to intakes or reservoirs is a common practice in Colorado and has been successfully implemented by Fort Collins in the past through its South Side Ditch transfers among others. Agricultural rights are generally in priority during the irrigation season (April through October) and would therefore only be available to Fort Collins during those times. However, Fort Collins must deliver water to its customers year-round. To do so, many municipalities construct or acquire storage facilities to store the changed rights when in priority for later use, including multi-year carryover.

Fort Collins’ Proposed Action showed that existing agricultural water rights combined with additional storage at Halligan Reservoir would be sufficient to meet the purpose and need. Thus, transfer of additional water rights were not necessary to meet the purpose and need when combined with sufficient storage. The storage facility must meet the Fort Collins requirement for the storage reserve safety factor that the facility could deliver water to Fort Collins at any time, such as Halligan Reservoir or Glade Reservoir. The storage in the Overland Gravel Pits would count towards the storage safety factor if a pipeline between the Overland Gravel Pits and water treatment plant were constructed. Without the pipeline, the exchange potential between the Overland Gravel Pits and existing intakes limited the ability to divert this water by exchange at the existing intakes. Transfer of new agricultural rights without storage would require use of a substantial amount of the remaining water in the basin during the driest months of the critical drought.

The agricultural water availability listing (Table C-10 of Appendix C) showed that there is sufficient agricultural water during critical drought available in the basin when considered on an annual basis to meet the Fort Collins need (62,180 AF of consumptive use, 28,391 AF of which is at the Larimer and Weld Canal or higher). Fort Collins’ need includes maintaining the safety factor of 15 percent of annual demand in storage at all times through the critical drought. However, when considered on a monthly basis, there was not enough available agricultural water to meet Fort Collins’ demand and storage reserve safety factor without storage. A model run of future conditions without Halligan was run to demonstrate the timing of the Fort Collins need in the absence of Fort Collins’ Proposed Action. The model results showed that demand shortages occurred in August and September of the critical drought year, and that the storage reserve safety
factor was not met beginning in July of the critical drought year (Table 3-4). The model results showed that during some months of shortages in the critical drought year, there was not enough consumptive use water available in the entire Poudre Basin to meet the Fort Collins need even if all the water could be used by Fort Collins (Table 3-4). The available consumptive use shown in the Table 3-4 was derived from the consumptive use of the modeled water rights yield at each ditch headgate, multiplied by the ratio of remaining available ditch company shares to total shares as shown in Table C-10 of Appendix C. The actual amount of water available to Fort Collins would be less than the available CU shown in Table 3-4 because the minimum streamflow requirements at several locations on the Poudre River would limit the exchange potential to the Fort Collins intakes. Transfer of agricultural rights without some amount of storage did not fully satisfy the storage reserve safety factor. Nonetheless, even without additional storage or a smaller amount of storage, transferring new water rights could meet a significant portion of the Fort Collins need. The amount of water potentially available from additional agricultural transfers satisfied the purpose and need and practicable criteria and was retained for the preliminary alternatives formulation process.

Table 3-4. Availability of agricultural water during critical drought shortages (all values AF).

<table>
<thead>
<tr>
<th>Month in Critical Drought Year</th>
<th>Fort Collins Demand Shortage</th>
<th>Storage Reserve Safety Factor Shortage</th>
<th>Total Fort Collins Shortage</th>
<th>Available CU above Larimer and Weld Canal</th>
<th>Available CU Entire Poudre Basin</th>
</tr>
</thead>
<tbody>
<tr>
<td>column</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>July</td>
<td>0</td>
<td>497</td>
<td>497</td>
<td>1,270</td>
<td>7,802</td>
</tr>
<tr>
<td>August</td>
<td>0</td>
<td>3,771</td>
<td>611</td>
<td>6,647</td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>1,178</td>
<td>5,583</td>
<td>6,761</td>
<td>444</td>
<td>4,576</td>
</tr>
<tr>
<td>October</td>
<td>1,533</td>
<td>5,783</td>
<td>7,316</td>
<td>257</td>
<td>1,298</td>
</tr>
</tbody>
</table>

Explanation of Columns
1. Sum of shortages at Fort Collins system model demand nodes Citydem, LCUwc, LCUsu
2. Storage safety factor (5,786 AF) minus end-of-month system storage in Joe Wright Reservoir and Horsetooth Reservoir
3. Column 1 + Column 2
4, 5 Derived from future conditions model run water rights yields and available shares as shown in Table C-10 of Appendix C.

3.2.5.2 Acquire Water to Meet Return Flow Obligations Only

This concept relied on increasing the diversions of existing transferred agricultural water rights at the Fort Collins diversions by acquiring a different source of water to meet return flow obligations. Under Colorado water law, an entity that transfers an absolute water right to a new use or location must maintain the return flows in the time, location, and amount as the historical
use\textsuperscript{1} and the consumptive use of the transferred right may not exceed the historical consumptive use of the original water right. Water diverted under a changed water right generates a return flow obligation; a specified amount, timing, and location where the new water user must deliver flow to maintain the historical return flow pattern.

To meet return flow obligations, some transfers allow only the consumptive use portion of the water to be diverted under the changed use, and the remainder is either diverted at the original headgate and recharged near the original point of use, or simply left in the stream. However, if other sources of water are available to meet return flow obligations in the time, location, and amount as determined in the change of use decree, a larger portion of the changed water right can be diverted at the new location. Conditions under historical irrigation and after a transfer to a municipal user are depicted schematically in Figure 3-3. For example, under its South Side Ditch decree\textsuperscript{2}, Fort Collins diverts the equivalent of the Farm Headgate Delivery at its intakes. The historical ditch conveyance losses associated with the transferred shares are diverted at the original agricultural headgates. Fort Collins return flow obligations are equivalent to the on-field return flows shown in the upper portion of Figure 3-3, and are met primarily through consumable effluent from its wastewater treatment plants.

Fort Collins already takes advantage of diverting an amount larger than the consumptive use of its changed water rights. Return flow obligations generated from the use of its rights are offset to a large degree by the effluent from its wastewater treatment plants. Occasionally, Fort Collins must meet return flow obligations from other sources, such as Joe Wright or Halligan Reservoirs, gravel pit releases, or by foregoing diversions of its South Side Ditch water. Of these sources, only replacing the foregone diversions would allow Fort Collins to divert more of its South Side Ditch water. The amount of foregone diversions simulated with the Common Technical Platform hydrology model varies by model scenario, but is on the order of 100 to 400 AFY. Preserving water in storage at Joe Wright or Halligan Reservoir would also help meet the Fort Collins need, but releases from these reservoirs to meet return flow obligations are infrequent and would not produce a significant amount of firm yield. Therefore, since Fort Collins already diverts a

\textsuperscript{1} Changing a transbasin water right (also called imported or foreign water) does not generally require historical return flows to be met. This is because transbasin water is not native to the basin of use and return flows would not have been available to appropriators in the receiving basin except for the importation of water.

\textsuperscript{2} In this context, the South Side Ditches are comprised of the New Mercer Ditch, Larimer County No. 2 Ditch, and Arthur Ditch. Fort Collins’ water rights in these ditches were transferred to municipal use in Case No. 92CW129. In some contexts, South Side Ditches also includes the Pleasant Valley and Lake Canal. Fort Collins changed its shares of Pleasant Valley and Lake Canal in Case No. 80CW193.
significant portion of the changed water right in excess of the historical consumptive use and additional water rights acquired solely to meet return flow obligations would produce between 100 and 400 AF of firm yield, this concept failed the firm yield criterion and was eliminated from further consideration.

Figure 3-3. Schematic of example agricultural transfers to municipal use.

3.2.5.3 Full Utilization of Existing Rights

Fort Collins currently owns and has transferred a significant amount of agricultural water rights. The firm yield of these water rights can be increased by storing water in excess of demand when in priority and releasing at a later time when demand exceeds other supplies. In addition to the
current and future projected agricultural water rights portfolio, Fort Collins projects that it will be able to acquire a 1/16th share in the conditional Grey Mountain right and the conditional Halligan Reservoir Expansion right.

This concept, in conjunction with the proposed Expanded Halligan Reservoir storage element, is Fort Collins’ proposed action and has already been shown to meet the purpose and need criteria through the Common Technical Platform hydrology modeling process. The concept also met the practicable criteria as this is a standard method used in Colorado to develop a firm supply and was retained for the preliminary alternatives formulation process. Therefore, this concept was carried forward to the next stage of the alternatives formulation.

3.2.5.4 Deliver Transferred Water Rights to a New Advanced Water Treatment Plant on the Plains

This concept was similar to other agricultural transfer concepts, but would deliver raw water to a plains water treatment plant. The plains water treatment plant would deliver water to the eastern end of the Fort Collins potable distribution system, and could require upsizing or installation of new treated water mains and storage tanks to obtain proper hydraulic characteristics within the distribution system. This concept made lower river ditches and plains storage sites more feasible than requiring use of the existing water treatment plant near Horsetooth Reservoir. Water quality in the Poudre River degrades as it moves downstream due to a number of factors, including irrigation runoff, urban runoff, wastewater effluent discharges, temperature, and changing streambed sediments. Historically, water providers diverted water higher in the basin to take advantage of the higher quality source water. This water flowed by gravity to the water treatment plant and was treated by conventional treatment technology. More recently, in response to scarcity, water providers in the region have turned to advanced water treatment technologies in order to utilize source supplies of lower quality while still delivering high quality potable water to their customers (e.g., City of Aurora, City of Brighton, Town of Lochbuie, City of Sterling, East Cherry Creek Valley Water and Sanitation District).

An advanced water treatment plant located east of Fort Collins would be able to utilize water rights from lower ditches to deliver water of a similar quality as currently delivered to the Fort Collins customers into the eastern end of the potable distribution system. The advanced water treatment plant would likely need to treat source water located upstream of wastewater treatment plants and significant urban and agricultural return flows so that reverse osmosis is not required. Reverse osmosis, while practicable on smaller scales, generates a brine byproduct that is difficult to dispose of in large quantities. This would require diversion no lower than the Larimer and Weld Canal. The yield for remaining agricultural rights from the Larimer and Weld Canal and upstream in the critical year of the synthetic drought is approximately 41,766 AF (Table C-10 of Appendix C). In addition, existing transferred water rights could be delivered to the new advanced water treatment plant from a lower point of diversion on the stream. As shown in Table C-10 of Appendix C, storage would be required to provide a sufficient level of firm yield and year-round operation because there are not enough available agricultural rights to meet the full...
Fort Collins need in the late part of the irrigation season. Specific reservoir sites are evaluated in the preliminary alternatives formulation (Section 1). For the concept screening, it is sufficient to note that the firm yield criterion would be satisfied if associated with storage.

One advantage to a plains water treatment plant for Fort Collins would be that water stored in any reservoirs that can deliver water to the new treatment plant would count towards the safety factor. There are several agricultural reservoirs located north of Fort Collins that could serve as storage facilities for such a water treatment plant. For Fort Collins, use of pro-rata storage in NPIC reservoirs (excluding Fossil Creek Reservoir) would result in up to 16,135 AF of storage capacity for Fort Collins (Halligan Reservoir, Park Creek, NPIC Reservoir Nos. 15, 2, 3, 5, and 6) if it could obtain independent use of its pro-rata storage capacity in those reservoirs. Infrastructure to deliver reservoir releases to the new treatment plant would be required, such as diversion structures from reservoir outlets or ditch company canals, pipelines, and potentially pump stations. The general topography of the region may allow for a gravity flow system from the reservoirs to the new water treatment plant.

The Tri-Districts have stated that they intend to construct a plains water treatment plant in the future to be able to better use its agricultural water rights. Partnering with the Tri-Districts in such a treatment plant could reduce costs for Fort Collins, but the timing of the Tri-Districts water treatment plant may not align with Fort Collins need.

The evaluation of the recipient criterion relies on the assumption that the Fort Collins potable water distribution system could be modified or improved to accept a new source of water on the eastern end of the system. For the concept screening, this is a reasonable assumption, even if new infrastructure such as potable water tanks to blend supplies and additional transmission mains are required. All concept criteria are satisfied and the concept of delivering transferred agricultural water to a new advanced water treatment plant was retained for the preliminary alternatives formulation process.

### 3.2.5.5 Deliver Alternate Supply to Town of Wellington to Free-up Additional Supply for an Interruptible Supply Agreement

This concept relied on Fort Collins being able to provide 2,000 AFY to the Town of Wellington in lieu of Wellington’s normal delivery from NPIC and thus making this water available to Fort Collins through an interruptible supply agreement with NPIC. The Town of Wellington currently has a contract with NPIC for delivery of 2,000 AF from NPIC Reservoir No. 3 and this delivery is expected to become an annual delivery under future conditions. Water stored in NPIC Reservoir No. 3 serves 824 irrigated acres. The low agricultural demand from this reservoir may limit the ability to perform an intra-ditch exchange that would be required to allow Fort Collins to bypass an equal amount of water at the river headgate under an interruptible supply agreement. This concept may produce more than 600 AF on an annual basis, but the nature of an interruptible supply agreement would allow delivery of water when needed. On a monthly basis, this yield would likely be much less than 600 AF, and thus the firm yield criterion is not
satisfied. Furthermore, Fort Collins does not have the authority to modify a contract between NPIC and the Town of Wellington and therefore violated the integral to others criterion. Thus, the Alternate Supply to the Town of Wellington concept failed the concept screening and was eliminated from further consideration.

### 3.2.5.6 Change the Native Portion of Fort Collins' NPIC Shares

This concept utilized the native portion of the shares of NPIC owned by Fort Collins as a new supply. Fort Collins currently owns 35.5 percent of the NPIC shares and projects future ownership at 37.4 percent of the NPIC shares. Each NPIC shareholder is entitled to the use of four C-BT units and an equal allocation of other NPIC supplies, including native direct flow and storage rights. Fort Collins currently uses only the water from the C-BT portion of NPIC shares, and leases the native portion back to NPIC irrigators. NPIC relies on this leased supply to meet its future demands.

The yield of the native portion of a share of NPIC in the critical drought is estimated in the listing of agricultural rights (Table C-10 of Appendix C) at 2.86 AF of headgate diversion, 2.00 AF of farm delivery, and 1.40 AF of consumptive use. Due to the location of the NPIC system, return flow obligations would most likely be owed to locations somewhat distant and at a higher elevation than Fort Collins, which makes it difficult to meet return flow obligations from return flows discharged at the Fort Collins wastewater treatment plants. Thus, only the consumptive use portion of the NPIC native rights was considered. The consumptive use of the native portion of the Fort Collins NPIC shares was 7,400 AF on average and 4,398 AF in the critical drought year (3,742 shares at 1.98 AF/share and 1.18 AF/share, respectively). The majority of the annual yield of the NPIC native shares came in May and June, which would not meet any of the Fort Collins shortages (Table 3-5). The NPIC native yields in July through October of the critical drought year were fairly low and the Fort Collins consumptive portion would not be sufficient to meet the full purpose and need. The table shows that the critical year native portion of Fort Collins’ NPIC shares annual consumptive use yield 4,398 AF, but the yield in July through October was only 408 AF. This illustrates Fort Collins’ need for storage to capture water when in priority for use later in the year when yields drop to lower levels in the late summer and fall.

The critical year consumptive use yield was nearly half of the Fort Collins need if water could be used prior to the onset of shortages in July. Strategies for preserving water in storage are described in Section 3.2.7. Modeling further indicated that the NPIC native water was not needed in the Fort Collins system except in dry years. The more infrequent use is described as part of an interruptible supply agreement in Section 3.2.6. This analysis showed that conversion of the native portion of the NPIC shares alone will not meet the purpose and need. Instead, Fort Collins would have to match the native portion with additional storage in order to utilize the NPIC yield in the early summer for use in the later part of the summer when it experienced shortages in the critical year drought. This concept, when combined with a storage element, would provide a reliable amount of water over 600 AF and satisfied the firm yield criterion.
NPIC native water rights are diverted at the North Poudre Canal and the Munroe Canal. Fort Collins would take delivery of the native portion of the Munroe Canal portion of its shares either through the Munroe Canal and Pleasant Valley Pipeline or at the Fort Collins pipeline intake, located just downstream of the Munroe Canal diversion. The native portion of the shares that were historically diverted at the North Poudre Canal would be bypassed at the North Poudre Canal headgate and would be diverted at the Fort Collins pipeline through exchange from the confluence of the North Fork to the Fort Collins pipeline.

Exchange potential between the confluence of the North Fork and Poudre River down to the Fort Collins pipeline may be a limiting factor in the critical drought, but other exchanges may be possible, such as an exchange with NPIC, which would allow NPIC to divert more water at the North Poudre Canal in exchange for Fort Collins diverting more water at the Munroe Canal. Additionally, Fort Collins could exchange its NPIC water with other water users taking delivery of C-BT supplies to avoid issues with exchange potential. Thus, the recipient criterion was satisfied.

Currently, NPIC irrigators are able to use the native portion of Fort Collins' shares through leases from Fort Collins. Conversion of the native portion of its NPIC shares would reduce the yield

### Table 3-5. Critical drought yield of native portion of Fort Collins' NPIC shares.

<table>
<thead>
<tr>
<th>Date</th>
<th>Munroe Rights Yield CU (AF)</th>
<th>NPIC Rights Yield CU (AF)</th>
<th>Halligan Reservoir Rights Yield CU (AF)</th>
<th>Total Fort Collins CU (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov-22</td>
<td>0</td>
<td>0</td>
<td>333</td>
<td>333</td>
</tr>
<tr>
<td>Dec-22</td>
<td>0</td>
<td>0</td>
<td>297</td>
<td>297</td>
</tr>
<tr>
<td>Jan-23</td>
<td>0</td>
<td>110</td>
<td>60</td>
<td>170</td>
</tr>
<tr>
<td>Feb-23</td>
<td>0</td>
<td>88</td>
<td>0</td>
<td>88</td>
</tr>
<tr>
<td>Mar-23</td>
<td>0</td>
<td>56</td>
<td>0</td>
<td>56</td>
</tr>
<tr>
<td>Apr-23</td>
<td>273</td>
<td>190</td>
<td></td>
<td>463</td>
</tr>
<tr>
<td>May-23</td>
<td>183</td>
<td>810</td>
<td>0</td>
<td>993</td>
</tr>
<tr>
<td>Jun-23</td>
<td>621</td>
<td>970</td>
<td>0</td>
<td>1,590</td>
</tr>
<tr>
<td>Jul-23</td>
<td>21</td>
<td>190</td>
<td>0</td>
<td>212</td>
</tr>
<tr>
<td>Aug-23</td>
<td>4</td>
<td>86</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>Sep-23</td>
<td>0</td>
<td>83</td>
<td>0</td>
<td>83</td>
</tr>
<tr>
<td>Oct-23</td>
<td>0</td>
<td>23</td>
<td>0</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>1,102</td>
<td>2,606</td>
<td>691</td>
<td>4,398</td>
</tr>
</tbody>
</table>

Consumptive use (CU) calculation assumed 30 percent conveyance loss and 70 percent irrigation application efficiency.
delivered to NPIC agricultural users. Other NPIC shareholders intend to change the native portion of their NPIC shares for non-agricultural use, and it is within Fort Collins’ right to also use its share of the native yield of its NPIC shares. While a decision by Fort Collins to change the native portion would negatively impact the yield of the NPIC agricultural users who currently lease this supply from Fort Collins, this would not prevent Fort Collins from exercising its rights as a share owner. Thus this concept met the integral to others criterion. This concept met all purpose and need and practicability criteria and was retained for the preliminary alternatives formulation process.

3.2.6 Alternative Agricultural Transfers

This concept class included permanent interruptible supply agreement, shared water banking, and rotational fallowing.

3.2.6.1 Permanent Interruptible Supply Agreements

A permanent interruptible supply agreement is an agreement between two parties in which one party enters into a contract for the right to take delivery of the second party's water supply under defined conditions. For the purposes of this concept, the agreement would be between Fort Collins and NPIC, in which Fort Collins would have the right to take delivery of the native portion of its NPIC shares in dry years. Most agricultural water users would not enter into a permanent agreement of this nature because the value of a water right is in its dry-year yield and entering into a permanent agreement in essence sells the most valuable portion of the water right (DiNatale Water 2012). However, Fort Collins already owns more than one third of NPIC shares but only takes delivery of the C-BT units associated with each share. The interruptible supply agreement would only be implemented using the native portion of NPIC shares owned by Fort Collins so that permanency of the agreement would be established.

The interruptible supply agreement would operate by allowing Fort Collins to take delivery of the native portion of its own NPIC shares in dry years. The native portion of Fort Collins' shares would be bypassed at the North Poudre Canal and delivered to the Fort Collins intakes (by exchange to the existing intake). Fort Collins’ native portion of water at the Munroe Canal would be delivered via the Pleasant Valley Pipeline instead of to NPIC irrigators or bypassed to its existing pipeline just downstream of the Munroe Canal. Under current state water law (Section 37-75-309 CRS), a temporary arrangement can be approved by the State Engineer, provided the frequency is no more than three out of 10 years. However, a permanent change in use decree would eventually be required for permanency of the agreement, and since it is unclear if the interruptible supply agreement can be from the owner of the shares as lessor to the same owner as lessee, a permanent water court transfer was assumed. The native yield of Fort Collins' NPIC shares through the driest year of the critical drought (consumptive use only) is 4,398 AF, but the yield in July through October is only 408 AF (Table 3-5). This concept, when combined with a storage element, would provide a reliable amount of water over 600 AF and satisfied the firm yield criterion. Therefore, the purpose and need criteria are satisfied because the yield of the
As discussed in Section 3.2.5, use of the native portion of Fort Collins’s NPIC shares in every year (traditional agricultural transfer) satisfied the screening criteria. Under this concept, the frequency of use would be limited to a maximum of three of 10 years. Fort Collins would rely on triggers within its water system to decide which years to implement the interruptible supply agreement, such as C-BT quota, storage levels in Joe Wright Reservoir, or a combination thereof. Implementation triggers would be determined through final alternatives modeling. This concept is more favorable than the traditional agricultural transfer because it preserves water for agriculture in years that Fort Collins does not need the water, meeting an internal Fort Collins water policy goal. As the owner of the water rights, Fort Collins would have the right to use the water once transferred to municipal and industrial use and therefore the concept satisfied the institutional criterion and the existing technology criterion. The concept therefore satisfied all concept screening criteria and was retained for the preliminary alternatives formulation process.

### 3.2.6.2 Shared Water Banking

The concept of shared water banking relied on Fort Collins using available capacity in others' reservoirs to store excess supplies for future use. As was described in WEST et al. (2016), Fort Collins' water portfolio has water available in excess of demands in wet and average years, and even in some months of dry years, that is lost to Fort Collins due to its inability to store this water. Shared water banking would allow Fort Collins to use available storage capacity in others' facilities to store its excess supplies and later take delivery of this water during critically dry times. In return, Fort Collins would pay the owners of the storage facilities either monetarily or with water for the benefit of storing water.

To satisfy the firm yield criterion, the supply must be permanent, which implies that Fort Collins must have proposed storage facilities reliably available to them that would be used. Fort Collins owns a small portion of the shares in Water Supply & Storage Company and over one third of the shares of NPIC. The large majority of shares in both of these ditch companies are projected to be owned by non-agricultural water providers in the future. Therefore, it was assumed the ditch companies will permit activities that are beneficial for a majority of its share owners, including the use of available storage capacity in reservoirs, provided other shareholders are not injured and the ditch company is adequately compensated. For the purpose of the concept screening, only the NPIC system was considered because Fort Collins is projected to own over one third of NPIC shares and is projected to own less than five percent of the shares in Water Supply & Storage Company.

The concept would operate by allowing Fort Collins to store its surplus supplies, such as South Side Ditch, C-BT, Water Supply & Storage Company, and any excess Michigan Ditch water in available capacity of NPIC reservoirs. Under the shared water banking agreement envisioned for this concept, Fort Collins would give NPIC a percentage of all Fort Collins surplus water stored...
in the available capacity of NPIC reservoirs (e.g., 50 percent), would be subject to spill first, and would be subject to normal conveyance, evaporation, and seepage losses associated with the NPIC infrastructure. Reservoirs higher in the NPIC system would be preferred to store Fort Collins surplus water because in dry years Fort Collins would utilize its remaining water in storage by delivering water to agricultural users from these reservoirs in exchange for NPIC river headgate diversions. Thus, NPIC agricultural users receive the same amount of water as they would have absent the water banking agreement, but Fort Collins is able to take delivery of water available at the NPIC headgates in an amount equal to the amount of water it stored in the excess capacity of NPIC reservoirs. Delivery to Fort Collins would be the same as described in the permanent interruptible supply agreement concept, thereby satisfying the recipient criterion.

Common Technical Platform hydrology modeling results indicated that there is a large amount of available storage capacity in NPIC reservoirs during the 7-year critical drought and that Fort Collins has at least 1,000 AF of excess supply in all years (typically during the peak runoff), including the driest of the critical drought. Under this concept, the excess supply could be stored in the available capacity in agricultural reservoirs for use during the critical drought when supply falls below demand. Along with the permanent nature of the ownership of the NPIC shares by Fort Collins, the firm yield criterion is satisfied if Fort Collins develops the infrastructure needed to deliver water to its treatment plant year round.

Through its South Side Ditch change decree (Case No. 92CW129), Fort Collins is already able to divert and store any excess South Side Ditch supplies at NPIC headgates and major reservoirs. Similar alternate points of diversion and storage could be sought for its Water Supply & Storage Company shares. At the end of the water year, some C-BT unit holders, including NPIC, store excess C-BT supplies in non-C-BT storage facilities to avoid carryover charges from Northern Water and the loss of the C-BT water altogether. Therefore, since Fort Collins currently has the legal ability to store most of its excess water (South Side Ditch and C-BT) in NPIC reservoirs, and could reasonably obtain such a right for its Water Supply & Storage Company supplies, the institutional criterion was satisfied.

The shared water banking project would increase the water yield to NPIC agricultural users by providing a payment of water to other shareholders. The concept causes no injury to the existing shareholders and thus satisfied the integral to others criterion, but Fort Collins would need to obtain an agreement with NPIC to operate in its reservoirs in this manner. Shared water banking involves no new technology, and, because most of the source of water placed into storage has already been decreed for storage at these locations, there would be far fewer other institutional or proven technology challenges to its implementation. Thus, shared water banking satisfied all concept screening criteria and was retained for the preliminary alternatives formulation process.

3.2.6.3 Rotational Fallowing

The concept of rotational fallowing involved setting up a group of agricultural land owners who agree to fallow their land on a rotating basis. The water that would have otherwise been used to
irrigate the fallowed land would be made available for municipal use. The benefit of a rotational fallowing program is that irrigated acreage is not permanently removed from production and therefore may have fewer socio-economic and environmental impacts to the rural areas that are common in traditional agricultural transfers.

As a concept for meeting the Fort Collins need, rotational fallowing of NPIC lands irrigated primarily with native water that Fort Collins leases back to irrigators could become a permanent operation since Fort Collins owns the shares. This type of program would require a change in use case similar to that needed for a traditional agricultural transfer of NPIC shares. However, even in a 1-in-4-year fallowing program, the firm yield of the fallowing program on Fort Collins' NPIC shares would be approximately 1,100 AF. Different than the NISP, Fort Collins needs water only in dry years, and does not need a firm supply every year. This yield was relatively small for the complexity required to administer a rotating fallow program, but is more than the 600 AF threshold for firm yield and therefore satisfied the firm yield criterion.

Rotational fallowing was evaluated for the NISP Draft EIS (DEIS) (HDR 2007) and further evaluated for the NISP Supplemental DEIS (SDEIS) in response to an alternative proposed by an organization named “Save the Poudre: Poudre Waterkeeper” (Hydros 2012), and an alternative proposed by an organization called Western Resource Advocates during the public comment period. The evaluation in the NISP SDEIS determined that a rotational fallowing program would satisfy the 30 percent firm yield need of the NISP (much larger than Fort Collins' need) if the project applicant was the owner of the water rights. If ownership remained with the agricultural users, the nature of the program is temporary and would not satisfy the firm yield criteria. Hydros (2012) concluded that in Colorado, rotational fallowing was not a proven technology because no large scale rotational fallowing program had been implemented in Colorado and pilot projects (the best-known being the Super Ditch in the Arkansas River Basin) have to-date been unable to provide a reliable supply of water to municipalities. While the challenge of permanent ownership may be overcome since Fort Collins owns a large percentage of NPIC shares, the other factors such as lack of an existing functional rotational fallowing program in Colorado and other institutional challenges associated with such a program caused the concept to fail the existing technology criterion and therefore was eliminated from further consideration.

### 3.2.7 System Efficiency

This concept class included various changes to system operations that result in meeting a portion of the Fort Collins purpose and need. All of the following concepts involved modifications to

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3 A substitute water supply plan (SWSP) could be obtained from the State Engineer's Office while the formal change in use plan is in process, but is not permanent with regard to operations of a rotational fallowing program.
current operations in the Fort Collins system and therefore would be able to deliver water to Fort Collins. The concepts were not integral to the plans of others, unless specifically noted for operations that potentially impacted other entities. All concepts relied on proven strategies that utilize proven technology, and were not contrary to federal, state, or local laws. The remaining criterion to be evaluated was firm yield. The following sections describe the potential firm yield from various system efficiency operations for the concept screening.

### 3.2.7.1 Use Water Stored in Chambers Lake towards Storage Reserve Safety Factor

Fort Collins is a participant in the Joint Operations Plan, which is a plan for cooperative operations of water supply facilities owned and operated by Fort Collins, Greeley, and Water Supply & Storage Company in the Poudre basin and affecting National Forest land (Joint Operations Plan 1990). As part of the Joint Operations Plan, Fort Collins makes minimum releases from Joe Wright Reservoir to meet minimum streamflow targets. Under the Joint Operations Plan, Fort Collins releases 600 AF every October from Joe Wright Reservoir to Chambers Lake. Chambers Lake is located downstream of Joe Wright Reservoir in the Poudre River headwaters. Chambers Lake is owned by Water Supply & Storage Company. Chambers Lake releases the 600 AF of Fort Collins' water at a constant rate of two cfs from November through March and Fort Collins diverts this water at its intake lower on the Poudre River. Fort Collins does not currently account for the Joint Operations Plan water stored in Chambers Lake as part of its storage safety factor. However, the water is stored in a reservoir that can deliver water by gravity to Fort Collins and therefore should be included in the safety factor calculation. Because the storage reserve safety factor shortage is largest in October of the critical drought year, this concept would result in an increase in firm yield of 600 AF with no additional infrastructure, no new water source, and no change in operations. Therefore, the concept satisfied the firm yield criterion and was retained for the preliminary alternatives formulation process.

There is precedent for this concept already within the Fort Collins system model. When C-BT carryover is inactive, any remaining C-BT balance at the end of October reverts back to the C-BT and the Fort Collins C-BT account is emptied. A new C-BT allocation is provided in November, but the end of October C-BT storage amounts are zero. In the safety factor calculation, the water that reverted to the C-BT in the end of October counts in the storage reserve safety factor calculation. In a similar manner, the water removed from Joe Wright Reservoir at the end of October and delivered to Chambers Lake could also be included in the safety factor since it would be available for use in subsequent months.

### 3.2.7.2 Re-operation of Joe Wright Reservoir, Including Winter Carryover

This concept relied on meeting a portion of the Fort Collins need by maintaining a higher level of water in storage at Joe Wright Reservoir and thereby supplying a portion of the firm yield by increasing water in storage to meet the storage reserve safety factor. Joe Wright Reservoir is a key component of the Fort Collins system located in the headwaters of the Poudre River, and can
store water native to the Poudre River and transbasin water from Michigan Creek. Total storage capacity of Joe Wright Reservoir used in our analysis was 6,474 AF. Fort Collins owns and operates the reservoir.

In the winter, the reservoir storage is lowered to approximately 3,200 AF (half the total storage volume) to avoid icing problems in the outlet works. This concept relied on the ability of Fort Collins to carryover more water through the winter, which is counted towards the safety factor. This concept would require improvements to the outlet works to allow for higher winter carryover storage. If the reservoir were kept closer to its total storage capacity of 6,474 through the winter, more than half of the approximately 5,800 AF storage reserve safety factor would be met (additional 3,200 AF). This amount translates almost directly into firm yield for the Fort Collins system. In conjunction with other concepts, water normally delivered from Joe Wright Reservoir could be kept in storage, further increasing the potential firm yield amount of this concept. Therefore, the firm yield criterion was satisfied and the concept was retained for the preliminary alternatives formulation process.

3.2.7.3 Re-operation of C-BT Trade with NPIC Executed with Joe Wright Reservoir Releases

Under current and projected future operations, Fort Collins executes two water trades with NPIC by delivering water from Joe Wright Reservoir to NPIC via the Munroe Canal in exchange for NPIC water in Horsetooth Reservoir. The first trade is executed as part of Fort Collins' Reuse Plan (see Appendix C and CDM Smith 2015, Section 1 for details of the Reuse Plan) in which Fort Collins releases 1,771 AF of reusable Michigan Ditch water from Joe Wright Reservoir to NPIC in exchange for an equal amount (less conveyance losses) of NPIC's C-BT water (hereafter, the Reuse Trade). The Reuse Trade involves a 're-coloring' of water, meaning that NPIC uses the reusable Michigan Ditch water in a single-use manner, and Fort Collins uses NPIC's single-use C-BT water as reusable. Fort Collins has indicated that the Reuse Trade with NPIC is not permanent and Fort Collins could divert its Michigan Ditch supplies directly to satisfy its other obligations under the Reuse Plan.

The second trade with NPIC is a release of approximately 1,600 AFY in which Fort Collins delivers single-use water from Joe Wright Reservoir to NPIC in exchange for NPIC’s C-BT water in Horsetooth Reservoir (hereafter, the C-BT Trade). The amount of the C-BT Trade is reduced in some years based on an algorithm developed by Fort Collins that approximates historical operations. The first 1,000 AF of Michigan Ditch water and the first 800 AF of native Joe Wright Reservoir water is decreed single-use and this trade utilizes these single-use supplies.

The combined effect of these two water trades with NPIC is an annual release of approximately 3,300 AF from Joe Wright Reservoir. These operations help Fort Collins lower the storage level of Joe Wright Reservoir to the desired winter storage level. Common Technical Platform hydrology modeling shows that in some years through the critical drought, these operations lower Joe Wright Reservoir significantly below the desired winter storage of 3,200 AF and
negatively impact the storage reserve safety factor. In addition, Fort Collins takes delivery of NPIC’s C-BT water that cannot be carried over year to year and Fort Collins loses the benefit of carrying water over through these trades that it would have if water were kept in Joe Wright Reservoir.

This concept relied on not executing the C-BT Trade with NPIC in selected years that were identified as either low supply years or low storage years. The concept would allow Fort Collins to maintain more water in storage and carry water over from year to year in Joe Wright Reservoir. Common Technical Platform hydrology modeling showed that Joe Wright Reservoir is empty at the lowest point in the critical drought, but that the C-BT Trade is executed in all seven years of the critical drought, though at a reduced level in some years. By not executing the C-BT Trade in some years, Fort Collins would be able to keep more water in storage, thereby meeting a portion of the storage reserve safety factor.

Not executing the C-BT Trade may adversely impact NPIC in dry years if NPIC is not able to take delivery of its C-BT supplies by other means. This supply accounts for approximately 3% of the average annual NPIC supply, and about 5% during dry years. NPIC considers this water supply when making share allocations in the spring. To the extent this supply is not provided by Fort Collins, NPIC must use an exchange that is not as reliable as a direct delivery from Fort Collins. During the late part of the irrigation season when the trade normally occurs (August and September), the exchange potential from the Hansen Supply Canal to the Munroe Canal is diminished compared to the spring runoff periods. However, preliminary results from the Common Technical Platform hydrology modeling indicate that NPIC would be able to exchange most of its C-BT supply to the Munroe Canal even through the critical drought. For NPIC, the C-BT Trade allows for water diversions at the Munroe Canal during periods when, in the late summer or early fall, the exchange potential for moving CBT water released to the Poudre from the Hansen Supply Canal upstream to the Munroe Canal can be low. Although there are times when the exchange potential is sufficient to allow CBT exchanges to the Munroe Canal, NPIC cannot count on the exchange potential being available when it is needed. This is especially relevant considering that NPIC determines water allocations in the spring, and cannot predict or guarantee that CBT exchanges will be available later in the summer or fall. The deliveries from Joe Wright Reservoir provide NPIC assurance that water will be available at the Munroe Canal in late summer and early fall, and thus allow NPIC to set higher allocations in spring. However, any of NPIC’s water actually exchanged can be stored for use in subsequent years, increasing the allocation in the next year. In addition, NPIC is not limited to a direct exchange of C-BT water to its headgate; it may exchange supplies with other water users in the basin to affect the exchange, such as Greeley, Tri-Districts, or other agricultural users. This concept did not violate the integral to others criterion, even though it may result in fewer deliveries of Joe Wright Reservoir water to NPIC. Therefore, the concept firm yield criterion was satisfied and the concept was retained for the preliminary alternatives formulation process.
3.2.7.4 Enhanced Use of Overland Gravel Pits and South Gravel Pits including Exchanges

Fort Collins considered future storage in a portion of the Overland Gravel Pits and the South Gravel Pits in the future conditions modeling scenarios. Fort Collins does not currently have a right to use storage capacity in the Overland Gravel Pits but agreed that use of a portion of the Overland Gravel Pits in the future may be considered a Reasonably Foreseeable Future Action. Fort Collins completed construction of the South Gravel Pits in 2015 (now called Rigden Reservoir) with a capacity of 1,700 AF for Fort Collins Utilities. The gravel pits are configured in the Common Technical Platform hydrology modeling to meet return flow obligations associated with transferred water rights. Common Technical Platform hydrology modeling showed that the two gravel reservoirs remain nearly full throughout the critical drought. This concept relied on using the gravel reservoirs to meet both potable demands through exchanges to the Fort Collins intakes, to meet other non-potable demands in order to free up other supplies for potable use, or to preserve water in higher storage reservoirs.

One of the final elements (from Section 2) is Overland Gravel Pits gravel pit element. The City of Greeley and the Tri-Districts currently use the site for water storage, but there is potential to construct additional capacity within or near the same site. The enhanced use of the gravel pits in this concept developed firm yield without being considered in the storage reserve safety factor. However, a direct connection to the Fort Collins system would allow water stored in the Overland Gravel Pits to be considered in the storage reserve safety factor. A direct connection would require a pump station and pipeline from the Overland Gravel Pits to the Pleasant Valley Pipeline, the Fort Collins pipeline, or both pipelines, which directly connect the Overland Gravel Pits to the Fort Collins water treatment plant. For the purposes of the concept screening, a direct connection was not required to meet the screening criteria, but this does not preclude the ability to further enhance the firm yield with a direct connection.

In the Common Technical Platform hydrology modeling, the Fort Collins system model was not configured to allow exchanges of water stored in the gravel reservoirs to the municipal intakes. Much of Fort Collins' return flow obligations are met through wastewater effluent or through excess South Side Ditch yield that is not otherwise used, while water stored in the Overland Gravel Pits is not used. In fact, there are no outflows from the Overland Gravel Pits in the Common Technical Platform hydrology modeling (Run 7) other than evaporation, and the majority of South Gravel Pits releases meet winter (Nov-Mar) return flow obligations. Exchanging water from the Overland Gravel Pits and South Gravel Pits to municipal intakes could provide another source of water to Fort Collins.

Exchange potential is limited from the Overland Gravel Pits to the existing municipal intakes in the later part of the irrigation season as flows recede after the spring runoff. However, during the runoff period, there is ample opportunity for Fort Collins to exchange some Overland Gravel Pits water to the existing municipal intakes. Exchange potential is more limited from the South Gravel Pits to the municipal intakes throughout the year due to the longer exchange reach and
minimum streamflow water rights. However, there would be opportunities to exchange water from the South Gravel Pits to the Overland Gravel Pits for later exchange to the municipal intake. The potential firm yield from these exchanges would depend on the ability to meet a demand that otherwise would be met from other sources, such as releases from storage. Common Technical Platform hydrology model results showed that Fort Collins draws approximately 650 to 800 AF of water from storage May through June to meet the Reuse Plan demand, and at higher levels at other times of the year. If water stored in the gravel pits could be used to meet this demand rather than a release from storage in Horsetooth Reservoir, water would be kept in storage in Horsetooth Reservoir and count towards that storage reserve safety factor. These potential changes to operations of the Reuse Plan would require approval of the parties to that agreement and a water court application to modify the Reuse Plan Decree. As in any water court change proceeding, there is a risk to the applicants that the terms of the decree can be modified, potentially placing some of the terms of the Reuse Plan at risk. Although there are some potential institutional challenges to obtaining such modifications, it is not unreasonable at this level of screening to assume that it could not be obtained through the water court. Therefore, assuming such a modification to the Reuse Plan could be obtained, the firm yield criterion was satisfied and the concept was retained for the preliminary alternatives formulation process.

3.2.7.5 Overland Gravel Pits Releases for Non-potable Demands

Fort Collins dedicates a portion of its South Side Ditch and C-BT water supply to meet non-potable demands, such as irrigation of parks and golf courses. These supplies are delivered to the historical headgates of the South Side Ditches, located near the Overland Gravel Pits diversion point. This concept relied on delivering water from the Overland Gravel Pits to these non-potable demands and simultaneously using additional South Side Ditch water for other uses, such as meeting the reusable or single-use large contractual user demands, as an alternate source of reusable water for the Reuse Plan (if the underlying water right decree associated with the Reuse Plan were modified), storage, or simply to satisfy traditional residential and commercial demands. Similar to the exchanges of Overland Gravel Pits and South Gravel Pits water to the municipal intakes, additional firm yield would be developed by this concept if the use of water stored in the Overland Gravel Pits offset other uses of storage in the Fort Collins system or would allow Fort Collins to utilize otherwise lost sources of water at a different time of year.

Fort Collins has agreements with various entities to provide this raw water, and these potential changes to operations to use Overland Gravel Pit water instead of C-BT or South Side Ditch supplies would require approval of the parties to that agreement. Any C-BT raw obligations met from a release of Overland Gravel Pits water would be simply kept in storage in Horsetooth Reservoir and would add directly to the firm yield through the storage safety factor. On average, the amount of South Side Ditch water dedicated to raw water use is 2,450 AF (based on the 40-year decreed limitation) and is approximately 1,300 AF through the critical drought year. Annual C-BT raw obligations are 843 AF. Although there are some potential institutional challenges to obtaining agreement for use of a different water source with the recipients of the raw water supply, it is not unreasonable at this level of screening to assume that such an agreement could not be obtained. Therefore, assuming such a modification to current raw water operations could
be obtained, there would be potentially more than 2,000 AF of water through the critical drought available and thus satisfied the firm yield criterion and the concept was retained for the preliminary alternatives formulation process.

### 3.2.8 Re-regulation of Reservoirs

This concept class included the single concept of re-regulating ditch company reservoirs to provide storage for Fort Collins' use. Fort Collins projects that it will own approximately 37 percent of NPIC shares in the future and 4.4 percent of Water Supply & Storage Company shares. The large majority of shares in both these ditch companies are projected to be owned by non-agricultural water providers in the future. There is approximately 35,000 AF of storage in the NPIC system, excluding Fossil Creek Reservoir, and approximately 38,000 AF in the Water Supply & Storage Company system, half of which is located in headwater reservoirs (Long Draw Reservoir and Chambers Lake) upstream of the Fort Collins Poudre River intake. Over the past several decades, several agricultural ditch companies have entered into agreements with other water providers to allow for independent use of pro-rata storage (DiNatale Water 2013). This concept relied on Fort Collins being able to acquire independent use of a portion of its shareholder pro-rata storage in these agricultural systems to store both its pro-rata share of water from changed shares in those ditch companies and any other excess supplies (e.g., excess South Side Ditch or excess C-BT). For the purposes of this concept, it is assumed that Fort Collins could obtain storage in proportion to its ownership in NPIC and Water Supply & Storage Company reservoirs. Since both companies have a majority of non-agricultural water provider shareholders, it was not unreasonable to assume that these shareholders can operate the ditch company assets in a manner that benefits non-agricultural shareholders as well as the remaining agricultural users.

Use of the mountain storage reservoirs would be particularly beneficial to Fort Collins because the water could be counted towards the storage safety factor calculation and would flow by gravity to the existing intake structures (Halligan Reservoir releases would require an exchange from the North Fork confluence to the Fort Collins intake located just upstream of the confluence). Water Supply & Storage Company owns two major mountain reservoirs (Long Draw Reservoir and Chambers Lakes) and NPIC owns the existing capacity in Halligan Reservoir. Fort Collins’ pro-rata storage in these three reservoirs alone results in approximately 3,250 AF of storage. Re-regulation of this storage space, particularly operating to keep this capacity full through the critical drought, would result in approximately an equal amount of firm yield, thus satisfying the firm yield and recipient criteria. This action would not be contrary to state or federal laws and similar agreements are already in place in Colorado. Because non-agricultural water providers would own the majority of shares in NPIC and Water Supply & Storage Company, implementation of this concept would likely align with the plans of other municipal providers that own shares in those ditches. Thus, this concept satisfied all concept criteria and was retained for the preliminary alternatives formulation process.
3.2.9 Reuse

This concept class evaluated possibilities for reuse of wastewater effluent.

3.2.9.1 Direct Reuse for Non-potable Applications

Direct reuse refers to treating wastewater effluent to the applicable reuse standards and distributing this water for non-potable uses, such as irrigation of parks, golf courses, street medians, etc. Many municipalities in the Front Range have developed such systems and are easily recognizable by 'do not drink' signs, purple pipes, and purple irrigation valve boxes where the reuse water is used. In order to reuse wastewater effluent, the water must be a legally consumable return flow. Not all water sources are consumable. For example, Fort Collins' direct flow municipal water rights are not fully consumable and are limited to the first use through the potable water system. Similarly, C-BT water is permitted to be used one time before returning to the stream system as return flows for use by other water users. Consumable effluent is generated when a consumable water source is not fully consumed through the municipal system. For example, a portion of Fort Collins' South Side Ditch water is consumable (the amount equivalent to the historical consumptive use of the original irrigation water use). However, the first use of this water through the municipal potable system may not consume as much water as the original irrigation (e.g., cooking, bathing, clothes washing, and toilet use return a majority of water to the sewage system). A reuse system takes advantage of the available consumable effluent.

The Fort Collins system has a relatively small amount of unused consumable effluent, varying between approximately 50 AFY and 300 AFY depending on the scenario. Fort Collins has a large fully consumable water demand from large contractual users that utilizes most of the Fort Collins’ consumable water. Thus, the firm yield criterion of 600 AF was not satisfied for a direct reuse system and is therefore eliminated from further consideration.

3.2.9.2 Meet Additional Non-Potable Demand from the Platte River Power Authority Pipeline

This concept relied on meeting any future non-potable demand along the Platte River Power Authority pipeline corridor rather than supplying these areas with potable water. Fort Collins delivers treated wastewater effluent to the Platte River Power Authority power plant via a pipeline that runs north from the Drake wastewater treatment plant to the Platte River Power Authority power plant located 20 miles north of the Drake wastewater treatment plant. At the time of this report, there were no readily identified future non-potable demands in the area, and thus the concept failed the firm yield criterion and was eliminated from further consideration.

3.3 Summary of Concept Screening Results

The long-list of concepts had 35 concepts that were evaluated in Section 3.2. The screening process resulted in the elimination of 23 concepts, and retention of 13 concepts (Table 3-6).
concepts that failed were eliminated from further evaluation. The remaining 13 concepts were retained to be combined with the five final elements in the preliminary alternatives formulation process, described in Section 1. The concept screening resulted in the following:

- **Conservation** – All three concepts failed and were eliminated.
  - **Conservation of non-C-BT agricultural water** failed to meet the firm yield and recipient criteria.
  - **Conservation of C-BT agricultural water** failed to meet the institutional and firm yield criteria.
  - **Foothills/Plains Storage Transfer** failed to meet the firm yield and recipient criteria.

- **Hydrologic Alteration** – All three concepts failed and were eliminated.
  - **Cloud Seeding** failed to meet the firm yield and recipient criteria.
  - **Forest Management** failed to meet the firm yield and recipient criteria and would have adverse effects on water quality.
  - **Phreatophyte Removal** failed to meet the firm yield and recipient criteria.

- **Other Water Rights** - All three concepts failed and were eliminated.
  - **Transbasin Projects** failed to meet the firm yield criterion.
  - **Groundwater Development** failed to meet the firm yield criterion.
  - **Purchase Conditional Rights** failed to meet the firm yield criterion.
  - **New Water Right Appropriation** failed to meet the firm yield criterion.

- **C-BT Options** – All but one of the eight concepts failed and were eliminated.
  - **C-BT Reoperation** failed the firm yield and recipient criteria.
  - **Lease of Excess Windy Gap Shares** failed to meet the firm yield criterion.
  - **Permanent Lease of C-BT Units** failed to meet the firm yield and institutional criteria.
  - **Permanent C-BT Carryover Program** is not a permanent program and therefore failed to meet the firm yield criteria and institutional criteria.
  - **Acquire Additional C-BT Units Directly** failed to meet the firm yield and institutional criteria.
  - **Acquire Additional C-BT Units via Purchases of NPIC Shares** failed to meet the firm yield criterion.
  - **Require Developers to Bring C-BT Units** failed to meet the firm yield criterion.
  - **Store Excess C-BT Water in Available Storage at the End of the Irrigation Year** met all the criteria and was retained for further consideration.
• **Traditional Agricultural Transfers** – Two of the six concepts failed and were eliminated from further consideration.
  
  o **Transfer New Agricultural Water to Intakes or Reservoirs** met all the criteria and was retained for further consideration.
  
  o **Acquire Water to Meet Return Flow Obligations Only** failed to meet the firm yield criterion.
  
  o **Full Utilization of Existing Rights** met all the criteria and was retained for further consideration.
  
  o **Deliver Transferred Water Rights to a New Advanced Water Treatment Plant on the Plains** met all the criteria and was retained for further consideration.
  
  o **Deliver Alternate Supply to Town of Wellington to Free-up Additional Supply for and Interruptible Supply Agreement** failed to meet the firm yield and integral criteria.
  
  o **Change the Native Portion of Fort Collins NPIC Shares** met all the criteria and was retained for further consideration.

• **Alternative Agricultural Transfers** – One of the three concepts failed and was eliminated from further consideration.
  
  o **Permanent Interruptible Supply Agreements** met all the criteria and was retained for further consideration.
  
  o **Shared Water Banking** met all the criteria and was retained for further consideration.
  
  o **Rotational Fallowing** failed the proven technology and firm yield criteria.

• **System Efficiency** – All five of the concepts met the criteria and were retained for further consideration.
  
  o **Use Water Stored in Chambers Lakes towards Storage Reserve Safety Factor** met all the criteria and was retained for further consideration.
  
  o **Re-operation of Joe Wright Reservoir, Including Winter Carryover** met all the criteria and was retained for further consideration.
  
  o **Re-operation of C-BT Trade with NPIC Executed with Joe Wright Reservoir Releases** met all the criteria and was retained for further consideration.
  
  o **Enhanced Use of Overland Gravel Pits and South Gravel Pits including Exchanges** met all the criteria and was retained for further consideration.
  
  o **Overland Gravel Pits Releases for Non-potable Demands** met all the criteria and was retained for further consideration.
- **Re-regulation of Reservoirs** met all the criteria and was retained for further consideration.

- **Reuse** – Both Concepts failed and were eliminated from further consideration.
  - **Direct Reuse for Non-potable Application** failed to meet the firm yield criterion.
  - **Meet Additional Non-Potable Demand from the Platte River Power Authority Pipeline** failed to meet the firm yield criterion.
Table 3-6. Summary of concept screening results.

<table>
<thead>
<tr>
<th>Concept Class</th>
<th>Concept Description</th>
<th>Purpose and Need</th>
<th>Practical</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation</td>
<td>Conservation of non-C-BT agricultural water</td>
<td>X</td>
<td>X</td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>Conservation of C-BT agricultural water</td>
<td>X</td>
<td></td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>foothills/plains Storage Transfer</td>
<td>X</td>
<td>X</td>
<td>FAILED</td>
</tr>
<tr>
<td>Hydrologic Alter</td>
<td>Cloud Seeding</td>
<td>X</td>
<td>X</td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>Forest management</td>
<td>X</td>
<td></td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>Phreatophyte removal</td>
<td>X</td>
<td>X</td>
<td>FAILED</td>
</tr>
<tr>
<td>Other Water Rights</td>
<td>Transmountain projects</td>
<td></td>
<td></td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>Groundwater development</td>
<td>X</td>
<td></td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>purchase conditional rights</td>
<td></td>
<td></td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>new water rights appropriation</td>
<td></td>
<td></td>
<td>FAILED</td>
</tr>
<tr>
<td>C-BT Options</td>
<td>C-BT Project reoperation</td>
<td>X</td>
<td>X</td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>leases of excess Windy Gap shares</td>
<td></td>
<td></td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>permanent lease of C-BT units</td>
<td></td>
<td>X</td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>permanent C-BT carryover program</td>
<td></td>
<td>X</td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>acquire additional C-BT units directly</td>
<td></td>
<td>X</td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>acquire additional C-BT units via purchases of NPIC shares</td>
<td></td>
<td>X</td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>require developers to bring C-BT</td>
<td></td>
<td></td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>store excess C-BT in available storage at end of water year</td>
<td></td>
<td></td>
<td>RETAINED</td>
</tr>
<tr>
<td>Traditional Ag Transfers</td>
<td>transfer new water to intakes or reservoir</td>
<td></td>
<td></td>
<td>RETAINED</td>
</tr>
<tr>
<td></td>
<td>acquire water to meet RFOs only</td>
<td></td>
<td>X</td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>full utilization of existing rights using storage</td>
<td></td>
<td></td>
<td>RETAINED</td>
</tr>
<tr>
<td></td>
<td>deliver transferred water rights to a new advanced water treatment plant on the plains</td>
<td></td>
<td></td>
<td>RETAINED</td>
</tr>
<tr>
<td></td>
<td>deliver alternate supply to Town of Wellington to free up additional supply for an interruptible supply agreement</td>
<td>X</td>
<td>X</td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>change native portion of Fort Collins NPIC shares</td>
<td></td>
<td></td>
<td>RETAINED</td>
</tr>
<tr>
<td>Alternative Ag Transfers</td>
<td>permanent interruptible supply agreement (ISA)</td>
<td></td>
<td></td>
<td>RETAINED</td>
</tr>
<tr>
<td></td>
<td>shared water banking</td>
<td></td>
<td>X</td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>rotational following</td>
<td></td>
<td></td>
<td>RETAINED</td>
</tr>
<tr>
<td>Increased System Efficiency</td>
<td>use water stored in Chambers toward storage reserve safety factor</td>
<td></td>
<td></td>
<td>RETAINED</td>
</tr>
<tr>
<td></td>
<td>re-operation of Joe Wright reservoir, including winter carryover</td>
<td></td>
<td></td>
<td>RETAINED</td>
</tr>
<tr>
<td></td>
<td>re-operation of C-BT trade with NPIC executed with Joe Wright Reservoir releases</td>
<td></td>
<td></td>
<td>RETAINED</td>
</tr>
<tr>
<td></td>
<td>Enhanced use of Overland Gravel Pits and South Gravel Pits including exchanges</td>
<td></td>
<td></td>
<td>RETAINED</td>
</tr>
<tr>
<td></td>
<td>Overland Gravel Pit releases for non-potable demands</td>
<td></td>
<td></td>
<td>RETAINED</td>
</tr>
<tr>
<td>Reregulation of Reservoirs</td>
<td>re-regulation of ditch company reservoirs to provide storage</td>
<td></td>
<td></td>
<td>RETAINED</td>
</tr>
<tr>
<td>Reuse</td>
<td>direct reuse for non-potable applications</td>
<td></td>
<td>X</td>
<td>FAILED</td>
</tr>
<tr>
<td></td>
<td>meet additional non-potable demand from Platte River Power Authority pipeline</td>
<td></td>
<td>X</td>
<td>FAILED</td>
</tr>
</tbody>
</table>

X denotes a concept that failed the indicated screening criterion.
4 Preliminary Alternatives Development

The preliminary alternatives development process involved combining concepts with elements, screening the various concept-element combinations, and then grouping the retained combinations into preliminary alternatives to meet the full purpose and need (Figure 4-1). The preliminary alternatives were provided to Fort Collins (Corps 2012; Memorandum dated October 5, 2012) for final alternative identification by Fort Collins (Section 5).

Figure 4-1. Alternative screening process flow chart showing the screening process in four stages with the preliminary alternatives screening stage outlined in red.
Combinations of concepts and elements were generated from the final elements listed at the end of Section 2.5.2 and the final concepts listed in Section 3.3. The concept-element combinations were screened using a concept-element compatibility criterion, duplication criterion, firm yield criterion, and an environmental criterion that assessed the length of river reach affected as well as the severity of likely flow decreases. Concept-element combinations that were retained through the screening were grouped into preliminary alternatives by grouping concept-element combinations that together were likely to meet the full purpose and need and maintained a reasonable range of practicable alternatives (Section 4.2). In some instances, multiple concept-element combinations with no identifiable or discernible differences in impacts to the aquatic environment could have been incorporated into a preliminary alternative. In those cases, a best fit analysis was used to select the combination that would likely have the lowest capital costs and best operational efficiencies. In the event that any of those concept-element combinations selected through the best fit analysis prove impractical upon more detailed investigation, the combinations with no identifiable or discernible differences in impacts to the aquatic environment that were not selected through the best fit analysis will be substituted into the alternative to maintain a reasonable range of practicable alternatives as required by the NEPA and Section 404(b)(1) Guidelines.

Each preliminary alternative is expected to meet the full purpose and need. Preliminary modeling and analysis was performed to estimate the yield from various concept-element combinations to determine the potential contribution towards meeting the full purpose and need. The preliminary alternatives were developed by the Corps and the Third-Party Contractor team and are described in this Section 1. These preliminary alternatives were provided to Fort Collins for more detailed modeling and evaluation. The more detailed modeling was used to refine the preliminary alternatives and formulate the final alternatives that were carried through to the EIS (Section 5). The preliminary alternatives were formulated assuming that Fort Collins’ reasonably foreseeable future actions are implemented (CDM Smith 2015). The preliminary alternatives are not intended to change or replace Fort Collins’ reasonably foreseeable future actions and in some cases may rely upon reasonably foreseeable future actions that have not yet occurred, such as projected acquisitions of shares in agricultural ditch companies.

### 4.1 Overview of Fort Collins Infrastructure and Preliminary Modeling of Need

In order to better understand how different combinations of concepts and elements can function in the Fort Collins system, this section provides an overview of the Fort Collins water supply infrastructure and analysis of the Fort Collins need. Fort Collins diverts water from the Poudre River at its Poudre Park diversion into the Fort Collins Pipeline, located on the Poudre River just upstream of the confluence with the North Fork. In addition, Fort Collins is a participant in the Pleasant Valley Pipeline, which diverts water from the Munroe Canal and delivers it to the Fort Collins water treatment plant. The Munroe Canal diverts from the Poudre River just upstream of
the Fort Collins Pipeline. Together, the Fort Collins Pipeline and the Pleasant Valley Pipeline are the existing Fort Collins raw water supply lines.

Fort Collins owns Joe Wright Reservoir, located in the headwaters of the Poudre River, with a capacity of approximately 6,400 AF. Joe Wright Reservoir is filled with native water rights and Fort Collins' Michigan Ditch water. Michigan Ditch is a transbasin diversion with water originating in the North Platte River headwaters. As one of its reasonably foreseeable future actions, Fort Collins anticipates that it will obtain approximately 980 AF of storage in the Overland Gravel Pits located on the banks of the Poudre River, north of the city near the New Mercer and Larimer County Canal No. 2 headgates. It also projects construction of a southern gravel pit facility located near the Drake wastewater treatment plant (which has now been constructed and is known as Rigden Reservoir). Fort Collins does not own or operate Horsetooth Reservoir, but receives water from the reservoir in the form of C-BT water and Windy Gap water. Windy Gap water is provided to Fort Collins from the Platte River Power Authority under terms and conditions of the Reuse Plan. Fort Collins also owns shares in several ditch companies and has changed some of these shares to municipal use. Fort Collins currently uses changed water rights from the South Side Ditch (Arthur Ditch, New Mercer Canal, Larimer County Canal No. 2, Pleasant Valley and Lake Canal) and uses the four C-BT units per share associated with its shares of NPIC.

In order to further identify the timing and magnitude of the Fort Collins project need, Common Technical Platform hydrology model Run 8 (future demand, with expanded Halligan Reservoir) was modified such that future demands were simulated without the expanded Halligan Reservoir. Results of this model run were used to identify the timing and magnitude of the shortages to be met by the preliminary alternatives. The modeling showed that Fort Collins does not experience shortages every year, and only showed shortages in the most severe of the one-in-fifty year design drought. The magnitude of the shortages in that year were approximately equivalent to the project need of 7,900 AF. The term firm yield often refers to the amount of water needed annually by a water provider. However, since the shortages occur only in one year, the Fort Collins need can be met by increasing the dry year yield of its system.

Fort Collins has determined that a storage reserve safety factor of 15 percent of annual demand must be kept in storage at all times. This equates to a minimum storage of approximately 5,800 AF in storage using the future demand of approximately 38,600 AF. The modified Common Technical Platform hydrology model Run 8 indicated that Fort Collins storage falls to zero during the design drought. Therefore, the ability to keep 5,800 AF of water in storage through the design drought accounts for approximately 75 percent of the overall need and thus played a pivotal role in each alternative.

4.2 Concept-Element Combinations and Screening

The process of screening concept-element combinations for use in a preliminary alternative used up to four screening criteria sequentially. Retained concept-element combinations formed the
components of the preliminary alternatives. Some combinations did not meet the full purpose and need individually, but were later grouped with other concept-element combinations into preliminary alternatives that were expected to do so.

4.2.1 Concept-Element Combinations

The concept screening resulted in retaining 13 concepts (Section 3.3), and the element screening resulted in retaining five elements (Section 2.5.2). In addition to the list of final elements, a 'no new storage' element was included in the process of combining concepts and elements to allow for a concept that can operate without use of one of the final storage elements. Thus, 13 concepts and six elements were combined for 78 concept-element combinations (Table 4-1). This was accomplished by developing a matrix whereby concepts were listed in rows and elements were listed in columns. The concepts were grouped by concept class (similar types of concepts, see Section 3.2).

Table 4-1. Concept-element combination matrix showing all possible combinations of final concepts and final elements and results of concept-element screening.

<table>
<thead>
<tr>
<th>Concept Class</th>
<th>Concept Description</th>
<th>No New Storage</th>
<th>Halligan Reservoir</th>
<th>Glade Res. with NISP</th>
<th>Overland Gravel Pits</th>
<th>Pro-Rata Ag. Storage</th>
<th>Joe Wright Reservoir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Ag Transfers</td>
<td>transfer new agricultural water to intakes or reservoir</td>
<td>E</td>
<td>Y</td>
<td>Y</td>
<td>retained</td>
<td>retained</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>full utilization of existing rights</td>
<td>D</td>
<td>retained</td>
<td>retained</td>
<td>retained</td>
<td>retained</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>deliver transferred water to a new advanced water treatment plant on the plains</td>
<td>retained</td>
<td>C</td>
<td>C</td>
<td>retained</td>
<td>retained</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>change the native portion of Fort Collins NPIC share</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>Alternative Ag Transfers</td>
<td>permanent uninterruptible supply agreement (ISA)</td>
<td>retained</td>
<td>E</td>
<td>retained</td>
<td>retained</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>shared water banking</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>retained</td>
<td>Y</td>
<td>C</td>
</tr>
<tr>
<td>Increased System Efficiency</td>
<td>use water stored in Chambers Lake towards storage reserve safety factor</td>
<td>retained</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>re-operation of Joe Wright Reservoir, including winter carryover</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>retained</td>
</tr>
<tr>
<td></td>
<td>Re-operation of C-BT trade with NPIC executed with Joe Wright Reservoir Releases</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>retained</td>
</tr>
<tr>
<td></td>
<td>enhanced use of Overland Gravel Pits and South Gravel Pits including exchanges</td>
<td>retained</td>
<td>C</td>
<td>C</td>
<td>retained</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Overland Gravel Pit releases for non-potable demands</td>
<td>retained</td>
<td>C</td>
<td>C</td>
<td>retained</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Reregulation of Reservoirs</td>
<td>re-regulation of ditch company reservoirs to provide storage</td>
<td>Y</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>retained</td>
</tr>
<tr>
<td>C-BT</td>
<td>store excess C-BT in available storage at end of the irrigation year</td>
<td>retained</td>
<td>Y</td>
<td>retained</td>
<td>retained</td>
<td>retained</td>
<td>Y</td>
</tr>
</tbody>
</table>

Key
- C = combination eliminated under the compatibility screening criterion
- D = combination eliminated under duplicate screening criterion
- Y = combination eliminated under the firm yield screening criterion
- E = combination eliminated under the aquatic environmental impacts screening criterion
- retained = combination retained for preliminary alternatives formulation

4.2.2 Concept-Element Screening

Every possible combination of the concepts and elements that advanced to the alternatives formulation process were screened using the criteria described in Table 4-2. In order to maintain
a reasonable range of practicable alternatives, the screening criteria were applied sequentially, but ensuring that at least one concept-element combination remained within each concept class.

Table 4-2. Concept-element combination screening criteria presented in order of application.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compatibility</td>
<td>Concept-element combinations must be compatible</td>
</tr>
<tr>
<td>Duplication</td>
<td>Concept-element combinations must not be duplicates of other concept-element combinations</td>
</tr>
<tr>
<td>Firm Yield</td>
<td>Concept-element combination must contribute at least 600 AF of firm yield</td>
</tr>
<tr>
<td>Aquatic Environment Impacts</td>
<td>Eliminate concept-element combinations that would most negatively impact streamflows based on length reach and severity of the impact.</td>
</tr>
</tbody>
</table>

### 4.2.2.1 Compatibility Screening Criterion

The compatibility criterion eliminated concept-element combinations where specific concepts were paired with specific storage elements that were not compatible with each other. Specific pairings may not be compatible by definition of the concept or storage element. Concept-element combinations with four concept classes were eliminated with the compatibility screen.

#### 4.2.2.1.1 Traditional Agricultural Transfers

The concept of delivering transferred water to a new advanced water treatment plan on the plains combined with the expanded Halligan Reservoir or the expanded Glade Reservoir was eliminated. Both the expanded Halligan Reservoir and the expanded Glade reservoirs are located in the foothills and are situated to deliver water to the existing water treatment plant much more practicably to a more eastern plains water treatment plant. The purpose of the plains water treatment plant is to be able to utilize water resources lower in the basin. By storing the water high in the basin, the purpose of the concept was lost.

#### 4.2.2.1.2 Alternative Agricultural Transfers

The concept of shared water banking combined with either Joe Wright Reservoir or the expanded Halligan Reservoir was eliminated because the concept required sharing storage capacity with other reservoir owners and Joe Wright Reservoir and the expanded Halligan reservoirs are owned by Fort Collins.

#### 4.2.2.1.3 Increased System Efficiency

The concept of using water stored in Chambers Lake towards storage reserve safety factor required no new storage so combinations with all other elements were eliminated.

The concept of re-operation of Joe Wright Reservoir, including winter carryover was compatible only with Joe Wright Reservoir, so combinations with all other elements were eliminated.
The concept of re-operation of C-BT trade with NPIC executed with Joe Wright Reservoir releases was compatible only with Joe Wright Reservoir, so combinations with all other elements were eliminated.

The concept of enhanced use of Overland Gravel Pits and South Gravel Pits including exchanges by definition involved the Overland Gravel Pits and South Gravel Pits. Both the expanded and non-expanded versions of the Overland Gravel Pits functioned with this concept. If the Overland Gravel Pits are not expanded, it would be considered no new storage, so combinations with all other elements were eliminated.

The concept of Overland Gravel Pits releases for non-potable demands relied on keeping water in higher storage by using Overland Gravel Pits water to meet South Side Ditch raw water obligations and C-BT raw water obligations. The concept is only applicable to non-expanded Overland Gravel Pits (no new storage element) or the expanded Overland Gravel Pits (Overland Gravel Pits element) so combinations with all other elements were eliminated.

4.2.2.1.4 Re-Regulation of Reservoirs
The sole concept in this class relied on using existing agricultural reservoirs. Only the elements of no new storage and pro-rata agricultural storage used existing agricultural reservoirs. All other elements were eliminated.

4.2.2.2 Duplication Screening Criterion
The duplication criterion eliminated duplicate concept-element combinations that were formed through the concept-element matching process. Concept-element combinations with two concept classes were eliminated with the duplication screen.

4.2.2.2.1 Traditional Agricultural Transfers
The concept of full utilization of existing rights combined with the no new storage element duplicated several concepts within the system efficiency concept class so that combination was eliminated.

The concept of transferring native portions of NPIC shares is essentially the same as the concept of a permanent interruptible supply agreement when considering that Fort Collins would enter into a permanent interruptible supply agreement only using its owned shares of NPIC. The native portion of NPIC that Fort Collins could transfer would only be needed in drought years, which is how the interruptible supply agreement would operate. Therefore, the concept of transferring native portions of NPIC shares when combined with any of the final elements was eliminated under the duplication screen.

4.2.2.2.2 Alternative Agricultural Transfers
The concept of a permanent interruptible supply agreement combined with the pro-rata storage element is essentially the same as the shared water banking concept so was eliminated.
4.2.2.3 Firm Yield Screening Criterion

The firm yield criterion eliminated concept-element combinations that did not produce at least 600 AF of firm yield. The firm yield criterion was already evaluated in concept screening, but assumed a generic storage element, if needed, to develop firm yield from the concept. In the concept-element screening, firm yield of the specific concept-element combination was evaluated. In some instances, a determination that a concept-element combination would deliver no firm yield was possible without additional analysis of modeling results. In other cases, the Common Technical Platform hydrology modeling results were used to quantify the potential firm yield available to a specific concept-element combination. In accordance with the purpose and need statement, firm yield for Fort Collins required that the concept-element combination provide a supply of water through the design drought. Concept-element combinations with four concept classes were eliminated with the firm yield screen.

4.2.2.3.1 Traditional Agricultural Transfers

As Fort Collins’ Proposed Action, the expanded Halligan Reservoir has been shown to meet the project need without additional water rights. Fort Collins’ future conditions water rights are sufficient without additional acquisitions if stored in the expanded Halligan Reservoir. Therefore, additional agricultural rights did not produce any additional firm yield needed for the purpose and need at the expanded Halligan Reservoir. Therefore, the concept of transferring new agricultural water to intakes or reservoirs combined with the expanded Halligan Reservoir element was eliminated.

The proposed expansion of Glade Reservoir has a capacity at least as large as the proposed expansion of Halligan Reservoir. The river reach between Fort Collins’ existing South Side Ditch water rights and the expanded Glade Reservoir inlet is shorter than to the expanded Halligan Reservoir. The shorter river reach ensures that Fort Collins’ ability to exchange its rights to the expanded Glade Reservoir is better than to the expanded Halligan Reservoir, and so additional water rights stored at the expanded Glade Reservoir would likewise not increase the firm yield needed for the purpose and need. Therefore, the concept of transferring new water rights to intakes or reservoirs combined with the expanded Glade Reservoir element was eliminated.

4.2.2.3.2 Alternative Agricultural Transfers

The shared water banking concept relied on permanent use of storage, so only storage in which Fort Collins had a property interest could generate permanent firm yield. Therefore the combination with no new storage, Expanded Glade, and Overland Gravel Pits elements were eliminated because they relied on non-permanent agreements involving storage not controlled by Fort Collins.
4.2.2.3.3 Re-regulation of Reservoirs
The concept of re-regulating agricultural reservoirs relied on permanent use of storage. The combination with the no new storage element would have required an agreement with other agricultural ditch companies with existing storage in which Fort Collins has no property interest. Since Fort Collins would not have property interest such reservoir facilities owned by other ditch companies, this combination was eliminated because the non-permanent nature of the use of the facilities would not provide any firm yield. Using the same logic, the combination of this concept with pro-rata agricultural reservoirs (in which Fort Collins has a property interest), was retained.

4.2.2.3.4 C-BT Options
The concept of storing excess C-BT in available storage at the end of the water year (October) relied on the ability to deliver water to the specific storage element. Exchange potential through the design drought was evaluated in the Common Technical Platform hydrology modeling and showed that the ability to exchange C-BT water from the Hansen Feeder Canal (where C-BT is introduced to the Poudre River) to the upstream expanded Halligan Reservoir and Joe Wright Reservoir was less than 600 AF in October of two years of the design drought. Therefore, these two elements in combination with storing excess C-BT were eliminated because they failed the firm yield criterion.

4.2.2.4 Aquatic Environment Impacts Screening Criterion
The environmental criterion was applied to the remaining concept-element combinations within a concept class and eliminated the combinations that appeared to result in the most severe impacts to the affected stream reach in terms of the severity of impact or length of the affected stream reach. Many concepts involved the use of river exchanges, which can increase or reduce the streamflow between two points, depending on the location of the exchange and if the exchanged water is subsequently released back to the stream from a storage facility. The environmental screening criteria took potential flow reductions and likely severity of streamflow impacts into account. The streamflow impacts screening was applied to each concept class and eliminated combinations with the most flow reduction or longest stream reach impacted within each concept class, but was only applied if at least one concept-element combination would remain within that class. At least one combination within each concept class was preserved so that a range of practicable alternatives could be developed using concepts from each concept class. Concept-element combinations with two concept classes were eliminated with the firm yield screen.

4.2.2.4.1 Traditional Agricultural Transfers
The concept of transferring new agricultural water rights to intakes or reservoir combined with the no new storage element required depleting the majority of the flow below the Fort Collins intake in dry months and was therefore eliminated.
The concepts of transferring new agricultural water to intakes or reservoirs, full utilization of existing rights, or delivering transferred water rights to a new advanced water treatment plant on the plains combined with Joe Wright Reservoir element would impact the longest length of stream reach of all the elements due to the length of the required river exchange and were therefore eliminated.

### 4.2.2.4.2 Alternative Agricultural Transfers

The concept of a permanent interruptible supply agreement combined with the Joe Wright Reservoir element would impact the entire Poudre River. The concept of a permanent interruptible supply agreement combined with the expanded Halligan Reservoir element would impact the North Fork below the expanded Halligan Reservoir. Therefore, these combinations were eliminated because the length of stream impacted is longer than other combinations in this concept class.

#### 4.3 Preliminary Alternatives Configuration

The concept-element screening resulted in 25 retained combinations, indicated by the white cells with the word “retained” in Table 4-1. We configured the preliminary alternatives by combining the retained concept-element combinations that share the same element (i.e., within a single column of the matrix in Table 4-1). If the concept-element combinations associated with a single element were unlikely to meet the purpose and need, other combinations utilizing other elements were added to the preliminary alternative configuration. We estimated the firm yield of various combinations using preliminary modeling results.

In some cases, multiple concept-element combinations could reasonably be included in the preliminary alternative configuration. In those cases, the combination that appeared to have fewer impacts to the aquatic environment were selected. In cases where the impacts to the aquatic environment had no identifiable or no discernible difference, a best fit analysis was used to select the combination that was estimated to have lower capital costs or the best operational efficiencies. This process resulted in a wide range of practicable preliminary alternatives that utilized all of the final elements and at least one concept from each concept class.

The grouping of concept-element combinations in this manner produced five preliminary alternatives, including Fort Collins’ proposed action. Of the 25 retained concept-element combinations, 18 were used in at least one of preliminary alternatives, and the remaining seven were not selected through a best fit analysis. In addition to the five preliminary alternatives, Fort Collins produced a no action alternative described in more detail in Section 5. Table 4-3 shows the 25 retained Fort Collins concept-element combinations and indicates the preliminary alternative in which each is utilized. We named each preliminary alternative using the primary element feature of the alternatives, listed below.
• Fort Collins’ Proposed Action
• Expanded Glade Preliminary Alternative
• Gravel Pits Preliminary Alternative
• Mountain Reservoir Preliminary Alternative
• Alternative Agricultural Transfer Methods Preliminary Alternative

In Table 4-3, each cell with an abbreviated preliminary alternative name indicates that combination of a concept and element was incorporated into that preliminary alternative. Cross hashed cells indicate a combination of a concept and element that was not selected through a best fit analysis. Descriptions of the preliminary alternatives and the best fit analyses are provided in Sections 4.3.1 to 4.3.6.

Table 4-3. Concept-element combination matrix showing the preliminary alternative in which the concept-element combination was used.

<table>
<thead>
<tr>
<th>Concept Class</th>
<th>Concept Description</th>
<th>No New Storage</th>
<th>Halligan Reservoir</th>
<th>Glade Res. with NISP</th>
<th>Overland Gravel Pits</th>
<th>Pro-Rata Ag. Storage</th>
<th>Joe Wright Reservoir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Ag Transfer</td>
<td>transfer new agricultural water to intakes or reservoir</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mt. Res.</td>
</tr>
<tr>
<td>Traditional Ag Transfer</td>
<td>full utilization of existing rights</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Proposed Action</td>
</tr>
<tr>
<td>Traditional Ag Transfer</td>
<td>deliver transferred water to a new advanced water treatment plant on the plains</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Exp. Glade</td>
</tr>
<tr>
<td>Traditional Ag Transfer</td>
<td>change the native portion of Fort Collins NIPIC shares</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Gravel Pits</td>
</tr>
<tr>
<td>Alternative Ag Transfer</td>
<td>permanent interreservoir supply agreement (ISA)</td>
<td>Mt. Res. Alt. Ag</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative Ag Transfer</td>
<td>shared water banking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased System Efficiency</td>
<td>use water stored in Chambers Lake towards storage reserve safety factor</td>
<td>Exp. Glade</td>
<td>Gravel Pits</td>
<td>Mt. Res. Alt. Ag</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased System Efficiency</td>
<td>re-operation of Joe Wright Reservoir, including winter carryover</td>
<td>Mt. Res.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Gravel Pits Alt. Ag</td>
</tr>
<tr>
<td>Increased System Efficiency</td>
<td>Re-operation of C-BT trade with NIPIC executed with Joe Wright Reservoir Releases</td>
<td>Mt. Res.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased System Efficiency</td>
<td>enhanced use of Overland Gravel Pits and South Gravel Pits including exchanges</td>
<td>Exp. Glade</td>
<td>Mt. Res. Alt. Ag</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased System Efficiency</td>
<td>Overland Gravel Pit releases for non-potable demands</td>
<td>Exp. Glade</td>
<td>Mt. Res. Alt. Ag</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulating of Reservoirs</td>
<td>re-regulation of ditch company reservoirs to provide storage</td>
<td>Mt. Res.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Gravel Pits</td>
</tr>
<tr>
<td>C-BT</td>
<td>store excess C-BT in available storage at end of the irrigation year</td>
<td>Mt. Res.</td>
<td>Exp. Glade</td>
<td>Gravel Pits</td>
<td></td>
<td></td>
<td>Alt. Ag</td>
</tr>
</tbody>
</table>

Key:
- Shaded = concept-element combination eliminated in screening (see Section 4.2)
- Cross hatch = concept-element combination not selected through best fit analysis (see Section 4.3.6)
- Text = abbreviation for preliminary alternative in which concept-element combination is used

Preliminary Alternative Abbreviations:
- Proposed Action = Fort Collins’ proposed action
- Exp. Glade = Expanded Glade Reservoir preliminary alternative
- Gravel Pits = Gravel Pits preliminary alternative
- Mt. Res. = Mountain reservoir preliminary alternative
- Alt. Ag = Alternative Agricultural Transfer methods preliminary alternative

The following sections describe each preliminary alternative including a list of concept-element combinations used in the formulation and description of operations of that preliminary alternative. In addition, a list of potential modifications and/or additions to each preliminary
alternative was also included in the event that additional detailed modeling indicates that the full purpose and need is not met by the preliminary alternative. Some concept-element combinations were not selected through a best-fit analysis and were not used in any of the preliminary alternatives. Section 4.3.6 describes the best-fit analysis in more detail.

Any concept-element combination that in the future is determined to be impractical through more detailed analysis may be replaced with another concept-element combination that was not selected through the best fit analysis. In the event that an element is determined to be not practicable, other elements not selected in the element screening best fit analysis can be substituted into the concept-element combination in order to maintain a wide-range of practicable alternatives.

4.3.1 Fort Collins’ Proposed Action

Fort Collins’ Proposed Action is to enlarge Halligan Reservoir by 8,125 AF. Halligan Reservoir is an existing reservoir located on the North Fork upstream of the North Poudre Canal. Fort Collins would use existing water supplies and water rights to fill the expanded Halligan Reservoir when exchange potential is available. The alternative includes use of the conditional Halligan Reservoir storage right as well as 1/16th of the conditional Grey Mountain right. Fort Collins would use water stored in the expanded Halligan Reservoir by releasing water through the dam into the North Fork below and then diverting the water by exchange from the confluence of the North Fork and the Poudre River to the Fort Collins intake or Munroe Canal headgate (and subsequent diversion into the Pleasant Valley Pipeline), located on the Poudre River. The Fort Collins intake is a half mile upstream of the confluence with the North Fork, and the Munroe Canal is located a mile upstream of the Fort Collins intake.

4.3.1.1 Fort Collins’ Proposed Action Concept-Element

- Full utilization of existing rights concept with enlarging the Halligan Reservoir element.

4.3.1.2 Fort Collins’ Proposed Action Elements

- Halligan Reservoir element with an additional capacity of 8,125 AF.

4.3.1.3 Fort Collins’ Proposed Action Operations

To fill the expanded Halligan Reservoir, Fort Collins would fully utilize its existing water rights by exchanging water from its transferred agricultural rights to the expanded Halligan Reservoir when exchange potential is available. This includes the changed South Side Ditch and Water Supply & Storage Company water rights. Under this alternative, Fort Collins would not store any of its Water Supply & Storage Company direct flow rights or excess C-BT supplies in the expanded Halligan Reservoir. In addition, Fort Collins would store the Grey Mountain and Halligan Reservoir Expansion conditional water rights in priority at Halligan Reservoir.
Fort Collins cannot take physical delivery of the water released from the expanded Halligan Reservoir because the confluence of the North Fork and Poudre River is just downstream of the Fort Collins intakes (both the original pipeline and the Pleasant Valley Pipeline via the Munroe Canal). In order to use the water in the expanded Halligan Reservoir, Fort Collins must exchange the water from the confluence to its intakes. In the event of limited exchange potential between the intakes and the confluence, Fort Collins may be able to deliver the Halligan Reservoir water to the City of Greeley’s intake or other downstream water users and take delivery of a like amount of water from the other user's C-BT account.

In addition to releasing water via exchange to the Fort Collins intakes, Fort Collins could also use releases from the expanded Halligan Reservoir to meet return flow obligations that arise from its use of transferred agricultural water rights. Additional releases to meet return flow obligations could be made when other sources (e.g., consumable effluent and releases from Overland Gravel Pits or South Gravel Pits) are not sufficient to meet the return flow obligations. Under its proposed action, Fort Collins would also release three cfs from Halligan Reservoir throughout the winter and divert this water via exchange at its intakes. Consumable effluent resulting from use of this water could be used to meet return flow obligations or could be stored in the South Gravel Pits for later use.

4.3.1.4 Fort Collins’ Proposed Action Potential Modifications

Fort Collins’ Proposed Action did not require any modifications to meet the full project need because final modeling has already been performed through the Common Technical Platform hydrology modeling process. Fort Collins’ Proposed Action was simulated in Common Technical Platform hydrology model Runs 3c, 4c, 5a, and 8 (refer to Section 1.3).

4.3.2 Expanded Glade Preliminary Alternative

The Expanded Glade Preliminary Alternative involved enlarging Glade Reservoir (if constructed by Northern Water) by 8,125 AF beyond what is proposed in the NISP EIS. Under this alternative, water that would have been stored in the expanded Halligan Reservoir in Fort Collins’ Proposed Action would instead be diverted at the Poudre Valley Canal or the Munroe Canal and delivered into Glade Reservoir. Diversions through the Poudre Valley Canal would initially be delivered to the expanded Glade Reservoir forebay and subsequently pumped into the expanded Glade Reservoir. If Glade Reservoir is constructed pursuant to the NISP proposed action, the Munroe Canal would be partially inundated by Glade Reservoir, so there is potential that Glade Reservoir could be filled at least partially from the realigned Munroe Canal. Water released from Glade Reservoir would be delivered to Fort Collins either through an exchange to its intakes, an exchange through the C-BT system, or a pipeline from Glade Reservoir to Fort Collins facilities.
4.3.2.1 Expanded Glade Preliminary Alternative Concept-Element Combinations

- Glade Reservoir with NISP element with full utilization of existing rights concept.
- Glade Reservoir with NISP element with 'store excess C-BT in available storage at end of water year'.

4.3.2.2 Expanded Glade Preliminary Alternative Elements

- Glade Reservoir with NISP element with Fort Collins capacity of 8,125 AF. This is in addition to others' Glade Reservoir capacity as part of NISP.

4.3.2.3 Expanded Glade Preliminary Alternative Operations

To fill the Glade Reservoir expansion, Fort Collins would fully utilize its existing water rights by exchanging water from its transferred agricultural rights to Glade Reservoir when exchange potential is available. This would include the changed South Side Ditch and Water Supply & Storage Company water rights. Under this alternative, Fort Collins would store its Water Supply & Storage Company direct flow rights and excess C-BT supplies in the expanded Glade Reservoir. In addition, Fort Collins would store its portion of the Grey Mountain and Halligan Reservoir Expansion conditional water rights in priority at the expanded Glade Reservoir. It is assumed that a change in location decree could be obtained to store these rights at Glade Reservoir.

At this stage of the screening process, several Glade Reservoir options were being evaluated as part of the NISP Supplemental Draft EIS (SDEIS), which included options for a Glade Reservoir to Horsetooth Reservoir pipeline and a Glade Reservoir to Carter Lake pipeline. Both pipeline scenarios would allow Fort Collins to divert water either directly from the pipeline or from Horsetooth Reservoir. If not relying on a pipeline for deliveries from Glade Reservoir, Fort Collins would not able to take physical delivery of the water released from Glade Reservoir because the Glade Reservoir outlet would be located downstream of the Fort Collins intakes (both the original Fort Collins pipeline and the Pleasant Valley Pipeline via the Munroe Canal). In the absence of a new pipeline, or in the event that pipeline capacity is limited between Glade Reservoir and the Fort Collins water treatment plant, Fort Collins could construct its own pipeline from Glade Reservoir, or could exchange its releases from Glade Reservoir to the existing Fort Collins intakes. In the event of limited exchange potential between the intakes and the confluence, Fort Collins may be able perform a trade with other water users by delivering the Glade Reservoir water to other downstream water users and take delivery of a like amount of water from the other user's C-BT supply.

If a pipeline is built between Glade Reservoir and Horsetooth Reservoir or between Glade Reservoir and Carter Lake with a turnout to the Fort Collins treatment plant, Fort Collins' storage in Glade Reservoir could be counted towards the storage reserve safety factor. If no pipeline is built, and Fort Collins had to rely on an exchange to its intakes, the use of storage in Glade Reservoir for the storage safety factor would be more questionable. In Fort Collins' Proposed
Action, Fort Collins counts storage in Halligan Reservoir towards its storage reserve safety factor even though an exchange from the North Fork confluence to the intakes is required. This exchange reach would be a short distance without any intervening water users, which would reduce the risk of limited or no exchange potential. The location of the Glade Reservoir outlet would be near the location where the Hansen Supply Canal enters the Poudre River. The Greeley intake and the Pleasant Valley Canal are upstream of the Glade Reservoir outlet and diversions at either headgate would reduce exchange potential to the Fort Collins intakes and potentially limit Fort Collins' ability to divert its Glade Reservoir water by exchange, especially in dry years. Thus, if there is no Glade Reservoir to Horsetooth Reservoir or Glade Reservoir to Carter Lake pipeline, the storage in Glade Reservoir should not be counted towards the storage reserve safety factor.

Fort Collins could also fill its portion of the expanded Glade Reservoir with excess C-BT supplies at the end of the water year. C-BT supplies stored in Horsetooth Reservoir can be delivered directly to Glade Reservoir through the Hansen Canal and the Windsor Extension. The Windsor Extension is a canal that diverts from the Hansen Canal, enters a siphon under the river, and delivers water to the Poudre Valley Canal. From the Poudre Valley Canal, C-BT water could be delivered to the Glade Reservoir forebay and pumped into Glade Reservoir.

### 4.3.2.4 Expanded Glade Preliminary Alternative Potential Modifications

In the event that final modeling of the Expanded Glade Preliminary Alternative as described above does not meet the full project need, additional concept-element combinations that passed the concept screening will be added to the alternative configuration. While any of the concept-element combinations shown in Table 4-1 are eligible for consideration, the most likely candidate to help in meeting the overall need are the system efficiency concepts described more fully in the Mountain Reservoir Preliminary Alternative. The only reason that the full project need would not be met under this alternative is if storage in Glade Reservoir cannot be used for the storage reserve safety factor. In that case, the system efficiency concepts are designed to maintain water in other storage reservoirs, which would assist in meeting the storage reserve safety factor.

### 4.3.3 Gravel Pits Preliminary Alternative

The Gravel Pits Preliminary Alternative involved expansion of the Overland Gravel Pits by using berms to provide additional above-grade storage. In addition, a pipeline and pump station from the Overland Gravel Pits would be constructed with a connection to the existing Pleasant Valley Pipeline for delivery to the Fort Collins water treatment plant. This preliminary alternative is hereafter referred to as the Gravel Pits Preliminary Alternative.

Greeley and the Tri-Districts currently own the Overland Gravel Pits site, each at 50 percent. It was assumed that Fort Collins would be able to obtain 25 percent of the expansion (half of Greeley's portion) from Greeley based on past discussions with Fort Collins, Greeley and the
Corps (personal communication C. Peter, Corps 2012). Based on States West Water Resources Corporation's estimate of an additional 5,157 AF of additional above-grade storage, Fort Collins' total storage would be 2,270 AF (980 AF below-grade storage plus 25 percent of the expansion). In addition, the element screening identified several mine sites near the Overland Gravel Pits site that may provide additional gravel pit storage opportunity for Fort Collins if Greeley and the Tri-Districts are unwilling to provide storage to Fort Collins under the terms previously discussed. Under this alternative, the Overland Gravel Pits and pipeline would act as another intake for the Fort Collins system. As such, Fort Collins' supplies delivered to the Overland Gravel Pits could meet the potable demand in addition to return flow obligations as used in Fort Collins’ Proposed Action. Fort Collins’ storage in the Overland Gravel Pits would be counted towards the storage reserve safety factor.

Water quality in the Poudre River at the Overland Gravel Pits could be worse than at the upstream diversion points due to a number of factors (see Section 3.2.5). A water pre-treatment facility may be required to treat water diverted and stored at the Overland Gravel Pits facility to standards comparable to the raw water delivered through the Pleasant Valley Pipeline prior to introducing this supply into the pipeline that carries other water providers’ water. Such a treatment facility could treat water near the Overland Gravel Pits or near the interconnection point with the Pleasant Valley Pipeline. Additional water quality information was required to determine the level of pre-treatment required (see Section 5.4).

The Gravel Pit Preliminary Alternative also involves several system efficiency concepts that are designed to keep water in storage through the design drought to meet the storage reserve safety factor, as discussed below.

### 4.3.3.1 Gravel Pits Preliminary Alternative Concept-Element Combinations

- **The Overland Gravel Pits element was combined with multiple concepts:**
  - Full utilization of existing rights.
  - Store excess C-BT in available storage at the end of the water year.
  - Enhanced use of the Overland Gravel Pits and South Gravel Pits including exchanges from South Gravel Pits to the Overland Gravel Pits intake and meeting reusable demand.
  - Overland Gravel Pits releases for non-potable demands (raw water obligations of South Side Ditch and C-BT).
- **The Joe Wright Reservoir element was combined with the ‘Re-operation of C-BT Trade with NPIC Executed with Joe Wright Reservoir Releases' concept.**
- **The No New Storage element was combined with the concept 'use of Joint Operations Plan water stored in Chambers Lake in the Safety Factor calculation'.**
4.3.3.2 Gravel Pits Preliminary Alternative Elements

- Overland Gravel Pits element. The preliminary alternative included a pump station from river, diversions from New Mercer and Larimer County No. 2 canals, and outlets to the river located above and below the Larimer and Weld Canal as shown in a map of the Overland Gravel Pits (Water Management Consultants, received as Exhibit A from the City of Greeley, September 25, 2012) with appropriate modifications for the above-grade storage and new pump station to the pipeline to the Pleasant Valley Pipeline, and pre-treatment facility.

- Joe Wright Reservoir (existing reservoir without modification to the outlet structure).

4.3.3.3 Gravel Pits Preliminary Alternative Operations

The Gravel Pits Preliminary Alternative involved several components, including the expanded Overland Gravel Pits and Pipeline, pre-treatment facility, and changes to operations at Joe Wright Reservoir and other Fort Collins operations.

4.3.3.3.1 Operations at the Overland Gravel Pits

A key component of this preliminary alternative was the expansion of the Overland Gravel Pits with an associated pipeline connecting the gravel pits to the Pleasant Valley Pipeline, the Fort Collins pipeline, or both. With the pipeline from the gravel pits to the Pleasant Valley Pipeline, or the Fort Collins pipeline, Fort Collins would be able to deliver water from the Overland Gravel Pits directly to its water treatment plant and therefore all of Fort Collins' storage in the Overland Gravel Pits could be incorporated in the storage reserve safety factor calculation. Under this preliminary alternative, Fort Collins would divert its South Side Ditch and Water Supply & Storage Company supplies at the Overland Gravel Pits and deliver to the water treatment plant through the new pipeline. This operation would potentially allow for increased utilization of its South Side Ditch and Water Supply & Storage Company water because the Overland Gravel Pits are located below the Water Supply & Storage Company headgate and at or below three of the four South Side Ditch agricultural headgates. The Arthur Ditch headgate is located just downstream of the Overland Gravel Pits, and water from the Arthur Ditch would be exchanged to the Overland Gravel Pits. Compared to other preliminary alternatives that rely on exchanges to Fort Collins’ upstream intakes, use of the South Side Ditch rights at the Overland Gravel Pits will enhance streamflows between the existing Fort Collins intakes and the Overland Gravel Pits diversion point because the water would not have to be exchanged to the existing intakes.

Fort Collins would also be able to divert a portion of the conditional water rights at the Overland Gravel Pits and South Gravel Pits when space is available. Due to the relative junior priority of the conditional water rights, much of the yield of the conditional rights may not be able to be stored. However, under the Fort Collins Proposed Action, on average only 7 percent of the available conditional water rights yield was stored, so reduced ability to store these rights would not be a significant factor in meeting the purpose and need.
Fort Collins loses a significant amount of C-BT water in most years (annual average of more than 9,500 AF) in the Common Technical Platform firm yield model runs because the C-BT carryover program was inactive for those model runs. The C-BT losses are greater when the C-BT quota is larger. Under this alternative, Fort Collins would use the Overland Gravel Pits to carryover a portion of its C-BT at the end of the water year. Fort Collins would release excess C-BT to the Overland Gravel Pits and South Gravel Pits at the end of the water year, provided there is available capacity, in order to reduce the C-BT losses. The C-BT stored in the Overland Gravel Pits could be delivered directly to the water treatment plant via the Overland Gravel Pits Pipeline or could be used to meet other potable or non-potable C-BT obligations.

Fort Collins supplies could be further utilized by exchanging water from the South Gravel Pits to the Overland Gravel Pits. Exchange potential is often limited between the South Gravel Pits and the Overland Gravel Pits. However, when exchange potential is available, water in the South Gravel Pits could be exchanged to the Overland Gravel Pits for storage or to meet potable or non-potable demands from the Overland Gravel Pits. Fort Collins has a significant reusable water demand that is met from various sources. Use of the Overland Gravel Pits or exchanged South Gravel Pits water to meet the reusable demands would allow Fort Collins to keep other reusable sources in storage at Horsetooth Reservoir and Joe Wright Reservoir, thereby helping meet the storage reserve safety factor. These potential changes to operations may require modification of the Reuse Plan and would require approval of the parties to that agreement and a water court application to modify the Reuse Plan Decree. As in any water court change proceeding, there is a risk to the applicants that the terms of the decree can be modified, potentially placing some of the terms of the Reuse Plan at risk.

Fort Collins provides a significant amount of South Side Ditch and C-BT water to meet non-potable demands, such as irrigation of parks and golf courses. Fort Collins dedicates approximately 20 percent of its Platte Valley & Lake Canal, New Mercer, and Arthur Ditch shares and 5 percent of its Larimer County Canal No. 2 shares to non-potable demands. In addition, Fort Collins provides nearly 800 AF of C-BT water annually to non-potable demands, delivered to the agricultural headgates of the South Side Ditches. Under this alternative, Fort Collins would meet these non-potable demands from water stored in the Overland Gravel Pits, thereby freeing up shares of South Side Ditch normally dedicated to non-potable use, for potable use. By increasing the use of South Side Ditch water to meet potable demands, use of C-BT water could be reduced and thereby maintain more water stored in Horsetooth Reservoir. Similarly, using Overland Gravel Pits water to meet C-BT obligations would keep more water in Horsetooth Reservoir. Both operations would help maintain water in storage to meet the storage reserve safety factor and minimize the amount of storage required at the Overland Gravel Pits.

Preliminary modeling of the expanded Overland Gravel Pits and Pipeline indicated that much of the Fort Collins need was met through these modifications, but the storage reserve safety factor was not fully satisfied. Thus, additional concept-element combinations that help meet the storage safety factor were incorporated into the alternative.
4.3.3.2 Operations at Joe Wright Reservoir

Joe Wright Reservoir stores water derived from native water rights and from transbasin supplies via the Michigan Ditch. The first 1,000 AF of water from the Michigan Ditch is decreed as single-use only (i.e., does not generate any consumable effluent after the first use), and the first 800 AF of native water rights is decreed as single use. Thereafter, the inflows to Joe Wright Reservoir are considered reusable. Fort Collins uses the reusable water and the single use water in Joe Wright Reservoir for different demands within its system. In addition, winter storage at Joe Wright Reservoir is limited to approximately 3,200 AF (approximately 50 percent of total capacity) due to icing problems in the outlet works at higher storage levels.

In order to use its water and drop the reservoir level for the winter, Fort Collins releases up to 3,400 AF from Joe Wright Reservoir to NPIC via the Munroe Canal in August and September. The release is a combination of reusable and single-use water. The reusable component is part of the Reuse Plan (see Appendix C, Section C.1.2.3) and is a trade of Fort Collins' reusable water in Joe Wright Reservoir for NPIC's C-BT water stored in Horsetooth Reservoir, referred to in this report as the Reuse Trade (see Section 3.2.7.3). The Reuse Trade re-categorizes a like amount of NPIC's C-BT water in Horsetooth Reservoir as reusable supply for Fort Collins, and NPIC uses the delivery of reusable Joe Wright Reservoir water as single-use C-BT water. Fort Collins takes delivery of the reusable water in Horsetooth Reservoir and uses the consumable effluent from this water to meet its obligations under the Reuse Plan. The single-use component of the Joe Wright Reservoir release is delivered to NPIC and Fort Collins receives a like amount of NPIC's C-BT water in Horsetooth Reservoir. This operation is referred to as the C-BT Trade this report (see Section 3.2.7.3). Once the C-BT Trade is executed, Fort Collins is not able to carry the water over from year to year in Horsetooth Reservoir and this water is lost at the end of the water year if not otherwise used in the Fort Collins system.

Under Fort Collins’ Proposed Action, the C-BT Trade was reduced in some years, but the C-BT Trade is performed through the 7-year design drought. In this preliminary alternative, the C-BT Trade would be reduced even further such that no C-BT Trade would be made in years when Joe Wright Reservoir did not fill to at least 5,000 AF within the water year. Preliminary modeling indicated that this would keep approximately 2,500 AF of water in storage at Joe Wright Reservoir through the critical drought, which directly meets 2,500 AF of the project need by meeting the storage reserve safety factor.

This operation may potentially reduce the supply to NPIC if NPIC was not able to directly exchange its C-BT supplies in August and September. Preliminary modeling indicated that this reduction in the C-BT Trade would not be needed in more than three of 10 years for Fort Collins. In years when the C-BT Trade is not implemented, NPIC’s allocation may be reduced by 3% to 5% if it determines that it cannot rely on an exchange of its water stored in Horsetooth Reservoir. It appears that there would be sufficient exchange potential for NPIC to exchange a significant portion of its C-BT water without the trade with Fort Collins in most years, but the exchange is less reliable than a direct delivery from Fort Collins through the C-BT Trade. For NPIC, the C-
BT Trade allows for water diversions at the Munroe Canal during periods when, in the late summer or early fall, the exchange potential for moving CBT water released to the Poudre from the Hansen Supply Canal upstream to the Munroe Canal can be low. Although there are times when the exchange potential is sufficient to allow CBT exchanges to the Munroe Canal, NPIC cannot count on the exchange potential being available when it is needed. This is especially relevant considering that NPIC determines water allocations in the spring, and cannot predict or guarantee that CBT exchanges will be available later in the summer or fall. In other words, the deliveries from Joe Wright Reservoir provide NPIC assurance that water will be available at the Munroe Canal in late summer and early fall, and thus allow NPIC to set higher allocations in spring. Any water actually exchanged could be stored and would increase allocations in the following year. Streamflow reductions that would occur from NPIC exchanging this C-BT water to the Munroe Canal headgate in years when Fort Collins does not execute the C-BT Trade could be minimized through a variety of other potential exchanges or trades between NPIC and Fort Collins, Greeley, NISP (if permitted with a diversion at the Poudre Valley Canal) or the Tri-Districts. This operation would not require modification to the Joe Wright Reservoir outlet works because it assumed winter storage could be reduced to approximately 3,200 AF, which is the current winter operating level.

4.3.3.3 Other Operations

Currently, Fort Collins releases 600 AF of water from Joe Wright Reservoir to Chambers Lake in October. Chambers Lake is located upstream of the Fort Collins intakes in the headwaters of the Poudre River. This water is subsequently released from Chambers Lake to the Fort Collins intakes at a rate of two cfs throughout the winter and helps meet minimum streamflow targets associated with the Joint Operations Plan. Under Fort Collins’ Proposed Action, Fort Collins’ water stored in Chambers Lake was not included in the storage reserve safety factor calculation. In this preliminary alternative, this water would be counted towards the storage reserve safety factor. This operation would meet 600 AF of the project need without any infrastructure or modifications to stream or reservoir operations; it would simply be a recognition of Fort Collins' water stored in Chambers Lake as part of the storage reserve safety factor calculation.

4.3.3.4 Gravel Pits Preliminary Alternative Potential Modifications

In the event that final modeling of the Gravel Pits Preliminary Alternative as described above does not meet the full project need, additional retained concept-element combinations may be added to the alternative configuration. While any of the concept-element combinations shown in Table 4-1 would be eligible for consideration, the most likely candidates to increase yield to meet the purpose and need are the concept of transferring new water rights to intakes or reservoir matched with the Overland Gravel Pits element, and the concept of re-regulating agricultural reservoirs with the pro-rata storage element, specifically Water Supply & Storage Company mountain storage.

There are additional shares in agricultural ditch companies available for acquisition by Fort Collins. The analysis of available agricultural supplies (see Section 3.2.5) indicated that there are
additional shares of Water Supply & Storage Company and Larimer and Weld Canal available. Either of these ditch companies would be suitable with the Gravel Pits Preliminary Alternative since transferred water could be diverted at the Overland Gravel Pits. Transferred Water Supply & Storage Company water rights would enhance flow from the Water Supply & Storage Company headgate to the Overland Gravel Pits. The Larimer and Weld Canal headgate is less than a mile downstream of the Overland Gravel Pits so exchanges would impact a relatively short section of the Poudre River.

The re-regulation of agricultural reservoirs option would allow Fort Collins to fully utilize its pro-rata share of Water Supply & Storage Company mountain reservoir storage. Fort Collins owns and has recently changed 26.42 shares of the total 600 shares in Water Supply & Storage Company. Fort Collins' pro-rata share of storage in Water Supply & Storage Company mountain reservoirs based on its 26.42 shares would be approximately 840 AF. In the change of water rights (Case No. 11CW265), Fort Collins obtained the independent use of at least 393 AF in Chambers Lake. Its additional pro-rata storage in Long Draw Reservoir was not considered in the recent change of use case. Under this alternative, Fort Collins would use this storage independently from other Water Supply & Storage Company operations and maintain its storage in the mountain reservoirs full. The storage in the Water Supply & Storage Company mountain reservoirs would be included in the storage reserve safety factor calculation. Acquisition of additional shares of Water Supply & Storage Company would also increase this pro-rata amount of mountain storage.

4.3.4 Mountain Reservoir Preliminary Alternative

The Mountain Reservoir Preliminary Alternative utilized strategies and operations to preserve water in storage to assist in meeting the storage reserve safety factor and other Fort Collins demands to meet the full project need. This involved use of pro-rata shares in Water Supply & Storage Company mountain reservoirs, re-operation of Joe Wright Reservoir, and other operational strategies designed to keep water in storage with a preference for storage that can be carried over year to year (i.e., non-C-BT facilities due to assumption of no future C-BT carryover). In this alternative, the Overland Gravel Pits were not expanded and there was no pipeline between the Overland Gravel Pits to the Pleasant Valley Pipeline. Fort Collins' Overland Gravel Pits capacity was set to 980 AF as defined in the reasonably foreseeable future actions.

4.3.4.1 Mountain Reservoir Preliminary Alternative Concept-Element Combinations

- Pro-rata storage in Water Supply & Storage Company mountain reservoirs and re-regulation of ditch company reservoirs concept.
- Joe Wright Reservoir and reoperation of Joe Wright Reservoir, including winter carryover concept.
- No new storage with multiple concepts:
o Use of water stored in Chambers Lake for storage safety factor.
o Enhanced use of Overland Gravel Pits and South Gravel Pits including exchanges to intakes and meeting reusable demand.
o Overland Gravel Pits releases for non-potable demands (raw water obligations of South Side Ditch and C-BT).
o Store excess C-BT in available storage at the end of the water year.

4.3.4.2 Mountain Reservoir Preliminary Alternative Elements

- Pro-rata storage in agricultural reservoirs, specifically Water Supply & Storage Company mountain reservoirs (Long Draw Reservoir and Chambers Lake, total of 841 AF).
- Joe Wright Reservoir (existing reservoir with modification to the outlet structure).
- No new storage (use of 980 AF in Overland Gravel Pits without expansion)

4.3.4.3 Mountain Reservoir Preliminary Alternative Operations

The Mountain Reservoir Preliminary Alternative involved several components, including use of pro-rata storage in agricultural reservoirs, reoperation of Joe Wright Reservoir, and multiple system efficiency concepts that were designed to maintain water in storage to help meet the storage reserve safety factor.

4.3.4.3.1 Pro-rata Storage in Water Supply & Storage Company Mountain Reservoirs

Water Supply & Storage Company mountain storage is comprised of Chambers Lake and Long Draw Reservoir totaling 19,119 AF. Fort Collins currently owns 26.42 shares of the 600 total Water Supply & Storage Company shares. If Fort Collins can acquire independent use of its pro-rata storage, this would result in 841 AF of storage in Chambers Lake and Long Draw Reservoir. Each additional share of Water Supply & Storage Company Fort Collins acquires would result in an additional 31.86 AF of pro-rata storage in those reservoirs. In order to help meet the storage reserve safety factor, Fort Collins would maintain its pro-rata portion of these reservoirs full using its pro-rata share of the Water Supply & Storage Company yield at those reservoirs. Pro-rata storage would include full independent use of the storage capacity, including carryover from year to year. It was anticipated that by keeping the reservoirs full, Fort Collins would spill a portion of the pro-rata share of the inflows to the reservoirs. This spilled water would be used first to meet other reusable demands in the Fort Collins system or stored in the Overland Gravel Pits or South Gravel Pits rather than lost. Water stored in the Water Supply & Storage Company mountain reservoirs would be counted towards the storage safety factor since it could be delivered to the Fort Collins water treatment plant directly. This operation met 841 AF of the project need by keeping the pro-rata portion of the reservoirs full, and may meet other Fort Collins demands if any water spilled from the Water Supply & Storage Company mountain reservoirs can be used in the Fort Collins system where stored water would otherwise be used, such as meeting the reusable demands of large contractual users or the Reuse Plan. The use of
pro-rata Water Supply & Storage Company storage in this manner may reduce the annual yield to Fort Collins from the Water Supply & Storage Company shares if spilled water cannot be used. Any potential loss of yield would be verified in the final modeling of the alternatives.

4.3.4.3.2 Operations at Joe Wright Reservoir

Fort Collins owns Joe Wright Reservoir and the Michigan Ditch system, which is more fully described in the Gravel Pits alternative (Section 4.3.3). The existing Joe Wright Reservoir outlet works has an operational limitation that requires winter storage to be reduced to approximately 3,200 AF during the winter due to icing issues. The full capacity of Joe Wright Reservoir is 6,474 AF. Under this alternative, modifications to the outlet works would allow for higher winter carryover storage. Preliminary modeling performed for this preliminary alternative indicated that if improvements to the outlet were made, Joe Wright Reservoir could be maintained at 4,500 AF through the critical drought by reducing the amount of water traded with NPIC in the C-BT Trade. The C-BT Trade is more fully described in the Gravel Pits alternative and elsewhere (see Section 4.3.3 and Section 3.2.7.3). In order to reduce the impact of the C-BT Trade, final modeling could be used to refine the year-to-year decision on whether it is necessary to target the full 4,500 AF in storage at Joe Wright Reservoir, based on the amount of C-BT and Windy Gap water remaining in storage as the end of the irrigation year nears. For example, if it were clear that there would be enough C-BT water in Horsetooth Reservoir to maintain the storage reserve safety factor through the irrigation season (e.g., in high C-BT quota years), then the storage level in Joe Wright Reservoir could be dropped below the 4,500 AF target.

4.3.4.3.3 System Efficiency Concepts

Fort Collins releases 600 AF of water from Joe Wright Reservoir to Chambers Lake in October. This water would be counted towards the storage safety factor as described more fully in the Gravel Pits alternative operations (Section 4.3.3).

Common Technical Platform hydrology modeling showed that under Fort Collins’ Proposed Action, the Overland Gravel Pits and the South Gravel Pits were full through the critical drought and made minimal releases through the entire 86-year simulation. This indicated under-utilization of the storage in the gravel pits. The following operations detail how Fort Collins could utilize the Overland Gravel Pits and South Gravel Pits to meet a portion of the project need.

Fort Collins takes deliveries from Horsetooth Reservoir year-round to satisfy the obligations to the Platte River Power Authority under the Reuse Plan. The Reuse Plan requires Fort Collins to treat an amount of reusable water that will result in 350 AF per month (4,200 AFY) of consumable effluent, which is then piped to Platte River Power Authority's Rawhide power plant north of Fort Collins. Historically, Fort Collins has used reusable supplies it has in Horsetooth Reservoir and from the releases of reusable Michigan Ditch water from Joe Wright Reservoir to meet this demand. Releases from Joe Wright Reservoir satisfy Fort Collins' portion of the winter Joint Operations Plan flow targets in the headwaters and are diverted at the pipeline to meet a
portion of the Reuse Plan demand. Releases from reusable water in Horsetooth Reservoir reduce the amount of water in storage that can be included in the storage reserve safety factor calculation.

By using available consumable supplies such as Water Supply & Storage Company or the reusable portion of its South Side Ditch water, or by exchanging water stored in the Overland Gravel Pits to the intakes to meet the Reuse Plan demand, water could be kept in storage in Horsetooth Reservoir, thereby increasing water in storage available to meet the storage reserve safety factor. Fort Collins uses 4,200 AF of Windy Gap water stored in Horsetooth Reservoir to meet its large contractual users reusable demand. Similarly, by using available South Side Ditch water or by exchanging water from the Overland Gravel Pits to the intakes, the large contractual user reusable demand could be met with other sources and the Windy Gap water could be kept in storage in Horsetooth Reservoir. Utilizing the Overland Gravel Pits water as described above may create storage capacity for Fort Collins to exchange SGP water to the Overland Gravel Pits during the limited times that there is exchange potential between the two gravel pit facilities. This would further enhance the ability of Fort Collins to maintain the storage reserve safety factor by using another source (South Gravel Pits) that was under-utilized in the Fort Collins Proposed Action. These potential changes to operations of the Reuse Plan would require approval of the parties to that agreement and a water court application to modify the Reuse Plan Decree. As in any water court change proceeding, there is a risk to the applicants that the terms of the decree can be modified, potentially placing some of the terms of the Reuse Plan at risk.

Fort Collins also provides a significant amount of South Side Ditch and C-BT water to meet non-potable demands, such as irrigation of parks and golf courses. Fort Collins dedicates approximately 20 percent of its Pleasant Valley and Lake Canal, New Mercer, and Arthur Ditch shares and 5 percent of its Larimer County Canal No. 2 shares to non-potable demands. In addition, Fort Collins provides nearly 800 AF of C-BT water annually to non-potable demands, delivered to the agricultural headgates of the South Side Ditch. Under this alternative, Fort Collins would meet these non-potable demands from water stored in the Overland Gravel Pits, thereby freeing up shares of South Side Ditch normally dedicated to non-potable use, for potable use. By increasing the use of South Side Ditch water to meet potable demands, use of C-BT water could be reduced thereby maintaining more water stored in Horsetooth Reservoir. Similarly, using Overland Gravel Pits water to meet C-BT obligations would keep more water in Horsetooth Reservoir. Both operations would help maintain water in storage to meet the storage reserve safety factor.

Fort Collins loses a significant amount of C-BT water in most years (annual average of more than 9,500 AF) in the Common Technical Platform firm yield runs because the C-BT carryover program was inactive for those model runs. The C-BT losses were greater when the C-BT quota was larger. Under this alternative, in order to reduce the C-BT losses, Fort Collins would release excess C-BT to the Overland Gravel Pits and South Gravel Pits at the end of the water year, provided there is available capacity. The C-BT water stored in the Overland Gravel Pits could be used to meet the non-potable C-BT obligations described above or exchanged to the intakes.
when exchange potential exists. C-BT water could not be used for augmentation or for meeting return flow obligations, thus, any C-BT water stored in the Overland Gravel Pits or South Gravel Pits would be spilled or leased to other water users in favor of storing reusable water.

Finally, Fort Collins would also be able to divert a portion of the conditional water rights at the Overland Gravel Pits and South Gravel Pits if there is space available. Due to the relative junior priority of the conditional water rights, much of the yield of the conditional rights may not be able to be stored. However, under Fort Collins’ Proposed Action, on average only 7 percent of the available conditional water rights yield was stored, so reduced ability to store these rights may not be a significant factor in meeting the purpose and need.

4.3.4.4 Mountain Reservoir Preliminary Alternative Potential Modifications

In the event that final modeling of the Mountain Reservoir Preliminary Alternative as described above does not meet the full project need, additional concept-element combinations that passed the concept screening may be added to the alternative configuration. While any of the concept-element combinations shown in Table 4-1 would be eligible for consideration, most likely candidates to increase yield to meet the purpose and need would be the acquisition of additional agricultural water rights shares concept matched with pro-rata agricultural storage, transferring of the native portion of NPIC shares concept under an interruptible supply agreement with no new storage.

Acquiring additional shares of Water Supply & Storage Company would provide for an increased amount of pro-rata storage in Water Supply & Storage Company mountain reservoirs under this alternative. The additional yield from Water Supply & Storage Company direct flow rights, plains storage rights, and any un-stored portion of the mountain storage rights would be used to offset other releases from storage (e.g., reusable demands as described above or in place of C-BT use or C-BT obligations), or stored in the Overland Gravel Pits or South Gravel Pits for later use.

Fort Collins could use the native portion of its NPIC shares in dry years under a permanent interruptible supply agreement. This would provide for additional water that would be used to meet demands during times when water was otherwise released from storage. The permanent interruptible supply agreement with NPIC is more fully described in the Alternative Agricultural Transfers concept section (Section 3.2.6.1).

If final modeling shows that the Fort Collins need is still not satisfied with the above modifications, use of a larger storage element may be required, such as an expanded Overland Gravel Pits or Glade Reservoir (if constructed). Such use of a larger storage element would be similar to the Gravel Pits and Expanded Glade Reservoir alternatives, except that it would not require a pipeline from the Overland Gravel Pits to the Pleasant Valley Pipeline. Operational efficiency concepts used in the Mountain Reservoir Preliminary Alternative would likely reduce the required size of the additional storage compared to the storage required for those alternatives.
4.3.5 Alternative Agricultural Transfer Methods Preliminary Alternative

The Alternative Agricultural Transfer Methods Preliminary Alternative utilized transferred agricultural water supply and pro-rata storage in the ditch systems in which Fort Collins has an ownership interest. Future conditions modeling showed that Fort Collins is water-short in only one in 50 years, so there was opportunity to incorporate alternative agricultural transfers, whereby water would be used on agricultural lands the majority of the time, while creating a supply for Fort Collins through drought periods. This alternative utilized two alternative agricultural transfer methods; permanent interruptible supply agreement and shared water banking. Both alternative agricultural transfer methods relied on Fort Collins’ large ownership interest in NPIC for permanency of the agreements. Both methods also relied on the fact that Fort Collins does not need water from the alternative agricultural transfer method every year and often has excess water, but lacks facilities to store the excess for later use.

Fort Collins owns a large percentage of NPIC shares (37 percent under future conditions), and 85 percent of NPIC shares are projected to be owned by non-agricultural water providers in the future. The likelihood of securing an agreement that allows for maximization of use by non-agricultural water users is high, provided no shareholders would be injured by the agreement. Both alternative agricultural transfer methods described in this alternative provide additional water to agricultural water users in most years under the shared water banking concept, and both alternative agricultural transfer methods provide more water to agricultural users than if Fort Collins transferred the native portion of its NPIC shares for full-time municipal use. Fort Collins will own a relatively small percentage of the Water Supply & Storage Company shares in the future, but municipalities already own more than 50 percent of Water Supply & Storage Company shares. The City of Thornton, owner of nearly 50 percent of the Water Supply & Storage Company shares, has stated that it intends to use pro-rata storage of Water Supply & Storage Company reservoirs.

Fort Collins is projected to own approximately 37 percent of the NPIC shares in the future and NPIC has nearly 38,000 AF of storage (including the existing Halligan Reservoir, excluding Fossil Creek Reservoir). Fort Collins' pro-rata share of storage in NPIC reservoirs would be approximately 14,000 AF. Fort Collins is projected to own approximately 4 percent of Water Supply & Storage Company shares, which would result in approximately 1,650 AF in Water Supply & Storage Company mountain and plains reservoirs.

4.3.5.1 Alternative Agricultural Transfer Method Preliminary Alternative Concept-Element Combinations

- No new storage and permanent interruptible supply agreement concept.
- Pro-rata storage in agricultural reservoirs and shared water banking concept.
- Pro-rata storage in agricultural reservoirs and store excess C-BT in available storage at the end of the water year concept.
- Joe Wright Reservoir and do not trade C-BT for Joe Wright Reservoir with NPIC if Joe Wright Reservoir storage below a certain level concept.

4.3.5.2 Alternative Agricultural Transfer Method Preliminary Alternative Elements

- Pro-rata storage in agricultural reservoirs, specifically NPIC and Water Supply & Storage Company reservoirs.
- Joe Wright Reservoir

4.3.5.3 Alternative Agricultural Transfer Method Preliminary Alternative Operations

The Fort Collins need was met through a combination of the two alternative agricultural transfer methods in this alternative. The permanent interruptible supply agreement would function by using Fort Collins' pro-rata share of native NPIC direct flows in the Fort Collins system when Fort Collins system storage falls below a threshold level. Since an interruptible supply agreement would still require meeting historical return flows, only the consumable portion of Fort Collins’ NPIC native water rights would be delivered to Fort Collins. The remainder would be diverted through the NPIC headgates to maintain return flows. The frequency of the interruptible supply agreement would be a maximum of three out of 10 years. The interruptible supply agreement could either be approved under an amended interruptible supply agreement statute that allows for permanent interruptible supply agreement arrangements or Fort Collins could change the use of the native portion and include a leaseback arrangement as part of the change case.

Preliminary modeling indicated that triggering the interruptible supply agreement in years when the C-BT quota is 50 percent, in combination with the shared water banking concept, would likely meet the full project need, but more detailed modeling could determine the triggers for implementation. In years when Fort Collins took interruptible supply agreement water, the C-BT trade with NPIC would not occur and could be considered part of the interruptible supply agreement. This would limit the releases from Joe Wright Reservoir and thereby keep water in storage to meet the storage reserve safety factor. In addition, since NPIC direct flows delivered to Fort Collins under the interruptible supply agreement would be fully consumable, Fort Collins would use these flows to meet reusable demands that would otherwise be met from releases from Horsetooth Reservoir or Joe Wright Reservoir, thus maintaining more water in storage for the storage reserve safety factor.

Shared water banking would operate by Fort Collins accounting for its pro-rata share of water in NPIC and Water Supply & Storage Company reservoirs every year and storing excess water (e.g., C-BT, South Side Ditch, or Water Supply & Storage Company supplies) in agricultural reservoirs on a space-available basis. In return for the ability to store this water in available capacity, Fort Collins would provide a portion of this water (to be negotiated) to irrigators in all but the driest years, thereby building a Fort Collins pool in the reservoirs and simultaneously
increasing the agricultural water users’ water supply. Payments could also be negotiated by Fort Collins in lieu of providing water. In dry years, Fort Collins would release stored reservoir water from its pool to irrigators and take delivery of a similar amount of water that would have been diverted at the agricultural headgates. Preliminary modeling indicated that by providing 50 percent of the excess water to agricultural users, and applying annual seepage and evaporation losses, Fort Collins would be able to maintain a storage pool in excess of 6,000 AF in its pro-rata space of agricultural reservoirs in the NPIC system through the critical drought. Utilization of available capacity in the NPIC reservoirs in addition to the Fort Collins pro-rata storage capacity would increase this amount. In order to provide permanency, Fort Collins would negotiate for the first use of any available capacity that is not part of its pro-rata share of storage. The preliminary modeling also indicates that there are sufficient diversions at the NPIC headgates to execute the internal exchange, even when the interruptible supply agreement is implemented in the same year.

The Fort Collins storage reserve safety factor would include water stored in Chambers Lake as described in the Gravel Pits and Mountain Reservoir alternatives. In addition, Fort Collins would utilize its pool from shared water banking in the existing Halligan Reservoir as part of the safety factor.

4.3.5.4 Alternative Agricultural Transfer Method Preliminary Alternative Potential Modifications

In the event that final modeling of the Alternative Agricultural Transfer Method Preliminary Alternative as described above does not meet the full project need, additional concept-element combinations that passed the concept screening would be added to the alternative configuration. While any of the concept-element combinations shown in Table 4-1 would be eligible for consideration, most likely candidates to help meet the project need include implementation of concepts described in the Mountain Reservoir Preliminary Alternative that would not require major infrastructure investments (e.g., enhanced use of the Overland Gravel Pits and South Gravel Pits, reoperation of Joe Wright Reservoir or pro-rata use of storage in Water Supply & Storage Company mountain reservoirs).

Another viable option, however, would be to build a new water treatment plant on the plains that can deliver water to the eastern end of the Fort Collins potable system. The Tri-Districts have stated that they intend to build a new water treatment plant on the plains at some point in the future and could be a potential partner with Fort Collins. Additionally, a similar alternative is potentially viable for the City of Greeley’s Seaman Reservoir project and partnering would be an option. This plant could be sited to be able to take delivery of water from multiple existing agricultural plains reservoirs. This treatment plant would allow for direct delivery of the Fort Collins interruptible supply agreement water and shared water banking water without requiring an internal ditch exchange. Furthermore, water in storage in the agricultural reservoirs would be counted towards the storage safety factor.
4.3.6 Concept-Element Combinations Not Selected Through Best Fit Analyses

Of the 25 concept-element combinations retained in the concept-element screening, 17 were used in formulating the preliminary alternatives. The remaining eight concept-element combinations were not used in the preliminary alternative and were not selected through best fit analyses.

The best fit analyses were used only to compare concept-element combinations if there were no identifiable or discernible differences to impact to the aquatic environment. When the difference of impacts to the aquatic environment are not identifiable or discernible, the concept-element combination that is more advantageous to the Applicant can be selected because the selection does not remove a concept-element combination that would have less impacts to the aquatic environment. Concept-element combinations not selected through the best fit analyses are indicated with cross-hatching in Table 4-3. Seven of the concept-element combinations were not selected for use in the preliminary alternatives through separate best fit analyses.

4.3.6.1 Overland Gravel Pits Best Fit Analysis

The concept of full utilization of existing water rights matched with enlarging the Overland Gravel Pits element was selected in favor of three other concept-element combinations: 1) transferring new water rights matched with the Overland Gravel Pits element; 2) transferring water and building a new plains water treatment plant matched with no new storage elements; and 3) transferring water and building a new plains water treatment plant matched with the Overland Gravel Pits element. Three of these four combinations utilize the Overland Gravel Pits element, so diversions from the Poudre River would occur in the same location for all three. The other combination that uses no new storage elements requires the acquisition of additional shares of agricultural water and change to municipal use. While this would have an impact on local agriculture, the water would most likely be changed from the South Side Ditches or the Larimer and Weld Canal given the location of a potential plains water treatment plant. This water would be diverted at headgates near the Overland Gravel Pits, just as the other three elements. In all four cases, the volume of water diverted from the stream would be similar because all four combinations would meet a portion of the purpose and need from the same sources of water at the same location. Therefore, the best fit analysis was appropriate and any of the four combinations could be selected because differences of the impacts to the aquatic environment are not identifiable or discernible.

Given that differences of impacts to the aquatic environment are not identifiable or discernible, the best fit analysis selected the concept-element combination that we believed was most practicable from the Applicant’s operational perspective. From an operational standpoint, a water utility would fully utilize water rights already owned before acquiring additional water rights. Common Technical Platform hydrology modeling showed that Fort Collins has sufficient water rights and does not need new water rights if a sufficient amount of storage were available. The concept of new water rights was included as a potential modification in the event that the
expanded Overland Gravel Pits are not large enough to firm the existing water rights and additional dry-year yield would be required. Both concept-element combinations that included a new plains water treatment plant were not selected because operation of another water treatment plant adds complexity and expense to the Fort Collins system if water stored in the Overland Gravel Pits can be delivered to the existing water treatment plant. Delivery of the Overland Gravel Pits may require pre-treatment processes that could be added at the existing water treatment plant site or other facilities at the Overland Gravel Pits that are less costly and complex than a full water treatment plant at that location.

4.3.6.2 Shared Water Banking Best Fit Analysis

The shared water banking concept matched with pro-rata storage in agricultural reservoirs element was selected in favor of two other concept-element combinations: 1) full utilization of existing water rights matched with pro-rata storage; and 2) transfer water and build new plains water treatment plant matched with the pro-rata storage element. All three concept-element combinations would utilize pro-rata storage so the point of diversion from the Poudre River or the North Fork would be the same in all cases. The volume of water would be similar in all three scenarios because all three combinations would meet a portion of the purpose and need from similar sources of water at the same location. Some differences in the amount and location of the water source would be expected between the concepts. However, likely candidate water rights such as the South Side Ditches, and native NPIC water rights are already diverted by Fort Collins or NPIC water users, and the operations and use of this water would change only after diversion. Therefore, the best fit analysis was appropriate and any of the three combinations could be selected and would not cause identifiable or discernible differences to the aquatic environment.

Given that differences of impacts to the aquatic environment are not identifiable or discernible, the best fit analysis selected the concept-element combination that is most practicable from the Applicant’s operational perspective. The shared water banking concept would potentially be more efficient for Fort Collins since it would be providing water to the ditch company for the use of the storage capacity and would only take delivery of its water in dry years. This type of arrangement may be more widely accepted by agricultural users because they would receive a tangible benefit of additional water, as compared to outright claims on ownership of pro-rata storage by Fort Collins. Furthermore, Fort Collins shared water banking aligns with Fort Collins’ policy goal of maintaining agriculture in the region (although this is not part of the purpose and need statement), while at the same time providing a mechanism for Fort Collins to benefit from its substantial investment in NPIC shares. This scenario may be favorable to Fort Collins as compared to the full utilization of water rights due to the ability to achieve its policy goal of maintaining agriculture. In addition, water banking may be preferable to transferring water to new plains water treatment plant because Fort Collins would not have to construct a second water treatment plant.
4.3.6.3 Permanent Interruptible Supply Agreement Best Fit Analysis

The concept of a permanent interruptible supply agreement matched with no new storage elements was selected in favor of two other concept-element combinations: 1) permanent interruptible supply agreement matched with the expanded Glade Reservoir element; and 2) permanent interruptible supply agreement matched with expanded Overland Gravel Pits element. All three scenarios utilized the concept of a permanent interruptible supply agreement that relies on use of the Fort Collins native portion of NPIC shares in drought years. Water would be delivered to Fort Collins by bypassing water at the NPIC headgates to the Fort Collins intakes or Glade Reservoir or the Overland Gravel Pits. This operation would result in increased streamflows on the North Fork from the North Poudre Canal to the confluence with the Poudre River in all three scenarios. In all three scenarios, water needed immediately would be diverted at the Fort Collins intakes into the Fort Collins Pipeline or the Pleasant Valley Pipeline. In the combinations matched with Glade Reservoir and the expanded Overland Gravel Pits, some of the native NPIC water could increase streamflows between the North Fork and the Poudre Valley Canal (for Glade Reservoir) and to the Larimer County Canal No. 2 headgate (for the Overland Gravel Pits). However, increases in streamflows based on these deliveries to storage would be made during the earlier part of the year when streamflows are high and Fort Collins has no immediate demand for the water. The increases in streamflow due to deliveries to Glade Reservoir or the Overland Gravel Pits would be small compared to the streamflow in the Poudre River without these flows. Therefore, the best fit analysis was appropriate and any of the three combinations could be selected and be expected to have similar and indistinguishable impacts to the aquatic environment.

Given the similar and indistinguishable impacts to the aquatic environment, the best fit analysis selected the concept-element combination that we believe is most practicable from the Applicant’s operational perspective. Since an interruptible supply agreement was combined with shared water banking in the Alternative Agricultural Transfer Methods Preliminary Alternative, it would make more sense to use the same storage capacity already acquired as part of the shared water banking concept rather than attempting to acquire and operate additional storage capacity in Glade Reservoir or in the Overland Gravel Pits. Therefore, an interruptible supply agreement combined with no new storage elements was selected.
5 Final Alternatives Identification

This section presents the final alternatives selected by the Corps for comparative analysis in the DEIS. The Corps provided the preliminary alternatives identified in Section 1 to Fort Collins in October 2012, and a draft of this report through Section 1 was provided to Fort Collins in March 2013. The screening approach (Section 1), element screening (Section 2), concept screening (Section 3) and preliminary alternatives formulation (Section 1) were conducted by the Third-Party Contractor team and the Corps. At Fort Collins’ request, the Corps gave responsibility of creating the technical detail for the final alternatives and conducting the detailed modeling effort to Fort Collins (letter from Corps July 31, 2012). The Corps and Third-Party Contractor team performed an independent review of the added technical detail and modeling performed by Fort Collins, and the final alternatives were selected by the Corps.

This section provides a description of the process and the results of the work on the final alternatives by Fort Collins. Fort Collins analyzed and technically refined the five preliminary alternatives identified in Section 1. The Fort Collins analysis concluded that several of the same concept-element combinations were used in both the Gravel Pits Preliminary Alternative (Section 4.3.3) and the Mountain Reservoir Preliminary Alternative (Section 4.3.4). The analysis also concluded that the storage reserve safety factor would not be met in the Mountain Reservoir Preliminary Alternative. Therefore, Fort Collins proposed to combine these two preliminary alternatives into a single final alternative that uses the expanded Overland Gravel Pits with a pipeline connection to the water treatment plant. Through the Corps’ and Third-Party Contractor team’s review, the Corps determined that the resulting four final alternatives proposed by Fort Collins were reasonable and acceptable refinements of the preliminary alternatives and conformed to the overall goals of the alternatives screening process. In addition to the four final alternatives, Fort Collins developed a No-Action Alternative. The No-Action Alternative describes the actions that Fort Collins would take to meet all or a part of its need that would not require a permit from the Corps. The No-Action Alternative is also described in this section.

5.1 Final Alternatives Identification Process

The concept-level design used in the preliminary alternatives was further developed to a point where infrastructure sizing, pipeline alignment, facility location and costs could be more accurately estimated (Figure 5-1). The following sections describe the process used to refine the preliminary alternatives into a final alternative and the key components of each final alternative.
In general, the following steps guided the process to identify and develop the final alternatives:

- Meetings held between Fort Collins staff, Corps and Third-Party Contractor team to discuss preliminary alternatives and preliminary modeling in depth.
- Fort Collins developed detailed modeling or other analysis to incorporate the preliminary alternatives into the Fort Collins system model and evaluated the technical aspects of some concept-element combinations from the preliminary alternatives.
- Fort Collins developed documents that described each final alternative (termed “alternative definitions” by Fort Collins) that served as proposals for final alternatives to be approved by the Corps. The alternative definitions identified the portions of the preliminary alternatives Fort Collins proposed to retain and omit for technical reasons in the final alternatives. These alternative definitions were reviewed and approved by the Corps and Third-Party Contractor team. Fort Collins produced an Alternatives Report (MWH 2015) that documents the final alternatives. The alternative definitions are provided as an appendix to the Fort Collins Alternatives Report.
• Fort Collins performed the full Common Technical Platform hydrology modeling sequence for each final alternative. Modeling files were transmitted to the Corps and Third-Party Contractor team for detailed quality control, quality assurance (QA/QC) review and testing.

• Fort Collins refined infrastructure sizing, location, and costs associated with each final alternative based on model results. The results of this refinement were provided to the Corps and Third-Party Contractor team in the Fort Collins Alternatives Report (MWH 2015) and included mapping needed for the comparative effects analysis for the EIS.

• The Corps and Third-Party Contractor team completed the final alternatives selection and this screening report based on the above information.

The alternatives screening process resulted in Fort Collins’ Proposed Action, three final alternatives for Fort Collins, and the No-Action Alternative. Table 5-1 provides a summary of the key components for each alternative and additional detail related to each alternative is described in the following sections. The Fort Collins Alternatives Report (MWH 2015) contains much of the detailed technical information related to each alternative.
Table 5-1. Final alternative components.

<table>
<thead>
<tr>
<th>Alternative Features</th>
<th>Water rights associated with new storage</th>
<th>Water sources</th>
<th>Storage</th>
<th>Conveyance</th>
<th>New Treatment</th>
<th>Pumping</th>
<th>Non Structural Components</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fort Collins’ Proposed Action</strong></td>
<td><strong>Existing water rights</strong></td>
<td><strong>North Fork at Halligan Dam</strong></td>
<td><strong>8,125 AF enlargement of existing Halligan Reservoir</strong></td>
<td><strong>Existing Fort Collins raw water supply pipelines</strong></td>
<td><strong>None</strong></td>
<td><strong>None</strong></td>
<td>(Current operation) Exchange Halligan Reservoir releases from the confluence of the North Fork and the Poudre River to the Fort Collins existing river intake or the Munroe Gravity Ditch intake</td>
</tr>
<tr>
<td><strong>Expanded Glade Alternative</strong></td>
<td><strong>Existing water rights</strong></td>
<td><strong>Poudre River at Poudre Valley Canal headgate</strong></td>
<td><strong>6,075 AF enlargement of proposed Glade Reservoir</strong></td>
<td><strong>Proposed NISP pipeline, canal facilities and Glade Reservoir outlet pipeline; existing Pleasant Valley Pipeline; existing Fort Collins raw water pipelines</strong></td>
<td><strong>Pretreatment of Glade Reservoir releases</strong></td>
<td><strong>All water pumped into Glade Reservoir; some water releases pumped to Fort Collins water treatment facility</strong></td>
<td><strong>River exchanges when possible to existing Fort Collins intakes to reduce water treatment and pumping to water treatment plant</strong></td>
</tr>
<tr>
<td><strong>Gravel Pits Alternative</strong></td>
<td><strong>Existing water rights</strong></td>
<td><strong>Poudre River at Larimer County Canal No. 2 diversion point</strong></td>
<td><strong>3,975 AF new storage in proposed gravel pits</strong></td>
<td><strong>New pipelines to convey flows between Larimer County Canal No. 2, the gravel pit complex, existing Fort Collins raw water pipelines and Pleasant Valley Pipeline and canal facilities</strong></td>
<td><strong>Pretreatment of gravel pit releases</strong></td>
<td><strong>Some releases pumped to Fort Collins water treatment facility</strong></td>
<td><strong>Reoperation of Joe Wright Reservoir, river exchanges when possible to existing Fort Collins intakes to reduce water treatment and pumping to water treatment plant</strong></td>
</tr>
<tr>
<td><strong>Agricultural Reservoirs Alternative</strong></td>
<td><strong>Existing water rights</strong></td>
<td><strong>Poudre River at Munroe Gravity Ditch headgate</strong></td>
<td><strong>6,475 AF contract for existing storage in NPIC Reservoirs Nos. 5 and 6</strong></td>
<td><strong>New pipelines to convey flows to the reservoirs from existing pipelines, existing diversion and ditch, and existing Fort Collins pipelines and Pleasant Valley raw water pipelines</strong></td>
<td><strong>Pretreatment of reservoir releases</strong></td>
<td><strong>Some reservoir releases pumped to Fort Collins water treatment facility</strong></td>
<td><strong>River exchanges when possible to existing Fort Collins intakes to reduce water treatment and pumping to water treatment plant</strong></td>
</tr>
<tr>
<td><strong>No-Action Alternative</strong></td>
<td><strong>Existing water rights</strong></td>
<td><strong>Acquisition of shares in the NPIC specifically for the shares’ C-BT storage component</strong></td>
<td><strong>C-BT storage through acquisition of shares</strong></td>
<td><strong>Existing Fort Collins raw water supply pipelines</strong></td>
<td><strong>None</strong></td>
<td><strong>None</strong></td>
<td><strong>Reoperation of Joe Wright Reservoir. More frequent and severe mandatory water use restrictions for Fort Collins</strong></td>
</tr>
</tbody>
</table>

Note: Existing water rights includes Southside Ditch rights, reusable Water Supply and Storage Company rights, and conditional storage rights.
5.2 Fort Collins’ Proposed Action

Fort Collins’ Proposed Action was based primarily on the expansion of Halligan Reservoir (Figure 5-2; reproduced from MWH 2015, Map B-8). This alternative had already been substantially developed by Fort Collins at the beginning of the project, and modified as necessary when the Tri-Districts and NPIC withdrew from the project. Modeling for this alternative was performed as part of the Common Technical Platform that was performed by the Third-Party Contractor team and completed in 2012 prior to Fort Collins’s taking on the detailed modeling responsibility for the alternatives. Fort Collins subsequently updated the modeling in 2015 to incorporate more recent changes to the project.

5.2.1 Alternative Finalization Process

The Fort Collins’ Proposed Action required relatively little additional analysis to be finalized because it had been developed and modeled previously as part of the Common Technical Platform. Between the time of the completed Common Technical Platform hydrology modeling (June 26, 2012) and Fort Collins’ submittal of its alternatives report (MWH 2015), there were two key changes to Fort Collins’ Proposed Action. First, NPIC withdrew from the Halligan Project in 2014, reducing the expansion size from 13,125 AF to 8,125 AF. Second, Fort Collins’ conditional water right for the storage at the expanded Halligan Reservoir was cancelled by the water court. Fort Collins re-filed for the conditional water right, but lost the previous 1986 priority date. The new Halligan Reservoir conditional water right was decreed with a December 10, 2013 appropriation date. These two changes were incorporated into new modeling of Fort Collins’ Proposed Action. The revised modeling was submitted to the Corps and Third-Party Contractor team in December 2014.

During the conceptual review of the revised proposed action modeling, the Third-Party Contractor team asked Fort Collins to clarify the criteria for its storage reserve safety factor. Through the alternatives refinement process, Fort Collins stated that water stored must be able to be released directly to the Fort Collins intakes or water treatment facility. Releases from Halligan Reservoir cannot be directly diverted into the Fort Collins existing intake facilities. All releases from Halligan Reservoir are diverted at the intakes by an exchange from the confluence of the North Fork with the Poudre River to the intakes on the Poudre River. There are no intervening water rights or diversion structures between the confluence and the Fort Collins intakes. Fort Collins provided an analysis of the reliability of this exchange showing that there is sufficient exchange potential 94 percent of the time, including through the entire design drought. The instances of insufficient exchange potential occur primarily during the late fall or winter when releases from other sources such as Joe Wright Reservoir or Horsetooth Reservoir can be made without an exchange and without affecting the total amount of water counted towards the storage reserve safety factor (Fort Collins 2015). This exchange was also shown to be significantly more reliable than exchanges from the expanded Glade Reservoir or the expanded Overland Gravel Pits, which were used in the other alternatives. This provided adequate justification for accounting for water...
Figure 5-2. Map of Fort Collins' Proposed Action from MWH (2015)
stored in Halligan Reservoir towards the storage reserve safety factor even though there is no direct physical connection between Halligan Reservoir and the Fort Collins intakes. The Corps concurred with Fort Collins’ conclusion that water stored in Halligan Reservoir could be counted in the storage reserve safety factor, while storage in other storage facilities could not be counted without a direct connection to the Fort Collins system or use of a comparably reliable exchange.

In February 2015, the Corps and Third-Party Contractor team completed its review of the detailed modeling conducted by Fort Collins for Fort Collins’ Proposed Action. The Third-Party Contractor team found the changes for the reduced size of Halligan Reservoir, and later priority date for the conditional water right were correctly implemented in the modeling. The Third-Party Contractor team evaluated the impact of the changed priority of the junior water right and determined that the priority change from 1986 to 2013 did not impact the size of the reservoir enlargement because the right did not yield water through the critical drought with either the 1986 or 2013 priority. The Corps approved the modeling for Fort Collins’ Proposed Action and distributed the model results to other Third-Party Contractor team resource specialists for the comparative effects analysis in the EIS.

5.2.2 Key Components of Fort Collins’ Proposed Action

Fort Collins’ Proposed Action is the same as the preliminary alternative described in Section 4.3.1. The alternative is the result of combining the expanded Halligan Reservoir element with full utilization of existing water rights. The modeling for this alternative demonstrated that it is able to meet Fort Collins’ purpose and need.

5.2.2.1 Facilities

The primary structural component of this alternative is the expansion of Halligan Reservoir. When the application for the permit was originally filed, the proposed expansion was for approximately 33,000 AF and would require a new dam downstream of the existing Halligan Reservoir dam. Due to the withdrawal of the Tri-Districts in 2009 and NPIC in 2014, the reservoir expansion for Fort Collins was reduced to 8,125 AF. Fort Collins determined that this size of expansion is capable of being constructed by raising the existing dam instead of the previously-envisioned downstream location. The Fort Collins Alternatives Report (MWH 2015) has additional detail about the proposed construction methods for the dam raise. The total size of the expanded Halligan Reservoir would be 14,525 AF including the existing 6,400 AF of storage that belongs to NPIC. The surface area of the expanded reservoir would be approximately 253 acres.

5.2.2.2 Operations

Water rights already owned or projected to be owned in the future would be diverted into storage at Halligan Reservoir by exchange. When needed, Fort Collins would make releases of water from Halligan Reservoir to the North Fork, and then exchange these flows from the confluence...
of the North Fork and Poudre River to its intakes on the Poudre River. Fort Collins’ Proposed Action included winter releases of three cfs from Halligan Reservoir to boost winter flow on the North Fork and, after diversion and use in the Fort Collins municipal system, met return flow obligations from changed water rights with the resulting effluent.

5.3 Expanded Glade Alternative

The Expanded Glade Alternative (Figure 5-3; reproduced from MWH 2015, Map B-6) involved the expansion of the proposed Glade Reservoir. Glade Reservoir is a reservoir proposed as part of NISP and Fort Collins is not a participant in NISP. The Corps released the NISP supplementary draft EIS (SDEIS) in June 2015.

A key assumption in the development of the Expanded Glade Alternative is that Glade Reservoir will be permitted by the Corps for NISP and constructed. The Fort Collins expansion of Glade Reservoir is contingent upon Glade Reservoir being constructed for NISP and is not feasible without NISP. As described in Section 2.1.3, if Glade Reservoir is not selected for NISP, this alternative may be reconfigured with other elements that were screened through the best fit analysis. Northern Water is the NISP applicant and would be the owner of Glade Reservoir. This alternative is contingent upon Fort Collins entering into an agreement with Northern Water to allow Fort Collins to acquire the additional storage capacity in the reservoir and construct the associated enhancements to the inlet and outlet facilities that Fort Collins would require. Northern Water has previously expressed its willingness to cooperate with Fort Collins in the event that Glade Reservoir is selected as the permitted alternative for NISP.

5.3.1 Alternative Finalization Process

Fort Collins provided its draft alternative definition to the Corps and Third-Party Contractor team in February 2014. The definition outlined the proposed approach Fort Collins intended to take to finalize the alternative based on the Expanded Glade Reservoir Preliminary Alternative (Section 4.3.2). The approach included the expansion of Glade Reservoir, associated enlargements to inlet and outlet facilities to Glade Reservoir, a pre-treatment facility and a pipeline connection to the existing Fort Collins raw water supply lines. In addition, Fort Collins would utilize water stored in Chambers Lake towards its storage reserve safety factor.

The Expanded Glade Reservoir Preliminary Alternative included the concept-element combination of storing excess C-BT water in Glade Reservoir at the end of a water year to reduce the loss of C-BT water stored in Horsetooth Reservoir at the end of the water year. Through the alternatives finalization process, Fort Collins determined that this concept-element combination was not required for a workable alternative. Fort Collins demonstrated that use of its projected future water rights (e.g. South Side Ditch and Water Supply & Storage Company changed water rights) would be sufficient to fill the Fort Collins expansion of Glade Reservoir during the spring runoff through the critical drought periods, making additional storage of C-BT
water unnecessary. The Corps and Third-Party Contractor team found this to be sufficient justification of eliminating this concept-element combination in the final alternative.

The final modeling performed by Fort Collins determined that Glade Reservoir would be expanded by 6,075 AF. This capacity is 2,050 AF smaller than Fort Collins’ proposed expansion of Halligan Reservoir. The required capacity is less in the Expanded Glade Alternative due to the
Figure 5-3. Map of the Expanded Glade Alternative from MWH (2015).
incorporation of water stored in Chambers Lake into the storage reserve safety factor calculation, and the fact that there is better exchange potential between the South Side Ditch and Water Supply & Storage Company headgates to Glade Reservoir inlet than there is to Halligan Reservoir. This allowed more frequent exchange of water into Glade Reservoir than into Halligan Reservoir and thereby reduced the storage capacity necessary to meet the purpose and need.

At the time Fort Collins was developing the Expanded Glade Alternative, final design information for Glade Reservoir was not available. Fort Collins made several assumptions about the proposed infrastructure, particularly about the Glade Reservoir inlet and outlet configuration that may need to be modified depending on final design of Glade Reservoir by Northern Water, if permitted. Fort Collins may refine some aspects of the configuration of this alternative, if warranted, based on new information in the NISP final EIS or subsequent decisions related to NISP. Any such refinements would be included in the Halligan Project’s DEIS if available at the time of DEIS publication. It is anticipated that any such changes to the alternative will have little to no impact on streamflows, but could involve changes to facility locations or alignments. Changes that do not affect streamflows would not require new hydrologic modeling.

The revised modeling for the Expanded Glade Alternative was submitted to the Third-Party Contractor team in late July 2014. In October 2014, the Corps and Third-Party Contractor team completed its review of the detailed modeling conducted by Fort Collins for the Expanded Glade Alternative (email from Corps to Fort Collins October 14, 2014). The Corps approved the modeling for the Expanded Glade Alternative and distributed the model results to other Third-Party Contractor team resource specialists for the comparative effects analysis in the EIS.

5.3.2 Key Components of the Expanded Glade Alternative

The operation of the Expanded Glade Alternative is similar to the Expanded Glade Reservoir Preliminary Alternative described in Section 4.3.2. The modeling for this alternative demonstrated that it was able to meet Fort Collins’ purpose and need with an expansion of Glade Reservoir by 6,075 AF. The alternative was the result of combining the Glade Reservoir with NISP element with full utilization of existing water rights and no new storage elements with the use of water stored in Chambers Lake for storage reserve safety factor. The storage of excess C-BT water at the end of the water year was not needed to meet the Fort Collins purpose and need. The other concept-element combinations identified in the preliminary alternative as potential enhancements were not needed to meet the purpose and need.

5.3.2.1 Facilities

5.3.2.1.1 Glade Reservoir

The primary structural component of this alternative is the expansion of the proposed Glade Reservoir by 6,075 AF. The proposed Glade Reservoir for NISP is 170,000 AF, so the total expanded size would be 176,075 AF. This expansion would require a dam height increase of
approximately 3.6 feet above the NISP design. The expansion would increase the maximum surface area of Glade Reservoir by 52 acres from 1,626 acres to 1,678 acres.

5.3.2.1.2 Glade Reservoir Inlet Facilities

The proposed Glade Reservoir would be filled through an enlargement of the Poudre Valley Canal. The Poudre Valley Canal diverts from the Poudre River near the mouth of the canyon, downstream of the confluence with the North Fork. The Poudre Valley Canal is proposed to be expanded from the current capacity of approximately 500 cfs to 1,800 cfs for NISP. Fort Collins would require an additional 60 cfs capacity, based on the modeling results, for a total Poudre Valley Canal capacity of 1,860 cfs.

Water would be delivered from the Poudre Valley Canal through a turnout to a pumping forebay located near the foot of the Glade Reservoir dam. Water would be pumped from the forebay into Glade Reservoir. The forebay for NISP is approximately 1,600 AF, and Fort Collins would require approximately 80 AF of additional storage in the forebay to regulate its flows at times when NISP is diverting at its peak rate. Fort Collins determined that the additional 80 AF could be provided by deepening the forebay by 0.85 feet and assumed this additional depth could be accommodated within the proposed NISP forebay site. The turnout from the Poudre Valley Canal to the forebay would also be increased from the NISP capacity of 1,200 cfs to 1,260 cfs to accommodate Fort Collins’ use during NISP peak operations.

Water diverted into the forebay would be pumped directly into Glade Reservoir through a bi-directional inlet-outlet pipe through the dam. The pipe is proposed to be 10-foot in diameter and connected to the inlet/outlet tower near the upstream face of the dam. Fort Collins determined that pumps must be sized with an additional 18 feet of dynamic head compared to the NISP only pump size in order to pump Fort Collins’ water into Glade Reservoir when operating at peak capacity. The pumping could integrate into the NISP pumps or Fort Collins could develop independent pumps within the same pump station.

The inlet/outlet tower located in the reservoir would be raised by 3.6 feet to accommodate Fort Collins’ additional capacity when the NISP portion of Glade Reservoir is full. The sluice gates inside the tower that control flow into and out of the reservoir would be designed to accommodate the peak NISP flows as well as the additional 60 cfs required by Fort Collins.

5.3.2.1.3 Glade Reservoir Outlet Facilities

Water would be released from Glade Reservoir through the same inlet/outlet tower described above. Fort Collins’ peak release rate was estimated at 42 cfs, and the sluice gates inside the tower that control flow into and out of the reservoir would be designed to accommodate releases during peak NISP flows as well as at low reservoir levels.

Water released from the reservoir for Fort Collins will be directed either to a river turnout or into a pre-treatment facility located near the pump station at the foot of the dam. Releases to the river turnout would be delivered to the river and exchanged to the existing upstream intakes. When
there is not sufficient exchange potential, water would be delivered into the pre-treatment plant for treatment and direct delivery into the raw water supply lines.

Fort Collins determined that a pre-treatment facility would likely be required because the water quality in Glade Reservoir is expected to be lower than water diverted at the existing Fort Collins intakes. Conveyance to Fort Collins’ water treatment plant would utilize the Pleasant Valley Pipeline and the Fort Collins pipeline. The Pleasant Valley Pipeline is a shared facility with other water providers. Pre-treatment of water stored at Glade Reservoir may be required to ensure water quality in the pipeline for use by others is not degraded by the introduction of water stored at Glade. Fort Collins has proposed a 16 million gallons per day (MGD) pre-treatment facility that would use ballasted flocculation with powder activated carbon to reduce total organic carbon (TOC) to levels comparable to the existing upstream intakes. Fort Collins proposed the pre-treatment facility at the Glade Reservoir site so that it can deliver water from Glade Reservoir via a pipeline to the existing Fort Collins raw water supply pipelines located approximately 1.5 miles from the pre-treatment site without degrading the water quality in those pipelines. The 16 MGD capacity is less than the projected peak release of 42 cfs from Glade Reservoir. Based on the water quality information available to Fort Collins at the time of its alternatives report, 16 MGD was the required amount of water to blend into the untreated Glade Reservoir release to achieve the desired water quality. The size of the pre-treatment facility may be altered as additional water quality information becomes available.

Fort Collins would construct a pipeline from the pre-treatment facility and connect to the Fort Collins raw water supply lines in the vicinity. Fort Collins uses an older raw water supply line year-round and has use of the Pleasant Valley Pipeline during the summer. To increase operational flexibility, Fort Collins proposed to connect to both supply lines. In addition, the pipeline would also have a river turnout that would enable Fort Collins to deliver water to the Poudre River where the pipeline would cross the river, and then exchange this water to the upstream intakes. When Fort Collins is able to deliver water to the Poudre and exchange for water diverted higher at its intakes, the water would not require pre-treatment and would bypass the pre-treatment facility.

5.3.2.1.4 Chambers Lake Utilization

The Expanded Glade Alternative also included a concept-element combination that counts Fort Collins’ water stored in Chambers Lake as part of the storage reserve safety factor. Chambers Lake is located in the headwaters of the Poudre River. As part of the Joint Operations Plan, Fort Collins makes releases from its Joe Wright Reservoir to maintain minimum flows below the reservoirs. As part of the Joint Operations Plan operations, Fort Collins releases 600 AF of water from Joe Wright Reservoir to Chambers Lake in October of every year. This 600 AF is released from Chambers Lake at a rate of two cfs November through March. In the Expanded Glade Alternative, the amount of water remaining in storage in Chambers Lake would also be counted towards the storage reserve safety factor because the water can be released directly to the Fort Collins system.
The Fort Collins Alternatives Report (MWH 2015) has additional detail about the proposed construction of the expanded Glade Reservoir and associated upsized inlet and outlet facilities to accommodate Fort Collins’ flows in excess of peak NISP flows, and the utilization of Chambers Lake.

### 5.3.2.2 Operations

Water rights already owned or projected to be owned in the future would be diverted into storage at Glade Reservoir by exchange in a manner similar to the exchanges used in Fort Collins’ Proposed Action. It was assumed that Fort Collins would be able to change the location of the Halligan Reservoir conditional water right and the Grey Mountain conditional water right to divert at the Poudre Valley Canal for delivery into Glade Reservoir. When needed to meet its demands, Fort Collins would make releases of water from Glade Reservoir. When there is sufficient exchange potential, Fort Collins could release to the Poudre River through the river turnout structure, and then exchange these flows to existing upstream intakes. When there is not sufficient exchange potential, Fort Collins would make releases from Glade Reservoir to the pre-treatment facility and then pump the water directly into the raw water supply lines.

The Fort Collins Alternatives Report (MWH 2015) has additional detail about the proposed operations during periods when the NISP and Fort Collins are both operating. There are times when Fort Collins and the NISP could potentially require opposite operations (e.g. Fort Collins desired to fill Glade Reservoir while NISP desired to make a release). Many of these different scenarios are addressed in MWH (2015) in depth, and generally rely on standard book-over water accounting practices and the ability to pump from the forebay into the NISP or Fort Collins outlet pipelines.

It is noted that the final outlet configuration at Glade Reservoir for NISP was not complete when Fort Collins was adding detail to this alternative. The NISP DEIS (Corps 2008) included several possibilities. The Expanded Glade Alternative may need to be refined or updated to accurately reflect operations with the finalized outlet configuration at Glade Reservoir if it is selected as the permitted alternative for NISP and proceeds to final design.

### 5.4 Gravel Pits Alternative

The Gravel Pits Alternative is a combination of aspects from two of the preliminary alternatives: the Overland Gravel Pits Preliminary Alternative and the Mountain Reservoir Preliminary Alternative (Figure 5-4; reproduced from MWH 2015, Map B-2). The Gravel Pits Alternative consisted of constructing 3,875 AF of storage in gravel pits located north of the Poudre River near Taft Hill Road, a pre-treatment facility, and a pipeline from the pre-treatment facility to the Fort Collins raw water supply lines. The alternative also involves reoperation of Joe Wright Reservoir to target 3,200 AF of winter storage every year by reducing a water trade with NPIC in some years.
5.4.1 Alternative Finalization Process

The Gravel Pits Alternative was developed from two distinct preliminary alternatives that both used many of the same facilities. Both preliminary alternatives utilized the Overland Gravel Pits and Joe Wright Reservoir, although in different ways. Both preliminary alternatives included several other concepts related to increased system efficiency.

Fort Collins performed more detailed modeling of both preliminary alternatives and determined that the potential gain in yield from several of the increased efficiency concepts was small or not feasible due to various institutional constraints. Fort Collins met with the Corps and Third-Party Contractor team on several occasions in August and September 2013 to discuss the evaluation of these concepts. Fort Collins proposed enlarging the gravel pits and dropping several of the system efficiency concepts. The rationale for this proposal was that the Overland Gravel Pits site could support a larger storage facility, and by increasing the reservoir size over the size proposed in the preliminary alternatives, many of the system efficiency concepts would be unnecessary to make a workable alternative.

The proposal would simplify many of the future operations for Fort Collins and would not require Fort Collins to engage in some of the system efficiency concepts. Some of the system efficiency concepts could prove difficult to implement because they would require changing existing water rights decrees (e.g. the Reuse Plan) or would require participation of other entities that may or may not be amenable to altering their operations for Fort Collins’ benefit. The Corps agreed to the proposal because the change would not significantly change streamflows as contemplated in the preliminary alternatives and the larger size gravel pits would have no wetlands impacts. The Corps placed a contingency on the approval that if Fort Collins later determined that the larger gravel pit size could not be built, that the dropped system efficiency concepts could be re-introduced to form a workable alternative. In its alternatives report (MWH 2015), Fort Collins concluded that it would be able to construct sufficient gravel pit storage by constructing 20-foot berms around some of the gravel pits.

In addition, the Overland Gravel Pits on the south side of the Poudre River that were evaluated in the preliminary alternatives are owned jointly by the Tri-Districts and the City of Greeley. Both these entities were previously partners with Fort Collins in the Halligan-Seaman Water Supply Projects before the entities separated into distinct EIS processes. During initial alternative development, Fort Collins provided a letter from the City of Greeley indicating that Fort Collins would be able to obtain 980 AF of storage in the Overland Gravel Pits. Due to the withdrawal of the Tri-Districts from the project and the separation of Fort Collins’ Halligan Project from the City of Greeley’s Seaman Reservoir Project, Fort Collins sought out different gravel pit locations on the north side of the river for its Gravel Pits Alternative that it could own outright and would
Figure 5-4. Gravel Pits Alternative map from MWH (2015).
not require joint ownership or operations with its previous partners. This site is consistent with
the Overland Gravel Pits element identified through the element screening (Section 2.2) that
includes several individual gravel mining sites near the Greeley and Tri-Districts Overland
Gravel Pits.

The revised modeling for the Gravel Pits Alternative was submitted to the Corps and Third-Party
Contractor team in October 2014. In November 2014, the Corps and Third-Party Contractor team
completed its review of the detailed modeling conducted by Fort Collins for the Gravel Pits
Alternative (email from WEST to Fort Collins November 10, 2014). The Third-Party Contractor
team found that the proposal for combining the two preliminary alternatives into the Gravel Pits
alternative was correctly implemented in the modeling. The Corps approved the modeling for the
Gravel Pits Alternative and distributed the model results to other Third-Party Contractor team
resource specialists for the comparative effects analysis in the EIS.

5.4.2 Key Components of the Gravel Pits Alternative

The Gravel Pits Alternative involved the construction of 3,875 AF of new gravel pit storage on
the north side of the Poudre River near Taft Hill Road. The gravel pits would supply water to the
Fort Collins system through exchange to existing intakes or a pre-treatment facility that improves
water quality to levels similar to the water diverted at Fort Collins’ upstream intakes, and would
deliver this pre-treated water directly into the Fort Collins raw water supply lines. Conveyance to
Fort Collins’ water treatment plant would utilize the Pleasant Valley Pipeline and the Fort
Collins pipeline. The Pleasant Valley Pipeline is a shared facility with other water providers. Pre-
treatment of water stored in the gravel pits may be required to ensure water quality in the
pipeline for use by others is not degraded by the introduction of water stored in the gravel pits.
The Gravel Pits Alternative also included reoperation of Joe Wright Reservoir and use of
Chambers Lake to be able to retain more water in storage to meet the storage reserve safety
factor.

5.4.2.1 Facilities

5.4.2.1.1 Gravel Pits Reservoir

The primary structural component of this alternative was acquisition and construction of
approximately 3,875 AF of storage in gravel pits located on the north side of the Poudre River
near Taft Hill Road. The gravel pit complex would include eight interconnected cells. Two of the
pits would include above-grade storage by the construction of 20-foot tall berms around the
perimeter of the cell. Water would flow by gravity between cells, except pumping into the pits
with berms would be required under certain hydraulic conditions.

5.4.2.1.2 Inlet Facilities

Water would be diverted into the gravel pits by diverting water from the Poudre River at the
Larimer County Canal No. 2 headgate, and then into a 42-inch pipeline that diverts off the
Larimer County Canal No. 2. The 42-inch pipeline would be installed beneath the river bed to
cross to the north side of the river to the gravel pits. Water would enter the complex at the Stenger cell or Home Office cell, and could flow to other cells by gravity, or in some cases, by pumping into the North Shores No. 1 cell depending on the difference in water levels between the Stenger and North Shore cells. Once discharged into the cells from the pipeline, water would flow toward the lower cells and the pump station.

5.4.2.1.3 Outlet Facilities

Water in the gravel pit complex would flow towards the lower elevation cells and eventually to a pump station located between the North Shores No. 2 cell and the Home Office Mine-B cell. Water would be pumped from this pump station back through the 42-inch pipeline towards the ditch turnout from the Larimer County Canal No. 2. If there is adequate exchange potential, water would be turned out at the river and diverted by exchange at the existing Fort Collins upstream intakes. If there is not sufficient exchange potential, water would continue through the pipeline under the river, and would be delivered to a pretreatment facility located near the Larimer County Canal No. 2 turnout. Once treated, water would be pumped through a 42-inch pipeline directly into the Fort Collins raw water supply lines.

5.4.2.1.4 Chambers Lake Utilization

The Gravel Pits Alternative also included a concept-element combination that would count Fort Collins’ water stored in Chambers Lake as part of the storage reserve safety factor. Chambers Lake is located in the headwaters of the Poudre River. As part of the Joint Operations Plan, Fort Collins would make releases from Joe Wright Reservoir to maintain minimum flows below the reservoir. As part of the Joint Operations Plan operations, Fort Collins releases 600 AF of water from Joe Wright Reservoir to Chambers Lake in October of every year. This 600 AF is released from Chambers Lake at a rate of two cfs November through March. In the Gravel Pits Alternative, the amount of water remaining in storage in Chambers Lake would also count towards the storage reserve safety factor because the water could be released directly to the Fort Collins system.

5.4.2.1.5 Joe Wright Reservoir Reoperation

Joe Wright Reservoir is located in the headwaters of the Poudre River basin and is owned by Fort Collins. The Michigan Ditch delivers water from the Michigan River, which is tributary to the North Platte River, into the Poudre Basin just above Joe Wright Reservoir. Joe Wright Reservoir’s capacity is 6,474 AF, but due to icing problems during the winter, the water level is typically lowered to about 3,200 AF in the late fall. One of the preliminary alternatives included upgrading the outlet works so that winter carryover storage could be more than 3,200 AF, and then targeting winter storage of 4,500 AF. The other preliminary alternative included reoperation of Joe Wright Reservoir. The reoperation involved not releasing water to NPIC, as part of a water trade, if Joe Wright Reservoir did not fill to a threshold capacity during the runoff. Fort Collins recommended a hybrid of these two approaches for the Gravel Pits Alternative and would target winter storage of 3,200 AF for the end of October of each year by reducing the NPIC water trade if necessary to maintain that target storage. This operation was approved by the
Corps because it kept the overall concept of Joe Wright Reservoir re-operation that was contemplated in the preliminary alternatives, and a lower target storage could be compensated for by the larger gravel pits. The modeling performed for this alternative showed that the NPIC water trade would be reduced from an average of 1,512 AF to an average of 1,333 AF in the Gravel Pits Alternative. The Common Technical Platform baseline modeling includes a reduction in deliveries from Joe Wright Reservoir to NPIC in dry years (11 of the 86 years modeled) based on an algorithm currently used by Fort Collins. Under the Gravel Pits alternative, the reductions would occur more frequently (30 of the 86 years modeled).

Importantly, compared to Fort Collins’ Proposed Action where Joe Wright Reservoir was not re-operated in this manner, Fort Collins would be able to maintain 2,596 AF more in storage at Joe Wright Reservoir in Joe Wright Reservoir’s lowest month of the critical period of the design drought (March of the seventh year of the design drought).

5.4.2.2 Operations

Fort Collins’ water rights already owned or projected to be owned in the future would be diverted into storage at the Overland Gravel Pits complex. The Larimer County Canal No. 2 headgate is located downstream of the Water Supply & Storage Company and Pleasant Valley and Lake Canal headgate, so Fort Collins’ changed shares in those ditches would be delivered in the river channel to the Larimer County Canal No. 2 headgate. Fort Collins’ shares in the Larimer County No. 2 and New Mercer Canals originate at the river diversion dam shared by the Larimer County No. 2 and New Mercer Canals. Use of these shares would not require an exchange, but could be diverted directly at the Larimer County Canal No. 2 headgate and into the Overland Gravel Pits. The Arthur Ditch headgate is the next headgate downstream of the Larimer County Canal No. 2 headgate, and Fort Collins’ shares in the Arthur Ditch could be diverted by exchange.

Fort Collins would divert water into the Larimer County Canal No. 2 and would be required to enter into a carriage agreement with the ditch to divert at the headgate water that does not belong to Larimer County Canal No. 2. Such an agreement is common in the South Platte River basin (including the Poudre Basin), but is not guaranteed. In the event that a carriage agreement cannot be reached, Fort Collins could explore other options to divert water directly from the Poudre River into the gravel pits. Other diversion options would require re-configuration of some of the pipelines described in this alternative, and could involve a new diversion dam in the Poudre River.

It is assumed that Fort Collins would be able to change the location of the Halligan Reservoir conditional water right and the Grey Mountain conditional water right to divert at the Larimer County Canal No. 2 for delivery into the gravel pit complex.

When needed to meet its demands, Fort Collins would release water from the Overland Gravel Pits. When there is sufficient exchange potential, Fort Collins would pump water to the river turnout, releasing to the Poudre River, and then would exchange this water to existing upstream
intakes. When there is not sufficient exchange potential, Fort Collins would make releases from the Overland Gravel Pits to the pre-treatment plant and then pump directly into the raw water supply lines.

5.4.2.3 Additional Information

The Fort Collins Alternatives Report (MWH 2015) has additional detail about the proposed construction the Overland Gravel Pits complex, including proposed gravel pit configuration, hydraulic analyses for the pipelines and interconnection with the existing raw water supply lines, additional detail on the gravel pit excavation, construction, berms for above-grade storage, and details about the pre-treatment facility. The report also contains additional information about the utilization of Chambers Lake and Joe Wright Reservoir reoperation.

5.5 Agricultural Reservoirs Alternative

The Agricultural Reservoirs Alternative utilized storage in NPIC Reservoirs Nos. 5 and 6, located northeast of Fort Collins, and a pipeline from the reservoirs to the existing Fort Collins raw water supply lines (Figure 5-5; reproduced from MWH 2015, Map B-4). Fort Collins’ modeling showed that 6,475 AF of storage would need to be acquired from NPIC in Reservoirs Nos. 5 and 6. The alternative included construction of a bi-directional pipeline that would allow Fort Collins to fill the reservoirs from the existing Pleasant Valley Pipeline by gravity and allow for releases through the pipeline in the other direction to the water treatment plant. The NPIC canals currently used to deliver water the reservoirs would not be used by Fort Collins in this alternative so that Fort Collins could independently deliver water into or out of storage without coordination or restrictions from other NPIC operations in its canals. Water would be released from the reservoirs by gravity to either a river turnout or pre-treatment facility. Water delivered to the river turnout would be exchanged upstream to existing intakes. Pre-treated water would be pumped directly into the raw water supply lines.

5.5.1 Alternative Finalization Process

The Agricultural Reservoirs Alternative was developed based on the Alternative Agricultural Transfer Methods Preliminary Alternative. The preliminary alternative involved the use of two alternative transfer methods: an interruptible supply agreement and a shared water banking program. The preliminary alternative did not include a pipeline connection from NPIC reservoirs, but instead relied on Fort Collins’ ability to obtain pro-rata use of storage in NPIC facilities based on Fort Collins’ 37 percent ownership in the ditch. In combination with pro-rata capacity in Water Supply & Storage Company mountain reservoirs and reoperation of Joe Wright Reservoir as used in the Gravel Pits Alternative, it was posited that the storage reserve safety factor could be maintained without a pipeline connection to the agricultural reservoirs.

Fort Collins, the Corps, and the Third Party Contractor team met on several occasions in late 2013 to discuss various aspects of the alternative agricultural transfer methods preliminary
alternative. Fort Collins prepared a draft alternatives definition memorandum in February 2014 that outlined potential issues with the interruptible supply agreement and water banking concepts.
Figure 5-5. Agricultural Reservoirs Alternative map from MWH (2015).

Note: Valve houses at C and G allow deliveries from NPIC Res# 6 to Fort Collins WTF to be made either through the PVP by connecting the 48" new pipeline to the PVP by a valve house at C or through the existing 36" Fort Collins raw water pipeline by extending the 48" new pipeline to G and connecting it to the existing pipeline by a valve house.

The delivery option using the existing 36" pipeline corresponds to the most demanding pumping condition and was used to compute the pumping requirements shown in the map.
The interruptible supply agreement component of the preliminary alternative relied in part on Fort Collins ability to use the fully consumable portion of NPIC direct flow rights to meet its obligations under the Reuse Plan. This would have allowed Fort Collins to keep water in storage in Horsetooth Reservoir during the critical drought period when it would have water available at its raw water supply lines. However, Fort Collins believes this operation would be contrary to its Reuse Plan decree and any alteration of the decree would unnecessarily put the continued operation of the Reuse Plan at risk. The Corps and the Third Party Contractor team determined that without the ability to use the interruptible supply agreement water in the Reuse Plan or storage facilities in which to store the interruptible supply agreement water, the interruptible supply agreement concept provided little additional benefit. Table 3-5 shows very little consumable NPIC water available late in the year and this component is only feasible if Fort Collins can use the NPIC water earlier in the year (April, May and June) in lieu of releases from Horsetooth Reservoir for the Reuse Plan.

In discussions with NPIC, Fort Collins determined that it would likely not be able to obtain pro-rata storage in the NPIC facilities, in effect rendering the shared water banking concept infeasible. NPIC provided a letter to the Corps stating that its original constitution as a mutual ditch, its bylaws and operational policy do not recognize use of pro-rata capacity by Fort Collins in non-water assets such as Halligan Reservoir (NPIC 2012). In addition, Fort Collins has a policy to cooperate with agricultural entities. While there was some question in the Corps’ opinion regarding the legal analysis presented by NPIC, Fort Collins proposed a modification to the preliminary alternative that maintained the general intent of the preliminary alternative of using existing agricultural reservoirs, avoided a potential legal conflict with NPIC, and also kept the alternative in accord with Fort Collins’ policy on cooperation with agricultural entities.

In lieu of the alternative transfer concepts, Fort Collins proposed acquiring independent storage capacity in existing NPIC Reservoirs Nos. 5 and 6. Reservoirs Nos. 5 and 6 are two separate reservoirs, but are operated as a single reservoir by NPIC, with the outlet of NPIC Reservoir No. 5 flowing directly into NPIC Reservoir No. 6. Fort Collins identified these reservoirs due to the proximity to Fort Collins and, as the Fort Collins alternative definition noted, because these reservoirs are located low in the NPIC system and are not likely to be used as regulating storage facilities. In addition, it is noted that prior to its withdrawal from the Halligan Project, NPIC provided a system-wide planning model that included simulated storage in NPIC Reservoirs Nos. 5 and 6. The system model describes the reservoirs as “principally modeled as a vessel in which one might store unused water for possible later use for exchange or sale, etc.” indicating that the reservoirs are not primarily used for meeting NPIC irrigation demands. The Fort Collins proposal included a pipeline from the reservoirs to the raw water supply lines so that the reservoirs could count towards the storage reserve safety factor.

The Corps approved the proposed modifications to the alternative in December 2013 based on discussions at several meeting held in late 2013. In February 2014, Fort Collins provided a memo with additional information and detail about the proposed alternative, and the Corps approved the approach in March 2014. The revised modeling for the Agricultural Reservoirs
Alternative was submitted to the Third-Party Contractor team in November 2014. In February 2015, the Corps and Third-Party Contractor team completed its review of the detailed modeling conducted by Fort Collins for the Agricultural Reservoirs Alternative (email from Corps to Fort Collins February 11, 2015). The Third-Party Contractor team found the Agricultural Reservoirs Alternative was correctly implemented in the modeling based on the proposed approach provided in February 2014. The Corps approved the modeling for the Agricultural Reservoirs Alternative and distributed the model results to other Third-Party Contractor team resource specialists for the comparative effects analysis in the DEIS.

5.5.2 Key Components of the Agricultural Reservoirs Alternative

The Agricultural Reservoirs Alternative involved the acquisition of independent storage in NPIC Reservoirs Nos. 5 and 6. Water would be conveyed into and out of the reservoirs by a 48-inch bi-directional pipeline. The pipeline would connect to both of Fort Collins’ raw water supply lines. The reservoirs would fill by gravity from the Pleasant Valley Pipeline connection. Releases would be made through the bi-directional pipeline to a pre-treatment facility, and then pumped into the raw water supply lines. A river turnout would also be included so that Fort Collins could exchange reservoir releases to its upstream intakes when there is sufficient exchange potential.

5.5.2.1 Facilities

5.5.2.1.1 NPIC Reservoirs Nos. 5 and 6

In this alternative, Fort Collins would purchase or otherwise acquire the rights to 6,475 AF of storage capacity in NPIC Reservoirs Nos. 5 and 6 for its own use. The reservoirs are located northeast of Fort Collins, and have a total capacity of approximately 17,830 AF. The reservoirs are located low in the NPIC system, and were described by NPIC in its system model as useful for storing water for later exchange and/or sale. The NPIC system model indicates that 266 irrigated acres are served by NPIC Nos. 5 and 6 out of the total 18,500 acres to be served in the future by the NPIC system, and an exchange of up to 3,000 AF is made with the down-gradient Water Supply & Storage Company ditch system when water is available and there is demand in the Water Supply & Storage Company system.

The existing outlet works of the reservoirs would be modified to allow for inflows from the Fort Collins bi-directional pipeline and releases to be made either to the Fort Collins bi-directional pipeline or for continued use of the existing outlet for agricultural use. NPIC Reservoir No. 6 is located at a lower elevation than NPIC Reservoir No. 5. Currently, NPIC makes releases from NPIC Reservoir No. 5 into NPIC Reservoir No. 6, and makes releases to agricultural users from NPIC Reservoir No. 6. The 48-inch bi-directional pipeline that connects to the Fort Collins raw water supply lines would connect into a new valve house at the NPIC Reservoir No. 6 outlet. When Fort Collins is filling the reservoirs, the valve house would allow for inflows into NPIC Reservoir No. 6, or pass-through to a 36-inch pipeline that continues into NPIC Reservoir No. 5. The valve house would operate such that NPIC could make releases from NPIC Reservoir No. 6.
at times Fort Collins is filling NPIC Reservoir No. 5. The bi-directional pipeline would be able to fill both Reservoirs Nos. 5 and 6 by gravity from the Pleasant Valley Pipeline. Releases of water through the bi-directional pipeline would also flow by gravity back towards Fort Collins to a pre-treatment facility located near the Poudre River where it crosses Taft Hill Road.

NPIC system modeling performed as part of the Common Technical Platform hydrology modeling indicated that there would be 6,475 AF of available capacity in the reservoirs most of the time through the modeled study period. However, during the year leading up to the critical period (model year 2016), the NPIC system model showed NPIC Reservoirs Nos. 5 and 6 filling to capacity. The Fort Collins system model also showed use of 6,194 of its 6,475 AF of capacity at the same time. This indicates that Fort Collins’ use of the reservoirs would interfere with normal NPIC operations and will likely require purchase of the storage capacity rather than a space-available contract.

5.5.2.1.2 Inlet Facilities

Water delivered into NPIC Reservoirs Nos. 5 and 6 would be diverted from the Poudre River by exchange at the Munroe Canal headgate. The water would then be delivered into the Pleasant Valley Pipeline, which diverts from the Munroe Canal. The Pleasant Valley Pipeline would be connected to a new 48-inch bi-directional pipeline, with the connection located near the Overland Gravel Pits. The bi-directional pipeline would then deliver water from the Pleasant Valley Pipeline to a new valve house located at the outlet works of NPIC Reservoir No. 6 where water could be delivered into the reservoir through the existing outlet pipe or passed through the valve house into a 36-inch bi-directional pipeline for delivery into NPIC Reservoir No. 5. The hydraulic head from the Pleasant Valley Pipeline diversion from the Munroe Canal to the outlet at NPIC Reservoirs Nos. 5 and 6 would be sufficient to deliver the water to the reservoirs by gravity flow. A second connection from the 48-inch bi-directional pipeline would be made to the existing 36-inch Fort Collins Pipeline, but would be used for delivery to the water treatment plant, not for filling the reservoirs. Reservoir filling operations typically would occur only during the summer months when Fort Collins has capacity in the Pleasant Valley Pipeline.

5.5.2.1.3 Outlet Facilities

Water released from NPIC Reservoirs Nos. 5 and 6 would be released into the bi-directional pipe from NPIC Reservoir No. 6. Water stored in NPIC Reservoir No. 5 could be released into NPIC Reservoir No. 6 through the existing outlet works. Water delivered into the bi-directional pipeline would flow by gravity either to a river turnout or to a pre-treatment facility, both located near the Overland Gravel Pits. When there is sufficient exchange potential, Fort Collins would deliver water into the river turn-out and divert an equal amount of water by exchange at the existing upstream intakes. When there is not sufficient exchange potential, Fort Collins would pre-treat the water from the reservoirs to a quality similar to that diverted at the existing intakes in the Poudre Canyon. Once pre-treated, water would then be pumped into the Pleasant Valley Pipeline or the existing Fort Collins Pipeline for delivery to the Fort Collins water treatment plant. The connection to both of the existing raw water supply lines would allow Fort Collins to
deliver water to its water treatment plant during the summer (when it has capacity in the Pleasant Valley Pipeline), and in the winter when it does not have capacity in the Pleasant Valley Pipeline. Conveyance to Fort Collins’ water treatment plant would utilize the Pleasant Valley Pipeline and the Fort Collins pipeline. The Pleasant Valley Pipeline is a shared facility with other water providers. Pre-treatment of water stored at NPIC Reservoir Nos. 5 and 6 may be required to ensure water quality in the pipeline for use by others is not degraded by the introduction of water stored at NPIC Reservoir Nos. 5 and 6.

Fort Collins anticipated that a pre-treatment facility would be required to bring the quality of water delivered from NPIC Reservoirs Nos. 5 and 6 up to a similar quality of water diverted at its existing intakes. The pre-treatment facility would be used only for direct deliveries into the existing raw water supply lines. Fort Collins planned for a 28 MGD plant capacity to handle the largest flow expected to be delivered directly into the pipelines. In the event that water quality in the reservoirs is significantly poorer than water in the Poudre River near the Overland Gravel Pits, pre-treatment may be required for water that is delivered to the river turn-out for exchange. Sufficient water quality data was not currently available for NPIC Reservoirs Nos. 5 and 6 and the pre-treatment design, capacity and cost may be re-evaluated when additional information is available.

5.5.2.1.4 Chambers Lake Utilization

The Agricultural Reservoirs Alternative also included a concept-element combination that counts Fort Collins’ water stored in Chambers Lake as part of the storage reserve safety factor. Chambers Lake is located in the headwaters of the Poudre River. As part of the Joint Operations Plan, Fort Collins makes releases from its Joe Wright Reservoir to maintain minimum flows below the reservoirs. As part of the Joint Operations Plan operations, Fort Collins releases 600 AF of water from Joe Wright Reservoir to Chambers Lake in October of every year. This 600 AF is released from Chambers Lake at a rate of 2 cfs November through March. In the Agricultural Reservoirs Alternative, the amount of water remaining in storage in Chambers Lake would be counted towards the storage reserve safety factor because the water could be released directly to the Fort Collins system.

5.5.2.2 Operations

Water rights already owned or projected to be owned in the future would be diverted at the Munroe Canal headgate and delivered into the Pleasant Valley Pipeline and then delivered into NPIC Reservoir Nos. 5 and 6 through a new 48-inch bi-directional pipeline. Fort Collins would use its existing and projected future water rights and would divert at the Munroe canal by exchange. Water diverted into the Pleasant Valley Pipeline would flow by gravity into NPIC Reservoirs Nos. 5 and 6.

Fort Collins analyzed the capacity in the Pleasant Valley Pipeline during times when it would fill NPIC Reservoirs Nos. 5 and 6 and found the capacity would be sufficient for the water being delivered to storage. Other parties use the Pleasant Valley Pipeline, and Fort Collins would have
to obtain an agreement with the other parties to use the pipeline, ensure water quality, and the ability to maintain operational pressure in the pipeline through the new valve and pump station configuration at the connection of the new 48-inch bi-directional pipeline to the Pleasant Valley Pipeline.

It is assumed that Fort Collins would be able to change the location of the Halligan Reservoir conditional water right and the Grey Mountain conditional water right to divert at the Munroe Canal for delivery into the Pleasant Valley Pipeline and storage in NPIC Reservoirs Nos. 5 and 6.

When needed to meet its demands, Fort Collins would release water from NPIC Reservoirs Nos. 5 and 6. When there is sufficient exchange potential, Fort Collins could release water to the river turnout, releasing to the Poudre River, and then exchange these flows to existing upstream intakes. When there is not sufficient exchange potential, Fort Collins would make releases to the pre-treatment plant and then pump directly into the raw water supply lines. Water quality constraints may require pre-treatment of water delivered to the river turnout. Additional information regarding water quality would be required before making this determination.

5.5.2.3 Additional Information

The Fort Collins Alternatives Report (MWH 2015) has additional detail about the proposed construction of the bi-directional pipeline that delivers water from the Pleasant Valley Pipeline to NPIC Reservoirs Nos. 5 and 6, and also from the reservoirs back to the raw water lines. The report includes hydraulic analyses for the pipelines and interconnection with the existing raw water supply lines and additional detail on the new outlet works configuration at NPIC Reservoir No. 6. The report also provided additional details about the pre-treatment facility initial design.

5.6 No-Action Alternative

Fort Collins developed a No-Action Alternative for evaluation in the DEIS. The No-Action Alternative describes how Fort Collins would attempt to satisfy the purpose and need if Fort Collins’ Proposed Action were not permitted, or it decided to not proceed with a permitted alternative. According to Corps regulations, the No-Action Alternative should not require a federal permit of any type, including a Section 404 nationwide permit (33 CFR Part 325, Appendix B). Fort Collins’ No-Action Alternative consisted of three components: 1) reoperation of Joe Wright Reservoir; 2) acquisition of additional NPIC shares in order to obtain the C-BT storage component associated with each share; and 3) institute more frequent drought restrictions. As configured, the No-Action Alternative does not meet the purpose and need due to the mandatory drought restrictions that would be necessary to provide water through the 50-year design drought.
5.6.1 No-Action Alternative Finalization Process

Unlike the alternatives described above, the No-Action Alternative was not developed as part of the alternatives screening process. Instead, the No-Action Alternative was developed by Fort Collins and then reviewed by the Corps and Third-Party Contractor team for reasonability and accuracy in modeling. Fort Collins submitted a definition of the No-Action Alternative in January, 2015. The definition included a screening of several different options Fort Collins could pursue as part of its No-Action Alternative. The screening eliminated several of the available options, providing rationale for exclusion of some concepts in favor of others.

The Corps and Third-Party Contractor team provided feedback and several questions related to the No-Action Alternative. Fort Collins addressed all comments and questions and provided a revised No-Action Alternative definition in May 2015. In June 2015 Fort Collins provided modeling files for the No-Action Alternative and included a description of the No-Action Alternative in the Fort Collins alternatives report (MWH 2015). In July 2015, the Corps and Third-Party Contractor team completed its review of the detailed modeling conducted by Fort Collins for the No-Action Alternative (email from WEST to Fort Collins July 20, 2015). The Third-Party Contractor team found the No-Action Alternative was correctly implemented in the modeling based on the proposed approach provided in May 2015. The Corps approved the modeling for the No-Action Alternative and distributed the model results to other Third-Party Contractor team resource specialists for the comparative effects analysis in the EIS.

5.6.2 Key Components of the No Action Alternative

The screening process implemented by Fort Collins for the various options it could pursue under the No-Action Alternative resulted in the following three components: 1) reoperation of Joe Wright Reservoir; 2) acquisition of additional NPIC shares; and 3) increased frequency of drought restrictions.

5.6.2.1 Reoperation of Joe Wright Reservoir

The reoperation of Joe Wright Reservoir was also included as a component in the Gravel Pits Alternative (see Section 5.4.2.1.5). Releases from Joe Wright Reservoir would be reduced to target a winter carryover storage amount of 3,200 AF. This storage level would not require any modifications to the existing outlet facilities at Joe Wright Reservoir. The reduction in releases would be accomplished by not executing a water trade with NPIC for C-BT water under certain circumstances. Any unused C-BT water would be lost to the C-BT system at the end of October and would no longer count towards the storage reserve safety factor, whereas water kept in Joe Wright Reservoir could be used towards the storage reserve safety factor for as long as the water is kept in Joe Wright Reservoir.
5.6.2.2 Acquisition of Additional NPIC Shares

Throughout the project, Fort Collins has projected future acquisition of additional shares of several ditch companies above and beyond the shares already owned or changed for municipal use. For the No-Action Alternative, Fort Collins would acquire more shares of NPIC instead of the other ditch companies. Each share of NPIC includes four C-BT units. Each unit of C-BT provides one AF of water in the C-BT system, multiplied by the C-BT quota which has varied historically between 50 percent and 100 percent, with an average of approximately 70 percent. In addition, NPIC assesses a 20 percent ditch loss charge on delivery of the C-BT units because it must deliver an equal amount of water to each share of NPIC, accounting for delivery losses incurred in ditches and laterals in route to agricultural shareholders.

Fort Collins developed a conversion factor to determine how many additional shares of NPIC it could expect in lieu of other ditch sources it had previously planned to acquire. The conversion rate was based on the currently accepted raw water requirement factors used by Fort Collins for determining water rights needed to provide new water service. The computation resulted in an additional 390 shares of NPIC. In addition, Fort Collins assumed that it would use an equal amount of funding that it would have spent on the expansion of Halligan Reservoir and purchase an additional 275 NPIC shares. Fort Collins also included the additional 189 shares of NPIC it had already planned on acquiring in the future and used in all other alternatives modeling. In total, the No-Action Alternative contemplates acquisition of an additional 854 NPIC shares, of which, 665 additional shares are unique to the No-Action Alternative. These 665 shares represent 6.65 percent of the outstanding NPIC shares. The maximum municipal ownership of NPIC shares is assumed to be 85 percent. This portion of the No Action alternative would increase the Fort Collins ownership to approximately 44 percent from 37 percent and would likely reduce projected municipal ownership by other entities by the same percentages (7 percent). The additional 665 shares that have a 50 percent C-BT quota would provide 1,064 AF of additional storage in Horsetooth Reservoir for Fort Collins during the critical year of the drought.

5.6.2.3 Mandatory Drought Restrictions

The No-Action Alternative included mandatory drought restrictions on Fort Collins water utility customers during periods of drought in order to reduce the water demands on the system. The use of drought restrictions to supply water through the 1-in-50 design drought would not meet the purpose and need for the project. Fort Collins quantified the frequency, duration and severity of necessary drought restrictions using the hydrologic modeling.

Fort Collins developed an initial version of the model for the No-Action Alternative that included the Joe Wright Reservoir reoperation and the additional shares of NPIC. In order to estimate the necessity and severity of the mandatory drought restriction, Fort Collins evaluated the initial model results in each May of the simulation. Years where restrictions would be necessary were identified based on the state of the model in each May and projected water
availability for the rest of the summer using methods currently employed by the City (e.g. estimates of water rights yield based on remaining snowpack, reservoir levels etc.).

If a shortfall was projected for a given summer, Fort Collins assigned a drought restriction level to reduce demands through the following modeled October. In years with no projected shortfall, no drought restrictions would be implemented. Fort Collins uses a tiered system of drought restrictions, with Level 1 being the least restrictive, to Level 4 being the most restrictive. The restriction levels are defined in the City’s Water Supply Shortage Response Plan, with. Table 5-2 (replica of Table 8-3 in MWH 2015) shows the restriction levels, the water supply shortfall trigger based on the beginning of May projection, and the corresponding demand reduction factor.

Table 5-2. Fort Collins water supply shortage response plan.

<table>
<thead>
<tr>
<th>Restriction Level</th>
<th>Restriction Trigger</th>
<th>Projected Demand Reduction* Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>1-10% water supply shortage</td>
<td>5%</td>
</tr>
<tr>
<td>Level 2</td>
<td>11-20% water supply shortage</td>
<td>15%</td>
</tr>
<tr>
<td>Level 3</td>
<td>21-30% water supply shortage</td>
<td>25%</td>
</tr>
<tr>
<td>Level 4</td>
<td>&gt;30% water supply shortage</td>
<td>35%</td>
</tr>
</tbody>
</table>

*Fort Collins’ ability to achieve the water demand reductions shown has not been proven in practice.

The model was re-run with reduced demands in years that a drought restriction was required. The model results indicate that restrictions would be necessary in five of the 86 simulated years, including four years of Level 1 restrictions, and one year of Level 3 restrictions. Only the one year of Level 3 restrictions were required during the 1-in-50 design drought. The storage reserve safety factor was not met through the design drought even with the Level 3 restrictions. The storage reserve safety factor is designed to provide Fort Collins with water to counteract an emergency, such as failure of one its raw water lines or the Horsetooth Reservoir intake. By not meeting the storage reserve safety factor, Fort Collins would be able to meet its demands, but is at risk of not having enough water to counteract these types of emergency situations during a drought.

The No-Action Alternative is unique in that it is the only alternative presented that does not meet the purpose and need. As part of the final modeling, a future conditions configuration model was run and used for comparative impacts (Common Technical Platform Run 4), which included the C-BT carryover program. The model results from the Common Technical Platform Run 4 of the No-Action Alternative showed that drought restrictions are not needed through the design drought when the C-BT carryover program is simulated. This indicates that the No-Action Alternative could meet the purpose and need when paired with the C-BT carryover program. However, the C-BT carryover project was not considered in the project sizing model runs that determine if the purpose and need has been met because it is not a permanent program (Section 3.2.4.4). Therefore, the No-Action Alternative does not meet the purpose and need.
5.6.2.4 Additional Information

The Fort Collins Alternatives Report (MWH 2015) and the Fort Collins No-Action Alternative definition provided in May 2015 have additional detail about the No-Action Alternative. The reports included additional detail on the screening process used by Fort Collins to arrive at the three components of the No-Action Alternative. The reports also contained additional technical details about the method used to project the number of additional NPIC shares it could acquire and additional technical details regarding the projection of the mandatory drought restrictions.
6 Literature Cited


Code of Federal Regulations


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Water Management Consultants, received as Exhibit A from Greeley 9/25/12


Appendix A: Long-List of Elements and Screening

Appendix A is available in a separate pdf file.
Appendix B: Geographic Information System Analysis

Appendix B is available in a separate pdf file.
Appendix C: Screening of Water Concepts

Appendix C is available in a separate pdf file.