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<th>Description</th>
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<tbody>
<tr>
<td>ACE</td>
<td>Anderson Consulting Engineers</td>
</tr>
<tr>
<td>C-BT</td>
<td>Colorado-Big Thompson Project</td>
</tr>
<tr>
<td>CDPHE</td>
<td>Colorado Department Public of Health and Environment</td>
</tr>
<tr>
<td>Corps</td>
<td>U.S. Army Corps of Engineers</td>
</tr>
<tr>
<td>EIS</td>
<td>Environmental Impact Statement</td>
</tr>
<tr>
<td>ERO</td>
<td>ERO Resources Corporation</td>
</tr>
<tr>
<td>Fish and Wildlife Service</td>
<td>U.S. Fish and Wildlife Service</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information System</td>
</tr>
<tr>
<td>NISP</td>
<td>Northern Integrated Supply Project</td>
</tr>
<tr>
<td>NPIC</td>
<td>North Poudre Irrigation Company</td>
</tr>
<tr>
<td>Pioneer</td>
<td>Pioneer Environmental Services</td>
</tr>
<tr>
<td>RFFAs</td>
<td>Reasonably foreseeable future actions</td>
</tr>
<tr>
<td>WEST</td>
<td>Western EcoSystems Technology, Inc.</td>
</tr>
</tbody>
</table>
4 Environmental Effects

4.1 INTRODUCTION

Chapter 4 provides information on the direct and indirect effects to the environment that could potentially result from implementation of the alternatives described in Chapter 2. An environmental effect is defined as any change to the environment, whether adverse or beneficial, resulting from an action taken. Effects vary in significance from no change or only slightly discernable change, to a full modification or elimination of the environmental condition. In accordance with 40 Code of Federal Regulations 1502.2(b), effects are discussed in proportion to their significance. The significance of the effect is considered in terms of context and intensity. Detailed discussions are provided for moderate to major or complex effects, and brief discussions are provided for minor effects.

An effect analysis was conducted for each resource described in Chapter 3. The analysis predicts the degree to which the resources would be affected upon implementation of an action. However, the preliminary nature of designs for Fort Collins’ Proposed Action and each of the alternatives provide conservative estimates for the extent of inundation areas, borrow areas, staging areas, and infrastructure such as pipeline corridors; therefore, the estimated disturbance areas represent maximum expected disturbances. Within each resource section, a discussion of potential environmental consequences includes:

- Direct and indirect effects and their significance
- Appropriate and practicable avoidance, minimization, and enhancement measures
- Adverse environmental effects which cannot be avoided should the proposal be implemented
- Compensatory mitigation for unavoidable adverse effects, if necessary

Most of the substantial effects to resources are associated with project facilities (direct effects) or proposed project operations that would alter flows in the North Fork and Main Stem (indirect effects). Flow-related resource effects discussed in this chapter do not include the reasonably foreseeable future (RFFAs). Analyses in Chapter 5, Cumulative Effects, include potential effects from the Reasonable Foreseeable Future Actions.

This Draft Environmental Impact Statement (EIS) uses two baseline conditions in the effects analyses. Project Alternative effects were compared to either Current Conditions Baseline (Chapter 3) or to hydrologic Future Conditions Baseline. Because Fort Collins can meet their demand with existing supplies through 2020 (Section 1.4.1.5) and there are a number of water supply infrastructure and operational actions that can be conducted by Fort Collins and other water providers during the planning period that do not require permits from the U.S. Army Corps of Engineers (Corps; Section 4.3.1.1.3.2, the Future Conditions Baseline best represents probable conditions when the need for the Project Alternatives would occur as a result of future demand on the water supply system for Fort Collins. The hydrologic Future Conditions Baseline is based on modeling, and is described in Section 4.3.
Fort Collins prepared a draft *Mitigation Plan for Fort Collins’ Proposed Action* (Appendix A) that identifies proposed mitigation to offset potential project effects described in this chapter. If Fort Collins’ Proposed Action is selected as the Environmentally Preferred Alternative, the Corps will evaluate in the Record of Decision the adequacy of the proposed mitigation, as well as any fish and wildlife mitigation that Fort Collins may develop through consultation under Section 7 of the Endangered Species Act, Section 106 of the National Historic Preservation Act, the State of Colorado’s Fish and Wildlife Mitigation plan process and the Colorado Department of Public Health and the Environment (CDPHE) 401 certification process, to offset significant environmental effects and ensure the proposed work is not contrary to the public interest.

### 4.2 Effects Analysis Framework

#### 4.2.1 Terms Used for the Effects Analysis

##### 4.2.1.1 Direct and Indirect Effects

Direct effects are those that would result directly from implementing one of the alternatives. Most direct effects would occur from construction of facilities (e.g., dams and pipelines), and inundation by reservoirs. Indirect effects are those that are project-induced, but occur later in time or are farther removed in distance. The primary indirect effects will be associated with resources affected by project-related changes in flows in the North Fork and Main Stem, but could include the economic effects of transferring agricultural water to municipal and industrial use and emission of carbon dioxide, a greenhouse gas, associated with operation of some of the alternatives. Estimated greenhouse gas emissions from project operations are presented in Section 4.19. Climate change is addressed in Chapter 5 as a reasonably foreseeable condition of the future affected environment.

##### 4.2.1.2 Effect Duration Terms

Effects are described as either short-term or long-term for each resource. For the purposes of this analysis, short-term impacts are estimated to persist for five years following disturbance and would result primarily from temporary construction disturbances that either would be reclaimed (e.g., pipelines) or would cease (e.g., construction noise). Long-term impacts are expected to be permanent (e.g., dams or the realignment of U.S. Highway 287) or will occur periodically over the life of the project (e.g., reservoir inundation).

##### 4.2.1.3 Intensity and Magnitude of Effect

Based on the alternatives descriptions and affected environment resource data, each resource specialist identified the types and amounts of impacts that could occur as a result of implementation of the alternatives. The potential vulnerability of each resource was considered qualitatively or quantitatively to predict the intensity of impacts and was evaluated considering the following:

- **Resource significance**: A measure of formal concern for a resource through legal protection or by designation as special status.
- **Resource sensitivity**: The probable response of a particular resource to Project-related activities.
- **Resource quality**: A measure of rarity, intrinsic worth, or distinctiveness, including the local values and importance of a resource.
- **Resources quantity**: A measure of resource abundance and the amount of the resource potentially affected.

Some resource impacts are more conducive to quantification than others, such as impacts on vegetation, which can be characterized partly by measuring the area of potential ground disturbance, and air quality impacts, which can be measured against air quality standards. Other resources are difficult to quantify, such as aesthetics and visual resources, and levels of effect were based on available information and best professional judgment.

For the purposes of analysis for this Draft EIS, the intensity of effects was described using the following terms:

- **No effect**: No discernable or measurable effect
- **Negligible**: Effects would be at the lowest levels of detection, barely measurable, with no perceptible consequences
- **Minor**: Effects result in a detectable change, but the change would be slight
- **Moderate**: Effects would result in a clearly detectable change, with measurable effects
- **Major**: Effects would be readily apparent with substantial consequences

These definitions are used unless otherwise stated in the resource methods discussions. Throughout this document for each resource determination, all effects are considered adverse unless otherwise stated as beneficial. Effect determinations include consideration of avoidance, minimization and enhancement measures that would either avoid causing an effect or minimize the effect’s intensity. Effect determinations do not include compensatory mitigation. Compensatory mitigation means the restoration, establishment, enhancement, and in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse effects that remain after all appropriate and practicable avoidance and minimization has been achieved (33 Code of Federal Regulations 332.2). While the definition of compensatory mitigation provided is specific to aquatic resources, it was applied to all resources.

### 4.2.1.4 Unavoidable Adverse Effects

Certain adverse effects cannot be avoided after all appropriate and practicable avoidance and minimization has been achieved. Implementation of any of the Project Alternatives would have unavoidable direct, adverse effects. Unavoidable indirect effects resulting from the Project Alternatives could include fugitive dust and exhaust emissions from construction activities, soil and wind erosion, water quality effects from stormwater runoff, displacement of wildlife species, disturbance of cultural and paleontological resources, and loss of natural viewsheds.
4.2.1.5 Incomplete and Unavailable Information

The Council on Environmental Quality’s National Environmental Policy Act regulations describe how federal agencies must handle instances where information relevant to evaluating reasonably foreseeable adverse effects of the alternatives is incomplete or unavailable (40 Code of Federal Regulations 1502.22). “Incomplete information” refers to information the agency cannot obtain because the overall costs of doing so are exorbitant. The term “unavailable information” refers to information that cannot be obtained because the means to obtain it are not known. “Overall costs” encompasses financial costs and other costs such as costs in terms of time (delay) and personnel (51 Federal Register 15625). As a federal agency, the Corps is to obtain information for an EIS if: (1) it is needed for evaluating reasonably foreseeable significant adverse effects; (2) it is essential to make a reasoned choice between alternatives; and (3) the overall costs of obtaining it are not exorbitant. In the following resource sections, the EIS describes the best available data for each resource in the study area. The Corps determined the data available and methods used are adequate to evaluate and describe reasonably foreseeable significant adverse effects on each resource in the study area and to enable the decision maker to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable information for any resource.

4.2.1.6 Relationship between Short-Term Uses and Long-Term Productivity

Pursuant to National Environmental Policy Act regulations [40 Code of Federal Regulations 1502.16], an EIS must consider the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity. Short-term is defined as the construction period through final reclamation, which is assumed to take up to 10 years. Long-term is defined as the period after the alternative would be completed and mitigation measures are in place. For example, short-term use of labor force could result in long-term productivity of the economic environment, including employment and tax revenue. The short-term and long-term effects relative to each resource are described under each resource section in this chapter.

4.2.1.7 Irreversible or Irretrievable Commitment of Resources

The National Environmental Policy Act requires a discussion of any irreversible or irretrievable commitment of resources resulting from implementing each alternative. An “irreversible commitment of resources” occurs when, once committed to the project, the resource would continue to be committed throughout the life of the project. An “irretrievable commitment of resources” refers to those resources that, once used, consumed, destroyed, or degraded during construction, operation, or decommissioning of the Project, would cause the resource to be unavailable for use by future generations. Examples of irretrievable types of resources include nonrenewable resources, such as minerals and cultural resources, as well as renewable resources that would be unavailable for future generations such as loss of production, harvest, or habitat. The monetary investment by Fort Collins is not considered to be an irreversible or irretrievable commitment of resources. If Fort Collins’ Proposed Action is not built, the investment that would have otherwise been spent on this project could be spent elsewhere.

For Fort Collins’ Proposed Action, the time frame for irretrievable resource commitments is the period of time that the project remains in place, or temporary facilities or disturbances remain. For example, native plant communities disturbed during construction but not inundated or covered by an impermeable surface
represents an irretrievable loss of resources. In this example, the period of time between disturbance and complete revegetation represents an irretrievable loss of resources. A summary of irreversible and irretrievable effects is presented in Table 4-1.

Table 4-1. Irreversible and irretrievable commitments of resources of action alternatives.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Irreversible Effects</th>
<th>Irretrievable Effects</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water quality</td>
<td>No</td>
<td>No</td>
<td>Changes to water quality would not be irreversible or irretrievable.</td>
</tr>
<tr>
<td>Water quantity</td>
<td>No</td>
<td>No</td>
<td>Loss of water to evaporation from the reservoirs, diversion, and consumptive use of water would reduce river flows and availability of water for other uses.</td>
</tr>
<tr>
<td>Soils</td>
<td>No</td>
<td>Yes</td>
<td>Loss of soil productivity due to reservoir inundation, facilities construction, and highway realignment; construction would also cause accelerated erosion.</td>
</tr>
<tr>
<td>Vegetation</td>
<td>No</td>
<td>Yes</td>
<td>Loss of vegetation that occurs within the facilities and roadway footprints that would be constructed.</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Yes</td>
<td>Yes</td>
<td>Loss of agricultural land within the footprints of the facilities that would be constructed and changes in agricultural lands associated with the transfer of irrigation water.</td>
</tr>
<tr>
<td>Wildlife</td>
<td>Yes</td>
<td>Yes</td>
<td>Loss of wildlife habitat that occurs within the footprints of facilities that would be constructed.</td>
</tr>
<tr>
<td>Aquatics</td>
<td>Yes</td>
<td>Yes</td>
<td>Changes to aquatic habitat associated with reduced river flows.</td>
</tr>
<tr>
<td>Cultural resources/</td>
<td>Yes</td>
<td>Yes</td>
<td>Loss of cultural and paleontological resources due to accidental disturbance during construction.</td>
</tr>
<tr>
<td>paleontological</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land use</td>
<td>Yes</td>
<td>No</td>
<td>Changes in land use associated with reservoirs and realignment of highways that would be constructed.</td>
</tr>
<tr>
<td>Construction materials</td>
<td>No</td>
<td>Yes</td>
<td>Use of aggregate, water, steel, concrete, and fossil fuels for construction of facilities.</td>
</tr>
<tr>
<td>Air quality</td>
<td>No</td>
<td>No</td>
<td>Changes to air quality would not be irreversible or irretrievable.</td>
</tr>
<tr>
<td>Visual</td>
<td>Yes</td>
<td>No</td>
<td>Degradation of scenic quality due to potential permanent changes in topography and vegetation patterns at the reservoir sites.</td>
</tr>
</tbody>
</table>

4.2.1.8 Natural or Depletable Resource Requirements and the Built Environment

As part of the discussion of environmental consequences, the National Environmental Policy Act requires a discussion of natural or depletable resource requirements and conservation potential of various alternatives and mitigation measures, and design of the built environment, including reuse and conservation potential of various alternatives and mitigation measures (40 Code of Federal Regulations 1502.16). These are discussed below, with the exception of mitigation, which is discussed in Appendix A, and will be evaluated in the Record of Decision (discussed earlier in this section). The Corps will review and evaluate Fort Collins’ proposed mitigation plan in light of the predicted effects. The Corps will describe the final mitigation requirements in its Record of Decision and may incorporate mitigation that
Fort Collins may develop through consultation under Section 7 of the Endangered Species Act, consultation under Section 106 of the National Historic Preservation Act, the State of Colorado’s Fish and Wildlife Mitigation Plan process, and the CDPHE’s 401 certification process.

The alternatives were designed to meet the future water supply needs of Fort Collins. As discussed in Chapter 1, the timing of the future water needs can be delayed but not avoided through water conservation. Fort Collins has implemented water conservation programs that have been successful at conserving water (Purpose and Need Report Western EcoSystems Technology, Inc. [WEST] et al. 2016). Water is a valuable resource that Fort Collins will continue to conserve and look for ways to improve water conservation under any of the alternatives.

All alternatives with the exception of Fort Collins’ Proposed Action would use electrical energy to convey water. If an alternative requiring electrical energy is selected, Fort Collins would select the type, size, and number of pumps needed to minimize energy demands and achieve maximum efficiency. Fort Collins also would operate that alternative to minimize the energy used to pump each acre-foot of water.

Fort Collins’ Proposed Action and the Gravel Pits Alternative would require dam or berm construction. The design and construction of Halligan Dam or gravel pit berms would include maximizing use of geologic materials (soil, aggregate, and rock) near the reservoir or extracted from the gravel pit to minimize the mining of geological materials and their import from other locations.

### 4.2.1.9 Design of the Built Environment

All alternatives with the exception of Fort Collins’ Proposed Action would require pre-treatment facilities and structures to house pumps and other equipment. All buildings would incorporate designs to minimize energy requirements (e.g., high efficiency heating, ventilation, and cooling systems; use of insulated building materials; and use of natural lighting).

### 4.2.2 Resource Effects Studies

The Corps conducted detailed studies for each resource and generated technical reports detailing the methods and discussing the results for each resource for this Draft EIS. These studies are listed in Table 4-2 and full citations are listed in Chapter 7. Each technical report is available at [https://www.nwo.usace.army.mil/Missions/Regulatory-Program/Colorado/EIS-Halligan/](https://www.nwo.usace.army.mil/Missions/Regulatory-Program/Colorado/EIS-Halligan/). Additionally, this Draft EIS presents Main Stem baseline information and some analyses that were extracted from technical reports and the Draft EIS, Supplemental EIS, and Final EIS for the Northern Integrated Supply Project (NISP).
Table 4-2. Draft EIS technical memos and reports.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Draft EIS Technical Memos and Reports</th>
<th>Chapter 4 Citation</th>
<th>Abbreviated Title in Draft EIS</th>
</tr>
</thead>
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<tr>
<td>Resource</td>
<td>Draft EIS Technical Memos and Reports</td>
<td>Chapter 4 Citation</td>
<td>Abbreviated Title in Draft EIS</td>
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<td>--------------------------</td>
<td>------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Climate change</td>
<td>Climate Change Hydrologic Impacts Analysis for the Common Technical Platform for the NISP and HSWSP Environmental Impact Statements</td>
<td>DiNatale Water Consultants and CDM Smith 2014</td>
<td>Climate Change Technical Report</td>
</tr>
</tbody>
</table>
4.2.3 Features Common to All Alternatives

4.2.3.1 Ownership of Halligan Reservoir

Under all alternatives other than Fort Collins’ Proposed Action, ownership of Halligan Reservoir and all related facilities would revert from Fort Collins back to the North Poudre Irrigation Company (NPIC). NPIC would take over all responsibility for dam maintenance and reservoir operations on the part of its shareholders.

4.2.3.2 Water Rights Involved

Fort Collins would use a consistent set of existing and conditional water rights under all alternatives. The existing water rights include converted Southside Ditch water rights and Water Supply and Storage Company water rights. Conditional water rights include the Halligan Reservoir enlargement conditional right and half of the 1/8th share of the Grey Mountain Conditional Decree currently owned by the Cache La Poudre Water Users Association. The storage and use of the water rights differ as described for each alternative.

4.2.3.3 Land Purchases and Easements

Fort Collins would seek either fee ownership or permanent easements with landowners for all acreage required to support permanent facilities, such as gravel pit sites, pump stations and pre-treatment plants, or to expand existing reservoirs (with the exception of the Right of Way obtained on Bureau of Land Management property on the northeast side of Halligan Reservoir). Fort Collins would obtain easements for project components such as pipelines, access roads, staging areas, and borrow areas where ownership would not be required. In the case of easements, use of the property may be permanent or temporary. For example, pipelines may require permanent easements since periodic access may be required for maintenance or other purposes. Staging areas may only require temporary easements during the construction period.

4.2.3.4 Construction Disturbance Areas

Physical disturbances from inundation or construction of access roads or other facilities (i.e., pump stations, pre-treatment plants) would remain as permanent changes to the landscape and land uses. Other construction disturbances, including the creation of borrow areas, staging areas, pipeline routes or other features, would be temporary. Fort Collins would return these areas to their original conditions after construction (MWH Global 2015a). That work may require re-vegetation or other remediation measures.

Pipeline construction would require sufficient right-of-way to accommodate the pipeline trench, excavation pile and a haul route along the side of the work area. This area could be from 75 feet to 150 feet wide depending on trench width and depth of the pipe. Construction contractors would need to create a haul road along the alignment to move equipment in and out and to haul aggregates and pipe to the alignment, as well as to load and haul waste material away from excavations.
Parking for commuting workers would be located within the identified construction disturbance areas for each alternative. Construction workers would commute to specific sites in the morning and drive away from those sites at the end of the workday. Fort Collins prohibits trespassing by workers onto private property.

Public access to staging and borrow areas and to other construction disturbance areas would be restricted for safety and other reasons. However, construction activities would not restrict access to other surrounding properties.

### 4.2.3.5 Power Supplies and Line Locations

With the exception of the Fort Collins’ Proposed Action, each action alternative would require power supplies to operate specific facilities or equipment, including water treatment plants, pump stations, reservoir valves or other items. Fort Collins construction contractors may need to create new transmission lines or connections to existing lines to obtain additional power supplies. Fort Collins and its contractors would erect new power poles or towers as needed and conductors would be installed to connect to the power source (MWH Global 2015b). To minimize visual disturbances, Fort Collins would install underground powerlines, where feasible.

### 4.2.3.6 Agricultural Operations

Ditch company shares associated with each of the action alternatives are already either controlled by Fort Collins or will be acquired as part of Reasonable Foreseeable Future Actions. The use of shares acquired through Reasonable Foreseeable Future Actions are not alternative related effects, but are instead addressed in the cumulative effects component of the Draft EIS. Therefore, the Corps considered only the additional, alternative specific, potential effects to agricultural acreage and operations in the land use analysis. For example, there may be additional agricultural effects under the Gravel Pit Alternative and the Agricultural Reservoirs Alternative related to the unique operations included in each of those alternatives. Fort Collins also would acquire additional NPIC shares under the No-Action Alternative.

### 4.3 Surface Water Resources

This section describes the changes in surface water hydrology (stream flow and reservoir volume, surface areas, and elevations) that potentially could result from implementation of any Project Alternative. Surface water hydrology is the foundational resource for the evaluation of the effects on other flow-related resources. The hydrologic modeling of the Poudre River and North Fork basins and modeled changes to surface water resources are described in four technical memoranda and reports prepared in support of the EIS, as follows:
- *Technical Memorandum: Water Administration in the Cache La Poudre River Basin* (CDM Smith, DiNatale, and Hydros 2011). Hereafter referred to as the *District 3 Water Administration Memo*, this document provides an overview of Colorado’s prior appropriation water rights system and defines many elements of the potentially affected environment including summaries of historical stream flows at gages critical for water administration, transbasin imports, major irrigation diversions, water exchanges, and other operations that affect water administration in the Poudre Basin.


- *Addendum to the Water Resources Technical Report for the Halligan Water Supply Project Environmental Impact Statement* (CDM Smith 2018a). Hereafter referred to as the *Surface Water Resources Addendum*, this report presents statistical summaries of stream flows at key locations under Fort Collins’ Proposed Action compared to Current Conditions Baseline and Future Conditions hydrology with the addition of several avoidance and minimization measures proposed by Fort Collins including a Peak Flow Bypass Program and a summer low flow plan (Summer Plan).


The objective of this section is to summarize modeled diversions and illustrate the modeled changes in stream flow compared to modeled Current Conditions Baseline hydrology at multiple locations important to disclosing the effects of the Project Alternatives. The tables and figures presenting modeled surface water diversions, reservoir water levels, and changes in stream flow in this chapter are mostly drawn from the *Operations Report* (Fort Collins 2019) and the *Surface Water Resources Technical Report* (CDM Smith 2017). These tables and figures are intended to be representative examples and summaries of the types of data and presentations provided in greater detail in those reports. This section does not include
evaluation of effect intensity, but rather sets the stage for such designations in the context of the flow-related resource effects analyses that follow. The reader is encouraged to review the full technical reports to gain a more complete understanding of project operations (e.g., modeled diversion and reservoir releases) and modeled changes in the North Fork and Main Stem stream flows associated with the Project Alternatives.

4.3.1 Methods

The following sections summarize the methods of hydrologic modeling, data analysis, and data presentation used for the Project surface water analyses. Detailed accounts are provided in the technical reports referenced above.

4.3.1.1 Hydrologic Modeling

The purpose of the hydrologic modeling was to quantify the yields and to estimate potential changes to surface water resources resulting from construction and operations of each Project Alternative. Proposed operations and infrastructure under each Project Alternative were superimposed on the existing or future river system to estimate the volume of water available for the project under variable hydrologic conditions (2010 Current Conditions Baseline hydrology and 2065 Future Conditions hydrology). Diversion and exchange of water for the Project Alternatives and resulting changes in stream flows were quantified through the modeling process and documented in the *Operations Report* (Fort Collins 2019) and the *Surface Water Resources Technical Report* (CDM Smith 2017).

4.3.1.1.1 Development of the Hydrologic Models

At the direction of the Corps, the Common Technical Platform was developed so that potential environmental effects on multiple flow-related resources (surface water, groundwater, and some aspects of water quality, geomorphology, aquatic habitat, riparian habitat, etc.) occurring as a result of the proposed Halligan Project, Seaman Water Supply Project, and NISP implementation could be compared against consistently defined Current Conditions Baseline hydrology and Future Conditions hydrology. This directive was accomplished through the development and integration of a series of hydrologic models representing the Poudre River Basin and lower South Platte River Basin into a Common Technical Platform model sequence. The hydrologic models include all major municipal and industrial and agricultural water systems, and were designed to simulate Current Conditions Baseline hydrology, Future Conditions hydrology, Project Alternatives scenarios, and cumulative effects of the Project Alternatives.

The Common Technical Platform model sequence includes eight separate model applications maintained in either the MODSIM or Excel software platforms. Each component can be categorized as a basin water allocation model, water system operations model, or pre- or post-processing tool. The Common Technical Platform model sequence is executed in series to calculate stream flow and determine water systems operations for use in assessment of potential environmental effects.
4.3.1.1.2 Hydrologic Model Time Step and Output

Based on the analytical needs for surface water and other flow-related resources, the Common Technical Platform model sequence simulations were run on a monthly time step, with an additional Excel spreadsheet tool executed at the end of the sequence to disaggregate final modeled monthly stream flows to estimates of daily flows. Taking the availability of supporting historical data into consideration, the Corps selected two study periods for Common Technical Platform model sequence simulations and subsequent analyses. Both are based on the irrigation year, which runs from November 1 of the preceding year through October 31 of the stated year. The study periods are:

- **Monthly**: Irrigation years 1950 to 2005 (56 years, November 1949 to October 2005)
- **Daily**: Irrigation years 1980 to 2005 (26 years, November 1, 1979 to October 31, 2005)

For the monthly time step it was important to capture as long of a period as possible for analysis as well as to capture the extended drought of the mid-1950s which has been regarded as the drought of record for water supply planning in northern Colorado. The drought of the early 2000s was at least equal to and perhaps more severe than that of the mid-1950s and the study period captures these two critical events. Historic daily data records are not as available, so the daily study period is shorter. However, the daily data are better able to capture high and low flow events of particular interest for certain environmental effects. An analysis of historical stream flow data at the major Poudre River gages (Canyon Mouth, Lincoln Street, Boxelder, and Greeley) found that the two study periods were statistically similar.

Documentation of this comparative assessment was provided in Technical Appendix 8 of the 2018 Common Technical Platform Modeling Report. Historical stream flow data on the North Fork are more limited than the Main Stem, with historical daily flows at the Livermore Gage not available until October 1, 1986. Due to this limited availability of historical gage data, the daily disaggregation tool for the North Fork provides daily flow values for irrigation years 1987 to 2005 (CDM Smith Inc. and DiNatale Water Consultants 2016).

Both monthly and daily stream flow data were used to analyze and describe potential changes to surface water resources associated with each Project Alternative. Operational flows (e.g., diversions, exchanges, pipeline deliveries, etc.) for each Project Alternative are presented in the Operations Report (Fort Collins 2019) as monthly average flows in volumetric units of acre-feet and acre-feet per month. Unless otherwise noted, those monthly average volumes were calculated based on the 56 years of simulated data for the study period encompassing irrigation years 1950 to 2005. Similarly, some of the tables and figures illustrating stream flow changes in the Surface Water Resources Technical Report (CDM Smith 2017) use the monthly stream flow data, presented as average volumetric flows with units of acre-feet over the irrigation years 1980 to 2005.

The final output from the daily disaggregation tool is a time series of daily flows at a series of specified structures, representing key points along the river with a diversion or inflow (e.g., tributary inflow or effluent discharge). Daily disaggregation data were provided to other resource specialists for use as inputs for their models and other analytical tools used for assessing potential effects, such as to aquatic resources or stream morphology. The daily flow disaggregation method used for the Current Conditions Baseline and Future Conditions hydrology runs and Project Alternative model runs on the Main Stem is based on a daily point-flow model that provides estimates of daily flows for irrigation years 1980 to 2005 at every diversion and inflow point on the Main Stem from immediately above Munroe Canal downstream to the
Greeley Gage. The daily flow disaggregation method for the North Fork is similar to that of the Main Stem, except that no point flow model existed on the North Fork; historical daily flow data at each point along the river had to be compiled from a variety of data sources. Given that these datasets are derived from application of historical daily flow patterns to the Common Technical Platform monthly final river conditions, the estimated daily flows maintain a volumetric consistency with the monthly Common Technical Platform model sequence output while capturing the range of variability recorded in the historical gage measurements. The estimated daily flows were used for the statistical analyses of the Project Alternatives rather than as a representation of stream flow on a specific calendar day, which was not the intent of the modeling.

4.3.1.1.3 Hydrologic Model Runs Used for Analyses

The Common Technical Platform model sequence was employed in a series of model runs to simulate Current Conditions Baseline hydrology (2010 hydrology without Project Alternative, NISP, or Seaman projects), Future Conditions hydrology (2065 hydrology without Project Alternative, NISP, or Seaman Water Supply Project), and projected effects for the various Project Alternatives.

4.3.1.1.3.1 Common Technical Platform Run 1 – Current Conditions Baseline Hydrology

The Current Conditions Baseline hydrology uses irrigation years 1950 to 2005 monthly naturalized stream flows with 2010 demands, infrastructure, and operations to estimate 56 years of Poudre River stream flows under a Current Conditions Baseline scenario. Naturalized flows represent the expected stream flow in the river without any diversions or discharges. Common Technical Platform Run 1 is not intended to replicate historical hydrology, and therefore Common Technical Platform Run 1 simulation results (e.g., stream flows, diversions, and reservoir operations) should not be expected to exactly match recorded historical high flows, low flows, flood volumes, flow rates, or any other substantial hydrologic events that occurred at a particular time during the study period. Rather, based on the assumption that the variability of historical naturalized flows is representative of the expected variability of recent naturalized flows, Common Technical Platform Run 1 provides an estimate of how 2010 demands and operations would have affected water rights yields and stream flows given the variability of historical water availability (i.e., naturalized flows). Section 3.2.1 of the Surface Water Resources Technical Report (CDM Smith 2017) provides statistical summary plots of the estimated daily flows (minimum, maximum, median, and average) for Common Technical Platform Run 1.

4.3.1.1.3.2 Common Technical Platform Run 2 – Future Conditions Baseline Hydrology

Future Conditions Baseline hydrology uses irrigation years 1950 to 2005 monthly naturalized stream flows with projected 2065 demands, infrastructure, and operations to estimate 56 years of Poudre River stream flows under a Future Conditions Baseline scenario. The Future Conditions Baseline scenario does not include operation of the Project Alternatives, NISP, or the Seaman project, but does include Reasonable Foreseeable Future Actions, which were defined for the Common Technical Platform modeling to include those water supply infrastructure and operational actions likely to be undertaken (i.e., are “reasonably foreseeable”) by water providers during the planning period for the Halligan Project, NISP and Seaman projects, but are independent of the alternatives evaluated for the fore mentioned
projects. RFFAs considered in the modeling are summarized in Section 1.2.6 of the Common Technical Platform Modeling Report (CDM Smith Inc. and DiNatale Water Consultants 2016) and are listed in Chapter 5. The analysis of effect of each alternative on Future Conditions Baseline hydrology is based on the assumption that the variability of historical naturalized flows is representative of the variability of future naturalized flows. With the exception of the Expanded Glade Alternative, the Common Technical Platform Run 2 provides an estimate of how anticipated future 2065 demands and operations would affect water rights yields and stream flows given a repeat of historical water availability (i.e., naturalized flows). Section 3.2.2 of the Surface Water Resources Technical Report (CDM Smith 2017) provides statistical summary plots of daily flows (minimum, maximum, median, and average) for Common Technical Platform Run 2.

Unlike analysis of the other alternatives, analysis of the Expanded Glade Alternative assumes the proposed Glade Reservoir has been constructed. Therefore, the Future Conditions Baseline hydrology used for the Expanded Glade Alternative is not the Common Technical Platform Run 2, but NISP Run 4a, which is the Alternative 2 Future Conditions in the NISP Supplemental Draft EIS (Corps 2015).

4.3.1.3.3 Common Technical Platform Run 3 – Project Alternative under Current Conditions

Common Technical Platform Run 3 uses Current Conditions Baseline hydrology with the Project Alternative but without RFFAs. The Corps used Common Technical Platform Run 3 to evaluate effects of each Project Alternative versus the Current Conditions Baseline hydrology (Common Technical Platform Run 1).

4.3.1.3.4 Common Technical Platform Run 4 – Project Alternative under Future Conditions

Common Technical Platform Run 4 uses Future Conditions hydrology with the Project Alternative and includes the Reasonable Foreseeable Future Actions. The Corps used Common Technical Platform Run 4 to evaluate effects of each Project Alternative versus the Future Conditions Baseline hydrology (Common Technical Platform Run 2).

4.3.1.2 Data Analysis

The following sections identify the model run comparisons used for analysis of changes to surface waters resources; describe the methods used to classify the years in the model simulation periods as hydrologically wet, average, or dry; and identify the locations at which final monthly and daily data were produced for flow-related resource analyses. The geographic scope (identification of an appropriate downstream end point) for flow-related resource analyses is addressed in Section 3.2.1.

4.3.1.2.1 Model Run Comparisons

To determine potential effects of each Project Alternative, the Corps compared each Project Alternative model run to the appropriate baseline run. For all Project Alternatives except the Expanded Glade Alternative, the Corps compared Common Technical Platform Run 3 to Common Technical Platform Run 1 (Current Conditions Baseline) and Common Technical Platform Run 4 to Common Technical Platform Run 2 (Future Conditions Baseline). Analysis of the Expanded Glade Alternative assumes that the
proposed Glade Reservoir already exists and is operating. Therefore, baseline runs for this alternative must include the NISP Project. For the Expanded Glade Alternative, the Corps compared Run 3 to NISP Run 3a (Alternative 2 Current Conditions hydrology in the NISP Supplemental Draft EIS), and for Future Conditions, the Corps compared Run 4 to NISP Run 4a (Alternative 2 Future Conditions in the NISP Supplemental Draft EIS). The Corps considered differences in stream flows for each comparison (i.e., Current Conditions comparison and Future Conditions comparison) to be the stream flow effects of each Project Alternative.

Each Project Alternative model run was the same as the associated baseline run, with the following changes:

- Inclusion of an expanded Halligan Reservoir or the proposed storage for each Project Alternative, and any associated conveyance
- Inclusion of water rights used to fill the Project Alternative storage or used under the No-Action Alternative
- Other operational changes under the No-Action Alternative
- Increased municipal demand by Fort Collins

The inclusion of increased municipal demand and changes to water rights portfolios was necessary to achieve realistic modeled operations of each Project Alternative. These changes also ensured realistic operation of Fort Collins’ water supply system as a whole under both baseline and with-projects conditions. However, comparing model runs in which demands and water right portfolios are different indicates stream flow effects that are in fact wholly unrelated to the operation of each Project Alternative. Stream flow effects therefore fell into two categories of indirect effects, including both primary and secondary indirect effects of the Project Alternatives, as follows:

- Primary indirect effects of the Project Alternatives
  - Stream flows dropping when Fort Collins diverts water into storage
  - Stream flows increasing when Fort Collins releases water from storage
  - For the No-Action Alternative, stream flows changing due to revised diversions and releases at Joe Wright Reservoir

- Secondary indirect effects of the Project Alternatives
  - Increased reliance on other water rights within the Fort Collins water supply system to meet increased demand, including increased diversions at the Fort Collins intake pipeline on the Upper Poudre and increased reliance on transbasin supplies from Horsetooth Reservoir.
  - Increased return flows at the two wastewater treatment plants due to increased demand

Therefore, some stream flow effects could be attributed to changes in demand and water rights portfolios distinct from the Project Alternatives themselves. However, including the changes in demands and water rights was necessary to accurately model the Project Alternative operations and effects, and these secondary indirect effects reflect the fact that the Project Alternatives would meet an increased future need and be integrated into the larger Fort Collins water supply system. The secondary indirect effects are
not attributable to the Project Alternatives but are included in the modeling to identify the primary indirect effects of the Project Alternatives. Indirect effects were more significant in the Current Conditions comparisons due to the larger changes in demand and water rights required to simulate realistic operations of a future project using Current Conditions. Because Runs 2 and 4 both include full utilization of other water rights and infrastructure expected to be within Fort Collins’ water supply system when Fort Collins actually will need the Halligan Project, the Future Conditions comparison best identifies the primary indirect effects attributable to each of the Project Alternatives. Therefore, this Draft EIS will focus on the results of the Future Conditions comparison when discussing flow related effects. The results and discussion of the Current Conditions comparison can be found in the *Surface Water Resources Technical Report* (CDM Smith 2017).

The No-Action Alternative was determined by the Corps to be a reasonable representation of an alternative that might occur if the permit was denied. As modeled for the Draft EIS (CDM Smith and DiNatale Water Consultants 2016), the No-Action Alternative is compared with Run 2 (Future Conditions Baseline hydrology) to determine predicted changes in river flows. The modeling of the No-Action Alternative consists of post-processing of the final river flows dataset from Common Technical Platform Run 2 (Future Conditions Baseline hydrology). Effects of the No-Action Alternative are assessed by comparison of the adjusted post-processed stream flow to the original Common Technical Platform Run 2 dataset. The Corps directed that the No-Action Alternative be compared to Future Conditions Baseline so the effect of the No-Action Alternative could be discriminated from other likely future actions. Thus, this Draft EIS only discusses Future Conditions comparisons for the No-Action Alternative.

### 4.3.1.2.2 Wet/Average/Dry Years Analysis

A percentile-based approach was developed to classify years within the study period as hydrologically wet, average, or dry. This method was developed collaboratively with the other flow-related resource analysts to provide a reasonable and useful distribution of years across different types of hydrology and to meet specific data requirements for those analyses. Annual naturalized flows at the Canyon Gage were sorted and ranked from highest to lowest. Percentiles were calculated and used to determine wet, average, and dry years for the effects analyses, as follows:

- Years with annual naturalized flows above the 75th percentile are wet.
- Years between the 25th and 75th percentiles are average.
- Years below the 25th percentile are dry.

The resulting distribution of years breaks down evenly, with 14 years meeting the wet years definition, 28 years meeting the average years definition, and 14 years meeting the dry years definition over the 56 irrigation years from 1950 to 2005 (Table 4-3). Bold formatting in Table 4-3 identifies the subset of years within the daily study period (irrigation years 1980 to 2005). This classification represents a benchmark that was used for surface water resources and other flow-related resources in the cumulative effects analysis as well as the assessment of estimated project effects under Current and Future Conditions hydrology.
Table 4-3. Benchmark summary of wet, average, and dry at Canyon Gage.

<table>
<thead>
<tr>
<th>Category</th>
<th>Years</th>
</tr>
</thead>
</table>

Bold = irrigation years 1980 to 2005.

4.3.1.2.3 Data Delivery Mile Locations for Resource Effects Analyses

Key locations along the North Fork and the Main Stem were identified for resource effects analyses based on results of resource analyses for other flow-related resources, including water quality, aquatic habitat, and geomorphology. Key locations included 49 locations on the Main Stem and seven locations along the North Fork (Table 4-4 and Figure 4-1). Data delivery miles were identified as primary, secondary, and tertiary types. Primary data delivery miles include stream flow gages and points below diversion points used to convey water to one or more of the Project Alternative reservoirs. Secondary data delivery miles include points below exchange-from locations, dry-up points, and points below return flow locations. All remaining data delivery miles are tertiary and are locations identified as being critical to some other flow-related resource, but not necessarily of critical importance to surface water resources.
Table 4-4. Data delivery mile location, purpose, and type used in the Common Technical Platform Hydrology Model.

<table>
<thead>
<tr>
<th>DDM</th>
<th>Flow Location</th>
<th>Purpose</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF1</td>
<td>Upstream of Halligan Reservoir</td>
<td>Provides flows into Halligan Reservoir</td>
<td>Tertiary</td>
</tr>
<tr>
<td>NF2</td>
<td>Downstream of Halligan Reservoir</td>
<td>Provides flows below diversions into the on-channel Halligan Reservoir for the Proposed Action</td>
<td>Primary</td>
</tr>
<tr>
<td>NF3</td>
<td>Upstream of North Poudre Canal headgate</td>
<td>Provides flows prior to NPIC diversion on the North Fork</td>
<td>Tertiary</td>
</tr>
<tr>
<td>NF4</td>
<td>Downstream of North Poudre Canal</td>
<td>Provides flows below NPIC diversion location on the North Fork</td>
<td>Secondary</td>
</tr>
<tr>
<td>NF5</td>
<td>Livermore Gage</td>
<td>Provides measured flow in North Fork downstream of North Poudre Canal diversion and upstream of Seaman Reservoir</td>
<td>Tertiary</td>
</tr>
<tr>
<td>NF6</td>
<td>Upstream of Seaman Reservoir</td>
<td>Provides flows into Seaman Reservoir</td>
<td>Tertiary</td>
</tr>
<tr>
<td>NF7</td>
<td>Downstream of Seaman Reservoir</td>
<td>Provides flows below Seaman Reservoir</td>
<td>Tertiary</td>
</tr>
<tr>
<td>0.05</td>
<td>Upstream of Munroe Canal</td>
<td>Provides flows above the furthest upstream major diversion on the Upper Poudre. Below Joe Wright Reservoir.</td>
<td>Secondary</td>
</tr>
<tr>
<td>1.59</td>
<td>Downstream of Munroe Canal and Fort Collins intake</td>
<td>Diversion location for Fort Collins and for NPIC. Munroe Canal is the diversion location for the Agricultural Reservoirs Alternative.</td>
<td>Primary</td>
</tr>
<tr>
<td>1.69</td>
<td>Between North Fork Confluence and Poudre Valley Canal</td>
<td>Provides flows on the Main Stem downstream of the North Fork</td>
<td>Tertiary</td>
</tr>
<tr>
<td>5.17</td>
<td>Between Poudre Valley Canal and the Hansen Supply Canal outlet</td>
<td>Provides data downstream of Poudre Valley Canal, a propose point of diversion for the proposed Glade Reservoir</td>
<td>Tertiary</td>
</tr>
<tr>
<td>5.63</td>
<td>Canyon Gage</td>
<td>Critical stream flow gage for Poudre River administration; downstream of Poudre Valley Canal, the diversion point for the Enlarged Expanded Glade Alternative and the NISP</td>
<td>Primary</td>
</tr>
<tr>
<td>6.05</td>
<td>Upstream of Greeley Filters Pipeline intake</td>
<td>Winter dry-up point, municipal intake diversion point for Seaman Project Applicant City of Greeley</td>
<td>Tertiary</td>
</tr>
<tr>
<td>6.15</td>
<td>Downstream of Greeley Filters Pipeline intake</td>
<td>Winter dry-up point, municipal intake diversion point for Seaman Project Applicant City of Greeley</td>
<td>Secondary</td>
</tr>
<tr>
<td>6.93</td>
<td>Between the Hansen Supply Canal outlet and the Larimer County Canal</td>
<td>Daily flow estimates capture the effects of Hansen Supply Canal discharges (Colorado-Big Thompson water)</td>
<td>Secondary</td>
</tr>
<tr>
<td>8.02</td>
<td>Between Larimer County Canal and Little Cache</td>
<td>Provides data to evaluate effects of Larimer County Canal (the Water Supply and Storage Company) diversions, a Halligan Project exchange-from location</td>
<td>Secondary</td>
</tr>
<tr>
<td>DDM</td>
<td>Flow Location</td>
<td>Purpose</td>
<td>Type</td>
</tr>
<tr>
<td>------</td>
<td>------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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<tr>
<td>8.85</td>
<td>2D-WAT (Graves/Watson Lake 2D site for resource analysis)</td>
<td>Graves/Watson Lake 2-D site for resource analyses</td>
<td>Tertiary</td>
</tr>
<tr>
<td>9.44</td>
<td>Upstream of Watson Lake diversion</td>
<td>Irrigation season dry-up point, Watson Lake Fish Hatchery minimum flow Point</td>
<td>Tertiary</td>
</tr>
<tr>
<td>9.54</td>
<td>Downstream of Watson Lake diversion</td>
<td>Irrigation season dry-up point, Watson Lake Fish Hatchery minimum flow Point</td>
<td>Tertiary</td>
</tr>
<tr>
<td>11.24</td>
<td>Upstream of New Mercer, Larimer Number 2, Little Cache, Taylor and Gill, and Terry Lake headgates</td>
<td>Larimer Number 2 is the diversion location for the Gravel Pits Alternative. Winter dry-up point. New Mercer and Larimer Number 2 are Halligan Project exchange-from locations.</td>
<td>Tertiary</td>
</tr>
<tr>
<td>11.34</td>
<td>Downstream of New Mercer, Larimer Number 2, Little Cache, Taylor and Gill, and Terry Lake headgates</td>
<td>Larimer Number 2 is the diversion location for the Gravel Pits Alternative. Winter dry-up point. New Mercer and Larimer Number 2 are Halligan Project exchange-from locations.</td>
<td>Primary</td>
</tr>
<tr>
<td>13.63</td>
<td>Downstream of Arthur Ditch headgate</td>
<td>Winter dry-up point, proposed exchanges for Halligan Project, Seaman Project and NISP</td>
<td>Secondary</td>
</tr>
<tr>
<td>13.87</td>
<td>Upstream of Larimer Weld Canal headgate</td>
<td>Winter dry-up point, proposed exchanges for Halligan Project, Seaman Project and NISP</td>
<td>Tertiary</td>
</tr>
<tr>
<td>13.97</td>
<td>Downstream of Larimer Weld Canal headgate</td>
<td>Winter dry-up point, proposed exchanges for Halligan Project, Seaman Project and NISP</td>
<td>Secondary</td>
</tr>
<tr>
<td>14.92</td>
<td>Shields Street</td>
<td>Mid-point between Larimer-Weld Canal and Lake Canal</td>
<td>Tertiary</td>
</tr>
<tr>
<td>15.62</td>
<td>2D-MAR (Legacy/Martinez Park 2D site for resource analysis)</td>
<td>Legacy/Martinez Park 2-D site for resource analyses</td>
<td>Tertiary</td>
</tr>
<tr>
<td>15.96</td>
<td>Between Lake Canal and Timnath inlet</td>
<td>Boat Chute minimum flow point</td>
<td>Tertiary</td>
</tr>
<tr>
<td>16.84</td>
<td>Lincoln St. Gage</td>
<td>Critical stream flow gage for Poudre River administration</td>
<td>Primary</td>
</tr>
<tr>
<td>17.74</td>
<td>Upstream of Mulberry Wastewater Treatment Facility discharge</td>
<td>Daily flow estimates capture the contribution of effluent discharges to stream flow</td>
<td>Tertiary</td>
</tr>
<tr>
<td>17.84</td>
<td>Downstream of Mulberry Wastewater Treatment Facility discharge</td>
<td>Daily flow estimates capture the contribution of effluent discharges to stream flow</td>
<td>Secondary</td>
</tr>
<tr>
<td>18.66</td>
<td>Upstream of Timnath inlet headgate</td>
<td>Winter dry-up point</td>
<td>Tertiary</td>
</tr>
<tr>
<td>18.76</td>
<td>Downstream of Timnath inlet headgate</td>
<td>Winter dry-up point</td>
<td>Secondary</td>
</tr>
<tr>
<td>DDM</td>
<td>Flow Location</td>
<td>Purpose</td>
<td>Type</td>
</tr>
<tr>
<td>------</td>
<td>-------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>21.09</td>
<td>Between Timnath inlet and Fossil Creek inlet</td>
<td>Daily flow estimates capture the effects of tributary inflows (Spring Creek and Dry Creek) and Boxelder Ditch diversion</td>
<td>Tertiary</td>
</tr>
<tr>
<td>21.34</td>
<td>Upstream of Fossil Creek inlet headgate</td>
<td>Irrigation season and winter dry-up point</td>
<td>Tertiary</td>
</tr>
<tr>
<td>21.44</td>
<td>Downstream of Fossil Creek inlet headgate</td>
<td>Irrigation season and winter dry-up point</td>
<td>Secondary</td>
</tr>
<tr>
<td>21.84</td>
<td>Upstream of Drake Wastewater Treatment Facility outfall²</td>
<td>Daily flow estimates capture the contribution of effluent discharges to stream flow, Nature Center minimum flow point</td>
<td>Tertiary</td>
</tr>
<tr>
<td>21.94</td>
<td>Downstream of Drake Wastewater Treatment Facility outfall²</td>
<td>Daily flow estimates capture the contribution of effluent discharges to stream flow, Nature Center minimum flow point</td>
<td>Tertiary</td>
</tr>
<tr>
<td>22.69</td>
<td>Boxelder Gage</td>
<td>Important for Poudre River administration, captures effects of Boxelder Creek tributary inflows</td>
<td>Primary</td>
</tr>
<tr>
<td>23.04</td>
<td>Upstream of Boxelder Creek</td>
<td>Important for Poudre River administration, captures effects of Boxelder Creek tributary inflows</td>
<td>Tertiary</td>
</tr>
<tr>
<td>23.14</td>
<td>Downstream of Boxelder Creek</td>
<td>Important for Poudre River administration, captures effects of Boxelder Creek tributary inflows</td>
<td>Tertiary</td>
</tr>
<tr>
<td>27.76</td>
<td>Upstream of New Cache headgate/downstream of Fossil Creek outlet</td>
<td>Captures effects of Fossil Creek releases, including discharge from Drake wastewater treatment facility</td>
<td>Secondary</td>
</tr>
<tr>
<td>27.86</td>
<td>Downstream of New Cache headgate</td>
<td>Captures effects of Fossil Creek releases, including discharge from Drake wastewater treatment facility</td>
<td>Tertiary</td>
</tr>
<tr>
<td>31.66</td>
<td>Between Whitney and Greeley No. 3</td>
<td>Daily flow estimates capture the effects of diversion and return flows in this reach</td>
<td>Tertiary</td>
</tr>
<tr>
<td>34.04</td>
<td>2D-WIN (Yarrow / Eastman Park 2D site for resource analysis)</td>
<td>Yastrow/Eastman Park 2-D site for resource analyses</td>
<td>Tertiary</td>
</tr>
<tr>
<td>39.19</td>
<td>Upstream of Windsor Wastewater Treatment Facility</td>
<td>Daily flow estimates capture the contribution of effluent discharges to stream flow</td>
<td>Tertiary</td>
</tr>
<tr>
<td>39.29</td>
<td>Downstream of Windsor Wastewater Treatment Facility</td>
<td>Daily flow estimates capture the contribution of effluent discharges to stream flow</td>
<td>Tertiary</td>
</tr>
<tr>
<td>39.39</td>
<td>Downstream of Kodak Wastewater Treatment Facility</td>
<td>Daily flow estimates capture the contribution of effluent discharges to stream flow</td>
<td>Tertiary</td>
</tr>
<tr>
<td>44.28</td>
<td>Upstream of Greeley No. 3 headgate</td>
<td>Irrigation season dry-up point</td>
<td>Tertiary</td>
</tr>
<tr>
<td>44.38</td>
<td>Downstream of Greeley No. 3 headgate</td>
<td>Irrigation season dry-up point</td>
<td>Secondary</td>
</tr>
<tr>
<td>DDM</td>
<td>Flow Location</td>
<td>Purpose</td>
<td>Type</td>
</tr>
<tr>
<td>------</td>
<td>------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>46.59</td>
<td>2D-GRE (Greeley 59th Street 2D site for resource analysis)</td>
<td>Greeley 59th Avenue 2-D site for resource analyses</td>
<td>Tertiary</td>
</tr>
<tr>
<td>50.11</td>
<td>Below Seeley Lake</td>
<td>Daily flow estimates capture inflows in the reach between Boyd Freeman Ditch and Ogilvy Ditch</td>
<td>Tertiary</td>
</tr>
<tr>
<td>55.14</td>
<td>Upstream of Greeley Wastewater Treatment Facility discharge</td>
<td>Daily flow estimates capture the contribution of effluent discharges to stream flow</td>
<td>Tertiary</td>
</tr>
<tr>
<td>55.24</td>
<td>Downstream of Greeley Wastewater Treatment Facility discharge</td>
<td>Daily flow estimates capture the contribution of effluent discharges to stream flow</td>
<td>Tertiary</td>
</tr>
<tr>
<td>55.56</td>
<td>Upstream of Ogilvy headgate</td>
<td>Irrigation season dry-up point</td>
<td>Tertiary</td>
</tr>
<tr>
<td>55.66</td>
<td>Downstream of Ogilvy headgate</td>
<td>Irrigation season dry-up point</td>
<td>Secondary</td>
</tr>
<tr>
<td>57.43</td>
<td>Greeley Gage</td>
<td>Critical for Poudre River administration; downstream end of study reach</td>
<td>Primary</td>
</tr>
</tbody>
</table>
Figure 4-1. Approximate location of data delivery miles used in the Common Technical Platform Hydrology Modeling along the North Fork and the Main Stem.
### 4.3.1.3 Data Presentation

For each model run comparison, a series of statistical summaries in the form of tables and figures was prepared for the primary and secondary data delivery miles. The data presentations included in Chapter 4 of the *Surface Water Resources Technical Report* (CDM Smith 2017) are described in the following sections.

#### 4.3.1.3.1 Median Daily Flows with Confidence Intervals

Comparisons of median daily flows for the with-project run versus the appropriate baseline run along with 90 percent upper and lower confidence intervals are shown in plots in the *Surface Water Resources Technical Report* (CDM Smith 2017) and *Surface Water Resources Addendum* (CDM Smith 2018a). Confidence intervals measure the probability that a statistical estimation, such as a median, for a particular sample is within a certain magnitude of the true median for the entire data set. These plots are based on estimated daily flows for irrigation years 1980 to 2005 and show changes to median stream flows and seasonal patterns while also demonstrating uncertainty in modeled daily flows. Figure 4-2 is a representative example of this type of plot for Fort Collins’ Proposed Action downstream of Halligan Reservoir.

![Confidence Lower Run 2 - Baseline - Future Conditions PA4 - Proposed Action - Future Conditions](image)

Figure 4-2. Median daily flow for Future Conditions Baseline with 90 percent upper/lower confidence intervals at data delivery mile NF 2 (downstream of Halligan Reservoir), irrigation years 1980 to 2005, compared to Fort Collins' Proposed Action under Future Conditions.
4.3.1.3.2 Minimum, Median, Average, Maximum Time Series

Hydrographs showing minimum, median, average, and maximum stream flows are presented to provide a comparison of common statistical parameters used for hydrologic and other resource analyses. For each day in the year, the minimum, median, average, and maximum values were determined to create a single year time series. These plots are based on estimated daily flows for irrigation years 1980 to 2005. A representative example (Figure 4-3) is shown at the Canyon Gage on the Main Stem. Similar figures were developed and presented in the *Surface Water Resources Technical Report* (CDM Smith 2017) and *Surface Water Resources Addendum* (CDM Smith 2018a) for Common Technical Platform Run 2 – Future Conditions Baseline hydrology and for the Project Alternatives under Future Conditions model runs.

![Box and Whisker Plot](image)

**Figure 4-3.** Fort Collins' Proposed Action statistical summary of daily flow at data delivery mile 5.63 (Canyon Gage).

4.3.1.3.3 Box and Whisker Plots

Box and whisker plots (Figure 4-4) show a data set divided into four quartiles based on the 25th, 50th, and 75th percentiles. Two vertical lines (the “whiskers”) illustrate the two extreme quartiles (the 75th and above and the 25th below), while a “box” illustrates the two middle quartiles. The objective is to show a simple but meaningful distribution of a data set's range of values.

The box and whisker plots use a logarithmic scale on the y-axis; due to the nature of this scale, figures for locations with low flows (less than one cubic foot per second) in some months may appear cut off at the
bottom. Although the conceptual box and whisker figure (Figure 4-4) illustrates the average as occurring between the median (50th percentile) and 75th percentile, some plots may show a diamond marker for the average outside of the box. This is due to the potential for a few extremely high or low monthly flows to skew the calculated average values and is the reason the Corps uses the median flow value extensively in this Draft EIS. These plots use estimated monthly average flows for irrigation years 1950 to 2005 and illustrate changes in median, average, high, and low flows, as well as overall flow variability. Figure 4-5 is a representative box and whisker plot of modeled stream flows below Halligan Reservoir that would result from Fort Collins’ Proposed Action.

![Figure 4-4. Illustration of box and whisker concept.](image)

![Figure 4-5. Fort Collins' Proposed Action box and whisker at data delivery mile NF2 (downstream of Halligan Reservoir).](image)
4.3.1.3.4 Flow-Duration Curves
Flow-duration curves show the percent of time a particular flow rate is equaled or exceeded within a given data set. Flow-duration curves, which are based on estimated daily flows for irrigation years 1980 to 2005, provide more detail than a box and whisker plot regarding distribution of a data set's values. Flow-duration curves show changes in high, low, and median stream flows. Figure 4-6 is a flow-duration curve showing the effects of Fort Collins’ Proposed Action at the Munroe Canal and Fort Collins intakes on the Upper Poudre.

![Flow-Duration Curve](image)

Figure 4-6. Fort Collins’ Proposed Action Flow-duration curve at data delivery mile 1.59 (Downstream of Munroe Canal and Fort Collins intake).

4.3.1.3.5 Wet, Average, Dry Year Tables
Tables were prepared using monthly model data that show key statistics by month for wet, average, and dry years. Determination of wet, average, and dry years is discussed in detail in Section 2.3.5 of the Surface Water Resources Technical Report (CDM Smith 2017). Median flows are provided in the main body of the Surface Water Resources Technical Report (CDM Smith 2017); however, similar tables that use other statistical measures including minimum, average, and maximum monthly stream flow are provided in Appendix A of Surface Water Resources Technical Report (CDM Smith 2017) for all primary and secondary data delivery miles. Table 4-5 is a representative example of median monthly flows for Fort Collins’ Proposed Action downstream of Halligan Reservoir.
Table 4-5. Fort Collins’ Proposed Action median monthly flow at data delivery mile NF2 (downstream of Halligan Reservoir).

<table>
<thead>
<tr>
<th>Run 2 - Baseline - Future Conditions (cfs)</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Years, IY 1950-2005</td>
<td>5.2</td>
<td>3.8</td>
<td>5.2</td>
<td>8.6</td>
<td>30</td>
<td>101</td>
<td>422</td>
<td>400</td>
<td>123</td>
<td>124</td>
<td>62</td>
<td>87</td>
<td>63</td>
</tr>
<tr>
<td>Avg Years, IY 1950-2005</td>
<td>3.9</td>
<td>3.8</td>
<td>4.0</td>
<td>10</td>
<td>25</td>
<td>68</td>
<td>230</td>
<td>212</td>
<td>112</td>
<td>79</td>
<td>37</td>
<td>64</td>
<td>41</td>
</tr>
<tr>
<td>Dry Years, IY 1950-2005</td>
<td>1.9</td>
<td>3.1</td>
<td>3.3</td>
<td>4.8</td>
<td>9.2</td>
<td>39</td>
<td>122</td>
<td>87</td>
<td>78</td>
<td>66</td>
<td>19</td>
<td>4.6</td>
<td>17</td>
</tr>
<tr>
<td>All Years, IY 1950-2005</td>
<td>3.6</td>
<td>3.8</td>
<td>3.8</td>
<td>6.9</td>
<td>24</td>
<td>64</td>
<td>237</td>
<td>212</td>
<td>109</td>
<td>84</td>
<td>41</td>
<td>51</td>
<td>38</td>
</tr>
<tr>
<td>All Years, IY 1980-2005</td>
<td>4.6</td>
<td>4.3</td>
<td>10</td>
<td>21</td>
<td>41</td>
<td>89</td>
<td>242</td>
<td>201</td>
<td>116</td>
<td>88</td>
<td>42</td>
<td>65</td>
<td>43</td>
</tr>
<tr>
<td>PA44 - Proposed Action Summer Plan - Future Conditions (cfs)</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wet Years, IY 1950-2005</td>
<td>8.2</td>
<td>6.8</td>
<td>8.2</td>
<td>12</td>
<td>33</td>
<td>103</td>
<td>394</td>
<td>300</td>
<td>117</td>
<td>121</td>
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<td>90</td>
<td>58</td>
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<tr>
<td>Avg Years, IY 1950-2005</td>
<td>6.9</td>
<td>6.8</td>
<td>7.1</td>
<td>13</td>
<td>27</td>
<td>68</td>
<td>200</td>
<td>194</td>
<td>107</td>
<td>80</td>
<td>47</td>
<td>55</td>
<td>44</td>
</tr>
<tr>
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<td>6.1</td>
<td>6.3</td>
<td>7.6</td>
<td>12</td>
<td>39</td>
<td>100</td>
<td>75</td>
<td>80</td>
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<td>25</td>
<td>12</td>
<td>17</td>
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<tr>
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<td>6.6</td>
<td>6.9</td>
<td>9.9</td>
<td>26</td>
<td>65</td>
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<td>45</td>
<td>39</td>
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<td>7.1</td>
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<td>24</td>
<td>43</td>
<td>92</td>
<td>216</td>
<td>176</td>
<td>108</td>
<td>85</td>
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<td>29</td>
<td>46</td>
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<td>Change in Flow (PA44 - Proposed Action Summer Plan - Future Conditions – Run 2 - Baseline - Future Conditions) (cfs)</td>
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<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>2.2</td>
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<td>10</td>
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<tr>
<td>Avg Years, IY 1950-2005</td>
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<td>3.0</td>
<td>3.1</td>
<td>2.9</td>
<td>1.7</td>
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<td>3.0</td>
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<td>2.9</td>
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<td>13</td>
<td>6.5</td>
<td>7.2</td>
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<tr>
<td>All Years, IY 1950-2005</td>
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<td>2.8</td>
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<td>3.1</td>
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<td>0.7</td>
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<td>All Years, IY 1980-2005</td>
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<td>79%</td>
<td>57%</td>
<td>35%</td>
<td>10%</td>
<td>2%</td>
<td>-7%</td>
<td>-3%</td>
<td>-4%</td>
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<td>-8%</td>
<td>3%</td>
<td>-9%</td>
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<td>Wet Years, IY 1950-2005</td>
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<td>78%</td>
<td>76%</td>
<td>28%</td>
<td>7%</td>
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<td>-8%</td>
<td>-4%</td>
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<td>-13%</td>
<td></td>
</tr>
<tr>
<td>Avg Years, IY 1950-2005</td>
<td>155%</td>
<td>98%</td>
<td>91%</td>
<td>58%</td>
<td>32%</td>
<td>1%</td>
<td>-18%</td>
<td>-15%</td>
<td>3%</td>
<td>-20%</td>
<td>35%</td>
<td>156%</td>
<td></td>
</tr>
<tr>
<td>Dry Years, IY 1950-2005</td>
<td>83%</td>
<td>75%</td>
<td>82%</td>
<td>45%</td>
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<td>-8%</td>
<td>-4%</td>
<td>-3%</td>
<td>13%</td>
<td>-12%</td>
<td></td>
</tr>
<tr>
<td>All Years, IY 1980-2005</td>
<td>66%</td>
<td>67%</td>
<td>25%</td>
<td>14%</td>
<td>4%</td>
<td>4%</td>
<td>-11%</td>
<td>-12%</td>
<td>-7%</td>
<td>-3%</td>
<td>27%</td>
<td>-56%</td>
<td>6%</td>
</tr>
</tbody>
</table>
4.3.1.4 Uncertainty

The hydrologic modeling was performed using a suite of models collectively known as the Common Technical Platform model sequence. The model sequence components – four are applications of the MODSIM tool and four are Excel-based – were run in series, with some variability to the inclusion of certain components depending on the specific purpose of each model run. Each component of the Common Technical Platform model sequence has some associated level of uncertainty and therefore the outputs of the Common Technical Platform model sequence as a whole also have a degree of uncertainty. Qualitatively, this uncertainty is a result of multiple factors including the quality and quantity of input data, model assumptions and conceptual simplifications, and model numerical error. The most common sources of uncertainty identified in the Common Technical Platform modeling are listed in Section 2.1.7 of the Surface Water Resources Technical Report (CDM Smith 2017).

4.3.1.5 Data Adequacy

Section 3.3 describes the best available data for surface water in the study area. The Corps determined the available data and methods used are adequate to evaluate and describe reasonably foreseeable significant adverse effects on surface water in the study area and to enable decision maker to make a reasoned choice between Project Alternatives. The Corps did not identify any incomplete or unavailable surface water information, as defined in Section 4.2.1.5. Effects of the Project Alternatives on surface water are described below.

4.3.2 Overview of Effects – Action Alternatives

Ultimately, all modeled changes in stream flow were due to Fort Collins’ increased future water demand. Project Alternatives represent different ways that Fort Collins could meet that demand, resulting in different timing and location of effects. Direct effects to stream flows from Project Alternatives would occur due to diversion and storage of junior rights, diversion and storage of converted agricultural rights, and releases from storage for use by Fort Collins. Indirect effects could occur due to changes in return flow locations from converted agricultural rights. Indirect effects could also occur due to operational changes by other basin water users or in other areas of Fort Collins’ water supply system.

The water rights portfolio Fort Collins would store in each Project Alternative reservoir includes two junior rights, the Grey Mountain right and the Halligan conditional right. Both of these conditional rights represent new, junior diversions to the river. Therefore, diversions into any of the alternative reservoirs under these rights would result in a reduction in peak stream flows during average and wet years, generally during May and June. This reduction in peak stream flows would occur at the point of diversion into the reservoir (different for each Project Alternative) and continue downstream. Figure 4-7 provides a graphic representation of the relative change in the average annual stream flows at these locations.
Figure 4-7. Percent change in annual average flow for each Project Alternative under Future Conditions.
The water rights portfolio Fort Collins would store also includes converted agricultural rights (both native and transbasin). Storage of agricultural rights would have a different impact on stream flows because use of these rights would represent a change in use and location of diversion of rights already in use, rather than a new right that allows for additional diversion from the river. Reduced diversions at the original headgates would offset any converted agricultural water diverted into storage by Fort Collins. For all Project Alternatives except the Gravel Pits Alternative, the diversion locations would be above the ditch headgates and Fort Collins would exchange the water up to the intake location. For the Gravel Pits Alternative, diversions by Fort Collins would reduce flows in the Poudre River in the reach from the diversion location downstream to the original headgate. Because the Gravel Pits Alternative diversion location is at or downstream of the original agricultural headgates, flows could increase in the river in the reach from each headgate to the Gravel Pits Alternative diversion location.

As modeled, diversion of the converted agricultural rights occurred from April to October with the largest diversions occurring in May and June. Converted Southside Ditch rights accounted for approximately 95 percent of the water stored in each alternative reservoir. Therefore, when Fort Collins is storing in the alternative reservoirs, the largest reduction in stream flows due to the Project Alternatives would occur below the reservoir diversion location for each alternative and extend downstream to the original headgate, but these reductions would become less substantial further downstream.

A separate set of effects on flows in the Poudre River would occur when Fort Collins makes releases from the alternative reservoirs. Fort Collins could pipe reservoir releases directly to the treatment plant, causing no effect on river flows. Alternately, Fort Collins could release supplies to the river and take water by exchange at the city’s existing intake (on the Upper Poudre). This diversion by exchange would reduce river flows in the reach from the intake to the river release point for each Project Alternative. For Fort Collins’ Proposed Action, Fort Collins would have no pipeline, but would have to exchange releases from Halligan Reservoir from the North Fork confluence up to the intake location.

Indirect effects to stream flows could occur due to changes in return flows on converted agricultural rights. Fort Collins could meet those historical return flow obligations using effluent from the city’s two wastewater treatment facilities, or by making releases from a ditch or reservoir to the river. Fort Collins could, as a result of its water court transfer decree, be allowed to replace water to meet return flow obligations at a location that differs from the historical return flows, causing a change in river flows in the reach between Fort Collins’ release and the historical return flow locations. In addition, although Fort Collins operates the city’s water supply system to optimize use of return flows, at times the wastewater effluent could exceed the historical return flows owed on the converted rights, causing an increase in stream flows below the two wastewater treatment facilities and continuing downstream until the water is diverted by Fort Collins to gravel lake storage or by another water user.

Indirect effects could also occur if Fort Collins operations change flows and water rights availability for other users in the basin. However, decreases in stream flows were generally minimal. Modeling results for all alternatives showed that decreases in stream flows were less below the Fossil Creek reservoir inlet (secondary data delivery mile 27.76). Previous operation of the Fossil Creek Reservoir included diversion of 75 percent to 95 percent of the river flow through the reservoir and subsequently releasing the same amount back to the river through the Fossil Creek outlet downstream (CDM Smith and DiNatale Water Consultants 2016). Therefore, when operations of the Project Alternatives changed flows in the river,
modeled diversions through the inlet also changed. This operation is no longer current administrative practice, but was included in the Common Technical Platform modeling sequence as it was in place when the model was developed.

Overall, modeling for all action alternatives showed a reduction in stream flows beginning below the Munroe Canal and Fort Collins’ original pipeline intake. These two diversions, both located on the Upper Poudre above the North Fork, are the only locations where Fort Collins can divert from the Poudre River to the city’s treatment and distribution system. Fort Collins would divert a substantial portion of the city’s future increase in demand at these two locations. The modeling also showed a reduction in flow below the diversion point for each alternative reservoir. Under all action alternatives, the flow reduction continued downstream but reduced diversions at agricultural headgates, the introduction of return flows to the river at the two wastewater treatment facilities, and releases from the alternative reservoirs all resulted in an increase in flows downstream of these locations. The Greeley Gage, the downstream end of the study area, is below all agricultural exchange-from points, wastewater treatment facilities, and river release points of the alternative reservoirs. Therefore, stream flow reductions at the Greeley Gage consisted only of increased consumptive use by Fort Collins met by new, junior rights.

4.3.3 Fort Collins’ Proposed Action

4.3.3.1 Operation Overview

Fort Collins’ Proposed Action is to enlarge Halligan Reservoir by 8,125 acre-feet, from an existing capacity of 6,400 acre-feet to an enlarged capacity of 14,525 acre-feet. The existing Halligan Reservoir is an on-channel impoundment, and as such, the enlarged Halligan Reservoir would store flows of the North Fork. Additional capacity in Halligan Reservoir would be obtained by raising the existing dam approximately 25 feet in elevation. Fort Collins would make releases from Halligan Reservoir to the North Fork, and use releases through an exchange on the Main Stem between its confluence with the North Fork and Fort Collins’ existing intakes on the Poudre River.

A Winter Release Plan would be included for Fort Collins’ Proposed Action and all other action alternatives. Under the Winter Release Plan for Fort Collins’ Proposed Action, three cubic feet per second of water would be released to the North Fork for subsequent diversion at Fort Collins’ intakes from October 1 to April 30 of each year. This operation would primarily be a means to meet wintertime return flow obligations. Because a very high proportion (approximately 95 percent) of winter water use is returned to the Poudre River rather than consumptively used, the return flows generated from the three cubic feet per second release would be used to meet wintertime return flow obligations. Secondly, winter releases would be an operational means to decrease reliance on other water sources from storage in the winter (i.e., Horsetooth Reservoir), thereby preserving these sources for use later in the summer. The winter releases would have a concurrent benefit of improving stream flows during periods when river flows are typically low. For Fort Collins’ Proposed Action, winter releases would result in an increase to stream flows in the North Fork between Halligan Reservoir and the Main Stem confluence.

Three avoidance and minimization actions, a Summer Plan, a Peak Flow Bypass Program, and a Ramping Rate Limitation, also are part of Fort Collins’ Proposed Action. The Summer Plan would adjust reservoir operations to maintain a flow of at least five cubic feet per second in 22 miles of the North Fork between
Halligan Dam and Seaman Reservoir from May 1 to September 30 each year. Under the proposed Summer Plan, diversions of Fort Collins’ water into storage in Halligan Reservoir would be curtailed when necessary to maintain a minimum flow of five cubic feet per second. When diversions were not occurring, but flows measured between Halligan Dam and Seaman Reservoir dropped below the five cubic feet per second target, releases would be made from Fort Collins’ portion of the enlarged Halligan Reservoir. Common Technical Platform modeling shows that the minimum flow of five cubic feet per second could be maintained without increasing the size of the proposed reservoir enlargement. All releases made under the Summer Plan would be delivered into Fort Collins’ municipal water supply system. The Summer Plan might be curtailed when operating the plan would cause a water supply shortage or would violate Fort Collins’ storage reserve factor. In general, Summer Plan curtailment would occur if the City required water restrictions for the coming year or in the case of a water supply emergency. The Summer Plan was simulated in all modeling of Fort Collins’ Proposed Action.

Fort Collins proposes a Peak Flow Bypass Program that would forgo all diversions to the enlarged pool at Halligan Reservoir for the three days that coincide with the forecasted annual peak runoff flow event for the North Fork at Halligan Dam. Peak flows drive many riverine physical and ecological processes, including sediment transport, aquatic habitat formation and maintenance, and riparian area inundation. The purpose of the Peak Flow Bypass Program is to prevent any additional attenuation of peak flows on the North Fork below Halligan Dam. The Peak Flow Bypass Program might be suspended or curtailed during water supply emergencies.

Under the Ramping Rate Limitation, Fort Collins would operate releases from Fort Collins’ portion of the enlarged Halligan Reservoir to limit large and dramatic flow changes in the North Fork. Releases of Fort Collins' water from the enlarged Halligan Reservoir would be tied to flows in the North Fork. Daily or hourly ramping rate limitations will be developed with input from Colorado Parks and Wildlife considering impacts to aquatic species. The Ramping Rate Limitation would only apply to operation of Fort Collins’ portion of the enlarged Halligan Reservoir; NPIC’s operation of its portion of the enlarged Halligan Reservoir might continue to cause North Fork flow changes that exceed the rates above. However, Fort Collins would seek an operational agreement with NPIC to operate all releases (both Fort Collins’ and NPIC’s) to meet the ramping rates above. The Ramping Rate Limitation might be suspended or curtailed during water supply emergencies.

The Winter Release Plan, Summer Plan, and Peak Flow Bypass Program are all simulated in modeling of Fort Collins’ Proposed Action. The Ramping Rate Limitation is not simulated, but its operation is not anticipated to affect the monthly results provided in this section because the Operations Plan Report was developed from model simulations using a monthly time-step. While the Ramping Rate Limitation may change daily operations, it is anticipated to have a negligible effect on monthly operations.

### 4.3.3.2 Halligan Reservoir

Modeled operations of Fort Collins’ Proposed Action are presented in Section 4 of the *Operations Report* (Fort Collins 2019). Halligan Reservoir would have an active storage capacity of 14,525 acre-feet resulting from the existing active capacity of 6,400 acre-feet plus the enlarged capacity of 8,125 acre-feet. Historically NPIC typically filled and drained or nearly drained Halligan Reservoir in most years. Under Fort Collins’ Proposed Action, the NPIC would continue to use their portion of the storage in the same fill...
and drain cycle. Fort Collins would fill and drain a portion of their storage each year. The Fort Collins’ Proposed Action under Future Conditions modeling showed total end-of-month storage would generally not drop below 9,100 acre-feet (Figure 4-8). Additionally, model results showed periods of extended reservoir drawdown corresponding to historical droughts in the mid-1950s, 1977, and early 2000s. Extended reservoir drawdown was also shown to occur in the mid-1960s, late 1980s, and early-1990s. However, even during those simulated drought periods, Halligan Reservoir would have an annual fill-and-drawdown cycle operating most of the time in the full to 30 percent of the storage volume (Figure 4-8).

Fort Collins’ minimum end-of-month storage volume in the enlarged portion of Halligan Reservoir in any month during the simulated period would be approximately 2,900 acre-feet with Future Conditions Baseline. Generally, use of the enlarged portion of Halligan Reservoir would occur when unexpected stressors occur during drought or other events that require use of the safety factor (Chapter 1.4.1.3.2), considered part of the system firm yield. The minimum end-of-month storage in the total enlarged Halligan Reservoir (both enlarged and existing portions combined) would be 4,000 acre-feet with Future Conditions Baseline. Under Future Conditions Baseline, the enlarged Halligan Reservoir would have a mean storage volume of 11,600 acre-feet compared to 4,500 acre-feet under the Future Conditions Baseline.

Water surface area and water surface elevation are properties calculated directly from the average storage volume (Figure 4-8). Section 4 of the Operations Report (Fort Collins 2019) provides time series plots for

Figure 4-8. End-of-month (EOM) storage volume in acre-feet (AF) for the existing (Baseline) Halligan Reservoir as simulated with Future Conditions hydrology (Run 2) and the total enlarged Halligan Reservoir under Fort Collins’ Proposed Action as simulated with Future Conditions hydrology (Run 4).
end-of-month surface water area, elevation, and volume for the total enlarged capacity at Halligan (14,525 acre-feet) and the enlarged capacity (8,125 acre-feet). Evaporation volume is a calculated property based on water surface area.

Changes in Halligan Reservoir water surface area may have implications on recreation and environmental resources at the reservoir (Sections 4.16.2 and 4.7.2). Water surface areas were estimated using simulated end-of-month storage volumes and interpolation of the surface area to storage volume curve provided in Section 4.1.1 of the Operations Report (Fort Collins 2019). The water surface area of the total enlarged Halligan Reservoir is estimated to range from 200 acres to 386 acres with Future Conditions hydrology. Mean (average) water surface area with Future Conditions hydrology is estimated at 340 acres.

The maximum water surface elevation of Halligan Reservoir, as measured at the crest of the spillway, would increase from 6,357.6 to 6,383.0 feet above mean sea level, a difference of 25.4 feet. The minimum water surface elevation would increase from 6,300 to 6,347 feet above mean sea level while the average water surface elevation would increase from 6,347 to 6,374 feet above mean sea level under the Future Conditions simulation.

Changes in Halligan Reservoir water surface elevation, particularly drawdown rates, may have implications on recreation and environmental resources at the reservoir. The water surface elevation of Halligan Reservoir has historically increased at a maximum rate of 53 feet per month and decreased at a maximum rate of 69 feet per month. The simulated water surface elevation increased at a similar rate of 32 feet per month and decreased at a similar rate of 48 feet per month under the Future Conditions Baseline. Water surface elevation of the enlarged Halligan Reservoir would increase at a much lower maximum rate of 14 feet per month and decrease at a much lower maximum rate of 19 feet per month under Future Conditions hydrology (Figure 4-9).

![Figure 4-9. Monthly water surface elevation fluctuation in feet per month for the existing (Baseline) Halligan Reservoir as simulated with Future Conditions hydrology (Run 2), and the total enlarged Halligan Reservoir under Fort Collins’ Proposed Action as simulated with Future Conditions hydrology (Run 4).](image)
The maximum monthly water surface elevation data were used to estimate the percent of years in the simulated period of irrigation years 1950 to 2005 that the water surface elevations of the baseline and enlarged Halligan Reservoir were near the ordinary high water mark (assumed as the spillway elevation) for at least 14 days during the growing season (May through September). This statistic may be used to determine if the shoreline of Halligan Reservoir would have the hydrology required to allow formation of wetlands; wetlands are required to be inundated or saturated in the top 12 inches for at least 14 consecutive days during the growing season during five out of 10 years. Historically, the water surface was within three feet, one foot, and six inches of the ordinary high water mark for 14 days during the growing season 80, 70, and 66 percent of the time, respectively, of irrigation years 1950 to 2005. Under Future Conditions hydrology, the existing Halligan Reservoir would have similar respective frequencies of 96, 95, and 93 percent while the enlarged Halligan Reservoir would have respective frequencies of 79, 73, and 77 percent.

Figure 4-10 illustrates simulated annual evaporation from the enlarged portion of Halligan Reservoir using Fort Collins’ Proposed Action Run 3 for Current Conditions and Proposed Action Run 4 for Future Conditions. Because evaporation correlates with surface area, evaporative losses are higher in years when Halligan Reservoir is full and lower in years when the reservoir is drained down. Under Fort Collins’ Proposed Action with Future Conditions hydrology, the enlarged portion of Halligan Reservoir would have an average annual storage volume of 7,100 acre-feet and lose about 310 acre-feet, or 4.3 percent of the average annual storage volume, annually to evaporation.

![Figure 4-10. Estimated annual evaporation in acre-feet per year (AFY) for the enlarged portion of Halligan Reservoir under Fort Collins’ Proposed Action as simulated with Current and Future Conditions hydrology, irrigation years 1950 to 2005.](image-url)
4.3.3.3 River Segments

4.3.3.3.1 Diversions

The enlarged Halligan Reservoir is proposed as an on-channel reservoir; therefore, the enlargement would physically capture and store a portion of North Fork flows. Consequently, the term “diversions” as discussed should be inferred as meaning that portion of flows on the North Fork captured by the enlarged Halligan Dam to fill the enlarged portion of Halligan Reservoir. Results of modeled diversions under Fort Collins’ Proposed Action are presented in a series of tables and figures in Section 4.2 of the Operations Report (Fort Collins 2019). The maximum net diversion to the enlarged portion of Halligan Reservoir in any month during the period of analysis is about 3,300 acre-feet with Future Conditions hydrology, equating to a maximum monthly net diversion flow rate of 55 cubic feet per second (Figure 4-11). Diversions would be made in January and March through September (Table 4-6) but most often in May (53 times out of 56 simulated years in the irrigation years 1950 to 2005 study period) and June (46 years out of 56 years) in the Future Conditions simulation.

Table 4-6. Estimated net diversions to the enlarged portion of Halligan Reservoir in acre-feet per month or acre-feet per year under Fort Collins’ Proposed Action as simulated with Future Conditions hydrology for irrigation years 1950 to 2005.

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of Years with Diversions (out of 56)</th>
<th>Future Conditions</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Minimum (AFM; AFY for Annual)</td>
<td>Maximum (AFM; AFY for Annual)</td>
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<tr>
<td>November</td>
<td>0</td>
<td>0</td>
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<td>December</td>
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<td>Annual</td>
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<th>Future Conditions</th>
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<td>Minimum (AFM; AFY for Annual)</td>
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<tr>
<td>Annual</td>
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AFM = acre-feet per month; AFY = acre-feet per year

Although the water stored in Halligan Reservoir would physically be sourced from the North Fork in terms of water rights accounting, the legal water rights sources for the diversions are actually associated with the Southside Ditch and Water Supply and Storage Company water rights, and Grey Mountain and Halligan Reservoir enlargement conditional storage decrees. Under Future Conditions hydrology most of the water stored in the reservoir would come from the Grey Mountain (55 percent) and Southside Ditch diversions (44 percent) conditional storage decrees with the remaining one percent coming from Water Supply and Storage Company water rights.
Figure 4-11. Estimated annual net diversions by source to the enlarged portion of Halligan Reservoir in acre-feet per year (AFY) under Fort Collins’ Proposed Action as simulated with Future Conditions hydrology, irrigation years 1950 to 2005.

4.3.3.3.2 Releases

As mentioned above, operation of the enlarged Halligan Reservoir would maintain minimum stream flows in the North Fork. Fort Collins would provide a continuous three cubic feet per second release of water from Halligan Reservoir to the North Fork from October 1 to April 30 of each year. From May 1 to September 30 of each year, Fort Collins would operate the Summer Plan to ensure a five cubic feet per second minimum stream flow in the North Fork between Halligan Dam and the inlet of Seaman Reservoir.

With the exception of meeting winter and summer releases, releases from the enlarged Halligan Reservoir by Fort Collins would be made only when other sources of water were unavailable. There is no pre-determined demand or releases pattern for the Halligan Reservoir enlargement.

In general, Fort Collins would release water from the enlarged Halligan Reservoir to:

- Meet Fort Collins’ reusable water demand when there was a lack of other reusable water sources, or
- Meet Fort Collins’ single-use and reusable water demands in dry years or during emergency water supply disruptions when other Fort Collins water sources were unavailable.

Releases from the enlarged portion of Halligan Reservoir are proposed to be made to the North Fork, and then exchanged upstream from the confluence of the North Fork and the Poudre River to Fort Collins’ existing intakes. Fort Collins’ ability to deliver releases from Halligan Reservoir to its intakes would be limited by available exchange potential. Firm yield and sizing modeling indicate at least some exchange...
potential is available in the exchange reach between the confluence and Fort Collins’ intakes in nearly 99 percent of the irrigation years 1950 to 2005 simulation period (Jokerst 2015). Furthermore, Fort Collins is able to fully execute the exchange of Halligan Reservoir releases in 95 percent of simulated months. During periods when exchange potential is limited, it is assumed that Fort Collins would trade releases from Halligan Reservoir for Colorado-Big Thompson Project (C-BT) water with, for example, the City of Greeley (Greeley). These trades are simulated in all modeling of Fort Collins’ Proposed Action. Fort Collins recognizes that because releases from Halligan Reservoir could be delivered only by river exchanges and C-BT trades, there could be periods when Fort Collins would be unable to deliver releases from Halligan Reservoir. However, modeling shows this limitation would occur less than five percent of the time.

As a result of the proposed exchange of Halligan Reservoir releases, the proportion of flow originating from the Poudre River and from the North Fork in the Main Stem downstream of the confluence would change. Figure 4-12 shows the percent of river flow originating from the North Fork in the reach of the Main Stem immediately downstream of the North Fork confluence. For comparison, the graph provides both the Current Conditions Baseline and Future Conditions Baseline (Common Technical Platform Run 1 and Common Technical Platform Run 2) and the enlargement of Halligan Reservoir simulated with Current and Future Conditions hydrology (Proposed Action Run 3 and Proposed Action Run 4). Under the Future Conditions Baseline the North Fork contribution to the Poudre River increases slightly from 46 percent in January to about 53 percent by March, then peaks at almost 80 percent in April. In May the contribution drops to 30 percent and further drops to 10 percent in June and a low of about five percent in July. The contribution of the North Fork to the Poudre River then generally increases to about 38 percent in December. Overall, the North Fork contributes about 31 percent to the Poudre River on an annual basis under the Future Conditions Baseline. Under Future Conditions, Fort Collins’ Proposed Action would generally increase the amount of water originating from the North Fork in the Main Stem downstream of the confluence. The difference would range from less than one percent in June and July to around eight percent in January and December. On an average annual basis, Fort Collins’ Proposed Action would increase the amount of water originating from the North Fork in the Main Stem downstream of the confluence compared to the Future Conditions Baseline conditions by about four percent.
4.3.3.3 North Fork Effects

The following discussion is a summary of the change in stream flow resulting from Fort Collins’ Proposed Action. Details of the modeling and supporting data are presented in the *Surface Water Resources Addendum* (CDM Smith 2018a).

Stream flow changes due to Fort Collins’ Proposed Action were determined by comparing Fort Collins’ Proposed Action under Future Conditions (Run 4) against the Future Conditions Baseline (Run 2). If the change in daily median flow under a given scenario remained within the 90 percent confidence interval surrounding the baseline flow, the change in stream flow was considered by the Corps to be within normal variability in the river and thus not a meaningful change. The Summer Plan was evaluated but remained within the daily median flow confidence interval. Changes in median daily and monthly stream flows at data delivery miles where a meaningful change was detected are summarized in box and whisker plots below (Figure 4-13). Additional tables and figures for stream flow effects of Fort Collins’ Proposed Action can be found in the *Surface Water Resources Addendum* (CDM Smith 2018a) with primary, secondary, and tertiary data delivery miles being located in Section 2.2, Appendix A, and Appendix B, respectively.

Modeling of Fort Collins’ Proposed Action detected four meaningful changes on the North Fork located at data delivery miles NF2, NF4, NF5 and NF6. At these locations the median daily flow was greater than the Upper Confidence Bound generally occurring between the months of October to February.
Modeling indicated a minor overall reduction of 2.2 percent (1,250 acre-feet per year) in average annual stream flow on the North Fork below Halligan Reservoir at data delivery mile NF2 (Figure 4-13) (CDM Smith 2018a). This reduction was primarily due to evaporation, since any water diverted from this reach during high flows would later be released through this reach. While there are some locations where the median daily flows and the monthly median data decrease due to the Fort Collins’ Proposed Action, none of the decreases were determined to be meaningful. A review of daily median flow plots (CDM Smith 2018a) indicated meaningful changes to increased stream flow at all six data delivery miles along the North Fork. At these locations, the median daily flow was greater than the Upper Confidence Bound and generally occurred from October to February but extended to March at NF4, and are a result of the Winter Release Plan. These changes were also reflected in the monthly median box and whisker plots. The discussion of effects focuses on these locations.

Below Halligan Reservoir at the primary data delivery mile NF2, the median daily flows increased from November to January, depicted in the monthly average box and whisker plot (Figure 4-13). The impact from the Winter Release Plan was observed in the daily mean flow above (tertiary data delivery mile NP3) and below the North Poudre Canal headgate (secondary data delivery mile NP4). At both these locations the flow increased from November through January while below the North Poudre Canal headgate increases were observed during October and extended through March. The increase in flow is also observed in the corresponding monthly average box and whisker plot (Figure 4-14 and Figure 4-15).
NF4 is downstream of the North Poudre Canal and under the Future Conditions Baseline can often be a dry-up point when the North Poudre Canal diverts all available flow.

Figure 4-14. Box and whisker plot showing maximum, middle 50th percentile, average (diamond), median (cross bar), and minimum monthly stream flows at data delivery mile NF3 (upstream of North Poudre Canal headgate) for Fort Collins' Proposed Action (PA4) and the baseline (Run2) as simulated with Future Conditions hydrology, irrigation years 1950-2005.
Figure 4-15. Box and whisker plot showing maximum, middle 50th percentile, average (diamond), median (cross bar), and minimum monthly stream flows at data delivery mile NF4 (Downstream of the North Poudre Canal) for Fort Collins’ Proposed Action (Run PA4) and the baseline (Run 2) as simulated with Future Conditions hydrology, irrigation years 1950 to 2005.

Simulated stream flows at the Livermore Gage (data delivery mile NF5) below the confluence of Rabbit, Lone Pine, and Stonewall creeks increase and decrease throughout the year to a degree similar to the change at data delivery mile NF4 (Figure 4-16). The increase and decrease in stream flow at data delivery mile NF 5 remains consistent down to data delivery mile NF6 located upstream of Seaman Reservoir (Figure 4-17). Both locations (data delivery miles NF 5 and 6) show a slight increase in daily mean stream flow as it tracks and exceeds the upper confidence bound from December through February. These monthly increases are observed in the monthly average box and whisker plots (Figure 4-17 and Figure 4-18).
Figure 4-16. Box and whisker plot showing maximum, middle 50th percentile, average (diamond), median (cross bar), and minimum monthly stream flows at data delivery mile NF5 (Livermore Gage) for Fort Collins’ Proposed Action (Run PA4) and the baseline (Run 2) as simulated with Future Conditions hydrology, irrigation years 1950 to 2005.
Figure 4-17. Box and whisker plot showing maximum, middle 50th percentile, average (diamond), median (cross bar), and minimum monthly stream flows at data delivery mile NF6 (upstream of Seaman Reservoir) for Fort Collins’ Proposed Action (Run PA4) and the baseline (Run 2) as simulated with Future Conditions hydrology, irrigation years 1950 to 2005.
Figure 4-18. Box and whisker plot showing maximum, middle 50th percentile, average (diamond), median (cross bar), and minimum monthly stream flows at data delivery mile NF6 (upstream of Seaman Reservoir) for Fort Collins’ Proposed Action (Run PA4) and the baseline (Run 2) as simulated with Future Conditions hydrology, irrigation years 1950 to 2005.

Metrics for extreme flow conditions in the North Fork are summarized in the Aquatics Effects Technical Report (GEI 2019) for the segments used for the aquatic resource analysis rather than the data delivery miles discussed above. The comparison of Fort Collins’ Proposed Action to the Future Conditions Baseline suggests there will be an overall increase to the flow likely due to the Winter Release Plan and Summer Plan, as well as an elimination of median no flow days in segment 2a (Table 4-7).

Table 4-7. Comparison of predicted 2065 extreme flows and extreme daily flow fluctuations for Fort Collins' Proposed Action and Future Conditions Baseline on the North Fork. The 95 percent confidence intervals are in parentheses.

<table>
<thead>
<tr>
<th>Flow Metric</th>
<th>Future Conditions Baseline</th>
<th>Future Conditions with the Fort Collins' Proposed Action</th>
<th>Percent Change</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>Value</td>
<td></td>
</tr>
<tr>
<td>North Fork Segment 1 - Halligan Reservoir Outlet to North Poudre Diversion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flows &lt;10 cubic feet per second (cfs)</td>
<td>Percent of years</td>
<td>100</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>112 (84-132)</td>
<td>100 (67-118)</td>
</tr>
<tr>
<td>Flows &lt; 5 cfs</td>
<td>Percent of years</td>
<td>95</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>87 (73-104)</td>
<td>18 (0-51)</td>
</tr>
</tbody>
</table>
### Flow Metric

<table>
<thead>
<tr>
<th>Flow Metric</th>
<th>Future Conditions Baseline</th>
<th>Future Conditions with the Fort Collins' Proposed Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>Value</td>
</tr>
<tr>
<td>Flows = 0 cfs</td>
<td>Percent of years</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>0 (0-12)</td>
</tr>
<tr>
<td>50% Flow decrease</td>
<td>Percent of years</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>6 (4-16)</td>
</tr>
<tr>
<td>100% Flow increase</td>
<td>Percent of years</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>4 (3-6)</td>
</tr>
<tr>
<td>200% Flow increase</td>
<td>Percent of years</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>95</td>
</tr>
</tbody>
</table>

#### North Fork Segment 2a - North Poudre Diversion to Rabbit Creek

<table>
<thead>
<tr>
<th>Flow Metric</th>
<th>Percent of years</th>
<th>Median days/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flows &lt;10 cfs</td>
<td>100</td>
<td>222 (199-250)</td>
</tr>
<tr>
<td></td>
<td>95</td>
<td>218 (175-249)</td>
</tr>
<tr>
<td>Flows &lt; 5 cfs</td>
<td>100</td>
<td>176 (144-208)</td>
</tr>
<tr>
<td></td>
<td>95</td>
<td>54 (40-84)</td>
</tr>
<tr>
<td>Flows = 0 cfs</td>
<td>95</td>
<td>43 (36-63)</td>
</tr>
<tr>
<td></td>
<td>95</td>
<td>0 (0-0)</td>
</tr>
<tr>
<td>50% Flow decrease</td>
<td>100</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>64 (56-87)</td>
<td>10 (8-12)</td>
</tr>
<tr>
<td>100% Flow increase</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>11 (9-14)</td>
<td>10 (8-12)</td>
</tr>
<tr>
<td>200% Flow increase</td>
<td>95</td>
<td>7 (4-8)</td>
</tr>
<tr>
<td></td>
<td>95</td>
<td>6 (5-9)</td>
</tr>
</tbody>
</table>

#### North Fork Segment 2b - Rabbit Creek to Seaman Reservoir Inlet

<table>
<thead>
<tr>
<th>Flow Metric</th>
<th>Percent of years</th>
<th>Median days/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flows &lt;10 cfs</td>
<td>100</td>
<td>102 (50-147)</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>36 (28-67)</td>
</tr>
<tr>
<td>Flows &lt; 5 cfs</td>
<td>100</td>
<td>28 (1-45)</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>0 (0-0)</td>
</tr>
<tr>
<td>Flows = 0 cfs</td>
<td>100</td>
<td>0 (0-0)</td>
</tr>
<tr>
<td></td>
<td>95</td>
<td>0 (0-0)</td>
</tr>
<tr>
<td>50% Flow decrease</td>
<td>100</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>4 (3-4)</td>
<td>3 (3-4)</td>
</tr>
<tr>
<td>100% Flow increase</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>6 (5-7)</td>
<td>5 (4-6)</td>
</tr>
<tr>
<td>200% Flow increase</td>
<td>95</td>
<td>2 (2-3)</td>
</tr>
<tr>
<td></td>
<td>95</td>
<td>2 (1-2)</td>
</tr>
</tbody>
</table>

#### North Fork Segment 3 - Seaman Reservoir Outlet to Confluence with Main Stem

<table>
<thead>
<tr>
<th>Flow Metric</th>
<th>Percent of years</th>
<th>Median days/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flows &lt;10 cfs</td>
<td>95</td>
<td>45 (33-112)</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>39 (21-62)</td>
</tr>
<tr>
<td>Flows &lt; 5 cfs</td>
<td>95</td>
<td>45 (33-112)</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>39 (21-62)</td>
</tr>
<tr>
<td>Flows = 0 cfs</td>
<td>95</td>
<td>0 (0-0)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>0 (0-0)</td>
</tr>
<tr>
<td>50% Flow decrease</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>90</td>
</tr>
</tbody>
</table>

4-49
4.3.3.3.4 Upper Poudre and Main Stem Effects

On the Upper Poudre and Main Stem no meaningful changes to the stream flow were detected as a result of Fort Collins’ Proposed Action. Model results for Fort Collins’ Proposed Action at all data delivery miles produced median daily flows that remained within the 90 percent confidence interval and thus the modeled changes in stream flow are considered to be part of the normal variability of the Future Conditions Baseline stream flow.

On the Upper Poudre, comparison of the modeling of Fort Collins’ Proposed Action under Future Conditions against the Future Conditions Baseline showed a minor increase in stream flows above the Munroe Canal (data delivery mile 0.05). Below the Munroe Canal and the Fort Collins Pipeline (data delivery mile 1.59), reductions in annual stream flows averaged 1.0 percent (1,790 acre-feet per year) due to higher demands with the Fort Collins’ Proposed Action as well as diversions taken from Halligan Reservoir by exchange. Reductions occurred year-round but were typically highest in June and July.

Annual stream flow reductions on the Main Stem upstream of the Poudre Valley Canal headgate (data delivery mile 1.69) averaged 1.0 percent (2,160 acre-feet per year). The reductions were generally highest in May and June and typically reached zero in winter months. Continuing downstream, annual stream flow reductions occurred below various agricultural headgates that served as a water supply source for Fort Collins. Stream flow reductions were lessen downstream of the headgates for the Larimer County Canal (owned by the Water Supply and Storage Company; secondary data delivery mile 8.02), below Larimer Canal Number 2 and New Mercer Ditch (primary data delivery mile 11.34), and below Arthur Ditch (secondary data delivery mile 13.63). Below the Arthur Ditch, stream flow reductions averaged 1.4 percent (2,030 acre-feet per year) and decreases below this point were 1.9 percent (1,720 acre-feet per year). This was a larger percent decrease than at upstream locations (e.g., below the Arthur Ditch)
because baseline stream flows were lower at this location, although the absolute value of stream flow reductions was lower.

As noted in Section 2.1 of the *Surface Water Resources Addendum* (CDM Smith 2018a) report, stream flow reductions decreased below the Fossil Creek inlet due to changes in operations of Fossil Creek Reservoir. Accordingly, flows at the Boxelder Gage (primary data delivery mile 22.69) decreased by 2.1 percent (1,240 acre-feet per year). Effluent from the Drake wastewater treatment facility discharges into Fossil Creek Reservoir, which ultimately releases the flows back to the Main Stem through the Fossil Creek outlet. Therefore, stream flow reductions decreased again below the Fossil Creek outlet (secondary data delivery mile 27.76) due to introduction of return flows to the river. At this location, reductions were about 0.3 percent (360 acre-feet per year).

Stream flow decreased by a greater amount in the reach from the Fossil Creek outlet through the Greeley Gage. These additional reductions were due to changes in the location of return flows from converted agricultural rights. Greeley Gage (primary data delivery mile 57.43), at the downstream end of the study area, is below all diversion, release, and exchange-from locations used for Fort Collins’ Proposed Action, so the Corps did not expect stream flow effects to change significantly further downstream. At the Greeley Gage, stream flow decreased by an average of 550 acre-feet per year, or 0.4 percent. These reductions occurred year-round but were still highest in May and June. Some months here also showed an increase in flow, when Fort Collins released water from storage or when Fort Collins had more effluent than needed to meet return-flow obligations.

Table 4-8 summarizes the average annual stream flows at the primary data delivery miles related to effects of Fort Collins’ Proposed Action under Future Conditions. Metrics for extreme flow conditions in the Main Stem are summarized in the *Aquatics Effects Technical Report* (GEI 2019) for the segments used for the aquatic resource analysis rather than the data delivery miles discussed above. Extreme low flows and fluctuations are not expected to change appreciably under Fort Collins’ Proposed Action throughout the Main Stem with the exception of Segment A (Table 4-9). Duration of flows of less than five and 10 cubic feet per second would increase in Segment A and extreme decreases and increases would be less frequent as a result of Fort Collins’ Proposed Action.
Table 4-8. Annual average flows and effects at primary data delivery miles, for Fort Collins’ Proposed Action as simulated with Future Conditions hydrology.

<table>
<thead>
<tr>
<th>Run</th>
<th>Parameter</th>
<th>Below Halligan Reservoir DDM NF2</th>
<th>Fort Collins Intake DDM 1.59</th>
<th>Canyon Gage DDM 5.63</th>
<th>US/DS Little Cache DDM 11.34</th>
<th>Lincoln St. Gage DDM 16.84</th>
<th>Boxelder Gage DDM 22.69</th>
<th>Greeley Gage DDM 57.43</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run 2</td>
<td>Annual average flows, acre-feet per year (AFY)</td>
<td>56,900</td>
<td>181,800</td>
<td>216,300</td>
<td>148,700</td>
<td>87,300</td>
<td>59,600</td>
<td>131,300</td>
</tr>
<tr>
<td>Run PA4</td>
<td>Annual average flows, AFY</td>
<td>55,600</td>
<td>180,000</td>
<td>214,100</td>
<td>146,700</td>
<td>85,300</td>
<td>58,300</td>
<td>130,800</td>
</tr>
<tr>
<td></td>
<td>Effects (Run PA4 minus Run 2)</td>
<td>AFY</td>
<td>-1,250</td>
<td>-1,790</td>
<td>-2,210</td>
<td>-2,030</td>
<td>-1,980</td>
<td>-1,240</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Percent of Run 2</td>
<td>-2.2%</td>
<td>-1.0%</td>
<td>-1.0%</td>
<td>-1.4%</td>
<td>-2.3%</td>
<td>-2.1%</td>
</tr>
</tbody>
</table>

Source: CDM Smith 2018a
Table 4-9. Comparison of extreme flows and extreme daily flow fluctuations for Fort Collins' Proposed Action and Future Conditions Baseline on the Main Stem. The 95 percent confidence intervals are in parentheses.

<table>
<thead>
<tr>
<th>Flow Metric</th>
<th>Future Conditions</th>
<th>Fort Collins’ Proposed Action</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>Value</td>
<td></td>
</tr>
<tr>
<td>Segments A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flows &lt;10 cfs (cubic feet per second)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>92</td>
<td>92</td>
<td>0</td>
</tr>
<tr>
<td>Median days/year</td>
<td>16 (7-38)</td>
<td>25 (9-49)</td>
<td>+56</td>
</tr>
<tr>
<td>Flows &lt; 5 cfs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>81</td>
<td>85</td>
<td>+5</td>
</tr>
<tr>
<td>Median days/year</td>
<td>4 (2-17)</td>
<td>5 (3-30)</td>
<td>+25</td>
</tr>
<tr>
<td>Flows = 0 cfs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>69</td>
<td>73</td>
<td>+6</td>
</tr>
<tr>
<td>Median days/year</td>
<td>2 (1-3)</td>
<td>2 (1-3)</td>
<td>0</td>
</tr>
<tr>
<td>50% Flow decrease</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Median days/year</td>
<td>8 (6-11)</td>
<td>9 (6-12)</td>
<td>+13</td>
</tr>
<tr>
<td>100% Flow increase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Median days/year</td>
<td>7 (5-8)</td>
<td>6 (4-8)</td>
<td>-14</td>
</tr>
<tr>
<td>200% Flow increase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>92</td>
<td>85</td>
<td>-8</td>
</tr>
<tr>
<td>Median days/year</td>
<td>3 (2-3)</td>
<td>2 (2-4)</td>
<td>-33</td>
</tr>
</tbody>
</table>

Segments B – Larimer-Weld Canal to Spring Creek in Fort Collins

| Flows <10 cfs |                       |                               |                |
| Percent of years | 100 | 100 | 0 |
| Median days/year | 101 (67–126) | 97 (64-138) | -4 |
| Flows < 5 cfs |                       |                               |                |
| Percent of years | 100 | 100 | 0 |
| Median days/year | 35 (26–53) | 39 (25-54) | +11 |
| Flows = 0 cfs |                       |                               |                |
| Percent of years | 8 | 8 | 0 |
| Median days/year | 0 (0–0) | 0 (0-0) | 0 |
| 50% Flow decrease |                   |                               |                |
| Percent of years | 100 | 100 | 0 |
| Median days/year | 21 (17–23) | 19 (16-21) | -10 |
| 100% Flow increase |                  |                               |                |
| Percent of years | 100 | 100 | 0 |
| Median days/year | 23 (21–25) | 22 (19-26) | -4 |
| 200% Flow increase |                  |                               |                |
| Percent of years | 100 | 100 | 0 |
| Median days/year | 11 (8–12) | 10 (8-13) | -9 |

Segments C - Spring Creek to the New Cache La Poudre Co. Ditch

| Flows <10 cfs |                       |                               |                |
| Percent of years | 100 | 100 | 0 |
| Median days/year | 162 (147-195) | 160 (146-193) | -1 |
| Flows < 5 cfs |                       |                               |                |
| Percent of years | 100 | 100 | 0 |
| Median days/year | 100 (73-116) | 101 (72-113) | +1 |
### Flow Metric

<table>
<thead>
<tr>
<th>Flow Metric</th>
<th>Future Conditions</th>
<th>Fort Collins’ Proposed Action</th>
<th>Value</th>
<th>Value</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flows = 0 cfs</td>
<td>Percent of years</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>50% Flow decrease</td>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>19 (16-22)</td>
<td>19 (16-21)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>100% Flow increase</td>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>21 (17-24)</td>
<td>21 (16-23)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>200% Flow increase</td>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>10 (10-13)</td>
<td>10 (9-12)</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

#### Segment D

<table>
<thead>
<tr>
<th>Flows &lt;10 cfs</th>
<th>Percent of years</th>
<th>100</th>
<th>100</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median days/year</td>
<td>83 (58-98)</td>
<td>82 (57-100)</td>
<td>-1</td>
</tr>
<tr>
<td>Flows &lt; 5 cfs</td>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>42 (23-58)</td>
<td>36 (19-56)</td>
<td>-14</td>
</tr>
<tr>
<td>Flows = 0 cfs</td>
<td>Percent of years</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
<td>0</td>
</tr>
<tr>
<td>50% Flow decrease</td>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>10 (8-11)</td>
<td>8 (8-10)</td>
<td>-20</td>
</tr>
<tr>
<td>100% Flow increase</td>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>11 (10-12)</td>
<td>10 (9-11)</td>
<td>-9</td>
</tr>
<tr>
<td>200% Flow increase</td>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>5 (4-6)</td>
<td>4 (3-5)</td>
<td>-20</td>
</tr>
</tbody>
</table>

#### Segment E

<table>
<thead>
<tr>
<th>Flows &lt;10 cfs</th>
<th>Percent of years</th>
<th>73</th>
<th>73</th>
<th>0</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Median days/year</td>
<td>14 (4-20)</td>
<td>11 (2-16)</td>
<td>-21</td>
</tr>
<tr>
<td>Flows &lt; 5 cfs</td>
<td>Percent of years</td>
<td>38</td>
<td>35</td>
<td>-8</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>0 (0-4)</td>
<td>0 (0-2)</td>
<td>0</td>
</tr>
<tr>
<td>Flows = 0 cfs</td>
<td>Percent of years</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
<td>0</td>
</tr>
<tr>
<td>50% Flow decrease</td>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>5 (3-5)</td>
<td>4 (3-5)</td>
<td>-20</td>
</tr>
<tr>
<td>100% Flow increase</td>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>6 (5-6)</td>
<td>5 (5-6)</td>
<td>-17</td>
</tr>
<tr>
<td>200% Flow increase</td>
<td>Percent of years</td>
<td>81</td>
<td>81</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>2 (1-2)</td>
<td>2 (1-2)</td>
<td>0</td>
</tr>
</tbody>
</table>
4.3.4 Expanded Glade Alternative

4.3.4.1 Operation Overview

The Expanded Glade Alternative would enlarge the primary storage facility associated with the NISP proposed Glade Reservoir. Under the Expanded Glade Alternative, the proposed Glade Reservoir would be enlarged from an active capacity of 170,000 acre-feet proposed under NISP to an active capacity of 176,075 acre-feet, a 3.6 percent increase in capacity. It is assumed that the proposed Glade Reservoir would be initially designed and constructed considering the increase in storage volume required by Fort Collins under this alternative. It is further assumed that Fort Collins would wholly control and independently operate the 6,075 acre-feet of expanded capacity in the proposed Glade Reservoir.

The NISP Supplemental Draft EIS (Corps 2015) describes two options under the NISP Proposed Action for delivering water from Glade Reservoir to NISP Participants: (1) the Reclamation Action Option, and (2) the No Reclamation Action Option. Operations of the expanded portion of the proposed Glade Reservoir by Fort Collins would not depend on whether the Reclamation Action Option or the No Reclamation Action Option is chosen for NISP. Given the No Reclamation Action Option’s higher stream flow depletions of the Poudre River in the reach between the Poudre Valley Canal and the Hansen Supply Canal relative to the Reclamation Action Option, the No Reclamation Action Option represents a “worse case” condition in terms of cumulative stream flow effects for which to evaluate the Expanded Glade Alternative for Fort Collins. Consequently, for the Expanded Glade Alternative the focus of alternative development, operations, and hydrologic modeling is the No Reclamation Action Option.

As part of the NISP Proposed Action, a flow augmentation program is proposed to compensate certain effects resulting from operation of the proposed Glade Reservoir. The hydrology modeling for this
alternative did not consider the augmentation program because information about the program was unavailable at the time modeling was conducted. Thus, NISP’s augmentation program was not considered in the Expanded Glade Alternative.

The Winter Release Plan for the Expanded Glade Alternative specifies a three cubic feet per second release of water from the proposed Glade Reservoir to meet treated water demands between the months of October and April. This release would be made into the Main Stem and would not alter the flow on the North Fork.

4.3.4.2 Expanded Glade Reservoir

Modeled operations of the Expanded Glade Alternative are presented in Section 5 of the Operations Report (Fort Collins 2019). Under the Expanded Glade Alternative, each year Fort Collins would generally fill their expanded portion of the proposed Glade Reservoir and release about 1,400 acre-feet. In drier years they would generally release up to 400 more acre-feet. The minimum end-of-month storage volume in the expanded portion of the proposed Glade Reservoir in any month during the simulated period is approximately 3,100 acre-feet with Future Conditions hydrology (Figure 4-19); average end-of-month storage would be about 5,500 acre-feet. Under Future Conditions, the expanded proposed Glade Reservoir would have a maximum, minimum, and mean end-of-month storage volume of 176,000, 41,900, and 130,000 acre-feet, respectively (Figure 4-20).

![Figure 4-19. Estimated end-of-month (EOM) storage volume in acre-feet (AF) for the expanded portion of the proposed Glade Reservoir under the Expanded Glade Alternative as simulated with Current and Future Conditions hydrology for irrigation years 1950 to 2005.](image)
Figure 4-20. End-of-month (EOM) storage volume in acre-feet (AF) for the total expanded proposed Glade Reservoir under the Expanded Glade Alternative (Run 4) and baseline condition (NISP Run 4) as simulated with Future Conditions hydrology for irrigation years 1950 to 2005.

Water surface area and water surface elevation are properties calculated directly from the average storage volume. Section 5 of the Operations Report (Fort Collins 2019) provides time series plots for end-of-month surface water area, elevation, and volume for the Expanded Glade Alternative. Water surface areas were estimated using simulated end-of-month storage volumes for the expanded proposed Glade Reservoir and interpolation of the water surface area to storage volume curve is discussed in Section 5.1.1 of the Operations Report (Fort Collins 2019). Under the Expanded Glade Alternative the 1,600-acre NISP proposed Glade Reservoir would be enlarged by 100 acres. Under Future Conditions, the total minimum surface area would increase from 510 to 660 acres while the mean water surface area would increase from 1,300 to approximately 1,400 acres.

The water surface elevation level of the Expanded Glade Alternative reservoir at maximum capacity is 5,520.6 feet above mean sea level, which is 3.6 feet higher than the maximum water surface elevation of the baseline Glade Reservoir as proposed in NISP. The minimum water surface elevation would increase from 5,383 to 5,405 feet above mean sea level while the average water surface level would increase from 5,483 to 5,488 feet above mean sea level under the Future Conditions simulation.

Changes in the proposed Glade Reservoir water surface elevation, particularly drawdown rates, may have implications on recreation and environmental resources at the reservoir. The water surface elevation of the proposed Glade Reservoir would increase at a maximum rate of 55 feet per month versus 59 feet per month for the Baseline Glade Reservoir under the Future Conditions simulation (Figure 4-21). The
maximum decrease for the proposed Glade Reservoir would be six feet per month versus eight feet per month for the Baseline Glade Reservoir under the Future Conditions simulation.

The maximum monthly water surface elevation data were used to estimate the percent of years in the simulated period of irrigation years 1950 to 2005 that water surface elevations of the Baseline and proposed Glade Reservoir were near the ordinary high water mark (assumed as the maximum water surface elevation) for at least 14 days during the growing season (May through September). Under Future Conditions hydrology, the water surface of the Baseline Glade Reservoir would be within three feet, one foot, and six inches of the ordinary high water mark for 14 days during the growing season 29, seven, and seven percent of the time, respectively. Under Future Conditions hydrology, the proposed Glade Reservoir would have similar respective frequencies of 30, nine, and seven percent, respectively.

As described in Section 7 of the Hydrologic Modeling Report (CDM Smith and DiNatale Water Consultants 2016), modeling used to evaluate the Expanded Glade Alternative segregates evaporation in the proposed Glade Reservoir between NISP’s portion of the reservoir and Fort Collins’ portion of the reservoir. Total evaporation in the reservoir is pro-rated based on the volume of water held in storage by each entity. As a result, the amount of evaporative losses in Fort Collins’ portion of the proposed Glade Reservoir is less than a standalone reservoir sized equally to the expansion. Because evaporation correlates with surface area, evaporative losses are higher in years when the proposed Glade Reservoir is full and lower in years when the reservoir is drained down (Figure 4-22). Under the Expanded Glade Alternative with Future Conditions hydrology, the enlarged portion of the proposed Glade Reservoir
would have an average annual storage volume of 5,500 acre-feet and lose about 130 acre-feet, or 2.3 percent of the average annual storage volume, annually to evaporation.

![Figure 4-22. Expanded portion of the proposed Glade Reservoir estimated annual evaporation in acre-feet per year (AFY) under the Expanded Glade Alternative, Current and Future Conditions hydrology, irrigation years 1950 to 2005](image)

4.3.4.3 River Segments

4.3.4.3.1 Diversions

Similar to the NISP Proposed Action, under the Expanded Glade Alternative all inflows to the expanded portion of the proposed Glade Reservoir would be diverted from the Poudre River via the Poudre Valley Canal. Under the Expanded Glade Alternative, the Poudre Valley Canal would be expanded by up to 60 cubic feet per second to convey diversions to Fort Collins’ portion of the proposed Glade Reservoir (MWH Global 2015b). Results of modeled diversions under the Expanded Glade Alternative are presented in a series of tables and figures in Section 5.3 of the Operations Report (Fort Collins 2019). The maximum monthly diversion to storage during the simulation period is zero cubic feet per month from October through January, increases to a peak of 1,800 acre-feet per month in June, and then decreases to 16 acre-feet per month in September for Future Conditions hydrology (Expanded Glade Alternative Run 4), equating to a maximum monthly flow rate of 30 cubic feet per second. The minimum monthly diversion rate under Future Conditions hydrology ranges from zero acre-feet per month from July through January to 15 and 23 acre-feet per month in May and June, respectively. The average monthly diversion rate under Future Conditions hydrology would be zero acre-feet per month from July through January to 15 and 23 acre-feet per month in May and June, respectively.
October through February, 1,100 acre-feet per month in May, 230 acre-feet per month in June, and less than 29 acre-feet per month in the remaining months. Diversions would be made in February through September occurring one, one, three, 56, 56, 55, 38, and 21 times out of 56 simulated years in irrigation years 1950 to 2005 under Future Conditions hydrology, respectively (Table 4-10).

Table 4-10. Estimated net diversions to the expanded portion of the proposed Glade Reservoir in acre-feet per month (AFM) or acre-feet per year (AFY) under the Expanded Glade Alternative, Current and Future Conditions hydrology, irrigation years 1950 to 2005.

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of Years with Diversions (out of 56)</th>
<th>Minimum (AFM; AFY for Annual)</th>
<th>Maximum (AFM; AFY for Annual)</th>
<th>Average (AFM; AFY for Annual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>November</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>December</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>January</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>February</td>
<td>1</td>
<td>0</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>March</td>
<td>1</td>
<td>0</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>April</td>
<td>3</td>
<td>0</td>
<td>470</td>
<td>13</td>
</tr>
<tr>
<td>May</td>
<td>56</td>
<td>15</td>
<td>1,400</td>
<td>1,100</td>
</tr>
<tr>
<td>June</td>
<td>56</td>
<td>23</td>
<td>1,800</td>
<td>280</td>
</tr>
<tr>
<td>July</td>
<td>55</td>
<td>0</td>
<td>270</td>
<td>29</td>
</tr>
<tr>
<td>August</td>
<td>38</td>
<td>0</td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td>September</td>
<td>21</td>
<td>0</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>October</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Annual</td>
<td>56</td>
<td>680</td>
<td>3,000</td>
<td>1,500</td>
</tr>
</tbody>
</table>

AFM = acre-feet per month; AFY = acre-feet per year

Sources diverted to the proposed Glade Reservoir could include Southside Ditch rights, Water Supply and Storage Company transbasin rights, and Grey Mountain and Halligan Reservoir enlargement conditional storage decrees (Table 4-10). Southside Ditch water would be exchanged from their original diversion locations to the Poudre Valley Canal diversion structure when exchange potential between the points allows. Water Supply and Storage Company transbasin and Grey Mountain conditional decree water would be diverted at the Poudre Valley Canal without requiring an exchange. Under the Future Conditions simulation, a majority (97 percent) of diversions to the expanded portion of the proposed Glade Reservoir are from Southside Ditch water rights, two percent are from the Grey Mountain conditional decree, and less than one percent is from the Halligan Enlargement conditional storage decree (Figure 4-23).
The Expanded Glade Alternative shows less use of the Grey Mountain conditional decree than other Project Alternatives because under the Expanded Glade Alternative, NISP is simulated and diverts the Grey Mountain water rights. When Fort Collins is the sole entity diverting under the Grey Mountain water rights, they are limited by the total yield of the water rights and by their pro-rata shares of the decreed volumetric limit. When NISP is also diverting, Fort Collins is limited by their pro-rata share of the yield rather than the full yield, leaving fewer Grey Mountain diversions available for Fort Collins. Consequently, Fort Collins diverts more water under the Halligan Reservoir enlargement conditional decree. In all other Project Alternatives, NISP is not simulated (except in cumulative effect runs, i.e., the Run 5 series).

4.3.4.3.2 Releases

Releases from Fort Collins’ portion of the proposed Glade Reservoir would be conveyed using a portion of NISP’s Glade Dam infrastructure as well as new infrastructure proposed by Fort Collins. Releases from a proposed Glade Reservoir may occur in one of two ways: (1) by gravity to the Main Stem for subsequent exchange from the release location upstream to Fort Collins’ intakes; or (2) by piping directly to the Water Treatment Facility. As with all Project Alternatives, the Expanded Glade Alternative includes a winter release plan which specifies a three cubic feet per second release of water from storage to meet treated water demands between October and April. With the exception of meeting winter releases, releases from the expanded portion of the proposed Glade Reservoir would be made only when other sources of water are unable to meet water demands; there is no pre-determined demand or release pattern.
for Fort Collins’ portion of the proposed Glade Reservoir. In general, releases from the proposed Glade Reservoir to Fort Collins would occur: (1) to meet Fort Collins’ water demand when there is a lack of other water sources, or (2) in dry years or during emergency water supply disruptions to meet Fort Collins’ single-use and reusable water demands when other City water sources are unavailable.

A majority (76 percent for Future Conditions hydrology) of all net releases from the expanded portion of the proposed Glade Reservoir would be delivered to the Main Stem for subsequent exchange to Fort Collins intakes. Releases piped directly to the Water Treatment Facility constitute 24 percent of all net releases from the expanded portion of the proposed Glade Reservoir under Future Conditions hydrology.

As with Fort Collins’ Proposed Action, the Expanded Glade Alternative could alter the proportion of flow in the Main Stem downstream of the confluence originating from the Poudre River and from the North Fork. Under the Future Conditions baseline the North Fork contribution to the Poudre River increases slightly from 47 percent in January to about 53 percent by March then peaks at about 78 percent in April. In May the contribution drops to 30 percent and further drops to 10 percent in June and a low of about five percent in July. The contribution of the North Fork to the Poudre River then generally increases to about 38 percent in December. Overall, the North Fork contributes about 31 percent to the Poudre River on an annual basis under the Future Conditions baseline (Figure 4-24). Under Future Conditions, the amount of water originating from the North Fork in the Main Stem downstream of the confluence would generally increase by one or two percent under the Expanded Glade Alternative except during May, June, and July.

Figure 4-24. Estimated percent of Poudre River stream flow below the North Fork confluence originating from the North Fork under the Expanded Glade Alternative and Current Conditions, Current and Future Conditions hydrology, irrigation years 1950 to 2005.
4.3.4.3.3 North Fork Effects

The following discussion is a summary of the change in stream flow resulting from Fort Collins’ Proposed Action. Details of the modeling and various other data are presented in the Surface Water Resources Technical Report (CDM Smith 2017). The change to other flow characteristics such as very high and very low flows important to other resources (i.e., aquatic resources and sediment transport) are discussed in conjunction with the effects evaluation for each resource.

Effects on stream flows due to the Expanded Glade Alternative were determined by comparing the Expanded Glade Alternative under Future Conditions (Run 4) with the NISP Run 4a (Future Conditions hydrology). As with Fort Collins’ Proposed Action, if the change in daily median flow remained within the 90 percent confidence interval the Corps determined that to be within the normal variability occurring in the river and not a meaningful change. Changes in median and monthly stream flows at data delivery miles are summarized and box and whisker plots are provided where a meaningful difference was detected. Additional tables and figures for stream flow effects of the Expanded Glade Alternative can be found in the Surface Water Resources Technical Report (CDM Smith 2017).

On the North Fork, no change was observed in the annual average stream flow as a result of the Expanded Glade Alternative. Model results at all data delivery miles produced median daily flows that remained within the 90 percent confidence interval which is considered to be within the normal variability of the stream flow. Therefore, any daily or monthly changes in flow resulting from the Expanded Glade Alternative were not meaningful.

Metrics for extreme flow conditions in the North Fork were summarized in the Aquatics Effects Technical Report (GEI 2019) for the segments used for the aquatic resource analysis rather than the data delivery miles discussed above. The comparison of the Expanded Glade Alternative to the Future Conditions Baseline suggests there would be limited changes in the extreme flows on the North Fork as a result of the Expanded Glade Alternative (Table 4-11).

Table 4-11. Comparison of extreme flows and extreme daily flow fluctuations for Expanded Glade and Future Conditions Baseline on the North Fork. The 95 percent confidence intervals are in parentheses.

<table>
<thead>
<tr>
<th>Flow Metric</th>
<th>Future Conditions</th>
<th>Expanded Glade Alternative</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>Value</td>
<td></td>
</tr>
<tr>
<td>North Fork</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Segment 1 - Halligan Reservoir Outlet to North Poudre Diversion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flows &lt;10 cubic feet per second (cfs)</td>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>117 (91-134)</td>
<td>107 (91-134)</td>
</tr>
<tr>
<td>Flows &lt; 5 cfs</td>
<td>Percent of years</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>91 (77-112)</td>
<td>88 (77-104)</td>
</tr>
<tr>
<td>Flows = 0 cfs</td>
<td>Percent of years</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>0 (0-6)</td>
<td>0 (0-6)</td>
</tr>
<tr>
<td>50% Flow decrease</td>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>5 (4-16)</td>
<td>5 (3-16)</td>
</tr>
</tbody>
</table>
## Flow Metric

<table>
<thead>
<tr>
<th>Future Conditions</th>
<th>Expanded Glade Alternative</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>100% Flow increase</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Median days/year</td>
<td>4 (4-6)</td>
<td>4 (4-6)</td>
</tr>
<tr>
<td><strong>200% Flow increase</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Median days/year</td>
<td>3 (2-3)</td>
<td>3 (2-3)</td>
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</tbody>
</table>

### North Fork Segment 2a - North Poudre Diversion to Rabbit Creek

<table>
<thead>
<tr>
<th>Flows &lt;10 cfs</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Median days/year</td>
<td>222 (201-255)</td>
<td>221 (201-253)</td>
</tr>
<tr>
<td>Flows &lt; 5 cfs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Median days/year</td>
<td>177 (146-207)</td>
<td>170 (150-207)</td>
</tr>
<tr>
<td>Flows = 0 cfs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>Median days/year</td>
<td>34 (27-45)</td>
<td>35 (27-49)</td>
</tr>
<tr>
<td><strong>50% Flow decrease</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Median days/year</td>
<td>56 (46-67)</td>
<td>50 (46-69)</td>
</tr>
<tr>
<td><strong>100% Flow increase</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>Median days/year</td>
<td>14 (10-15)</td>
<td>13 (10-14)</td>
</tr>
<tr>
<td><strong>200% Flow increase</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>Median days/year</td>
<td>9 (7-10)</td>
<td>8 (6-8)</td>
</tr>
</tbody>
</table>

### North Fork Segment 2b - Rabbit Creek to Seaman Reservoir Inlet

<table>
<thead>
<tr>
<th>Flows &lt;10 cfs</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of years</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>Median days/year</td>
<td>102 (50-145)</td>
<td>102 (50-146)</td>
</tr>
<tr>
<td>Flows &lt; 5 cfs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Median days/year</td>
<td>28 (1-45)</td>
<td>28 (1-45)</td>
</tr>
<tr>
<td>Flows = 0 cfs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Median days/year</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
</tr>
<tr>
<td><strong>50% Flow decrease</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Median days/year</td>
<td>3 (3-5)</td>
<td>3 (3-5)</td>
</tr>
<tr>
<td><strong>100% Flow increase</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>Median days/year</td>
<td>6 (5-6)</td>
<td>6 (5-6)</td>
</tr>
<tr>
<td><strong>200% Flow increase</strong></td>
<td></td>
<td></td>
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<tr>
<td>Percent of years</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>Median days/year</td>
<td>2 (1-3)</td>
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</table>

### North Fork Segment 3 - Seaman Reservoir Outlet to Confluence with Main Stem

<table>
<thead>
<tr>
<th>Flows &lt;10 cfs</th>
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</thead>
<tbody>
<tr>
<td>Percent of years</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>Median days/year</td>
<td>56 (31-112)</td>
<td>45 (35-112)</td>
</tr>
<tr>
<td>Flows &lt; 5 cfs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of years</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Median days/year</td>
<td>11 (0-62)</td>
<td>11 (0-31)</td>
</tr>
</tbody>
</table>
4.3.4.3.4 **Upper Poudre and Main Stem Effects**

No meaningful changes were detected overall on the Upper Poudre and Main Stem as a result of the Expanded Glade Alternative. Model results at all data delivery miles produced median daily flows that remained within the 90 percent confidence interval which is considered to be within the normal variability of the stream flow.

On the Upper Poudre, comparison of modeling of the Expanded Glade Alternative under Future Conditions against the NISP Run 4a (Future Conditions hydrology) showed minimal effects on stream flows above the Munroe Canal (secondary data delivery mile 0.05) but a reduction in stream flows below the Munroe Canal and the Fort Collins Pipeline (primary data delivery mile 1.59) due to higher demands in the with-projects runs as well as diversions taken from the proposed Glade Reservoir by exchange. The reductions averaged 0.8 percent of annual stream flow (1,400 acre-feet per year) and effects were typically greatest in May, June, and July. Fort Collins would divert from the Main Stem into the proposed Glade Reservoir via the Poudre Valley Canal, causing additional reductions in stream flows, with the largest reduction occurring in May and June and during wet years. Modeled reductions below the Poudre Valley Canal (primary data delivery mile 5.63, Canyon Gage) averaged 1.7 percent (2,900 acre-feet per year).

Further downstream, below the Pleasant Valley and Lake Canal (secondary data delivery mile 6.93), stream flows were still reduced but by a lesser amount. Releases from the proposed Glade Reservoir would occur just upstream of the Poudre Valley and Lake Canal, offsetting effects of diversions at the intake. In addition, Fort Collins owns some Poudre Valley and Lake Canal rights (though they are not stored in the proposed Glade Reservoir), so reduced diversions at the Poudre Valley and Lake Canal would offset some diversions at the intake. Stream flows below the Poudre Valley and Lake Canal were reduced an average of 1.1 percent (2,000 acre-feet per year), again with the largest reduction in May and June.

Continuing downstream, stream flow reductions decreased below various agricultural headgates that serve as a water supply source for Fort Collins. Stream flow reductions were lessened downstream of the headgates for the Larimer County Canal (owned by the Water Supply and Storage Company; secondary...
data delivery mile 8.02), below Larimer Canal Number 2 and New Mercer Ditch (primary data delivery mile 11.34), and below Arthur Ditch (secondary data delivery mile 13.63). Below the Arthur Ditch, stream flow reductions averaged 1.7 percent (1,820 acre-feet per year). Similarly, stream flow reductions at Lincoln Gage (primary data delivery mile 16.84) were about 3.2 percent (1,900 acre-feet per year) with the largest reductions occurring in May.

Average stream flow decreases below this point were 3.2 percent of stream flow (1,600 acre-feet per year). As with Fort Collins’ Proposed Action, this is a larger percent than upstream locations (e.g., below the Arthur Ditch) because baseline stream flows were lower. Stream flow reductions lessened below the Fossil Creek inlet due to changes in operations of Fossil Creek Reservoir as described under Fort Collins’ Proposed Action. Accordingly, annual flows at the Boxelder Gage (primary data delivery mile 22.69) decreased by 2.7 percent (970 acre-feet per year).

Effluent from Fort Collins’ Drake wastewater treatment facility discharges into Fossil Creek Reservoir, which ultimately releases the flows back to the Main Stem through the Fossil Creek outlet. Therefore, stream flow reductions lessened again below the Fossil Creek outlet (secondary data delivery mile 27.76) due to the introduction of return flows to the river. At this location, reductions were about 0.1 percent (130 acre-feet per year).

Stream flow decreased by a greater amount in the reach from Fossil Creek outlet to Greeley Gage due to changes in the location of return flows from converted agricultural rights. Greeley Gage (primary data delivery mile 57.43), the downstream end of the study area, is below all diversion, release, and exchange locations used for the Expanded Glade Alternative, so stream flow effects are not expected to change further downstream. At the Greeley Gage, flows decreased by an average of 190 acre-feet per year, or 0.2 percent of stream flow. Reductions here occurred year-round, but are still highest in May and June. At this location some months also showed an increase in flow when Fort Collins released water from storage or when Fort Collins had more effluent than needed to meet return flow obligations. Table 4-12 summarizes the average annual stream flows at the primary data delivery miles related to effects with Expanded Glade Alternative.

In the 0.5-mile Exchange Reach of Segment A of the Main Stem between the Fort Collins Intake and the confluence with the North Fork, the Expanded Glade Alternative would result in slightly reduced flows on most days and increased flows on some days compared to Future Conditions. The changes in extreme flows would have a negligible to minor adverse effect due to prolonged low flow periods in dry years. The adverse effect would be somewhat less than predicted for Fort Collins’ Proposed Action. The Expanded Glade Alternative would have similar effects on extreme flow metrics in all segments of the Main Stem as Fort Collins’ Proposed Action compared to Future Conditions.
Table 4-12. Annual average flows and effects at primary data delivery miles, for Expanded Glade Alternative as simulated with Future Conditions hydrology.

<table>
<thead>
<tr>
<th>Run</th>
<th>Parameter</th>
<th>Below Halligan Reservoir DDM NF2</th>
<th>Fort Collins' Intake DDM 1.59</th>
<th>Canyon Gage DDM 5.63</th>
<th>US/DS Little Cache DDM 11.34</th>
<th>Lincoln St. Gage DDM 16.84</th>
<th>Boxelder Gage DDM 22.69</th>
<th>Greeley Gage DDM 57.43</th>
</tr>
</thead>
<tbody>
<tr>
<td>NISP Run 4a</td>
<td>Annual average flows, acre-feet per year (AFY)</td>
<td>57,000</td>
<td>182,400</td>
<td>173,900</td>
<td>109,700</td>
<td>58,400</td>
<td>36,400</td>
<td>112,800</td>
</tr>
<tr>
<td>Run EG4</td>
<td>Annual average flows, AFY</td>
<td>57,000</td>
<td>181,000</td>
<td>171,000</td>
<td>107,800</td>
<td>56,700</td>
<td>35,500</td>
<td>112,700</td>
</tr>
<tr>
<td></td>
<td>Effects (Run PA4 minus Run 2)</td>
<td>AFY</td>
<td>-10</td>
<td>-1,400</td>
<td>-2,890</td>
<td>-1,810</td>
<td>-1,740</td>
<td>-980</td>
</tr>
<tr>
<td></td>
<td>Percent of Run NISP 4a</td>
<td>0.0%</td>
<td>-0.8%</td>
<td>-1.7%</td>
<td>-1.7%</td>
<td>-3.0%</td>
<td>-2.7%</td>
<td>-0.2%</td>
</tr>
</tbody>
</table>

Source: CDM Smith 2018a
4.3.5 Gravel Pits Alternative

4.3.5.1 Operation Overview

Under the Gravel Pits Alternative, Fort Collins would develop 3,875 acre-feet of additional water storage at the Overland Gravel Pit complex. The Gravel Pits Alternative also includes reoperation of existing storage at Joe Wright Reservoir. The Overland Gravel Pits would function as off-channel storage. Unless otherwise stated, the Overland Gravel Pit complex refers only to those gravel pits identified as proposed for use in the Gravel Pits Alternative.

The identified eight gravel pits at the Overland Gravel Pit complex have a total usable storage volume of 3,992 acre-feet, slightly higher than the 3,875 acre-feet determined for Fort Collins’ need, and would use both above- and below-grade storage (1,995 acre-feet of below-grade storage and 1,997 acre-feet of above-grade storage). Because the gravel pits within the Overland Gravel Pit complex would be interconnected and operated as a single unit, the operations analyses describe their operations collectively.

The Winter Release Plan specifies that three cubic feet per second of water be released from the Gravel Pits to meet treated water demands between October and April. This release would be made into the Main Stem and would not alter flow on the North Fork.

4.3.5.2 Gravel Pits

Modeled operations of the Gravel Pits are presented in Section 6 of the Operations Report (Fort Collins 2019). Under the Gravel Pits Alternative, the mean end-of-month storage volume in the Gravel Pits during the simulated period is approximately 3,000 acre-feet for Future Conditions hydrology (Figure 4-25). There are several occurrences representing the historical droughts in the mid-1950s, 1977, and early 2000s when the end-of the month storage volume approaches zero, indicating an emptying of the Gravel Pits.
Figure 4-25. Total Overland Gravel Pits estimated end-of-month (EOM) storage volume in acre-feet (AF) under the Gravel Pits Alternative, Current and Future Conditions hydrology, irrigation years 1950 to 2005.

The maximum water surface area and water depth in each of the eight gravel pits within the proposed Overland Gravel Pit complex are provided in Table 4-13. The modeling presented in the Operations Report (Section 6) indicates the Gravel Pits water surface area would range between zero and 207 acres with an average near 140 acres under the Future Conditions hydrology.

Table 4-13. Maximum water surface areas in acres and water depths in feet of each individual gravel pit within the Overland Gravel Pit complex.

<table>
<thead>
<tr>
<th>Gravel Pit</th>
<th>Surface Area (acres)</th>
<th>Water Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stegner Farms</td>
<td>55</td>
<td>36</td>
</tr>
<tr>
<td>North Shore Reservoir 1</td>
<td>55</td>
<td>34</td>
</tr>
<tr>
<td>North Shore Reservoir 2</td>
<td>30</td>
<td>16</td>
</tr>
<tr>
<td>Under the N. Taft Hill Boundary- A</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>Home Office Mine-A Released</td>
<td>14</td>
<td>22</td>
</tr>
<tr>
<td>Home Office Mine-B Released</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Home Office Mine-A</td>
<td>9</td>
<td>22</td>
</tr>
<tr>
<td>Home Office Mine-B</td>
<td>31</td>
<td>12</td>
</tr>
</tbody>
</table>

Gravel pits within the Overland Gravel Pit complex would be interconnected, and, with the exception of the North Shore Reservoir 1 pit, gravity conveyance would be used to move water between individual pits. In general, the Overland Gravel Pit complex would be expected to operate in such a way as to maximize the elevation of stored water. In other words, individual gravel pits with the highest topographic elevation would be filled first and emptied last. Conversely, pits with the lowest elevation would be filled last and emptied first. This method would reduce overall pumping inputs, provide mixing, and reduce retention time in the gravel pits with smaller volumes to improve water quality. In addition,
the method maintains more storage in the larger, above-grade pits (Stegner Farms and North Shore Reservoir 1), which reduces evaporation losses.

The methods for calculating evaporation losses for the Gravel Pits Alternative are described in Section 7 of the Hydrologic Modeling Report (CDM Smith and DiNatale Water Consultants 2016). Because evaporation correlates with surface area, evaporative losses are higher in years when the Gravel Pits are full and lower in years when the Gravel Pits are drained down (Figure 4-26). Under the Gravel Pits Alternative with Future Conditions hydrology, the average annual storage volume of 3,000 acre-feet would incur a loss of about 350 acre-feet, or 12 percent of the average annual storage volume, annually to evaporation.

Figure 4-26. Overland Gravel Pits estimated annual evaporation in acre-feet per year (AFY) under the Gravel Pits Alternative, Current and Future Conditions hydrology, irrigation years 1950 to 2005.

4.3.5.3 River Segments

4.3.5.3.1 Diversions

Water conveyed to the off-channel Overland Gravel Pit complex would be diverted from the Main Stem at the existing Larimer County Canal Number 2 (Larimer Number 2) diversion structure and conveyed through the existing Larimer Number 2 canal to a new lateral structure located approximately 1.2 miles from the diversion structure. No upgrades to the Larimer Number 2 diversion structure or canal are proposed under this alternative. Based on preliminary engineering, sufficient capacity in the Larimer Number 2 is available to convey flows to the proposed lateral structure. Results of modeled diversions under the Gravel Pits Alternative are presented in a series of tables and figures in Section 6.2 of the Operations Report (Fort Collins 2019). The maximum monthly diversion to the Gravel Pits complex during the simulation period under Future Conditions hydrology is 1,200 acre feet per month from May
through July with diversions in April (1,000 acre feet per month) almost reaching the peak as well (Table 4-14). This equates to a mean monthly flow rate of 20 cubic feet per second, the maximum monthly average diversion rate simulated for the pipeline between the lateral structure on the Larimer Number 2 canal and the Stegner Farms pit. Diversions would occur from March through September. Diversions would most often be made in May, June, and July (53, 54, and 26 simulated years in the irrigation years 1950 to 2005, respectively). From October through January there would be no diversion to storage except in January, when a maximum monthly diversion of 720 acre-feet would occasionally be made (two out of 56 years).

Table 4-14. Estimated net diversions to the Overland Gravel Pits in acre-feet per month or acre-feet per year under the Gravel Pits Alternative, Current and Future Conditions hydrology, irrigation years 1950 to 2005.

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of Years with Diversions (out of 56)</th>
<th>Minimum (AFM; AFY for Annual)</th>
<th>Maximum (AFM; AFY for Annual)</th>
<th>Average (AFM; AFY for Annual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>November</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>December</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>January</td>
<td>2</td>
<td>0</td>
<td>720</td>
<td>26</td>
</tr>
<tr>
<td>February</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>March</td>
<td>2</td>
<td>0</td>
<td>44</td>
<td>1</td>
</tr>
<tr>
<td>April</td>
<td>3</td>
<td>0</td>
<td>1,000</td>
<td>23</td>
</tr>
<tr>
<td>May</td>
<td>53</td>
<td>0</td>
<td>1,200</td>
<td>750</td>
</tr>
<tr>
<td>June</td>
<td>54</td>
<td>0</td>
<td>1,200</td>
<td>740</td>
</tr>
<tr>
<td>July</td>
<td>26</td>
<td>0</td>
<td>1,200</td>
<td>77</td>
</tr>
<tr>
<td>August</td>
<td>4</td>
<td>0</td>
<td>160</td>
<td>9</td>
</tr>
<tr>
<td>September</td>
<td>5</td>
<td>0</td>
<td>160</td>
<td>12</td>
</tr>
<tr>
<td>October</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Annual</td>
<td>56</td>
<td>0</td>
<td>3,200</td>
<td>1,600</td>
</tr>
</tbody>
</table>

AFM = acre-feet per month; AFY = acre-feet per year

Sources diverted to the Overland Gravel Pit complex include Southside Ditch rights, Water Supply and Storage Company transbasin rights, and Grey Mountain and Halligan Reservoir enlargement conditional storage decrees. All sources of water stored in the Overland Gravel Pit complex would be diverted at the Larimer Number 2 diversion structure. The Larimer Number 2 diversion structure is also the point of diversion for the New Mercer ditch. Therefore, for storage in the Overland Gravel Pit complex, these two Southside Ditch sources would be diverted at their original diversion location and no exchange would be necessary. The Larimer Number 2 diversion structure is just upstream of the point of diversion for the Arthur Ditch, so Arthur rights would require an exchange, albeit over a short reach of river with no intervening diversions. The other water sources of the Overland Gravel Pit complex diversions (Water Supply and Storage Company transbasin and conditional storage right sources) are quantified upstream of the Larimer Number 2 diversion structure and would not require exchanges.

Under the Future Conditions simulation, a vast majority (94 percent) of diversions to the Overland Gravel Pit complex are from Southside Ditch water rights and six percent are from the Grey Mountain Conditional Storage Decree (Figure 4-27). No Water Supply and Storage Company transbasin water
rights are diverted to the Overland Gravel Pit complex. As with Fort Collins’ Proposed Action, the lack of
Water Supply and Storage Company diversions to storage is due to the priority assigned to the various
water sources available to fill the Overland Gravel Pit complex in the modeling. Although modeling does
not show diversion of Water Supply and Storage Company to the Overland Gravel Pit complex, Fort
Collins would still likely seek authorization to store Water Supply and Storage Company sources in the
Overland Gravel Pit complex.

![Figure 4-27. Estimated annual net diversions by source to the Overland Gravel Pits in acre-feet per
year (AFY) under the Gravel Pits Alternative, Future Conditions hydrology, irrigation years 1950
to 2005.](image)

4.3.5.3.2 Releases

Releases from the Overland Gravel Pit complex may occur in one of two ways: (1) by gravity to the Main
Stem for subsequent exchange from the release location upstream to Fort Collins’ intakes; or (2) by
piping directly to the Water Treatment Facility. Releases to the Poudre River would also be made to meet
downstream Return Flow Obligations.

Multiple release mechanisms are necessary because Fort Collins requires year-round access to water
stored in the Overland Gravel Pit complex. Analysis shows there are many periods in which Fort Collins
would be unable to exchange releases from the Overland Gravel Pit complex to the Fort Collins’ intakes
due to a lack of exchange potential. The Gravel Pits Alternative therefore proposes that when exchanges
of releases from the Overland Gravel Pit complex cannot be performed, releases would be piped directly
to the Water Treatment Facility. All releases from the Overland Gravel Pit complex piped directly to the
Water Treatment Facility would require pretreatment and pumping, while releases to the river would not
require pretreatment or pumping. Therefore, making releases to the river for subsequent exchange is the
preferred method for delivering water from the Overland Gravel Pit complex.
As common to all Project Alternatives, the Gravel Pits Alternative includes a winter release plan, which specifies a three cubic feet per second release of water from storage to meet treated water demands from October through April. With the exception of meeting winter releases, releases from the Overland Gravel Pit complex would be made only when other sources of water are unavailable to Fort Collins. In general, releases from the Overland Gravel Pit complex would occur: (1) to meet Fort Collins’ reusable water demand when there is a lack of other reusable water sources, or (2) in dry years or during emergency water supply disruptions to meet Fort Collins’ single-use and reusable water demands when other City water sources are unavailable.

A majority (63 percent for Future Conditions hydrology) of all net releases from the Overland Gravel Pit complex would be piped directly to the Water Treatment Facility. The percent of releases that must be pumped and piped to the Water Treatment Facility under the Gravel Pits Alternative is greater than that for the Expanded Glade Alternative due to the longer exchange reach and lower exchange potential available to exchange releases from the Overland Gravel Pit complex relative to the proposed Glade Reservoir. Under Future Conditions hydrology (Gravel Pits Alternative Run 4), releases to the Poudre River for subsequent exchange to the Fort Collins’ intakes constitute 37 percent of all net releases from the Overland Gravel Pit complex.

As with other Project Alternatives, the Gravel Pits Alternative could alter the proportion of flow in the Main Stem downstream of the confluence originating from the Poudre River and from the North Fork. Under the Future Conditions baseline the North Fork contribution to the Poudre River increases slightly from 47 percent in January to about 53 percent by March then peaks at about 78 percent in April. In May the contribution drops to 30 percent and further drops to 10 percent in June and a low of about five percent in July. The contribution of the North Fork to the Poudre River then generally increases to about 38 percent in December. Overall, the North Fork contributes about 31 percent to the Poudre River on an annual basis under the Future Conditions baseline (Figure 4-28). Under Future Conditions the amount of water originating from the North Fork in the Main Stem downstream of the confluence would generally increase slightly by one or two percent under the Gravel Pits Alternative except during February, May, June, July, and October, when it would be the same as the Future Conditions baseline.
4.3.5.3.3 North Fork Effects

The following discussion is a summary of the change in stream flow resulting from Fort Collins’ Proposed Action. Details of the modeling and various other data are presented in the Surface Water Resources Technical Report (CDM Smith 2017). The change to other flow characteristics such as very high and very low flows important to other resources (i.e., aquatic resources and sediment transport) are discussed in conjunction with the effects evaluation for each resource.

Stream flow changes due to the Gravel Pits Alternative were determined by comparing the Gravel Pits Alternative under Future Conditions (Run 4) against the Future Conditions Baseline (Run 2). As with Fort Collins’ Proposed Action, if the change in daily median flow remained within the 90 percent confidence interval the Corps determined that to be within the normal variability occurring in the river and not a meaningful change. Changes in median and monthly stream flows at key data delivery miles are summarized and box and whisker plots are provided where a meaningful change was detected. Additional tables and figures for stream flow effects of the Gravel Pits Alternative can be found in the Surface Water Resources Technical Report (CDM Smith 2017) with primary, secondary, and tertiary data delivery miles being located in Section 2.2, Appendix A, and Appendix B, respectively.

On the North Fork no meaningful changes were detected as a result of the Gravel Pits Alternative. Model results at all data delivery miles produced median daily flows that remained within the 90 percent confidence interval which is considered to be within the normal variability of the stream flow.
Under Future Conditions hydrology, NPIC operations changed slightly, and NPIC made fewer releases from Halligan Reservoir for diversion at the North Poudre Canal. As a result, stream flow decreased by an average of 1.7 percent (960 acre-feet per year) below Halligan Reservoir (primary data delivery mile NF2). Due to the corresponding reduction in diversions at the North Poudre Canal, modeling showed minimal effects on the North Fork from the North Poudre Canal to the confluence with the Main Stem. The changes in NPIC operations are indirect effects because they are not due to specific Gravel Pits Alternative operations.

Metrics for extreme flow conditions in the North Fork were summarized in the Aquatics Effects Technical Report (GEI 2019) for the segments used for the aquatic resource analysis rather than the data delivery miles discussed above. Flow in the North Fork would not change much from Future Conditions with this alternative as the activities would primarily be downstream of the North Fork and the winter release plan would not affect flows in the North Fork. However, in Segment 3 of the North Fork, effects with the Gravel Pits Alternative compared to Future Conditions would be different than both Fort Collins’ Proposed Action and the Expanded Glade Alternative (Table 4-15).

Table 4-15. Comparison of extreme flows and extreme daily flow fluctuations for Gravel Pits and Future Conditions Baseline on the North Fork. The 95 percent confidence intervals are in parentheses.

<table>
<thead>
<tr>
<th>Flow Metric</th>
<th>Future Conditions</th>
<th>Gravel Pits Alternative</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>North Fork Segment 3 - Seaman Reservoir Outlet to Confluence with Main Stem</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flows &lt;10 cubic feet per second (cfs)</td>
<td>Percent of years</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>45 (33-112)</td>
<td>54 (33-109)</td>
</tr>
<tr>
<td>Flows &lt; 5 cfs</td>
<td>Percent of years</td>
<td>70</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>11 (0-31)</td>
<td>11 (0-40)</td>
</tr>
<tr>
<td>Flows = 0 cfs</td>
<td>Percent of years</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
</tr>
<tr>
<td>50% Flow decrease</td>
<td>Percent of years</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>4 (3-5)</td>
<td>4 (3-5)</td>
</tr>
<tr>
<td>100% Flow increase</td>
<td>Percent of years</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>5 (4-6)</td>
<td>5 (4-7)</td>
</tr>
<tr>
<td>200% Flow increase</td>
<td>Percent of years</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>2 (1-2)</td>
<td>2 (1-2)</td>
</tr>
</tbody>
</table>

4.3.5.3.4  Upper Poudre and Main Stem Effects

No meaningful changes were detected on the Upper Poudre and Main Stem as a result of the Gravel Pits Alternative. Model results at all data delivery miles produced median daily flows that remained within the 90 percent confidence interval which is considered to be within the normal variability of the stream flow.

Modeling showed minimal change in stream flows on the Upper Poudre above the Munroe Canal (secondary data delivery mile 0.05). Stream flow results showed a reduction in stream flows below the
Munroe Canal and the Fort Collins Pipeline (primary data delivery mile 1.59) due to higher demands in the with-projects runs as well as diversions taken from the gravel pit complex by exchange. The reductions averaged 0.5 percent of stream flow (960 acre-feet per year) with the greatest reduction typically occurring in May, June, and July.

Fort Collins would divert into the gravel pit complex via Larimer Canal No. 2 and release via a turnout downstream. In the modeling, the turnout was located at the same location as the Arthur Ditch headgate, although the physical location would be about 1.5 miles further upstream. Diversions into the gravel pit complex below the Larimer Canal No. 2 headgate (primary data delivery mile 11.34) would cause additional stream flow depletions. However, Fort Collins would exchange converted agricultural rights from Larimer Canal No. 2, as well as the New Mercer Ditch also located here, which would cause a stream flow reduction to be greater above than below the headgate due to reduced agricultural diversions offsetting increased diversions at the Fort Collins intake. In the modeling, increased diversions into the gravel pits complex was the larger factor, and stream flow depletions at data delivery mile 11.34 increased to 1.6 percent of flow (2,340 acre-feet per year).

Below the river turnout and the Arthur Ditch headgate (secondary data delivery mile 13.63), stream flow depletions decreased again due to a combination of agricultural water exchanged from the Arthur Ditch and releases from the gravel pit complex at the river turnout. The reductions averaged 1.2 percent of stream flow (1,800 acre-feet per year).

Average stream flow reductions below the Mulberry discharge location (secondary data delivery mile 18.84) point were 1.6 percent of stream flow (1,500 acre-feet per year). This is a larger percent than upstream locations (e.g., below the Arthur Ditch) because baseline stream flows were lower here; the absolute value of stream flow reductions was lower.

Stream flow reductions lessened further in the reach between the Mulberry wastewater treatment facility and the Fossil Creek inlet due primarily to differences in return flow locations of converted agricultural rights. Stream flow reductions decreased below the Fossil Creek inlet due to changes in operations of Fossil Creek reservoir. Accordingly, flows at the Boxelder Gage (primary data delivery mile 22.69) decreased by 1.6 percent (960 acre-feet per year).

Effluent from Fort Collins’ Drake wastewater treatment facility discharges into Fossil Creek Reservoir, where it is ultimately released back to the Main Stem through the Fossil Creek outlet. Therefore, stream flow reductions decreased again below the Fossil Creek outlet (secondary data delivery mile 27.76) due to introduction of return flows to the river. At this location, there were minimal changes to stream flows.

Stream flow decreased by a greater amount in the reach from the Fossil Creek outlet through Greeley Gage. This additional reduction was due to changes in the location of return flows from converted agricultural rights. Greeley Gage (primary data delivery mile 57.43), the downstream end of the study area, is below all diversion, release, and exchange locations used for the Gravel Pits Alternative, so stream flows are not expected to noticeably change further downstream. At Greeley Gage, flows decreased by an average of 170 acre-feet per year, or 0.1 percent of stream flow. These reductions occurred year-round, but were still highest in May and June. Some months here also showed an increase in flow when Fort Collins released water from storage or when Fort Collins had more effluent than
needed to meet return flow obligations. Table 4-17 summarizes the average annual stream flows at the primary data delivery miles related to effects of the Gravel Pits Alternative.

Metrics for extreme flow conditions in the North Fork were summarized in the *Aquatics Effects Technical Report* (GEI 2019) for the segments used for the aquatic resource analysis rather than the data delivery miles discussed above. Comparison of the Gravel Pits Alternative to the Future Conditions Baseline suggests the Gravel Pits Alternative would have somewhat different effects than Fort Collins’ Proposed Action and the Expanded Glade Alternative in Segment D of the Main Stem due to exchanges and changes in return flows to the river (Table 4-16). In all other segments the Gravel Pits Alternative would have similar extreme flow metrics on the Main Stem as Fort Collins’ Proposed Action and the Expanded Glade Alternative.

**Table 4-16. Comparison of extreme flows and extreme daily flow fluctuations for Gravel Pits and Future Conditions Baseline in Segment D on the Main Stem. The 95 percent confidence intervals are in parentheses.**

<table>
<thead>
<tr>
<th>Flow Metric</th>
<th>Future Conditions</th>
<th>Gravel Pits Alternative</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>Value</td>
<td>Percent Change</td>
</tr>
<tr>
<td><strong>Segment D</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flows &lt;10 cubic feet per second (cfs)</td>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>83 (58-98)</td>
<td>84 (59-97)</td>
</tr>
<tr>
<td>Flows &lt; 5 cfs</td>
<td>Percent of years</td>
<td>100</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>42 (23-58)</td>
<td>42 (24-57)</td>
</tr>
<tr>
<td>Flows = 0 cfs</td>
<td>Percent of years</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
</tr>
<tr>
<td>50% Flow decrease</td>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>10 (8-11)</td>
<td>9 (8-10)</td>
</tr>
<tr>
<td>100% Flow increase</td>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>11 (10-12)</td>
<td>10 (10-11)</td>
</tr>
<tr>
<td>200% Flow increase</td>
<td>Percent of years</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Median days/year</td>
<td>5 (4-6)</td>
<td>4 (4-5)</td>
</tr>
</tbody>
</table>
Table 4-17. Annual average flows and effects at primary data delivery miles, for Gravel Pits Alternative as simulated with Future Conditions hydrology.

<table>
<thead>
<tr>
<th>Run</th>
<th>Parameter</th>
<th>Below Halligan Reservoir DDM NF2</th>
<th>Fort Collins’ Intake DDM 1.59</th>
<th>Canyon Gage DDM 5.63</th>
<th>US/DS Little Cache DDM 11.34</th>
<th>Lincoln St. Gage DDM 16.84</th>
<th>Boxelder Gage DDM 22.69</th>
<th>Greeley Gage DDM 57.43</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run 2</td>
<td>Annual average flows, acre-feet per year (AFY)</td>
<td>56,900</td>
<td>181,900</td>
<td>216,300</td>
<td>148,700</td>
<td>87,300</td>
<td>59,600</td>
<td>131,300</td>
</tr>
<tr>
<td>Run GP4</td>
<td>Annual average flows, AFY</td>
<td>55,900</td>
<td>180,000</td>
<td>215,300</td>
<td>146,400</td>
<td>85,600</td>
<td>58,600</td>
<td>131,100</td>
</tr>
<tr>
<td></td>
<td>Effects (Run GP4 minus Run 2)</td>
<td>AFY</td>
<td>-940</td>
<td>-960</td>
<td>-1,080</td>
<td>-2,330</td>
<td>-1,690</td>
<td>-970</td>
</tr>
<tr>
<td></td>
<td>Percent of Run 2</td>
<td>-1.7%</td>
<td>-0.5%</td>
<td>-0.5%</td>
<td>-1.6%</td>
<td>-1.9%</td>
<td>-1.6%</td>
<td>-0.1%</td>
</tr>
</tbody>
</table>

Source: CDM Smith 2018a
4.3.6 Agricultural Reservoirs Alternative

4.3.6.1 Operation Overview

Under the Agricultural Reservoirs Alternative Fort Collins would acquire a portion of the active capacity in NPIC Reservoirs Number 5 and 6 from NPIC. NPIC Reservoirs Number 5 and 6 are interconnected reservoirs that can be operated as a single unit. No changes to the dam height or configuration or to the reservoir depth or footprint for NPIC Reservoirs Number 5 and 6 are proposed under this alternative.

NPIC Reservoirs Number 5 and 6 have a combined capacity of 16,392 acre-feet. Under the Agricultural Reservoirs Alternative, Fort Collins would obtain 6,475 acre-feet of storage in the reservoirs and NPIC would retain 9,917 acre-feet. Data displayed below distinguish between operations that pertain only to Fort Collins’ portion of NPIC Reservoirs Number 5 and 6 (the 6,475 acre-feet acquired by Fort Collins) and operations pertinent to the reservoirs as a whole (the 6,475 acre-feet acquired by Fort Collins plus the 9,917 acre-feet retained by NPIC). Unless otherwise noted, “Fort Collins’ portion of NPIC Reservoirs Number 5 and 6” refers to the 6,475 acre-feet volume and “total NPIC Reservoirs Number 5 and 6” refers to the entire 16,392 acre-feet reservoir. Capacity information for the total NPIC Reservoirs Number 5 and 6 assumes no dead storage pool, which is the volume of water filling the area below the elevation of the reservoir outlets that cannot be released or used.

The Winter Release Plan specifies that three cubic feet per second of water be released from the Agricultural Reservoirs to meet treated water demands between October and April. This release would be made into the Main Stem and would not alter the flow on the North Fork.

4.3.6.2 Agricultural Reservoirs

Modeled operations of the Agricultural Reservoirs Alternative are presented in Section 7 of the Operations Report (Fort Collins 2019). The Common Technical Platform baseline modeling for the Agricultural Reservoirs Alternative indicates a simulated capacity of NPIC Reservoirs Number 5 and 6 is approximately 13,000 acre-feet for Future Conditions hydrology. The minimum end-of-month storage volume of Fort Collins’ portion of NPIC Reservoirs Number 5 and 6 during any month in the simulated period is 2,500 acre-feet for Future Conditions hydrology (Agricultural Reservoirs Alternative Run 4). The minimum end-of-month storage in the total NPIC Reservoirs Number 5 and 6 is 6,700 acre-feet for Future Conditions hydrology (Figure 4-29). Under Future Conditions the total NPIC Reservoirs Number 5 and 6 would have a maximum, minimum, and mean end-of-month storage volume of 16,392, 6,600, and 13,500 acre-feet, respectively.

Water surface areas were estimated using simulated end-of-month storage volumes and interpolation of the surface area to storage volume curve provided in Section 7.1.1 of the Operations Report (Fort Collins 2019). The mean end-of-month water surface area is approximately 850 acres under Future Conditions hydrology. The maximum surface area would remain the same as baseline conditions at 957 acres while the minimum and mean surface areas would increase by 100 acres and 30 acres, respectively. The maximum gage depth in NPIC Reservoirs Number 5 and 6 at full capacity is 32.1 feet.
depth would remain the same as baseline conditions; however, the minimum water depth and mean water depth would increase slightly by two feet and one foot, respectively.

![Figure 4-29. End-of-month storage volume in acre-feet (AF) for the total NPIC Reservoirs Number 5 and 6 under the Agricultural Reservoirs Alternative and Current Conditions, Future Conditions hydrology, irrigation years 1950 to 2005.](image)

The changes in depth from month-to-month in NPIC Reservoirs Number 5 and 6, and particularly drawdown rates, may have implications for recreation and environmental resources at the reservoirs. The water surface elevation of NPIC Reservoirs Number 5 and 6 would have a maximum depth increase of approximately nine feet per month versus 12 feet per month under the Future Conditions simulation compared to the Future Conditions Baseline (Figure 4-30. The maximum decrease for the Alternatives Reservoir Alternative would be three feet per month versus four feet per month compared to Future Conditions Baseline.
The methods for calculating evaporation losses for the Agricultural Reservoirs Alternative are described in Section 7 of the *Hydrologic Model Report* (CDM Smith and DiNatale Water Consultants 2016). Because evaporation correlates with surface area, evaporative losses are higher in years when NPIC Reservoirs 5 and 6 are full and lower in years when the reservoirs are drained down (Figure 4-31). Under the Agricultural Reservoirs Alternative with Future Conditions hydrology, the average annual storage volume of 5,600 acre-feet would lose about 950 acre-feet, or 17 percent of the average annual storage volume, annually to evaporation. Total annual evaporation for Fort Collins’ portion of the reservoirs is larger than that observed for other Project Alternatives. Higher evaporative losses are due, in part, to the relatively lower elevation of NPIC Reservoirs Number 5 and 6 and their configuration as relatively large, shallow reservoirs compared to the storage facilities associated with other Project Alternatives.
4.3.6.3 River Segments

4.3.6.3.1 Diversions

Under the Agricultural Reservoirs Alternative, diversions to both NPIC’s portion and Fort Collins’ portion of NPIC Reservoirs Number 5 and 6 would be diverted from the Upper Poudre River at the Munroe Canal diversion structure. However, the method by which each entity would deliver water to NPIC Reservoirs Number 5 and 6 differs.

Diversions to Fort Collins’ portion of NPIC Reservoirs Number 5 and 6 under the Agricultural Reservoirs Alternative are limited by the physical capacity of the Pleasant Valley Pipeline and the bi-directional pipeline. All model simulations of the Agricultural Reservoirs Alternative impose a maximum monthly diversion rate of 21 cubic feet per second to the reservoirs. The bi-directional pipeline is designed for a maximum instantaneous flow rate of 42 cubic feet per second. Furthermore, no diversions to Fort Collins’ portion of NPIC Reservoirs Number 5 and 6 are made from November through March because the Pleasant Valley Pipeline used to make such diversions is used by Greeley during winter to deliver water from Horsetooth Reservoir to Greeley’s Bellevue Water Treatment Facility and is otherwise unavailable to Fort Collins.

Results of modeled diversions under the Agricultural Reservoirs Alternative are presented in a series of tables and figures in Section 7.2 of the Operations Report (Fort Collins 2019). The maximum monthly
diversion to Fort Collins’ portion of NPIC Reservoirs Number 5 and 6 under the Agricultural Reservoirs Alternative is zero acre-feet per month from October through March, increases to a peak of 1,300 acre-feet per month in May and June, and then decreases to 160 acre-feet per month in September for Future Conditions hydrology (Table 4-18). The peak of 1,300 acre-feet per month equates to a mean monthly flow rate of 21 cubic feet per second. Diversions under Future Conditions hydrology would occur March through September with diversions most often made in May, June, and July (56, 56, and 55 years out of 56 simulated years in the irrigation years 1950 to 2005 Future Conditions hydrology, respectively).

Table 4-18. Estimated net diversions to Fort Collins’ portion of NPIC Reservoirs Number 5 and 6 in acre-feet per month or acre-feet per year under the Agricultural Reservoirs Alternative, Future Conditions hydrology, irrigation years 1950 to 2005.

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of Years with Diversions (out of 56)</th>
<th>Minimum (AFM; AFY for Annual)</th>
<th>Maximum (AFM; AFY for Annual)</th>
<th>Average (AFM; AFY for Annual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>November</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>December</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>January</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>February</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>March</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>April</td>
<td>3</td>
<td>0</td>
<td>1,100</td>
<td>57</td>
</tr>
<tr>
<td>May</td>
<td>56</td>
<td>190</td>
<td>1,300</td>
<td>1,100</td>
</tr>
<tr>
<td>June</td>
<td>56</td>
<td>140</td>
<td>1,300</td>
<td>760</td>
</tr>
<tr>
<td>July</td>
<td>55</td>
<td>0</td>
<td>740</td>
<td>220</td>
</tr>
<tr>
<td>August</td>
<td>38</td>
<td>0</td>
<td>220</td>
<td>130</td>
</tr>
<tr>
<td>September</td>
<td>22</td>
<td>0</td>
<td>160</td>
<td>36</td>
</tr>
<tr>
<td>October</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Annual</td>
<td>56</td>
<td>900</td>
<td>3,400</td>
<td>2,300</td>
</tr>
</tbody>
</table>

AFM = acre-feet per month; AFY = acre-feet per year

Sources of water used in NPIC Reservoirs Number 5 and 6 under this alternative include Southside Ditch rights, Water Supply and Storage Company transbasin rights, and Grey Mountain and Halligan Reservoir enlargement conditional storage decrees. Southside Ditch water would be exchanged from its original diversion locations to the Munroe Canal diversion structure when exchange potential between the two points allows. As modeled, diversions of the Halligan Reservoir enlargement conditional decree are quantified on the North Fork at Halligan Reservoir but are diverted in priority at the Munroe Canal diversion structure. Similarly, the Grey Mountain conditional decree would be quantified at the Poudre Valley Canal diversion but diverted at the Munroe Canal. Under the Future Conditions simulation, a vast majority (97 percent) of diversions to Fort Collins’ portion of NPIC Reservoirs Number 5 and 6 are from Southside Ditch water rights rather than from the other listed water rights, three percent are from the Grey Mountain Conditional Storage Decree, and less than one percent of total net diversions are sourced from Water Supply and Storage Company rights (Figure 4-32). As with Fort Collins’ Proposed Action, the lack of Water Supply and Storage Company diversions to storage is because of the priority assigned in the
modeling to the various water sources available to fill Fort Collins’ portion of NPIC Reservoirs Number 5 and 6, but does not indicate an intention to forego use of Water Supply and Storage Company water under the alternative.

![Figure 4-32. Estimated annual net diversions by source to Fort Collins’ portion of NPIC Reservoirs Number 5 and 6 in acre-feet per year (AFY) under the Agricultural Reservoirs Alternative, Future Conditions hydrology, irrigation years 1950 to 2005.](image)

4.3.6.3.2 Releases

Releases from NPIC Reservoirs Number 5 and 6 for NPIC are made through the outlet works at Reservoir Number 6, and delivered to ditches and laterals downgradient of the reservoirs. Many of NPIC’s releases from NPIC Reservoirs Number 5 and 6 are provided to the Water Supply and Storage Company irrigation system to fulfill a long-standing exchange of water between the ditch companies (CDM Smith and DiNatale Water Consultants 2013). The Agricultural Reservoirs Alternative would not change the method by which NPIC would make releases from its retained portion of NPIC Reservoirs Number 5 and 6.

Releases from NPIC Reservoirs Number 5 and 6 for Fort Collins under the Agricultural Reservoirs Alternative would occur in one of two ways: (1) by gravity to the Poudre River for subsequent exchange from the release location upstream to Fort Collins’ intakes; or (2) by piping directly to the Water Treatment Facility.

Multiple release mechanisms are necessary because Fort Collins requires year-round access to water stored in its portion of NPIC Reservoirs Number 5 and 6. Analysis shows that Fort Collins would often be unable to use river exchanges to deliver water from Reservoirs Number 5 and 6 to its Water Treatment Facility because of a lack of exchange potential between the point of release and Fort Collins’ intakes. Releases piped to the Water Treatment Facility would be pre-treated and pumped, while releases to the
river would not require pretreatment or pumping. Consequently, the Agricultural Reservoirs Alternative proposes that making releases to the river for subsequent exchange is the preferred method for delivering water from the reservoirs, but when exchanges of releases cannot be performed, releases would be piped directly to the Water Treatment Facility.

As with all Project Alternatives, the Agricultural Reservoirs Alternative includes a winter release plan, which specifies that three cubic feet per second of water be released from storage to meet treated water demands from October through April. With the exception of meeting winter releases, releases from Fort Collins’ portion of NPIC Reservoirs Number 5 and 6 would be made only when other sources of water are unavailable to Fort Collins. In general, releases from Fort Collins’ portion of NPIC Reservoirs Nos. 5 & 6 would occur: (1) to meet Fort Collins’ reusable water demand when there is a lack of other reusable water sources, or (2) in dry years or during emergency water supply disruptions to meet Fort Collins’ single-use and reusable water demands when other City water sources are unavailable.

A majority of releases from Fort Collins’ portion of NPIC Reservoirs Number 5 and 6 (65 percent for Future Conditions hydrology) would be piped directly to the Water Treatment Facility. Releases to the Poudre River for subsequent exchange to Fort Collins’ intakes make up 35 percent of all net releases under Future Conditions hydrology.

As with the other Project Alternatives, the Agricultural Reservoirs Alternative could alter the proportion of flow in the Main Stem downstream of the confluence originating from the Poudre River and from the North Fork. Under the Future Conditions baseline the North Fork contribution to the Poudre River increases slightly from 47 percent in January to about 53 percent by March then peaks at about 78 percent in April. In May the contribution drops to 30 percent and further drops to 10 percent in June and a low of about five percent in July. The contribution of the North Fork to the Poudre River then generally increases to about 38 percent in December. Overall, the North Fork contributes about 31 percent to the Poudre River on an annual basis under the Future Conditions baseline (Figure 4-33). Under Future Conditions the amount of water originating from the North Fork in the Main Stem downstream of the confluence would generally increase slightly by one or two percent under the Agricultural Reservoir Alternative except during January, February, and July when it would be the same as the Future Conditions baseline.
4.3.6.3.3 North Fork Effects

The following discussion is a summary of the change in stream flow resulting from Fort Collins’ Proposed Action. Details of the modeling and various other data are presented in the Surface Water Resources Technical Report (CDM Smith 2017). The change to other flow characteristics such as very high and very low flows important to other resources (i.e., aquatic resources and sediment transport) are discussed in conjunction with the effects evaluation for each resource.

Stream flow changes due to the Agricultural Reservoirs Alternative were determined by comparing the Agricultural Reservoirs Alternative under Future Conditions (Run 4) against the Future Conditions Baseline (Run 2). As with Fort Collins’ Proposed Action, if the change in daily median flow remained within the 90 percent confidence interval the Corps determined that to be within the normal variability occurring in the river and not a meaningful change. Changes in median and monthly stream flows at data delivery miles are summarized and box and whisker plots are provided where a meaningful change was detected. Additional tables and figures for stream flow effects of the Agricultural Reservoirs Alternative can be found in the Surface Water Resources Technical Report (CDM Smith 2017) with primary, secondary, and tertiary data delivery miles being located in Section 2.2, Appendix A, and Appendix B, respectively.

On the North Fork no meaningful changes were detected as a result of the Agricultural Reservoirs Alternative. Model results at all data delivery miles produced median daily flows that remained within the 90 percent confidence interval which is considered to be within the normal variability of stream flow.
Under Future Conditions hydrology, NPIC operations changed slightly, and NPIC made fewer releases from Halligan Reservoir for diversion at the North Poudre Canal. As a result, stream flow decreased by an average of 1.6 percent (940 acre-feet per year) below Halligan Reservoir (primary data delivery mile NF2). Due to the corresponding reduction in diversions at the North Poudre Canal, modeling showed minimal effects on the North Fork from the North Poudre Canal to the confluence with the Main Stem. The changes in NPIC operations are indirect effects because they are not due to specific Agricultural Reservoirs Alternative operations.

Metrics for extreme flow conditions in the North Fork were summarized in the *Aquatics Effects Technical Report* (GEI 2019) for the segments used for the aquatic resource analysis rather than the data delivery miles discussed above. Extreme flow metrics in the North Fork would not change much from Future Conditions under this alternative as the activities with this alternative would mostly be downstream of the North Fork and the winter release plan would not affect flows in the North Fork.

### 4.3.6.3.4 Upper Poudre and Main Stem Effects

No meaningful overall changes were detected on the Upper Poudre and Main Stem as a result of the Agricultural Reservoirs Alternative. Model results at all data delivery miles produced median daily flows that remained within the 90 percent confidence interval which is considered to be within normal variability of the stream flow.

Modeling showed minimal changes in stream flows on the Upper Poudre above the Munroe Canal (secondary data delivery mile 0.05). Stream flow results showed a reduction in stream flows below the Munroe Canal and the Fort Collins Pipeline (primary data delivery mile 1.59) due to higher demands in the with-projects runs, diversions into the agricultural reservoirs via the Munroe Canal, and diversions taken from the agricultural reservoirs by exchange to the Fort Collins intake. The reductions averaged 1.5 percent of stream flow (2,800 acre-feet per year) with the greatest reductions typically occurring in May, June, and July.

Stream flow decreased again below the Larimer County Canal (owned by the Water Supply and Storage Company; secondary data delivery mile 8.02) and below the New Mercer Ditch and Larimer Canal Number 2 headgates (primary data delivery mile 11.34) due to increased exchange of agricultural rights by Fort Collins. Reductions in stream flows at data delivery mile 11.34 averaged 1.7 percent (2,540 acre-feet per year).

Releases from the agricultural reservoirs would enter the river via a turnout located above the Arthur Ditch. (In the modeling, the turnout was located at the same location as the Arthur Ditch, although the physical location would be about 1.5 miles further upstream.) Therefore, reductions in stream flows were lessened below the Arthur Ditch headgate (secondary data delivery mile 13.63) due to the addition of reservoir releases to the river. Stream flow reductions at this data delivery mile averaged 1.4 percent of total annual flow (2,000 acre-feet per year).

Stream flow reductions lessened again below the Mulberry discharge location (secondary data delivery mile 18.84). Average reduction in stream flows below this point were 1.8 percent of total annual stream flow (1,600 acre-feet per year). This is a larger percent than upstream locations (e.g., below the Arthur
Ditch) because baseline stream flows were lower here; the absolute value of reductions in stream flows were lower.

Stream flow reductions were lessened below the Fossil Creek inlet due to changes in operations of Fossil Creek Reservoir. Accordingly, flows at the Boxelder Gage (primary data delivery mile 22.69) decreased by 2.3 percent of total annual stream flow (1,370 acre-feet per year).

Effluent from Fort Collins’ Drake wastewater treatment facility discharges into Fossil Creek Reservoir, where it is ultimately released back to the Main Stem through the Fossil Creek outlet. Therefore, stream flow reductions decreased again below the Fossil Creek outlet (secondary data delivery mile 27.76) and were identical to the total annual stream flow due to introduction of return flows to the river.

Stream flow decreased by a greater amount in the reach from Fossil Creek outlet through Greeley Gage due to changes in the location of return flows from converted agricultural rights. Greeley Gage (primary data delivery mile 57.43), the downstream end of the study area, is below all diversion, release, and exchange locations used for the Agricultural Reservoirs Alternative, and stream flow is not expected to noticeably change further downstream. At the Greeley Gage, flows decreased by an average of 400 acre-feet per year, or 0.3 percent of annual stream flows. These reductions occurred year-round, but were highest in May and June. Some months also showed an increase in flow, when Fort Collins released water from storage or when Fort Collins had more effluent than needed to meet return flow obligations.

Table 4-19 summarizes the average annual stream flows at the primary data delivery miles related to effects of the Agricultural Reservoirs Alternative. The Agricultural Reservoirs Alternative would have very similar effects on extreme flows in much of the Main Stem as Fort Collins’ Proposed Action, the Expanded Glade Alternative, and the Gravel Pits Alternative.

### 4.3.7 No-Action Alternative

Stream flow changes due to the No-Action Alternative were determined by comparing Fort Collins’ Proposed Alternative Run 4 (Future Conditions with the Proposed Alternative) with Run 2 (Future Conditions Baseline). Additional tables and figures for stream flow effects of the No-Action Alternative can be found in the *Surface Water Resources Addendum* (CDM Smith 2018a) with primary, secondary, and tertiary data delivery miles being located in Section 2.2, Appendix A, and Appendix B, respectively.

Reoperation of Joe Wright Reservoir would reduce stream flows in the reach from Joe Wright Reservoir to Halligan Reservoir in August and September in years when Fort Collins reduced the amount of water swapped for NPIC’s C-BT water. The additional reliance on C-BT water would result in Fort Collins using a greater portion of allocated C-BT water in each year. Because Fort Collins would divert this transbasin, single-use water directly from Horsetooth Reservoir, use of this water would not affect the Poudre River until entering the river as return flows. Therefore, increased reliance on C-BT supplies would result in an increase in flows below the two wastewater treatment facilities and continuing downstream.
Table 4-19. Annual average flows and effects at primary data delivery miles, for Agricultural Reservoirs Alternative as simulated with Future Conditions hydrology.

<table>
<thead>
<tr>
<th>Run</th>
<th>Parameter</th>
<th>Below Halligan Reservoir DDM</th>
<th>Fort Collins’ Intake DDM</th>
<th>Canyon Gage DDM</th>
<th>US/DS Little Cache DDM</th>
<th>Lincoln St. Gage DDM</th>
<th>Boxelder Gage DDM</th>
<th>Greeley Gage DDM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Below Halligan Reservoir</td>
<td>Fort Collins’ Intake</td>
<td>Canyon Gage</td>
<td>US/DS Little Cache</td>
<td>Lincoln St. Gage</td>
<td>Boxelder Gage</td>
<td>Greeley Gage</td>
</tr>
<tr>
<td>Run 2</td>
<td>Annual average flows, acre-feet per year (AFY)</td>
<td>56,900</td>
<td>181,800</td>
<td>216,300</td>
<td>148,700</td>
<td>87,300</td>
<td>59,600</td>
<td>131,300</td>
</tr>
<tr>
<td>Run AR4</td>
<td>Annual average flows, AFY</td>
<td>56,000</td>
<td>179,100</td>
<td>213,500</td>
<td>146,200</td>
<td>85,400</td>
<td>58,200</td>
<td>130,900</td>
</tr>
<tr>
<td></td>
<td>Effects (Run AR4 minus Run 2)</td>
<td>AFY</td>
<td>-930</td>
<td>-2,780</td>
<td>-2,820</td>
<td>-2,520</td>
<td>-1,910</td>
<td>-1,370</td>
</tr>
<tr>
<td></td>
<td>Percent of Run 2</td>
<td>AFY</td>
<td>-1.6%</td>
<td>-1.5%</td>
<td>-1.3%</td>
<td>-1.7%</td>
<td>-2.2%</td>
<td>-2.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Percent of Run 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: CDM Smith
Modeled water use restrictions mimicked Fort Collins’ actual water restriction policy (Fort Collins 2012) based on the amount of water in storage and projected supply availability. However, modeling suggested that use restrictions were never necessary in No-Action Alternative Run 4. Therefore, water use restrictions had no effect on stream flows under the No-Action Alternative. Modeling of firm yield conditions did show water use restrictions; however, the purpose of the firm yield modeling was to size Project Alternatives and determine Fort Collins’ purpose and need, not to evaluate stream flow effects (CDM Smith Inc. and DiNatale Water Consultants 2016).

As with the other Project Alternatives, the No-Action Alternative modeling also showed indirect effects due to operational changes by other basin water users or in other areas of Fort Collins’ water supply system. Unlike the action alternatives modeling, Fort Collins owned fewer Southside Ditch shares in No-Action Alternative Run 4 (Future Conditions with the Alternative) than in Run 2 (Future Conditions Baseline), resulting in reduced exchanges and reduced return flow obligations.

### 4.3.7.1 Operation Overview

There are three components to the No-Action Alternative:

1. Reoperation of Joe Wright Reservoir to maintain higher winter carryover storage by reducing single-use water exchanges with NPIC
2. Acquisition through direct purchase and/or development dedication requirements of shares in NPIC, specifically for the Colorado-Big Thompson (C-BT) storage shares component, which again would result in more storage capacity
3. Mandatory water restrictions during periods of drought and system failures to account for the fact the No-Action Alternative will not satisfy Fort Collins’ purpose and need

Under the No-Action Alternative, Fort Collins’ Joe Wright Reservoir would be reoperated to target a November 1 storage volume of 3,200 acre-feet. The targeted winter carryover volume would not require modifications to Joe Wright Reservoir’s outlet works, nor would it require any new infrastructure. To maintain this target water level, Fort Collins would reduce the C-BT swap, which, as defined above, is an operation by which Fort Collins releases single-use water from Joe Wright Reservoir for subsequent exchange with NPIC.

Modeling presented in Section 8.1.1 of the *Operations Report* (Fort Collins 2019) provided the mean, maximum, and minimum end-of-month storage volume in Joe Wright Reservoir under the No-Action Alternative (4,100 acre feet, 6,474 acre-feet, and one acre-foot, respectively) and the Future Conditions baseline (3,800 acre-feet, 6,474 acre-feet, and 1,500 acre-feet, respectively). Reoperation of Joe Wright Reservoir under the No-Action Alternative increases the volume of water held in storage, particularly through the winter months. The mean end-of-month storage volume of Joe Wright Reservoir increases by about 300 acre-feet from the baseline (Run 2; Future Conditions Baseline) to the No-Action Alternative (Run 4; No-Action Alternative under Future Conditions), while the minimum end-of-month volume increases by 1,499 acre-feet.

Reoperation of Joe Wright Reservoir would reduce the C-BT swap conducted with NPIC to maintain a higher November 1 storage level in the reservoir. Table 4-20 provides simulated C-BT swap releases from Joe Wright Reservoir under both the No-Action Alternative and the Future Conditions baseline. In
addition to C-BT swap releases, water from Joe Wright Reservoir would be released for other purposes, including the Joint Operations Plan, the Reuse Plan, and directly meeting other City treated water demands. These other releases increase under the No-Action Alternative from the baseline, which is likely a consequence of Joe Wright Reservoir being used to meet a higher level of demand under the No-Action Alternative (Run 4; No-Action Alternative under Future Conditions) than that modeled in the Future Conditions baseline (Run 2).

Table 4-20. Total releases by release purpose from Joe Wright Reservoir in acre-feet per year under the No-Action Alternative and Current Conditions, Future Conditions hydrology, irrigation years 1950 to 2005.

<table>
<thead>
<tr>
<th>Purpose of Release</th>
<th>Mean Annual Release from Joe Wright Reservoir (acre-feet per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Future Conditions Baseline</td>
</tr>
<tr>
<td>Joint Operations Plan</td>
<td>940</td>
</tr>
<tr>
<td>Reuse Plan transfers</td>
<td>1,800</td>
</tr>
<tr>
<td>Direct use</td>
<td>27</td>
</tr>
<tr>
<td>Return flow obligations</td>
<td>0</td>
</tr>
<tr>
<td>C-BT swap</td>
<td>1,500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,200</strong></td>
</tr>
</tbody>
</table>

Reoperation of Joe Wright Reservoir under the No-Action Alternative would reduce releases for the C-BT swap by approximately 320 acre-feet per year on a mean annual basis for the irrigation years 1950 to 2005 period of simulation. While reoperation increases winter storage in Joe Wright Reservoir for Fort Collins, it may also cause a reduction in NPIC water deliveries because NPIC has historically relied on the C-BT swap to deliver water to its Munroe Canal diversion structure in the late summer and early fall and accounts for the C-BT swap when setting irrigation allocations in the spring. Reoperating the C-BT swap will create conditions in which the C-BT swap would be operated less frequently, which will likely reduce NPIC allocations.

Under the No-Action Alternative, Fort Collins would acquire more shares of NPIC, which would result in Fort Collins using approximately 13 percent more C-BT water than the baseline simulation and nine percent more than under the Proposed Action. Additional use of C-BT under the No-Action Alternative is required because no new storage is available and Fort Collins would acquire additional C-BT supplies under the No-Action Alternative.

The No-Action Alternative also considers mandatory water use restrictions for Fort Collins’ treated water customers. Mandatory water use restrictions would not provide new storage, but would stretch available supplies during a drought or other interruption in water supply. Water restrictions would be applied when the projected water supply is less than the projected demand and would be implemented according to Fort Collins’ Water Supply Shortage Response Plan (Fort Collins 2014).

In brief, the Water Supply Shortage Response Plan defines four levels of water supply shortage and outlines response measures to each shortage level. Response measures primarily relate to outdoor water use, and range from limiting the days and hours landscape watering is allowed to restricting vehicle washing and hydrant testing. The intent of mandatory water restrictions is to reduce demands to match
available supplies. Table 4-21 provides information on restriction levels, restriction triggers, and the intended demand reduction as specified by the Water Supply Shortage Response Plan.

Table 4-21. Water Supply Shortage Response Plan restriction levels, triggers, and demand reductions for the No-Action Alternative

<table>
<thead>
<tr>
<th>Water Supply Shortage Response Plan, Restriction Level</th>
<th>Restriction Trigger</th>
<th>Intended 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>Greater than 30% water supply shortage</td>
<td>35</td>
</tr>
</tbody>
</table>

For the No-Action Alternative, mandatory water restrictions are determined following implementation of other No-Action Alternative operations (i.e., Joe Wright Reservoir reoperation and acquisition of additional NPIC shares). Water restrictions are determined on May 1 of each year using the water supply information available at that time, along with projections of water supplies and demands for the months to come. When restrictions are determined to be needed, No-Action Alternative modeling assumes restrictions would be in effect from May 1 through October 31. Additional detail on the methods by which water restrictions are predicted and simulated for the No-Action Alternative is contained in the Hydrologic Modeling Report (CDM Smith and DiNatale Water Consultants 2016).

Modeling presented in the Operations Report (Fort Collins 2019) predicts mandatory water restrictions necessary for four out of the 56 years during the irrigation years 1950 to 2005 simulation period, all of which are Level 1 restrictions. Consequently, under the No-Action Alternative, restrictions would be needed seven percent of the years represented in the simulation period. Level 1 restrictions mandate a reduction of outdoor watering to two days per week. The need for Level 3 restrictions allot only two hours of landscape irrigation one day per week, along with severe restrictions to most other forms of outdoor water use. Even with Level 3 restrictions in place, the storage reserve factor is not met during the design drought in the No-Action Alternative modeling. The storage reserve factor during the 1-in-50 year drought with Level 3 restrictions is only 90 percent of the amount required. Without the implementation of water restrictions during the design drought, the safety factor would be 32 percent of the amount required. As a result, Fort Collins would not meet the criteria in the Fort Collins’ Water Supply and Demand Management Policy for the future.

4.3.7.2 River Segments

Stream flow changes due to the No-Action Alternative were determined by comparing Fort Collins’ Proposed Action Run 4 with Run 2 (Future Conditions). Additional tables and figures for stream flow effects of the No-Action Alternative can be found in the Surface Water Resources Addendum (CDM Smith 2018a) with primary, secondary, and tertiary data delivery miles being located in Section 2.2, Appendix A, and Appendix B, respectively.

Reoperation of Joe Wright Reservoir would reduce stream flows in the Upper Poudre downstream of Joe Wright Reservoir in August and September in years when Fort Collins reduced the amount of water
swapped for NPIC’s C-BT water. The additional reliance on C-BT water would result in Fort Collins using a greater portion of allocated C-BT water in each year. Because Fort Collins would divert this transbasin, single-use water directly from Horsetooth Reservoir, use of this water would not affect the Poudre River until entering the river as return flows. Therefore, increased reliance on C-BT supplies would result in an increase in flows below the two wastewater treatment facilities and continuing downstream.

Modeled water use restrictions mimicked Fort Collins’ actual water restriction policy (Fort Collins 2012) based on the amount of water in storage and projected supply availability. However, modeling suggested that use restrictions were never necessary in No-Action Alternative Run 4. Therefore, water use restrictions had no effect on stream flows under the No-Action Alternative. Modeling of firm yield conditions did show water use restrictions; however, the purpose of the firm yield modeling was to size Project Alternatives and determine Fort Collins’ purpose and need, not to evaluate stream flow effects (CDM Smith Inc. and DiNatale Water Consultants 2016).

As with the other Project Alternatives, the No-Action Alternative modeling also showed indirect effects due to operational changes by other basin water users or in other areas of Fort Collins’ water supply system. Unlike the action alternatives modeling, Fort Collins owned fewer Southside Ditch shares in No-Action Alternative Run 4 than in Run 2, resulting in reduced exchanges and reduced return flow obligations.

4.3.7.2.1 North Fork Effects

Beginning at the upstream end of the model reach, modeling of the No-Action Alternative showed minimal changes to stream flows on the North Fork above Halligan Reservoir. However, similar to the Gravel Pits Alternative and the Agricultural Reservoirs Alternative, NPIC operations changed slightly, and NPIC made fewer releases from Halligan Reservoir for diversion at the North Poudre Canal. As a result, stream flow decreased by an average of 1.6 percent (940 acre-feet per year) below Halligan Reservoir (primary data delivery mile NF2). Due to the corresponding reduction in diversions at the North Poudre Canal, modeling showed minimal changes to stream flows on the North Fork from the North Poudre Canal to the confluence with the Main Stem. The changes in NPIC operations are indirect effects because they are not due to specific No-Action Alternative operations.

4.3.7.2.2 Upper Poudre and Main Stem Effects

On the Upper Poudre above the Munroe Canal (secondary data delivery mile 0.05), reductions occurred in years when the Joe Wright swap was reduced. In addition, the modeling showed indirect effects due to changes in operations of other upstream reservoirs. At data delivery mile 0.05, stream flow reductions averaged 0.1 percent (160 acre-feet per year). Decreases typically occurred in August and September, but increases or decreases occurred throughout the year. In particular, stream flow increased on average in July and October.

Stream flow decreased further below the Munroe Canal and the Fort Collins original intake (primary data delivery mile 1.59) due to the increase in demand in the No-Action Alternative model run. Reductions here were 0.2 percent of stream flow (350 acre-feet per year) and occurred year-round, but were typically
highest in May and June. The median monthly flow for all irrigation years (1950-2005) decreased by one percent in May (or 6.4 cubic feet per second) and was unchanged in June (with a reduction of 6.4 cubic feet per second). Changes in stream flows were similar at Canyon Gage (primary data delivery mile 5.63), with decreases averaging 0.2 percent (340 acre-feet per year) and one percent gains and reductions in the median monthly flow throughout the year.

Continuing downstream, stream flow decreased further between the Canyon Gage and the Larimer County Canal due to reduced return flows from the reduced diversions at the North Poudre Canal. Stream flow decreases remained essentially constant through Fort Collins’ Mulberry wastewater treatment facility; reductions were 0.3 percent (410 acre-feet per year) below the New Mercer Ditch and Larimer Canal Number 2 headgates (primary data delivery mile 11.34) and 0.5 percent (410 acre-feet per year) at Lincoln Gage (primary data delivery mile 16.84). Below the Mulberry wastewater treatment facility discharge (secondary data delivery mile 18.84), stream flow reductions lessened slightly, averaging 0.2 percent of stream flow (220 acre-feet per year).

Stream flow decreased further in the reach between the Mulberry wastewater treatment facility and the Fossil Creek inlet due primarily to differences in return flow locations of converted agricultural rights. Unlike the action alternatives, indirect effects due to the reoperation of Fossil Creek Reservoir result in slightly reduced stream flows below the Fossil Creek inlet. Accordingly, reductions at Boxelder Gage (primary data delivery mile 22.69) were 0.6 percent (340 acre-feet per year).

Effluent from Fort Collins’ Drake wastewater treatment facility discharges into Fossil Creek Reservoir, where it is ultimately released back to the Main Stem through the Fossil Creek outlet. Therefore, reductions in stream flows lessened below the Fossil Creek outlet (secondary data delivery mile 27.76) due to the introduction of return flows to the river. At this location, stream flow increased by 0.3 percent (400 acre-feet per year).

Stream flow decreased by a greater amount in the reach from Fossil Creek outlet to Greeley Gage. This additional reduction was due to changes in the location of return flows from converted agricultural rights. The Greeley Gage (primary data delivery mile 57.43), the downstream end of the study area, is below all diversion, exchange, and reservoir reoperation points for the No-Action Alternative, so stream flow effects are not expected to change significantly further downstream. At Greeley Gage, flows increased by an average of 0.1 percent, or 190 acre-feet per year. Increases occurred at any time of year, but were typically highest in August. Reductions also occurred throughout the year, particularly in June and July, which showed decreased flows on average. Table 4-22 summarizes the average annual stream flows at the primary data delivery miles related to effects of the No-Action Alternative.
Table 4-22. Annual average flows and effects at primary data delivery miles, for Agricultural Reservoirs Alternative as simulated with Future Conditions hydrology.

<table>
<thead>
<tr>
<th>Run</th>
<th>Parameter</th>
<th>Below Halligan Reservoir DDM NF2</th>
<th>Fort Collins' Intake DDM 1.59</th>
<th>Canyon Gage DDM 5.63</th>
<th>US/DS Little Cache DDM 11.34</th>
<th>Lincoln St. Gage DDM 16.84</th>
<th>Boxelder Gage DDM 22.69</th>
<th>Greeley Gage DDM 57.43</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run 2</td>
<td>Annual Average Flows, AFY</td>
<td>56,900</td>
<td>181,800</td>
<td>216,300</td>
<td>148,700</td>
<td>87,300</td>
<td>59,600</td>
<td>131,300</td>
</tr>
<tr>
<td>Run NA4</td>
<td>Annual Average Flows, AFY</td>
<td>56,000</td>
<td>181,500</td>
<td>216,000</td>
<td>148,300</td>
<td>86,900</td>
<td>59,200</td>
<td>131,500</td>
</tr>
<tr>
<td></td>
<td>Effects (Run AR4 minus Run 2)</td>
<td>AFY</td>
<td>-930</td>
<td>-350</td>
<td>-340</td>
<td>-410</td>
<td>-400</td>
<td>-340</td>
</tr>
<tr>
<td></td>
<td>Percent of Run 2</td>
<td>-1.6%</td>
<td>-0.2%</td>
<td>-0.2%</td>
<td>-0.3%</td>
<td>-0.5%</td>
<td>-0.6%</td>
<td>-0.1%</td>
</tr>
</tbody>
</table>

Source: CDM Smith 2018a
4.4 Surface Water Quality

This section addresses changes in surface water quality in the North Fork and Main Stem, and the predicted water quality for each of the Project Alternatives. Surface water quality effects analyses were focused on the following segments within the Poudre River basin as described in Section 3.4:

- **Segment 7**: The North Fork from the inlet of Halligan Reservoir to the confluence with the Poudre River.
- **Segment 20**: All lakes and reservoirs tributary to the North Fork from the inlet of Halligan Reservoir to the confluence with the Poudre River (includes both Halligan and Seaman Reservoirs).
- **Segment 10a**: Poudre River from the Munroe Gravity Canal Headgate (also known as the North Poudre Supply Canal diversion) to a point immediately above the Larimer County Ditch diversion.
- **Segment 10b**: Poudre River from a point immediately above the Larimer County Ditch diversion to Shields Street.
- **Segment 11**: Poudre River from Shields Street in Fort Collins to a point immediately above the confluence with Boxelder Creek.
- **Segment 12**: Poudre River from a point immediately above the confluence with Box Elder Creek to the confluence with the South Platte River.

4.4.1 Methods

Water quality effects associated with the Project Alternatives were evaluated through two approaches: mass balance calculations for conservative parameters, and the Stream Network Temperature Model and CE-QUAL-W2 for stream and reservoir temperatures. Data-driven, conservative mass-balance modeling was used to predict how water quality would change in response to any of the Project Alternatives. Calculations were performed at multiple key locations throughout the North Fork basin using a conservative mixing equation, whereby the effects of project flow changes are captured through estimated changes in upstream mass loading only. The term “conservative”, in this case, refers to the conservation of mass implicit in the equation and the fact that the approach neglects any potential effects due to non-conservative reach biochemical processes. Conservative parameters tend to be relatively stable, long-lived compounds that persist within the environment. Instream biochemical processes, including plant uptake, chemical speciation or transformation (e.g., denitrification), and adsorption or desorption, could be indirectly affected by project flow changes via changes in reach hydraulics (velocities and depths) and residence time, vertical and lateral turbulent mixing, and water temperature. However, instream processing is likely minimal in these high gradient, cold water reaches and any effects to instream processing from the Project Alternatives are likely to be minor compared to the effects from changes in mass loading. This approach, therefore, neglects non-conservative dynamics in calculating project impacts.
This approach was selected to take advantage of the relatively large suite of available measured data and to provide a practical and transparent method that can be applied on a large spatial scale for multiple project scenarios. The approach also recognizes the complexity and spatial breadth and variability in the system that render more mechanistic modeling options less desirable and likely cost prohibitive. The conservative mass balance calculations effectively isolate the expected primary, mass loading effects of project flow changes on water quality. Instream processing and non-point loading are assumed to be unchanged in the comparison of baseline versus future project water quality. The following section describes the data and model development steps for the mass-balance analysis.

### 4.4.1.1 Parameter Identification

The list of parameters considered for water quality mass-balance modeling was limited to parameters with adopted numeric water quality standards suitable for conservative mass-balance evaluations at monthly timesteps (Table 4-23). As noted above, the Corps recognizes that none of these parameters are truly conservative, with some less conservative than others (e.g. *E. coli*, fecal coliform, and nutrients). However, such parameters are still suitable for inclusion in the conservative mass balance calculations to isolate and quantify impacts from stream flow alteration only. Note that dissolved oxygen was deemed unsuitable for the conservative mass balance modeling described here due to the highly dynamic nature, on a diurnal scale, of this parameter. Diurnal dissolved oxygen data were not available at most locations and daily patterns of variability are highly influenced by instream plant growth (photosynthesis and respiration). Due to this complexity, and data paucity, dissolved oxygen was not included in the analyses presented here.

The composition of parameters included in the mass-balance analysis varied at each mass-balance site due to data limitations described in Section 2.2.2.1.8 of the *Surface Water Quality Technical Report*. The complete set of parameters analyzed at each individual mass-balance site are also presented in the *Surface Water Quality Technical Report* (CDM Smith 2018b).

### 4.4.1.2 Mass-Balance Site Selection

Five locations for mass-balance analysis (Figure 4-34) were selected based on results of the Common Technical Platform hydrology modeling and by identifying locations expected to experience the greatest potential effect to water quality in response to the Project Alternatives. In general, the Common Technical Platform hydrology model predicted locations higher in the Poudre River basin would experience the greatest changes to stream flow (CDM Smith and DiNatalie Consultants 2016). Change in stream flow at a given point alone, however, does not necessarily mean water quality would be accordingly affected. Rather, effects to water quality are a response to how the relative apportionment of stream flow changes at that site (or upstream of it). For instance, if releases from Halligan Reservoir under a Project Alternative were curtailed, inflows from North Fork tributaries, such as Lone Pine Creek, would constitute a larger proportion of flow at downstream points and water quality would be affected accordingly. Sites were selected where the greatest change in flow composition (e.g., the mix of flows below a confluence, diversion, or other input) was expected to occur based on Common Technical Platform hydrologic modeling.
Table 4-23. Mass-Balance modeling parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Parameter</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkalinity (mg/L)</td>
<td></td>
<td>Dissolved Molybdenum (µg/L)</td>
<td></td>
</tr>
<tr>
<td>Ammonia as NH4 (mg/L)</td>
<td></td>
<td>Dissolved Nickel (µg/L)</td>
<td>Total Beryllium (µg/L)</td>
</tr>
<tr>
<td>Ammonia-N (mg/L)</td>
<td></td>
<td>Dissolved Phosphorus (mg/L)</td>
<td>Total Cadmium (µg/L)</td>
</tr>
<tr>
<td>Chloride (mg/L)</td>
<td></td>
<td>Dissolved Potassium (mg/L)</td>
<td>Total Chromium (µg/L)</td>
</tr>
<tr>
<td>Chlorophyll-a (mg/m²)</td>
<td></td>
<td>Dissolved Selenium (µg/L)</td>
<td>Total Chromium, hexavalent (µg/L)</td>
</tr>
<tr>
<td>Dissolved Aluminum (µg/L)</td>
<td></td>
<td>Dissolved Silver (µg/L)</td>
<td>Total Chromium, tetravalent (µg/L)</td>
</tr>
<tr>
<td>Dissolved Antimony (µg/L)</td>
<td></td>
<td>Dissolved Uranium (µg/L)</td>
<td>Total Copper (µg/L)</td>
</tr>
<tr>
<td>Dissolved Arsenic (µg/L)</td>
<td></td>
<td>Dissolved Vanadium (µg/L)</td>
<td>Total Iron (µg/L)</td>
</tr>
<tr>
<td>Dissolved Barium (µg/L)</td>
<td></td>
<td>Dissolved Zinc (µg/L)</td>
<td>Total Lead (µg/L)</td>
</tr>
<tr>
<td>Dissolved Beryllium (µg/L)</td>
<td></td>
<td>Excherichia coli (CFU/100 mL)</td>
<td>Total Manganese (µg/L)</td>
</tr>
<tr>
<td>Dissolved Boron (µg/L)</td>
<td></td>
<td>Fecal coliform (CFU/100 mL)</td>
<td>Total Mercury (µg/L)</td>
</tr>
<tr>
<td>Dissolved Cadmium (µg/L)</td>
<td></td>
<td>Hardness (mg/L)</td>
<td>Total Nickel (µg/L)</td>
</tr>
<tr>
<td>Dissolved Calcium (mg/L)</td>
<td></td>
<td>Nitrate-N (mg/L)</td>
<td>Total Phosphorus (mg/L)</td>
</tr>
<tr>
<td>Dissolved Chromium (µg/L)</td>
<td></td>
<td>Nitrite-N (mg/L)</td>
<td>Total Selenium (µg/L)</td>
</tr>
<tr>
<td>Dissolved Chromium, hexavalent (µg/L)</td>
<td></td>
<td>Orthophosphate-P (mg/L)</td>
<td>Total Silver (µg/L)</td>
</tr>
<tr>
<td>Dissolved Cobalt (µg/L)</td>
<td></td>
<td>pH (SU)</td>
<td>Total Sulfate (mg/L)</td>
</tr>
<tr>
<td>Dissolved Copper (µg/L)</td>
<td></td>
<td>Sodium (mg/L)</td>
<td>Total Sulfide (mg/L)</td>
</tr>
<tr>
<td>Dissolved Iron (µg/L)</td>
<td></td>
<td>Total Kjeldahl Nitrogen (mg/L)</td>
<td>Total Thallium (µg/L)</td>
</tr>
<tr>
<td>Dissolved Lead (µg/L)</td>
<td></td>
<td>Total Organic Carbon (mg/L)</td>
<td>Total Uranium (µg/L)</td>
</tr>
<tr>
<td>Dissolved Lithium (µg/L)</td>
<td></td>
<td>Total Aluminum (µg/L)</td>
<td>Total Zinc (µg/L)</td>
</tr>
<tr>
<td>Dissolved Magnesium (mg/L)</td>
<td></td>
<td>Total Antimony (µg/L)</td>
<td>Total Suspended Solids (mg/L)</td>
</tr>
<tr>
<td>Dissolved Manganese (µg/L)</td>
<td></td>
<td>Total Arsenic (µg/L)</td>
<td></td>
</tr>
<tr>
<td>Dissolved Mercury (µg/L)</td>
<td></td>
<td>Total Barium (µg/L)</td>
<td></td>
</tr>
</tbody>
</table>

µg/L=micrograms per liter; CFU=colony-forming units; mg/L=milligrams per liter;
Figure 4-34. Water quality reaches and mass-balance sites.
Each of the selected mass-balance sites is also associated with at least two upstream input sites that provide the input loads for the mass-balance calculations (Table 4-24). The approach to this analysis was shaped by the expectation that the Project Alternatives would affect water quality by altering pollutant loads where additional flow is added to, or removed from, a stream. In general, the Corps selected sites for mass balance analysis where Project Alternative effects are anticipated to be the greatest, specifically, just downstream of Project Alternative release water discharge or diversion changes, to estimate a worst-case water quality scenario. The selected sites are mostly located downstream of significant inflows or below diversions into the respective reservoirs (e.g., proposed Glade Reservoir, agriculture reservoirs, or gravel pits) for the Project Alternatives. Additionally, the Corps included site MS-3, located on the Main Stem downstream of the confluence with the North Fork, in all mass-balance analyses to assess the effect of water exchanges to the Fort Collins’ intake under each alternative. Further documentation on site selection under each scenario can be found in Section 2.2.1.2 of the Surface Water Quality Technical Report (CDM Smith 2018b).

Table 4-24. Mass-balance sites, upstream tributary input sites, and water quality reach names.

<table>
<thead>
<tr>
<th>Mass-Balance Site</th>
<th>Upstream Input Sites</th>
<th>Water Quality Reach Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF-8</td>
<td>NF-9</td>
<td>North Fork -- Outflow of Halligan Reservoir to confluence with Rabbit Creek</td>
</tr>
<tr>
<td></td>
<td>O-NF-3</td>
<td>North Fork -- Rabbit Creek</td>
</tr>
<tr>
<td></td>
<td>O-NF-5</td>
<td>North Fork -- Stonewall Creek</td>
</tr>
<tr>
<td></td>
<td>O-NF-7</td>
<td>North Fork -- Lone Pine Creek</td>
</tr>
<tr>
<td>MS-3</td>
<td>NF-2</td>
<td>North Fork -- Seaman Reservoir outflow to confluence with the Poudre River</td>
</tr>
<tr>
<td></td>
<td>MS-2</td>
<td>Poudre River -- Above confluence with North Fork</td>
</tr>
<tr>
<td>MS-16</td>
<td>MS-15</td>
<td>Poudre River -- Confluence of North Fork to Hansen Supply Canal</td>
</tr>
<tr>
<td></td>
<td>O-9</td>
<td>Hansen Supply Canal</td>
</tr>
<tr>
<td>MS-18</td>
<td>MS-16</td>
<td>Poudre River -- Hansen Supply Canal to Shield St.</td>
</tr>
<tr>
<td></td>
<td>O-4</td>
<td>Expanded Glade Turnout</td>
</tr>
<tr>
<td>MS-8</td>
<td>MS-7</td>
<td>Poudre River -- Hansen Supply Canal to Shield St.</td>
</tr>
<tr>
<td></td>
<td>O-12</td>
<td>Gravel Pits &amp; Agriculture Reservoir Turnout</td>
</tr>
</tbody>
</table>

4.4.1.3 Calculating Existing Water Quality Conditions

The sources of water quality data incorporated into the mass balance calculations are:

• Data provided by Fort Collins (“Fort Collins’ database”). Fort Collins provided data collected as part of the Upper Cache La Poudre Collaborative Water Quality Monitoring Program, which involves collecting water quality data on the upper Poudre River in partnership with Greeley and the Tri-Districts. The period of record for this data set is from 2003 to 2016.

• Data provided by Northern Colorado Water Conservancy District (“Northern Water database”). Northern Water provided a database containing water quality collected by a variety of agencies, municipalities and programs from locations on the lower and upper sections of the Poudre River. The Northern Water database also includes water quality data for several Poudre River tributaries, water treatment plants, and irrigation canal inflows. The period of record for this data set is 1990 to 2014. Note that some data from the 2012 to 2014 timeframe may be influenced by wildfires that occurred in that time period. However, to avoid the appearance of “cherry picking” no attempts were made to tease out those data from the analysis. All relevant data were included in the analysis described here.

• Water quality data collected by the United States Geologic Survey (Geologic Survey) at the Livermore Gage on the North Fork. These data were used to update and expand records contained in the Baseline Report dataset. The period of record for this data set is 1990 to 2003.

The water quality data sources contained data collected at numerous sample sites along the Poudre River and tributaries. However, the locations of these sample sites did not always match the locations of interest for modeling the effects of Project Alternatives. Therefore, the Corps aggregated the water quality data into reaches based on the location of key hydrologic inputs and outputs, such as major inflows and project-related infrastructure, to create the most robust and usable water quality dataset for the mass-balance analysis. The designation of the reaches (Table 4-25) relies on the fundamental assumption that changes in the apportionment of stream flow from upstream sources (e.g., project-related inputs and diversions) are the primary drivers of changes to downstream water quality. The Corps also assumed water quality was uniform between inflow points. In other words, any in-reach attenuation or transformation of water quality parameters was not included for this simplified analysis. While it is recognized that reach biochemical processes guarantee this assumption is not strictly accurate, we believe the impacts of such processes will be dwarfed by the impacts of the project flow changes. Since the focus of this study is on the impacts of projected changes in flow, these relatively minor, and indirect, impacts were not included in the analysis presented here.

Due to the lack of water quality data for releases from the alternative-related reservoirs (e.g., Glade, Gravel Pits and Agricultural Reservoirs), the Corps used water quality data from the point of diversion into these reservoirs, or water quality data from a suitable surrogate, to calculate existing water quality for these sites. For example, for the proposed Glade Reservoir, the quality of water discharged from the proposed Glade Reservoir turnout was assumed to be equivalent to the quality of water transported from Horsetooth Reservoir to the Poudre River via the Hansen Supply Canal. Similarly, the quality of water discharged from the gravel pits was assumed to be equivalent to the water quality at the point of diversion. Although the water quality impacts of processes such as settling (particulates), biochemical uptake and transformations (dissolved fraction), evapo-concentration, and groundwater interactions are not addressed in this assumption, the Corps determined it was the closest representation of the quality of water discharged from the gravel pits available for use in this study. The Corps made the same
assumption about the water discharged from the Agricultural Reservoirs. These are all deemed conservative assumptions (erring on the side of an over-prediction of project impacts), as any impact to water quality from small reservoir storage is likely to be an attenuation of pollutants (e.g., via settling, uptake, or bottom sediment adsorption). The details of these assumptions are discussed in Section 4.3 of the Water Quality Technical Report (CDM Smith 2018b).

Table 4-25. Water quality model segments, regulatory segment IDs, and water quality stations within each segment.

<table>
<thead>
<tr>
<th>Water Quality Model Segment</th>
<th>CDPHE⁵ Stream Segment ID</th>
<th>Water Quality Monitoring Sites Aggregated in Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poudre River -- Above confluence with North Fork</td>
<td>COSPCP02b</td>
<td>PNF¹,²</td>
</tr>
<tr>
<td>North Fork -- Outflow of Halligan Reservoir to confluence with Rabbit Creek</td>
<td>COSPCP07</td>
<td>NBH¹,², NRC¹,²</td>
</tr>
<tr>
<td>North Fork -- Confluence of Lone Pine Creek to outflow of Seaman Reservoir</td>
<td>COSPCP07</td>
<td>NFL¹,²,³</td>
</tr>
<tr>
<td>North Fork -- Seaman Reservoir outflow to confluence with the Poudre River</td>
<td>COSPCP07</td>
<td>NFG¹,²</td>
</tr>
<tr>
<td>Poudre River -- Confluence of North Fork to Hansen Supply Canal</td>
<td>COSPCP10a</td>
<td>26⁴, 5368⁴, HSC-PRU⁴, PBD⁴, PR-CAN⁴, PR-SRD⁴</td>
</tr>
<tr>
<td>Poudre River -- Hansen Supply Canal to Shield St.</td>
<td>COSPCP10b</td>
<td>2D-WAT⁴, 5310⁴, HSC-PRD⁴, PR-BEL⁴, PR-SHI⁴</td>
</tr>
<tr>
<td>North Fork -- Rabbit Creek</td>
<td>COSPCP09</td>
<td>RCM¹</td>
</tr>
<tr>
<td>North Fork -- Stonewall Creek</td>
<td>COSPCP08</td>
<td>SCM¹</td>
</tr>
<tr>
<td>North Fork -- Lone Pine Creek</td>
<td>COSPCP09</td>
<td>LCM¹</td>
</tr>
<tr>
<td>Poudre River -- Hansen Supply Canal</td>
<td>--</td>
<td>HSC-PR²</td>
</tr>
<tr>
<td>Poudre River – Expanded Glade Turnout</td>
<td>--</td>
<td>HSC-PR⁴</td>
</tr>
<tr>
<td>Poudre River – Gravel Pits &amp; Agriculture Reservoir Turnout</td>
<td>--</td>
<td>PNF¹,²</td>
</tr>
</tbody>
</table>

¹Fort Collins’ database
²Baseline Report data
³U.S. Geological Survey
⁴Northern Water database
⁵Colorado Department of Public Health and the Environment

Data from these sources were further reviewed through the following steps to establish existing water quality conditions:

- The numeric results for samples identified as non-detects were substituted, following common practice, with a value of one-half of the lowest detection limit or reporting limit for that parameter among all available data; these substituted values were then included in the existing conditions calculations.
• Water quality trends were analyzed using Mann-Kendall trend tests and time series visualizations.

• Existing concentrations were calculated, where adequate data were available, for high-flow and low-flow seasons following the CDPHE water quality assessment protocol (CDPHE Water Quality Control Commission 2012 303(d) Listing Methodology). Different assessment protocols are prescribed for total metals (water samples analyzed including the metals content both dissolved in the water and present in the particulates in the water) versus dissolved metals (water samples analyzed by removing the particulates with a filter). Parameters presented as a dissolved fraction used the 85th percentile of available water quality data, and parameters presented as a total fraction used the 50th percentile (median) of available water quality data. These summary statistics were calculated for both high-flow and low-flow seasons. After reviewing the annual hydrographs for the Livermore U.S. Geological Survey gage (06751490) and the Colorado Division of Water Resources Canyon Gage (CLAFTCCO) from 1995 to 2016, flow seasons were designated as High-flow (May 1 to July 31) and Low-flow (January 1 to April 30 and August 1 to December 31).

4.4.1.4 Calculating Future Water Quality Conditions

Potential changes to water quality were modeled using conservative mass-balance calculations at the five mass-balance calculation sites identified in Table 4-18. The potential change to water quality for a given parameter is a function of the differences in projected stream flow between the Common Technical Platform future baseline model run and the future “with-projects” model run at the mass-balance calculation site and upstream tributary sites. Existing ambient water quality concentrations are assumed to be constant for months within each season (high-flow and low-flow). The available data do not support further temporal disaggregation. For example, for many of the parameters, there are multiple discrete months where no data are available and monthly disaggregation of water quality data would not be possible. Since biochemical processes (e.g., pollutant uptake lengths) are closely linked with flow rates and velocities, it is also reasonable to assume that biochemical conditions are relatively stable within each of the respective hydrologic periods, compared to differences between hydrologic periods. A full set of monthly mass-balance calculations was performed for each of the three hydrological scenarios: average, wet, and dry conditions (Section 4.3.1).

As noted previously, implicit in the mass-balance analysis is the assumption that concentrations have not changed significantly over time (i.e., no trend exists in the water quality data). Parameters identified through the Mann-Kendall test as changing over time are included in the quantitative analysis and are noted in the results discussion (see discussion below and Appendix A in the Surface Water Quality Technical Report, CDM Smith 2018b). The mass-balance analysis combines the modeled flow changes with the existing ambient water quality data to quantify changes in load, and subsequently concentration, at specific locations. The equation used for this analysis, and a description of each of the parameters used in the equation, are presented in Section 2.2.3 of the Surface Water Quality Technical Report (CDM Smith 2018b).

The mass balance approach applied in this study assumes the targeted water quality constituents are not already changing in time. In other words, it assumes there are no significant underlying trends in the water quality of the study area. This assumption allows for use of historical measured data to characterize
“current” conditions and to isolate projected changes in future water quality due only to Project activities. To assess this assumption, additional analyses were performed to detect the presence of water quality trends, or lack thereof, for each parameter in each mass-balance reach. These analyses included the use of Mann-Kendall trend tests and time series visualizations. The R package “Kendall” was used to execute the Mann-Kendall trend tests, which is a non-parametric test to determine the presence of monotonic trends in time series data (Mcleod 2011). Prior to analyzing the data, the results of non-detect samples were set to zero to remove the confounding effect of having multiple detection and reporting limits. Lastly, a p-value of 0.05 was used to test for the presence, or absence, of monotonic trends in water quality.

Appendix A of the Water Quality Technical Report (CDM Smith 2018b) shows the results of the Mann-Kendall trend analysis for each reach and parameter. In general, the Mann-Kendall analysis identified at least one parameter in each mass-balance reach, with the exception of Rabbit Creek, that displayed a statistically significant increasing or decreasing monotonic trend. As noted above, trending water quality data are not ideal and indicate flaws in a key underlying approach assumption, thereby increasing the uncertainty of model projections. However, trending parameters were retained in the analysis to provide for a more comprehensive view of potential impacts, despite elevated uncertainties.

### 4.4.1.5 Percent Baseline Available Increment Metric Calculations

In addition to presenting the output of the mass-balance analysis, the Corps also calculated the percent of the “baseline available increment” that would be consumed for a given parameter in the modeled scenario. The baseline available increment is a calculation used by CDPHE for anti-degradation assessment and describes the difference between the applicable water quality standard and the baseline water quality concentration. The equations used to calculate the baseline available increment and the modification made to express the projected changes in water quality as a percent of baseline available increment are included in Section 2.2.3.1 of the Surface Water Quality Technical Report (CDM Smith 2018b). Note that CDPHE considers effects to be “significant” (under antidegradation regulations) when more than 15 percent of the baseline available increment is consumed.

### 4.4.1.6 Qualitative Assessment of Future Water Quality

Quantitative mass-balance analysis was not possible for all water quality parameters at all sites due to data limitations. For these water quality parameters, a qualitative assessment was made based on the results of those similarly-conservative parameters for which a quantitative analysis was possible. In all cases, this amounted to a qualitative statement of unlikely project impacts because all quantitative results showed no anticipated impact. Appendices A and B of the Surface Water Quality Technical Report (CDM Smith 2018b) show all parameters analyzed.

### 4.4.1.7 Water Temperature Methodology

The primary objective of temperature modeling was to quantify effects of the Project Alternatives on water temperature within Halligan Reservoir, Seaman Reservoir, the North Fork, and the Main Stem. Halligan Reservoir water temperature could be affected by Fort Collins’ Proposed Action in several possible ways:
• Increased storage volumes and surface areas associated with enlarging Halligan Reservoir would affect the ambient temperature exchange through radiation exchanges, evaporative heat loss, and sensitivity to atmospheric temperature fluctuations.

• Increased residence times as a result of the enlargement would alter atmospheric and sediment bed heat exchange times for a parcel of water prior to discharge.

• Increased water depths could strengthen thermal stratification (reduced vertical mixing) and alter the length of the stratification season.

Expanding Seaman Reservoir would affect Seaman Reservoir water temperatures, via the same mechanisms.

In addition to potential in-reservoir temperature changes, temperature changes in the North Fork and Main Stem could also occur due to the Project Alternatives. Altered flow regimes would change river hydraulics and thus the river could become more, or less, sensitive to fluctuations in air temperature. The timing and magnitude of flows in the rivers would affect reach hydraulics and residence times, and, consequently, alter the heat exchange dynamics of the reach. Relevant heat exchanges include both ambient exchanges (air to water) and direct solar radiation inputs, which occur as a function of channel surface area, water depth, and reach travel time. Additionally, reservoir water temperature changes, as a result of any of the Project Alternatives, would result in altered timing and magnitude of heat loads to the downstream receiving reaches.

A suite of temperature models was developed for Halligan and Seaman reservoirs, the North Fork, and the Main Stem to characterize daily water temperature effects resulting from the Project Alternatives. These models all perform mechanistic heat budget simulations of the targeted water bodies. Included in the heat budgets are direct solar radiation, ambient heat exchanges with the air, advective heat transfer from contributing tributaries, and, if applicable, heat exchanges with underlying sediments. The models include the ability to calculate both average and maximum temperature conditions as a function of environmental and hydrodynamic conditions.

A linked dynamic temperature and hydrodynamic model was developed to model temperature along the Main Stem for effects analysis associated with NISP. The model was also used to simulate temperature effects to the Main Stem associated with the Project Alternatives.

The Tennessee Valley Authority River Modeling System version 4.5 (Tennessee Valley Authority, Knoxville, TN) was used to simulate Main Stem flows and temperatures from the North Fork confluence to the Boxelder Gage. The tool simulates hourly water temperatures through automation, and includes factors that may be of interest for mitigation planning, such as channel structure effects and shading.

The Tennessee Valley Authority River Modeling System version 4.5 was initially used to model temperature effects of the Project Alternatives on the North Fork. This model, however, was found to be unsuitable for the North Fork because of model instabilities that occurred when simulating the steep slopes and high velocities resulting in supercritical flows (flows where velocity is higher than wave velocity, which are not supported in this model) occurring on the North Fork.

Because of the problems with the Tennessee Valley Authority River Modeling System model, the Stream Network Temperature Model (U.S. Geological Survey, Fort Collins, CO) was used to model temperature...
on the North Fork. The Stream Network Temperature Model is a well-known modeling platform developed for the U.S. Fish and Wildlife Service (Fish and Wildlife Service). This software allows for one-dimensional, steady-flow, physically based heat transport modeling that can be used to predict daily mean and maximum water temperatures as a function of stream distance and environmental heat flux. The instabilities that occurred in the Tennessee Valley Authority River Modeling System model did not occur in the Stream Network Temperature Model due to its use of a steady state hydraulic modeling approach. It is documented that the Stream Network Temperature Model may not perform well for water temperatures close to freezing (less than 4 degrees Celsius; Geologic Survey 2000). However, the focus of the impact analyses performed here is on higher temperatures, with the model simulation period limited to April through September. This extreme low temperature limitation is therefore not cause for concern. At its core, Stream Network Temperature Model calculates daily average water temperature throughout a stream network using a rigorous heat transfer algorithm. Daily maximum water temperatures, however, are calculated using a simplified empirical calculation, as a function of calculated average water temperature, diurnal air temperature fluctuations, and stream hydraulics. Due to the empirical nature of the calculation, site-specific calibration of maximum temperature parameters is generally required to add confidence to the model’s predictive ability. Such a site-specific calibration was performed here, lending confidence to the model’s predictions of daily maximum water temperature for this study.

A well-known and accepted lake water quality model, CE-QUAL-W2, was used to simulate effects of the proposed project on both Halligan and Seaman Reservoir water temperatures. CE-QUAL-W2 is a two-dimensional (longitudinal and vertical) dynamic (user-defined timestep) lake model that simulates both lake hydrodynamics and water quality dynamics for a continuous simulation period. The model assumes lateral homogeneity, but simulates variation longitudinally and vertically to the resolution specified. This includes the ability to simulate lake stratification and turnover, which were important processes with respect to the analysis of project effects. The model is also able to simulate ice cover and melt, critical to the analysis of winter temperature effects. The primary limitations of CE-QUAL-W2 are associated with its usability, lack of transparency (due to complexity), and, consequently, risk of user error. There is also a real risk of developing an “over-parameterized” model that attempts to do too much without adequate supporting data and does not allow for a uniquely-calibrated parameter set. For the application described here, the Corps attempted to develop a model with the appropriate level of complexity in consideration of the limitations in supporting data and the end objectives of the study.

For future scenario modeling, the reservoir and stream models were coupled. Calculated outflow temperatures (bottom releases) from the Halligan Reservoir model served as upstream boundary conditions for the North Fork stream temperature model. Similarly, the modeled stream temperatures at the bottom of the North Fork domain served as input upstream boundary conditions for Seaman Reservoir scenario modeling. Note that all reservoir operations and basin hydrologic conditions were prescribed in the temperature models based on output from the Common Technical Platform hydrologic model.

The technical model documentation for Halligan Reservoir, North Fork, and Seaman Reservoirs is provided in the Surface Water Quality Technical Report (CDM Smith 2018b; Appendix C). The model documentation for the Main Stem temperature modeling is provided in the Surface Water Quality Baseline Technical Report (CDM Smith 2018b; Appendix D).
These temperature models used the daily disaggregated data from the Common Technical Platform hydrologic model output for dry, average, and wet conditions. These three conditions were evaluated at five locations on the North Fork (Figure 4-35), including:

- **CSU-7**: Phantom Canyon;
- **CSU-4**: Cherokee Park Road (Above Rabbit Creek);
- **CSU-6**: Below Rabbit Creek (Phantom Canyon Ranch/Judson);
- **CSU-9**: Roberts Ranch (Below Lone Pine Creek); and
- **CSU-5**: Eagles Nest.

The conditions were also evaluated at six locations on the Main Stem (Figure 4-36). These locations include (upstream to downstream):

- **Canyon Gage**: Poudre River at the canyon mouth (downstream of North Fork confluence);
- **HSC-PRU**: Poudre River immediately upstream of Hanson Supply Canal;
- **HSC-PRD**: Poudre River immediately downstream of Hanson Supply Canal;
- **Shields Street**: Poudre River at Shields Street in Fort Collins;
- **Lincoln Gage**: Poudre River at Lincoln Street U.S. Geological Survey Gage (6752260);
- **Boxelder Gage**: Poudre River above Boxelder Creek.

### 4.4.1.8 Uncertainty

Water quality effects are largely based on available resource data, hydrologic modeling, and modeling of water quality parameters. There are inherent levels of uncertainty associated with modeling efforts, the necessary assumptions required for model input, and sometimes limited amounts of quality data. For some parameters, insufficient data are available for quantitative assessment, and inferences on likely trends or changes are estimated based on available data or surrogate parameters. Thus, the effects assessment focused on relative differences rather than predictions of absolute concentrations or values. Actual results with implementation of any of the Project Alternatives would likely vary from predicted values because of the multitude of variables and complex interactions that affect water quality. Model results and analysis provide a reasonable estimate of the likely direction and magnitude of effect.

### 4.4.1.9 Data Adequacy

Section 3.4 describes the best available data for surface water quality in the study area. The Corps determined the data available and methods used are adequate to evaluate and describe reasonably foreseeable significant adverse effects on surface water quality in the study area and to enable a reasoned choice among alternatives. The Corps did not identify any incomplete or unavailable surface water quality information, as described in Section 4.2.1.5. The effects of the alternatives on surface water quality are described below.
Figure 4-35. Temperature modeling result locations on the North Fork.
Figure 4-36. Temperature modeling result locations on the Poudre River.
4.4.2 Fort Collins’ Proposed Action

Detailed modeling results for all scenarios and hydrologic conditions are provided in both tabular and graphical form in the *Surface Water Quality Technical Report* (CDM Smith 2018b, Section 4.4, Appendices F through I).

4.4.2.1 Mass-Balance Analysis Results

Based on analysis of proportional changes in flow at various locations downstream of Halligan Reservoir as a result of Fort Collins’ Proposed Action, the greatest potential effects to water quality are expected to occur on the North Fork above Seaman Reservoir (NF-8) and on the Main Stem immediately below the confluence with the North Fork (MS-3) (Figure 4-37). Site NF-8 is on the North Fork above Seaman Reservoir. Inputs for the mass-balance calculations were from upstream points on the North Fork (site NF-9), Rabbit Creek (site O-NF-3), Stonewall Creek (site O-NF-5), and Lone Pine Creek (site O-NF-7) (Figure 4-37). The mass-balance calculations for NF-8 used the existing water quality parameter concentrations at NF-8 and upstream tributary sites.

MS-3 is on the Main Stem immediately below the confluence with the North Fork. Inputs for the mass-balance calculations were from upstream sites on the North Fork below Seaman Reservoir (site NF-2) and on the Main Stem above the confluence with the North Fork (site MS-2) (Figure 4-38). The mass-balance calculations for MS-3 used the existing water quality parameter concentrations at MS-3 and upstream tributary sites.

The mass-balance analysis did not predict significant water quality degradation at MS-3 and NF-8 under Fort Collins’ Proposed Action, with the exception of dissolved manganese. The predicted changes to water quality at MS-3 and NF-8 are driven primarily by alterations to the apportionment of upstream tributary stream flow caused by increased releases from Halligan Reservoir during low-flow months.

At NF-8, the predicted increase in dissolved manganese is a function of increased loading from upstream tributary site NF-9 (Halligan Dam to Rabbit Creek). NF-9 has a higher existing dissolved manganese concentration than NF-8, and stream flow contributions from NF-9 are predicted to increase during low-flow months under the Fort Collins’ Proposed Action model run.

At MS-3, the predicted increase in dissolved manganese is a function of increased loading from upstream tributary site NF-2 (Seaman Reservoir to Confluence). NF-2 has a higher existing dissolved manganese concentration than MS-3, and stream flow contributions from NF-2 are predicted to increase during low-flow months under the Fort Collins’ Proposed Action model run.

Under certain hydrological conditions, dissolved manganese is predicted to consume more than 15 percent of the baseline available increment at both sites. However, future concentrations are not predicted to exceed the secondary drinking water standard at either site. Appendix E of the *Surface Water Quality Technical Report* (CDM Smith 2018b) summarizes the percent baseline available index for each parameter for the Proposed Action.
Figure 4-37. Map of the North Fork above Seaman Reservoir showing mass balance site NF-8 and upstream input points.
Figure 4-38. Map of the Poudre River immediately below the confluence with the North Fork showing the MS-3 mass balance site and upstream input sites.
4.4.2.2  **Dynamic Temperature Modeling Results**

The simulation of Fort Collins’ Proposed Action focuses on the expanded Halligan Reservoir. The following section provides modeling results for this alternative.

4.4.2.2.1  **Halligan Reservoir**

Modeling results show that Fort Collins’ Proposed Action should have no adverse effects on Halligan Reservoir water temperatures relative to the numeric standards. The daily maximum temperature standards for Cold Lakes and Cold Large Lake (greater than 100 acres of surface area) Tier II waterbodies are 13.0 degrees Celsius between January 1 and March 31, and 21.2 and 23.8 degrees Celsius, respectively between April 1 and December 31. The maximum weekly average temperature standards are 9.0 degrees Celsius between January 1 and March 31, and 17.0 and 18.3 degrees Celsius, respectively between April 1 and December 31. The reservoir outflow (bottom release) daily maximum and weekly average temperatures are predicted to be unchanged, or reduced, when compared to Future Condition baseline. For some scenarios, the project is predicted to lower outflow temperatures below the standard; i.e., to eliminate an existing violation. The total number of standards violations is thus predicted to decrease. Further, results imply that relevant narrative standards associated with the maintenance of “normal” patterns of diel and seasonal temperature fluctuations would be achieved under the Fort Collins’ Proposed Action. A more detailed analysis of narrative temperature standards, which are only loosely defined for the study area, is not possible within the given study.

Modeling results of the reservoir vertical temperature profile suggest the expanded Halligan Reservoir may remain stratified until later into the fall compared to the Future Condition baseline (Figure 4-39), which is sensible given the additional depth and volume associated with the expanded reservoir. Meanwhile, surface temperatures are projected to remain largely unchanged, compared to the Future Condition baseline, indicating the close correlation with air temperature (which is also unchanged between the scenarios). For simplicity, only the surface and underflow temperatures are shown in Figure 4-39. Stratification exists when there is a difference between the bottom and surface temperatures. The rise in temperature in September is due to the fall overturn; this occurs five weeks later in the expanded reservoir scenario compared to the Future Condition baseline. As noted above, the net effect of Fort Collins’ Proposed Action on reservoir water temperatures, even with this change in stratification dynamics, is predicted to be very small - with a possible slight reduction in reservoir temperatures and standards violation risk. Further, the predicted modified stratification period is not expected to extend into the brown trout spawning season, which generally starts in October.
**Figure 4-39. Halligan Reservoir stratification.**

### 4.4.2.2.2 Seaman Reservoir

Modeling results show that effects from Fort Collins’ Proposed Action are predicted to have no adverse effects with respect to Seaman Reservoir water temperatures relative to the numeric standards stated in Section 4.4.2.2.1. The reservoir’s averaged daily maximum and weekly average outflow temperatures are predicted to be unchanged or reduced compared to baseline. For some scenarios, the project is predicted to lower temperatures below the standard – i.e., to eliminate an existing violation. The total number of standards violations is thus predicted to decrease. Further, results imply that relevant narrative standards, associated with the maintenance of “normal” patterns of diel and seasonal temperature fluctuations, would be achieved under Fort Collins’ Proposed Action. A more detailed analysis of narrative temperature standards, which are only loosely defined for the study area, is not possible within the given study.

A stratification plot (Figure 4-40) shows a mild increase in reservoir stratification at Seaman Reservoir under Fort Collins’ Proposed Action compared to the Current Condition baseline for the given hydrologic year (1989). Both the extent and duration of stratification are mildly increased in this scenario due to the Proposed Action. The duration of stratification appears to increase by only a few days in this scenario.
4.4.2.2.3 North Fork

Temperature modeling results show that effects from Fort Collins’ Proposed Action are predicted to be minimal with respect to North Fork water temperatures. The overall reach averaged daily maximum and weekly average temperatures are predicted to be reduced slightly compared to baseline (-0.3 and -0.2 degrees Celsius, respectively). Low, high, and median temperature statistics are all projected to decrease at all stations with a maximum decrease in temperature statistics of -1.8 degrees Celsius (maximum weekly average temperature for simulation period, dry hydrology, CSU-7). The day-to-day pattern of variability of water temperature metrics are also predicted to be similar but also slightly reduced (slightly lower amplitude) compared to baseline. The greatest temperature reductions are seen at site CSU-7 below Halligan Reservoir where colder water is released from the enlarged reservoir. There are some instances where Fort Collins’ Proposed Action is projected to increase water temperatures for short periods of time. In general, increases are small and follow the Future Conditions baseline temperature patterns (i.e., increases do not create new exceedances of water quality standards). In a small number of instances, temperatures are predicted to climb slightly above the applicable water quality standard under future conditions (late summer daily maximum temperature at CSU-4 under average hydrology, early summer daily maximum temperature at CSU-4 under dry hydrology, and early summer daily maximum temperature at CSU-9 under dry hydrology). However, the total number of standards violations for the entire segment is predicted to remain roughly the same as the baseline condition, or
even decrease slightly. For example, a large number of daily violations in the baseline model at site CSU-7 are eliminated under Fort Collins’ Proposed Action, particularly under dry conditions, with no additional violations predicted to occur on any of the other days. Further, results imply that relevant narrative standards (“Temperature shall maintain a normal pattern of diel and seasonal fluctuations and spatial diversity with no abrupt changes and shall have no increase in temperature of a magnitude, rate, and duration deleterious to the resident aquatic life.”) would be achieved under Fort Collins’ Proposed Action. A more detailed analysis of narrative temperature standards was not completed for this study. It is anticipated that additional evaluation of the effects of the Proposed Action on the narrative temperature standard will be completed during the 401 certification process.

4.4.2.2.4 Main Stem

Temperature modeling results show that effects from Fort Collins’ Proposed Action are predicted to be minimal with respect to Main Stem water temperatures. The overall reach averaged daily maximum and weekly average temperatures are predicted to be unchanged compared to baseline. Projected changes in low, high, and median temperature statistics are also small for all sites, with temperature changes ranging from -0.2 to +0.2 degree Celsius. The day-to-day pattern of variability of water temperature metrics are also predicted to be largely unchanged compared to baseline. There are, however, multiple periodic short-term changes in the magnitude of the daily temperature metrics, particularly at the downstream sites. While most of these effects represent a predicted reduction in water temperature, there are instances where the project is predicted to increase water temperatures for short periods of time. For one of these short-term excursions, temperatures are predicted to climb slightly above the relevant water quality standard under future conditions (wet hydrology at Shields Street). While this is potentially concerning, it is important to note that there is also an instance (average hydrology, Boxelder Gage) where the project is predicted to lower temperatures below the standard – i.e., to eliminate an existing violation. The total number of standards violations is thus predicted to remain roughly the same. Further, results imply that relevant narrative standards associated with the maintenance of “normal” patterns of diel and seasonal temperature fluctuations would be achieved under the Fort Collins’ Proposed Action. A more detailed analysis of narrative temperature standards, which are only loosely defined for the study area, is not possible within the given study.

4.4.3 Expanded Glade Alternative

Detailed modeling results for all scenarios and hydrologic conditions are provided in both tabular and graphical form in the Surface Water Quality Technical Report (CDM Smith 2018b, Section 4.4, Appendices F through I).

4.4.3.1 Mass-Balance Analysis Results

The potential water-quality effect of the Expanded Glade Alternative was assessed at three sites; MS-3, MS-16, and MS-18. Site MS-3 is on the Main Stem immediately below the confluence with the North Fork. Inputs for the mass-balance calculations were from upstream points on the North Fork below Seaman Reservoir (site NF-2) and on the Poudre River above the confluence with the North Fork (site
The mass-balance calculations for MS-3 used the existing water quality parameter concentrations at MS-3 and upstream tributary sites.

Site MS-16 is on the Main Stem immediately downstream of inflows from the Hansen Supply Canal. Inputs for the mass-balance calculations were from upstream points on the Poudre River (site MS-15) and in the Hansen Supply Canal (site O-9) (Figure 4-41). MS-16 was selected to evaluate water quality effects from the Expanded Glade Alternative because it captures any projected changes to water quality that would result from increased diversions through the Poudre Valley Canal to the proposed Glade Reservoir, which would decrease stream flow at MS-15 and make inflows from the Hansen Supply Canal (O-9) a larger proportion of stream flow at MS-16. The mass-balanced calculations for MS-16 used the existing water quality parameter concentrations at MS-16 and upstream tributary sites.

Site MS-18 is on the Main Stem immediately downstream of the proposed Glade Reservoir turnout. Inputs for the mass-balance calculations were from upstream points on the Main Stem (Site MS-16) and at the proposed Glade Reservoir turnout (site O-12) (Figure 4-41). Due to the lack of suitable surrogate water quality data for the proposed Glade Reservoir, it was assumed that quality of water discharged from the proposed Glade Reservoir turnout would be equivalent to water quality transported from Horsetooth Reservoir to the Poudre River via the Hansen Supply Canal. Therefore, the available water quality from the Hansen Supply Canal and modeled flow from the proposed Glade Reservoir turnout (site O-4) were used to estimate the water quality of releases from the proposed Glade Reservoir. The mass-balanced calculations for MS-18 used the existing water quality parameter concentrations at MS-18 and upstream tributary sites.

The mass-balance analysis did not predict significant water quality degradation at MS-3, MS-16, or MS-18 under the Expanded Glade Alternative. Although data limitations precluded mass-balance modeling for all parameters, the vast majority of the parameters analyzed did not show significant effects. The Corps can infer from this, assuming similar behavior for other conservative parameters, that project effects are also unlikely for those parameters the Corps was not able to analyze.

Because this alternative does not exist, the model for this alternative used water quality concentrations from releases from Horsetooth Reservoir, and transported via the Hansen Supply Canal, to serve as a proxy for water quality released from the proposed Glade Reservoir. Although this assumption does introduce additional uncertainty to the model projections, based on the best available data, the Expanded Glade Alternative is not predicted to cause significant water quality degradation at sites MS-3, MS-16, and MS-18.
Figure 4-41. Map of Poudre River below the Hansen Supply Canal (MS-16) and immediately below the proposed Glade Reservoir turnout (MS-18) mass balance site and upstream input points.
### 4.4.3.2 Dynamic Temperature Modeling Results

The Expanded Glade Alternative simulation modeled the expansion of the proposed Glade Reservoir proposed for NISP. The following section provides modeling results for this alternative for the Main Stem only. This alternative would not divert additional water from or to the North Fork so is not expected to affect water temperatures in the North Fork or Halligan or Seaman reservoirs. Therefore, no additional modeling of these water bodies was performed for this alternative.

Modeling results show the effects on Main Stem temperatures from the NISP Proposed Action may be significant. Under certain conditions, these effects are exacerbated by the Expanded Glade Alternative. However, the majority of the projected effects appear attributable to the NISP Proposed Action, rather than the Expanded Glade Alternative. Additionally, temperatures overall are reduced more than they are increased. The weekly average and daily maximum temperatures in the Main Stem are predicted to be reduced by 0.3 to 0.4 degree Celsius compared to baseline. Projected changes in the median temperature statistic range from -1.7 to +0.9 degrees Celsius. Projected changes in the targeted low temperature statistic (90th exceedance percentile) range from -1.1 to +0.7 degrees Celsius while the projected changes in the targeted high temperature statistic (10th exceedance percentile) range from -2.7 to 0.7 degrees Celsius. The day-to-day patterns of variability of water temperature metrics are predicted to generally follow baseline patterns. There are, however, multiple periodic short-term changes in the magnitude of the temperature metrics throughout the modeled reach. As noted above, the majority of these changes, particularly in the upper reach, represent a predicted reduction in water temperature. However, there are instances where the alternative is predicted to increase water temperatures for short periods of time. For a small number of these short-term deviations, temperatures are predicted to climb slightly above the relevant water quality standard for future water use conditions (e.g., dry hydrology at Boxelder Gage). While these excursions are potentially concerning, it is important to note that there are also multiple instances (e.g., dry hydrology at Shields Street; median hydrology at Canyon Gage) where the alternative is predicted to lower temperatures below the standard – i.e., to eliminate an existing violation. The total number of standards violations is thus predicted to remain roughly the same. Further, results imply that relevant narrative standards associated with the maintenance of “normal” patterns of diel and seasonal temperature fluctuations will be achieved for this alternative. A more detailed analysis of narrative temperature standards, which are only loosely defined for the study area, is not possible within the given study.

Overall, the Expanded Glade Alternative is projected to have a greater effect on Main Stem temperatures than Fort Collins’ Proposed Action. However, it appears that projected temperature reductions would be more prevalent than projected temperature increases for this alternative.

### 4.4.4 Gravel Pits Alternative

Detailed modeling results for all scenarios and hydrologic conditions are provided in both tabular and graphical form in the *Surface Water Quality Technical Report* (CDM Smith 2018b, Section 4.4, Appendices F through I).
4.4.4.1 Mass-Balance Analysis Results

The potential water-quality effect of the Gravel Pits Alternative was assessed at two sites, Site MS-3 and Site MS-8. Site MS-3 is on the Main Stem immediately below the confluence with the North Fork. Inputs for the mass balance calculations were from upstream points NF-2 and MS-2 (Figure 4-38). The mass-balance calculations for MS-3 used the existing water quality parameter concentrations at MS-3 and upstream tributary sites.

Site MS-8 is on the Main Stem immediately below the location of the proposed turnout for the Gravel Pits Alternative. Inputs for the mass-balance calculations were from upstream points MS-7 and O-12 (Figure 4-42).

Under the Gravel Pits Alternative, the water used to fill the gravel pits would be diverted from the Main Stem through the New Mercer Larimer County Number 2 Ditch and ultimately into the gravel pit complex. Due to the lack of suitable surrogate water quality data for the gravel pits, the Corps assumed the quality of water discharged from the gravel pits would be equivalent to water quality at the point of diversion. Although the water quality effects of processes such as settling (particulates), biochemical uptake and transformations (dissolved fraction), evapo-concentration, and groundwater interactions are not addressed in this assumption, the Corps determined it was the closest representation of the quality of water discharged from the gravel pits available for use in this study. Further, the Corps believes that this is a conservative assumption in the modeling. The combined net effect of in-lake processing (if any) would almost certainly be a small reduction in concentration for all constituents. Settling and biochemical transformation and uptake are likely to dominate over evapo-concentration, thereby resulting in a reduction in both pollutant mass and concentration prior to discharge from the gravel pits. This assessment is based on professional judgement only, as the Corps has no way of verifying without supporting data. Reservoir attenuation of pollutants is, however, well known in both the water resources and water treatment fields. Our assumption of outflow concentration equaling inflow concentration can therefore be considered a conservative assumption. The Corps recognizes, however, that in the absence of supporting measured data, significant uncertainty exists with respect to this assumption.

Because water quality at O-12 (discharge from the gravel pits), MS-7 (upstream of the gravel pits discharge point), and MS-8 (downstream of the gravel pits discharge point) was assumed to be identical, and the mass-balance model was parameterized as such, the mass-balance analysis did not project any change to water quality at Site MS-8 and the results are not presented.

The mass-balance analysis did not predict significant water quality degradation at MS-3 and MS-8 under the Gravel Pits Alternative. Although data limitations precluded mass-balance modeling for all parameters, none of the parameters analyzed showed significant effects. The Corps can infer from this, assuming similar behavior for other conservative parameters, project effects are also unlikely for those parameters the Corps was not able to analyze.

4.4.4.2 Dynamic Temperature Modeling Results

The following section provides modeling results for the Gravel Pits Alternative for the Main Stem only; the Gravel Pits Alternative would not divert water from or to the North Fork so is not expected to affect water temperatures in the North Fork or in either of the reservoirs (Halligan and Seaman).
Modeling results show that effects from the Gravel Pits Alternative are predicted to be minimal with respect to Main Stem water temperatures. The overall reach averaged weekly temperatures are predicted to be unchanged compared to baseline while reach averaged daily maximum temperatures are predicted to increase only slightly (+0.1 degree Celsius). Projected changes in low, median, and high temperature statistics are also small for all sites, with temperature changes ranging from -0.6 to +0.2 degree Celsius. The day-to-day pattern of variability of water temperature metrics are also predicted to be largely unchanged compared to baseline. There are, however, multiple periodic short-term changes in the magnitude of the daily temperature metrics, particularly at the downstream sites. While many of these effects represent a predicted reduction in water temperature, there are instances where the Gravel Pits Alternative is predicted to increase water temperatures for short periods of time. For one of these short-term excursions, temperatures are predicted to climb slightly above the relevant water quality standard for current water use conditions (e.g., Run GP3, dry hydrology at HSC-PRU). While this excursion is potentially concerning, it is important to note that there are also instances (e.g., Run GP-4, median hydrology and Shields Street and Boxelder Gage) where the alternative is predicted to lower temperatures below the standard – i.e., to eliminate an existing violation. The total number of standards violations is thus predicted to remain roughly the same. Overall, the Gravel Pits Alternative is projected to have an effect on Main Stem temperatures similar to that of Fort Collins’ Proposed Action.

4.4.5 Agricultural Reservoirs Alternative

Detailed modeling results for all scenarios and hydrologic conditions are provided in both tabular and graphical form in the *Surface Water Quality Technical Report* (CDM Smith 2018b, Section 4.4, Appendices F through I).

4.4.5.1 Mass-Balance Analysis Results

The potential water quality effects of the Agricultural Reservoirs Alternative were assessed at two sites on the Main Stem, Site MS-3 and Site MS-8. Site MS-3 is on the Main Stem immediately below the confluence with the North Fork. Inputs for the mass-balance calculations were from upstream points on the North Fork (site NF-2) and on the Poudre River (site MS-2) (Figure 4-38). The mass-balance calculations for MS-3 used the existing water quality parameter concentrations at MS-3 and upstream tributary sites.

Site MS-8 is on the Main Stem immediately downstream of the Agricultural Reservoirs Alternative discharge point. Inputs for the mass-balance calculations were from upstream points on the Poudre River (site MS-7) and at the gravel pits outfall (site O-12) (Figure 4-42).
Figure 4-42. Map of Poudre River immediately below the proposed Agricultural Reservoirs Alternative turnout (MS-8) mass balance site and upstream input points.
Due to the lack of suitable surrogate water quality data for Agricultural Reservoirs Number 5 and 6, the Corps assumed the quality of water discharged from the reservoirs was equivalent to water quality at the point of diversion. Although the water quality effects of processes such as settling (particulates), biochemical uptake and transformations (dissolved fraction), evapo-concentration, and groundwater interactions are not addressed in this assumption, the Corps determined it was the closest representation of the quality of water discharged from Agricultural Reservoirs Number 5 and 6 available for use in this study. Further, the Corps believes this is a conservative assumption in the modeling. The combined net effect of in-lake processing (if any) would almost certainly be a small reduction in concentration for all constituents. Settling and biochemical transformation and uptake are likely to dominate over evapo-concentration, thereby resulting in a reduction in both pollutant mass and concentration prior to discharge from the agricultural reservoirs. The assumption of outflow concentration equaling inflow concentration can therefore be considered a conservative assumption.

The mass-balance analysis did not predict significant water quality degradation at MS-3 and MS-8 under the Agricultural Reservoirs Alternative. Although data limitations precluded mass-balance modeling for all parameters, the vast majority of the parameters analyzed did not show significant effects. The Corps can infer from this, assuming similar behavior for other conservative parameters, project effects are also unlikely for those parameters the Corps was not able to analyze.

4.4.5.2 Dynamic Temperature Modeling Results

The following section provides modeling results for the Agricultural Reservoirs Alternative for the Main Stem only. This alternative would not divert water from or to the North Fork so is not expected to affect water temperatures in the North Fork or in either of the reservoirs (Halligan and Seaman).

Modeling results show that effects from the Agricultural Reservoirs Alternative are predicted to be minimal with respect to Main Stem water temperatures. The overall reach averaged daily maximum and weekly average temperatures are predicted to be largely unchanged compared to baseline. Projected changes in low and median temperature statistics are also small for all sites, with temperature changes ranging from zero to +0.2 degree Celsius. For the high temperature statistic (average daily maximum), the range of temperature change is even lower: -0.2 to +0.1 degree Celsius. The day-to-day pattern of variability of water temperature metrics are also predicted to be largely unchanged compared to baseline. There are, however, multiple periodic short-term changes in the magnitude of the daily temperature metrics, particularly at the downstream sites. While many of these effects represent a predicted reduction in water temperature, there are instances where the alternative is predicted to increase water temperatures for short periods of time. For a few of these short-term excursions, temperatures are predicted to climb slightly above the relevant water quality standard under future conditions (e.g., Run AR4, wet hydrology at Shields Street). While these excursions are potentially concerning, it is important to note that there are also instances (e.g., median hydrology, Shields Street) where the alternative is predicted to lower temperatures below the standard – i.e., to eliminate an existing violation. The total number of standards violations is thus predicted to remain roughly the same. Overall, the Agricultural Reservoirs Alternative is projected to have a slightly larger effect on Main Stem temperatures than Fort Collins’ Proposed Action.
4.4.6 No-Action Alternative

Detailed modeling results for all scenarios and hydrologic conditions are provided in both tabular and graphical form in the *Surface Water Quality Technical Report* (CDM Smith 2018b, Section 4.4, Appendices F through I).

4.4.6.1 Water Quality Mass-Balance Analysis Results

The mass-balance analysis projected that water quality effects of Future Conditions Comparison at NF-8 would not be significant (less than -15 baseline available increment percent) for any conservative parameters with sufficient data and applicable water quality standards. Small increases in concentrations were projected for other parameters, but these projected changes are less than the significant baseline available increment percent threshold.

4.4.7 Unavoidable Adverse Effects

There are no new exceedances of existing water quality or temperature standards under all Project Alternatives.

4.4.8 Effects Summary

In this section, the Corps summarizes the results of the water quality analysis for the future effects of the Project Alternatives. Detailed modeling results for all scenarios and hydrologic conditions are provided in both tabular and graphical form the *Surface Water Quality Technical Report* (CDM Smith 2018b).

4.4.8.1 Mass Balance Analysis

Overall, the mass-balance water quality analysis suggests that Fort Collins’ Proposed Action is not likely to result in new exceedances of existing water quality standards on the North Fork from Lone Pine Creek to Seaman Reservoir (NF-8) or on the Poudre River immediately below the confluence with the North Fork (MS-3). Additionally, the mass-balance analysis suggested that none of the alternatives would result in additional exceedances of existing water quality criteria at analyzed sites.

The mass-balance water quality analysis predicted both increases and decreases in monthly concentrations for individual parameters under some scenarios. However, none of the increases in projected monthly concentrations result in additional exceedances of water quality standards. The apparent minimal negative effect to future water quality was not unexpected given the fact that Project Alternatives will not significantly alter stream flow on the North Fork or Poudre River on an average annual basis, and that none of the alternatives will introduce additional mass into the system. The potential effects to water quality caused by the modeled changes to monthly average stream flow are mitigated in part by the relatively good overall water quality in the area.
4.4.8.2 **Dynamic Water Temperature Modeling**

Reservoir modeling results indicate that Fort Collins’ Proposed Action is likely to result in reduced temperatures in both Halligan and Seaman reservoirs during the critical summer season compared to baseline conditions. This is primarily attributable to the enlargement of Halligan Reservoir and the resulting changes in the reservoir heat balance, mixing, and outflow vertical profile. Enhanced stratification, compared to baseline, is predicted for both Halligan and Seaman reservoirs with respect to both the magnitude of the vertical temperature gradient and the duration of the stratification period. This appears to be the result of reduced flushing (both reservoirs) and increased volume and depth (Halligan Reservoir only) under Fort Collins’ Proposed Action compared to baseline conditions. Further, modeling results have not identified any additional risk of water quality standards exceedances for Fort Collins’ Proposed Action compared to baseline conditions.

North Fork modeling results show that day-to-day patterns of water temperature variability would be altered by Fort Collins’ Proposed Action during the modeled summer period. This appears to be the result of altered hydrographs and changes to the thermal loads released by the reservoirs. Included in these projected changes are short periods where water temperatures are predicted to increase compared to baseline. However, these predicted increases are generally short-lived, and a majority of the modeled effects are manifest as reduced temperatures in the river. Additionally, overall reach-averaged temperatures are projected to decrease slightly compared to baseline. The decreased river temperatures appear to be primarily attributable to reduced temperatures in the reservoir outflow water. The risk of temperature standards exceedances is not projected to increase under Fort Collins’ Proposed Action compared to baseline conditions, and may even decrease.

Poudre River modeling results indicate Fort Collins’ Proposed Action would have no deleterious effect on water temperatures in this part of the system. A moderate cooling effect is more likely. Day-to-day temperature patterns are predicted to be altered slightly, particularly at downstream sites. Poudre River modeling predicted short-term temperature increases at some locations. However, the majority of the modeled effects are temperature decreases, with overall reach-average temperatures projected to decrease slightly. No increased risk of standards exceedances was identified for the Poudre River as a result of Fort Collins’ Proposed Action.

Poudre River temperature modeling for the Agricultural Reservoirs and Expanded Glade alternatives predicted greater temperature effects than for Fort Collins’ Proposed Action and include multiple periods of temperature increases at downstream locations. The predicted Poudre River temperature effects for the Gravel Pits Alternative appear to be similar to the effects from the Fort Collins’ Proposed Action.

4.4.9 **Mitigation Measures**

Fort Collins has proposed the following mitigation measures related to water quality for their Proposed Action:

- To minimize effects to optimal temperature and dissolved oxygen, Fort Collins would construct a multi-level intake tower to allow selective withdrawals from specific locations in the reservoir water column to optimize temperature and dissolved oxygen of releases from Halligan Reservoir.
• Fort Collins proposes to install and maintain temperature gages at North Fork stream flow gaging stations below Halligan Dam, at or below the North Poudre Canal diversion, and at the Livermore gage, and would commit to maintain temperature monitoring for a minimum of 15 years following construction. Continuation of temperature monitoring after the 15-year period would be determined in consultation with the Adaptive Management Committee.

• Fort Collins proposes to conduct monthly or seasonal water quality monitoring in the North Fork Basin, including at the enlarged Halligan Reservoir and North Fork and tributary sites situated above and below Halligan Reservoir. Monitoring would identify any potential water quality impairments caused by the Halligan Reservoir enlargement that the City could then address. The sampling program would be based on Fort Collins’ existing North Fork monitoring plan; the sampling plan (locations, parameters, and frequency) would be updated periodically in consultation with the Adaptive Management Committee and subject to any additional conditions of the Section 401 Certification.

• Fort Collins may design outlet and spillway aeration measures that would provide operators with the option of turning the water as it exits the dam outlet works to manage the dissolved oxygen content of the water and improve the low dissolved oxygen content of the baseline water condition in Halligan Reservoir.

4.5 GROUNDWATER

The environmental effects to groundwater levels include both short-term effects, such as dewatering of excavations during construction, and long-term effects, such as raising groundwater levels around reservoirs. Groundwater quality may be affected by releases of contaminants during construction, changing flow directions and gradients, or changing recharge to the aquifer systems due to alternative implementation. The interaction of groundwater and surface water quality is discussed in Section 4.3 and the interaction of groundwater and wetlands and riparian areas is discussed in Section 0.

4.5.1 Methods

The Corps qualitatively evaluated potential effects to groundwater resources resulting from construction and operation of Project Alternatives, meaning the effect analysis was based on professional judgment and the nature of the aquifers that could be affected, as opposed to a quantitative analysis. The relationship between changes in stream stage and corresponding changes in groundwater levels on the North Fork was analyzed using the same method used in the NISP EIS (U.S. Army Corps of Engineers 2018). The method for data collection included four well transects at three locations; each transect consisted of a stream stage gage and two observation wells in adjacent alluvial materials. Weekly changes in stream stage and groundwater levels are available for a 2-year period. The change in groundwater level as a percent of the change in stream stage was assessed to allow analysis of potential effects on riparian areas under operating conditions.

The qualitative analysis of effects on the Main Stem used data and analytical methods documented in the NISP EIS (Corps 2018). NISP conducted specific studies along the Main Stem from where it exits the foothills to Greeley, which are relevant to the Gravel Pits Alternative. These investigations included
installing a series of wells in transects across the alluvial valley, monitoring groundwater levels and stream stage, conducting limited water quality sampling for total dissolved solids, and hydraulic testing (ERO Resources Corporation [ERO] 2012a). The total dissolved solids in the alluvial groundwater ranged from 276 to 2,090 milligrams per liter. There are no enforceable standards for total dissolved solids in groundwater, but there is a secondary standard of 500 milligrams per liter for drinking water based on aesthetics.

### 4.5.1.1 Data Adequacy

Section 3.5 describes the best available data for groundwater in the study area. The Corps determined the data available and methods used are adequate to evaluate and describe reasonably foreseeable significant adverse effects on groundwater in the study area and to enable decision makers to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable groundwater information, as defined in 4.2.1.5 (Incomplete and Unavailable Information). The effects of the alternatives on groundwater are described below.

### 4.5.2 Fort Collins’ Proposed Action

#### 4.5.2.1 Groundwater Level

Fort Collins’ Proposed Action would include raising the water level above the existing reservoir level by about 25 feet in Halligan Reservoir. Stream stage in the Main Stem channel would also increase when releases from the reservoir occur. The reservoir is in hydraulic communication with adjacent bedrock aquifers, so groundwater levels in the bedrock aquifers would also increase when the reservoir level was higher. This water level change would be most significant in areas adjacent to the reservoir (no data are available in adjacent areas to qualify); however, there is currently no significant groundwater development in areas where bedrock water levels may increase. Higher water levels do not constitute a negative effect in the bedrock aquifers.

The relationship between changes in stream stage and changes in groundwater levels were assessed at three locations with four well transects in riparian areas along the North Fork downstream of Halligan Reservoir. Stream stage and groundwater levels were monitored in the stream channel and two adjacent wells at each transect location over a two-year period. Transects were located in the Halligan Reservoir area (Figure 4-43), the Eagles Nest Open Space Area (Figure 4-44), and at locations upstream and downstream of the Gateway Park/Seaman Reservoir Area (Figure 4-45). Figure 4-46 presents the relationship between stream stage changes and corresponding groundwater level changes as a percent of the stream stage change. These relationships were based on weekly stream stage changes of one foot or greater, as was done for the NISP EIS analysis on the Main Stem. The relationship between stream stage changes and the response in groundwater levels ranges from about 94 to 22 percent and is specific to each transect. Groundwater level changes at all transects more closely reflect stream stage changes at locations closer to the stream channel and decrease as distance from the stream channel increases.
Figure 4-43 Location of the Halligan Reservoir ground water level transect.
Figure 4-44. Location of the Eagles Nest Open Space Area ground water level transect.

Location of Eagle’s Nest Open Space Area Transect

- Monitoring Well
- Stream Gauge
Figure 4-45. Location of the upstream and downstream ground water level transects at Gateway Park/Seaman Area.
Figure 4-46. Groundwater response to stream stage change at North Fork transects.
4.5.2.2 Groundwater Quality

Because the rise in water level associated with the incremental change in reservoir level would occur within the same rock types, the Corps does not expect there to be any change in water quality in the bedrock aquifer associated with Fort Collins’ Proposed Action.

4.5.3 Expanded Glade Alternative

4.5.3.1 Groundwater Level

The Expanded Glade Alternative would only raise the elevation of the proposed Glade Reservoir inundation pool by 3.6 feet. The incremental rise in groundwater levels for this alternative would not be significant since the additional storage volume would be a small percent of the currently planned reservoir volume. Pipelines that would be part of the NISP system would be used for conveyance, so there would be no additional pipeline related effects on groundwater from the incremental addition of this alternative.

4.5.3.2 Groundwater Quality

No significant effect on water quality is anticipated due to the small incremental rise in water level in the reservoir associated with this alternative. The rise in water level associated with the incremental change in reservoir level would occur within the same rock types and would not likely affect the adjacent trichloroethylene plume area at the former Air Force site due to the limited incremental change in head. There is some potential during excavation to encounter groundwater that would exceed surface water standards and would require treatment prior to discharge. Permitting of excavation dewatering discharge would need to address the potential for encountering trichloroethylene concentrations above discharge standards.

4.5.4 Gravel Pits Alternative

4.5.4.1 Groundwater Level

This alternative would use gravel pits for water storage, which would require installation of impermeable clay barrier walls from the surface down to bedrock to avoid loss of water to the aquifer. This would result in decreasing the portion of the alluvial aquifer currently conveying groundwater toward the river channel and down the valley. This is similar in concept to a subsurface dam blocking part of the alluvium. This blockage would likely result in an increase in water levels on the up gradient side of the gravel pit storage complex, and a corresponding decline in water levels on the downgradient side. The net change in flow in the Main Stem due to the composite effect of the gravel pits storage would be expected to be minimal downstream of the gravel pit storage facilities. Wells present in the area between individual storage sites would likely no longer be able to produce water, since communication with the surrounding alluvial aquifer would be cut off by the barrier walls. The increased water levels on the up gradient side of the storage reservoirs would also increase the hydraulic gradient toward the river channel, potentially increasing groundwater discharge to the adjacent Main Stem channel. The rise in water levels on the up
gradient side of the storage reservoirs could potentially affect structures, particularly basements, if the rise in water level is sufficient. This potential blockage and subsequent groundwater mounding can be minimized by including features in the design of the gravel pit storage facilities to minimize water level rise in the up gradient areas resulting in negligible effects to water levels.

Temporary effects to water levels may also be associated with dewatering of pipeline trenches, if necessary. Details on water levels and depth of trenches would be developed during final design if this alternative is implemented.

### 4.5.4.2 Groundwater Quality

The Corps anticipates no change in water quality associated with this alternative. Releases of contaminants during construction would have the potential to contaminate groundwater; however, best management practices can minimize this potential. The construction of this alternative would isolate the reservoir from the alluvial aquifer, so stored water would not interact with the alluvial aquifer. If a potential rise in water level occurs in the area up gradient of the reservoir, it would be within strata with the same geochemical characteristics as the remainder of the alluvial aquifer. Flow directions may change but not significantly enough to change groundwater quality in the area.

### 4.5.5 Agricultural Reservoirs Alternative

#### 4.5.5.1 Groundwater Level

No effect on groundwater levels is anticipated from the reservoirs associated with this alternative since these reservoirs would not change in size or overall operation. Temporary declines in water levels may be associated with trench dewatering, if necessary during construction. Information on dewatering requirements would be developed during the final design if this alternative is implemented.

#### 4.5.5.2 Groundwater Quality

No effect on groundwater quality is expected from this alternative. If dewatering is necessary within saturated zones in the Pierre Shale Formation, this dewatering effluent may elevate total dissolved solids, sulfate, and trace metals and metalloids such as selenium.

### 4.5.6 No-Action Alternative

Under the No-Action Alternative, no new infrastructure would be developed and no construction would occur. Risk of effect to groundwater resources occurs when contaminated water or soil is disturbed during construction or operation, when groundwater tables are raised due to new or expanded reservoir footprints, or when storm water runoff poses a risk to new water supply reservoirs. Because none of these would occur under the No-Action Alternative, effects on groundwater resources are not expected.
4.5.7 Unavoidable Adverse Effects

The predicted changes in alluvial groundwater levels are relatively small compared to the natural variability of groundwater levels, and the changes would be relatively short-lived. No unavoidable long-term adverse effects on groundwater, groundwater quality, or groundwater users are predicted with any of the alternatives.

4.5.8 Effect Summary

Potential effects from the Project Alternatives would primarily be associated with changes in groundwater levels in adjacent aquifers. Groundwater level changes in both alluvial aquifers and bedrock aquifers would occur within similar rock types, so no change in groundwater quality would be anticipated. Pipeline construction associated with alternatives could potentially require temporary dewatering in areas with a shallow water table.

Fort Collins’ Proposed Action and the Expanded Glade Reservoir Alternative would not result in any adverse long-term effects to groundwater resources because changes in local groundwater elevations associated with these alternatives would occur within the same rock types as the existing water table. The porous aquifer material associated with the Gravel Pits Alternative means that local groundwater levels are more sensitive to fluctuations in water levels in adjacent surface water bodies. Short-term adverse effects to groundwater quality could result from dewatering during construction activities; however, no adverse long-term effects would be anticipated from this alternative because groundwater levels would reach an equilibrium with the new reservoir expected to be within the same rock material as the current water table. Similar to the Gravel Pits Alternative, the Agricultural Reservoirs Alternative could result in short-term adverse effects to groundwater quality as a result of dewatering associated with pipeline construction. However, in the case of the Agricultural Reservoirs Alternative, the effluent water from dewatering activities could potentially contain elevated total dissolved solids and trace metals that could contaminate adjacent surface waters if not properly disposed of. The No-Action Alternative would not require any new infrastructure; however, historic aquifer recharge rates would likely be reduced due to diversion of historic irrigation water rights for municipal use, potentially resulting in long-term adverse effects to groundwater quality due to declines in the local water table in rural areas where water was diverted to Fort Collins.

4.5.9 Mitigation Measures

Fort Collins did not propose any mitigation measures related to groundwater resources.

4.6 STREAM MORPHOLOGY AND SEDIMENT TRANSPORT

This section summarizes the predicted potential effects of each alternative on stream morphology and sediment transport in the North Fork and Main Stem relative to Future Conditions comparisons. Detailed information on effects can be found in the *North Fork and Main Stem Stream Morphology and Sediment Transport Effects Technical Report* (ACE 2019a). This report presents results and interpretation for river morphology and sediment transport using the same analyses that were described in the *North Fork Stream*
Morphology Baseline Technical Report (ACE 2019b). The analyses that form the basis of the effects assessment are listed in Table 4-26. As discussed in the North Fork Stream Morphology Baseline Technical Report (ACE 2019b), there is no deterministic analysis that can provide an unequivocal description of future river morphology and sediment transport under each of the Project Alternatives. Instead, based on the range of analyses (Table 4-26), the predicted river response is discussed in light of the current river conditions presented in Section 3.6.2 for the North Fork and Section 3.6.3 for the Main Stem.

Table 4-26. Analyses conducted and presented in detail in the North Fork and Main Stem Stream Morphology and Sediment Transport Effects Technical Report to determine the potential effects on the North Fork and the Main Stem from each alternative.

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<th>Hydrology</th>
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<td>General statistics (annual, monthly, seasonal)</td>
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<td>Flow duration curves/histograms</td>
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<td>Exceedance discharge (1, 2, 5, 10, 25, 50, 75, 95 and 100 percent)</td>
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<td>Annual maximum flood discharge (2-, 10- and 25-year) with confidence intervals</td>
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<td>Spells analysis for movement of bed material</td>
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<td>Spells analyses for vegetation effects</td>
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<td>Duration of flow for flushing of fines</td>
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<td>Total work on channel boundary along river</td>
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<td>Total work on channel boundary above incipient motion</td>
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</table>

<table>
<thead>
<tr>
<th>Sediment transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual sediment transport potential (using Sediment Impact Analysis Method)</td>
</tr>
<tr>
<td>Transport potential by size fraction over flow range (using Sediment Impact Analysis Method)</td>
</tr>
</tbody>
</table>

Source: Anderson Consulting Engineers 2018

4.6.1 Methods

The methods used to provide the results for each alternative are described in detail in the North Fork Stream Morphology and Sediment Transport Baseline Technical Report (Anderson Consulting Engineers [ACE] 2019b), Main Stem Morphology Baseline Technical Report (ACE 2013), and the Main Stem Flushing Flow Report (ACE 2017). The effects analyses repeat the analyses described in these three reports for each of the modeled daily flow data sets. Results of these analyses were used to generate comparisons relative to Future Conditions for channel hydraulics, initiation of motion of bed material, magnitude and duration of stream power, and sediment transport. For each Project Alternative, the Common Technical Platform hydrologic modeling produced estimated daily stream flows for a 19-year time series on the North Fork (November 1, 1986 through October 31, 2005; irrigation years 1987 to 2005) and a 26-year time series on the Main Stem (November 1, 1979 through October 31, 2005; irrigation years 1980 to 2005) to demonstrate the potential effects of operations and infrastructure of each Project Alternative. The flow series were used to assess river hydrology and hydraulics for each scenario and then to analyze initiation of motion characteristics, channel morphology, and sediment transport behaviors for each cross section and reach in the North Fork and the Main Stem as described in detail in the North Fork Stream Morphology and Sediment Transport Baseline Technical Report (ACE 2019b) and
the Main Stem Morphology Baseline Technical Report (ACE 2013). A HEC-RAS model was developed for the North Fork and the Main Stem to calculate hydraulic conditions for specific flow conditions (Table 4-27). The model of the North Fork extended from the confluence with the Main Stem up the North Fork 2.3 miles upstream from Halligan Dam. The HEC-RAS model of the Main Stem extended along approximately 60 miles of the Main Stem.

Table 4-27. Flow conditions used in the HEC-RAS model to predict hydraulic conditions.

<table>
<thead>
<tr>
<th>Flow Condition</th>
<th>North Fork</th>
<th>Main Stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow intervals</td>
<td>Range between 20 and 10,000 cubic feet per second</td>
<td>200 and 10,000 cubic feet per second</td>
</tr>
<tr>
<td>Representative flows</td>
<td>1, 2, 5, 10, 25, 50, 75, and 95 percent exceedance flows</td>
<td>2, 20, and 50 percent exceedance flows</td>
</tr>
<tr>
<td>Flood flows</td>
<td>2-year, 5-year, and 10-year flood</td>
<td>2-year, 5-year, and 25-year flood</td>
</tr>
</tbody>
</table>

Evaluation of the frequency distribution of daily flows and flood frequency analysis was undertaken on the 19-year and 26-year period of modeled daily flows for the North Fork and Main Stem, respectively. Flow duration curves and exceedance flows developed through analysis of daily flow hydrology was used as a primary input to several hydraulic and sediment transport analyses. The flood frequency analysis considered the likelihood that a flood peak would occur or be exceeded in any year. It is important to note that while use of the modeled daily flow series would allow direct comparison of flood frequencies between current and project conditions, the limited duration of the generated data set means the magnitude of larger floods (e.g., the 25-, 50- or 100-year average recurrence interval event) cannot be reliably estimated. Also note that the daily flow series is representative of daily averages and not instantaneous peaks.

Both the North Fork and Main Stem were divided into seven study reaches as described in Section 3.3 of the North Fork Stream Morphology and Sediment Transport Baseline Technical Report (ACE 2019b) and Section 3.1 of the Main Stem Morphology Baseline Technical Report (ACE 2013). Reaches were river segments identified to have similar geomorphic and sediment transport characteristics, such that within each reach, response to change is expected to be similar (Table 4-28; Figure 4-47 and Figure 4-48).

Table 4-28. North Fork and Main Stem study reaches.

<table>
<thead>
<tr>
<th>Study Reach Name</th>
<th>Upstream Location of Study Reach</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Fork Study Reaches</td>
<td></td>
</tr>
<tr>
<td>NF 1</td>
<td>Dale Creek</td>
</tr>
<tr>
<td>NF 2</td>
<td>Halligan Dam</td>
</tr>
<tr>
<td>NF 3</td>
<td>North Poudre Canal Diversion</td>
</tr>
<tr>
<td>NF 4</td>
<td>Downstream end of Phantom Canyon</td>
</tr>
<tr>
<td>NF 5</td>
<td>Rabbit Creek</td>
</tr>
<tr>
<td>NF 6</td>
<td>Upstream end of Lower Canyon</td>
</tr>
<tr>
<td>NF 7</td>
<td>Seaman Dam</td>
</tr>
<tr>
<td>Main Stem Study Reaches</td>
<td></td>
</tr>
<tr>
<td>Laporte Reach</td>
<td>Munroe Canal</td>
</tr>
<tr>
<td>Fort Collins</td>
<td>Larimer-Weld Canal</td>
</tr>
<tr>
<td>Timnath Reach</td>
<td>Fossil Creek Inlet</td>
</tr>
<tr>
<td>Windsor Reach</td>
<td>Whitney Ditch</td>
</tr>
</tbody>
</table>
Sediment transport and morphologic analyses have endeavored to quantify, or at least provide some relative scale, to the predicted effects of Project Alternatives under Future Conditions. Interpretations of the results in the North Fork and Main Stem Stream Morphology and Sediment Transport Effects Technical Report (ACE 2019a) have avoided using value judgments and qualitative relative descriptors (like ‘large’ or ‘small’, ‘significant’ or ‘insignificant’, etc.) as much as possible. The following determination of overall effects have been applied to results:

- **Negligible**: The effect would be at the lowest levels of detection, barely measurable, with no perceptible consequences.
- **Minor**: The action would result in a detectable change, but the change would be slight.
- **Moderate**: The action would result in a clearly detectable change, with measurable effects.
- **Major**: The action would result in readily apparent effects with substantial consequences.

### 4.6.1.1 Uncertainty

Numerous uncertainties are inherent in predicting effects on stream morphology and sediment transport. The modeling aspects of the evaluation have some uncertainty in attempting to model natural variability of the affected environment. The range of geomorphic and sediment transport analyses used to estimate effects relies heavily on hydrologic modeling with associated uncertainties discussed in the Hydrologic Modeling Report (CDM Smith and DiNatale Water Consultants 2016). The temporal and spatial limitations of sediment samples and channel cross section data also contribute to uncertainty.

The intent of the modeling is not to replicate exactly what might happen in the future, because that cannot be known, but to predict tendencies and differences in tendencies as a means to identify the effects of each Project Alternative. There is no deterministic analysis that can provide an unequivocal description of future river morphology and sediment transport under each of the alternatives. Instead, based on the range of analyses, the estimated difference in river response is interpreted and discussed to inform development of the estimated effects (difference in the trajectory of river conditions) for each Project Alternative relative to baseline and future conditions.

### 4.6.1.2 Data Adequacy

Section 3.6 describes the best available data for stream morphology and sediment transfer in the study areas. The Corps determined the data available and methods used are adequate to evaluate and describe reasonably foreseeable significant adverse effects on stream morphology and sediment transport in the study area and to enable decision makers to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable stream morphology and sediment transport information, as defined in Section 4.2.1.5. The effects of the Project Alternatives on stream morphology and sediment transport are described below.
Figure 4-47. Geomorphology and sediment transport seven study reaches Along the North Fork.
Figure 4-48. Geomorphology and sediment transport seven study reaches along the Main Stem.
4.6.2 Fort Collins’ Proposed Action

Reduced flows generally lead to an increased tendency toward channel deposition. In turn, deposition can lead to the following effects on river condition:

- **Channel Contraction**: Deposition of silts, sands, or gravels on channel bars and margins or on mid-channel islands leading to reduced channel width and/or depth;

- **Fining of Surficial Material**: Reduced magnitude, frequency, or duration of flows leading to a fining of surficial material and possible blanketing of the bed with interstices filled with fine material; and

- **Loss of Hydraulic and Morphologic Complexity**: Channel contraction and fining of surficial material together with increased wavelength and decreased amplitude of meanders and possible loss of pool riffle sequencing leading to loss of hydraulic and morphologic complexity and reduced spatial frequency or variability of biotypes.

Evaluation of effects on the river’s trajectory (channel contraction, fining of surficial material, and loss of hydraulic and morphologic complexity) were developed using a range of hydrology, hydraulic, and sediment transport analyses (Table 4-26).

### 4.6.2.1 Effects on the North Fork

The trajectory of river condition predicted in the *North Fork Stream Morphology and Sediment Transport Baseline Technical Report* (ACE 2019b) under a continuation of the Current Conditions baseline includes on-going channel contraction, fining of surficial material, and loss of channel complexity as a result of hydrologic change. As a background for understanding effects of Fort Collins’ Proposed Action on the North Fork when evaluated under Future Conditions comparisons, the change in flow regimes would be as follows. During high flow months (April 16 to July 15) critical to maintaining stream morphology, daily average flows would be reduced by seven to nine percent. Average daily flows in the fall (July 16 to September 30), winter (October to February), and spring (March to April 15) would increase. Seasonal average daily flows for Fort Collins’ Proposed Action and Future Conditions are summarized in Table 4-29. The two percent exceedance discharge would be reduced by six to nine percent (Table 4-30). The two-year flood discharge would be reduced by six to 12 percent, with most reductions occurring downstream of the North Poudre Canal Diversion (Table 4-31).

**Table 4-29. Daily average discharge (cubic feet per second), Fort Collins’ Proposed Action vs Future Conditions.**

<table>
<thead>
<tr>
<th>Hydrologic Node</th>
<th>Study Reach</th>
<th>Hydrology</th>
<th>April 16&lt;sup&gt;th&lt;/sup&gt; – July 15&lt;sup&gt;th&lt;/sup&gt;</th>
<th>July 16&lt;sup&gt;th&lt;/sup&gt; – Sept</th>
<th>Oct – Feb</th>
<th>March – April 15&lt;sup&gt;th&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above Halligan</td>
<td>NF1</td>
<td>Fort Collins’ Proposed Action</td>
<td>214</td>
<td>44</td>
<td>26</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Future Conditions</td>
<td>214</td>
<td>45</td>
<td>26</td>
<td>51</td>
</tr>
<tr>
<td>Below Halligan</td>
<td>NF2</td>
<td>Fort Collins’ Proposed Action</td>
<td>204</td>
<td>70</td>
<td>19</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Future Conditions</td>
<td>218</td>
<td>71</td>
<td>17</td>
<td>46</td>
</tr>
</tbody>
</table>
Based on information presented in the North Fork and Main Stem Stream Morphology and Sediment Transport Effects Technical Report (ACE 2019a), the following effects of Fort Collins’ Proposed Action on the North Fork sediment transport and stream morphology when evaluated under Future Conditions are described in the context of channel contraction, fining of surficial material, and loss of morphologic complexity.

### 4.6.2.1.1 Channel Contraction

Between Halligan Reservoir and the North Poudre Canal Diversion, the current trajectory of the river includes a minor tendency towards marginal and mid-channel bar deposition and vegetation.
encroachment. Changes to the current trajectory are not predicted to occur under Fort Collins’ Proposed Action. The ability of the river to flush fine sediments released from Halligan Reservoir would also see negligible change under Fort Collins’ Proposed Action. Average annual sediment transport potential shows negligible change upstream of the North Poudre Canal Diversion, and the current trajectory would not be predicted to change with Fort Collins’ Proposed Action.

Downstream of the North Poudre Canal Diversion, there would be an overall increase of up to eight percent in average annual sediment transport potential. However, transport rates reviewed over a range of flows indicate there would be a reduction in transport potential in the high flow range of approximately 10 percent. For flows less than 100 cubic feet per second, the transport potential would increase. This would indicate more movement of finer material (sands) and less movement of coarse material (gravels). Increases in transport rates across the low flow range would not likely result in morphologic change. Reduction in transport rates in the high flow range would result in slightly reduced movement of gravels and coarse bed material. However, manifestation of changes in transport potential would only occur if upstream sediment supply was limitless and the system was transport limited (where sediment supply greatly exceeds sediment transport potential). Assessments of the river condition between the North Poudre Canal Diversion and Rabbit Creek indicate the process of channel contraction by vegetation encroachment and deposition of fine material on channel margins would continue under Future Conditions with Fort Collins’ Proposed Action.

Current tendencies toward sediment accumulation and vegetation encroachment on channel margins were noted in the reaches below Rabbit Creek, but to a smaller degree than upstream reaches. Tributary flows from Rabbit, Stonewall, and Pine creeks reduce the rate at which channel adjustments and encroachment occur over time. Given there would be limited sediment supply, changes in sediment transport potential under Fort Collins’ Proposed Action would provide little benefit and would not likely have an adverse impact.

4.6.2.1.2 Fining of Surficial Material

The occurrence of flushing flows would be reduced downstream of the North Poudre Canal Diversion by one to three years. This could result in a minor effect to flushing flows that maintain riffles and support aquatic habitat. The ecological effects of this change are discussed in Section 4.8.3.

The duration of channel maintenance flows would be reduced at 67 of 349 cross sections by an average of 10 percent under Fort Collins’ Proposed Action. Reductions at individual cross sections would be largest between the North Poudre Canal Diversion and Rabbit Creek. This reduction could lead to fining of surficial material. The ecological effects of this change are discussed in Section 4.8.3

4.6.2.1.3 Loss of Morphologic Complexity

Loss of morphologic complexity considers the totality of effects on channel contraction, fining of surficial material, and movement of bed material. Movement of bed material hydrology would be spatially limited to 34 of 349 cross sections. Under Fort Collins’ Proposed Action, the duration of bed material movement would be reduced at 16 of the 34 cross sections by an average of 14 percent. A signal of change in the duration of flows that move coarse bed material was noted but was not found to be spatially prevalent.
4.6.2.1.4 Summary

In summary, based largely on an observational model of response to Future Conditions hydrology, Fort Collins’ Proposed Action would be expected to have a negligible effect on stream morphology and sediment transport on the North Fork and the trends identified in the *North Fork Stream Morphology and Sediment Transport Baseline Technical Report* (ACE 2019b) would be expected to continue.

4.6.2.2 Effects on the Main Stem

The trajectory of the Main Stem condition predicted in the *Mainstem Morphology Baseline Technical Report* (ACE 2013) under a continuation of Current Conditions baseline includes on-going channel contraction, fining of surficial material, and loss of channel complexity as a result of hydrologic change. These trends are observed to be more severe downstream than upstream of Interstate Highway 25.

As a background for understanding effects of Fort Collins’ Proposed Action on the Main Stem when evaluated under Future Conditions, the change in flow regimes would be as follows. There would be minimal changes to flow frequency throughout the system. The two percent exceedance flow would be reduced by up to five percent. The two-year flood would be reduced by one to three percent and the ten-year flood peak generally less than two percent. Based on the information presented in the *North Fork and Main Stem Stream Morphology and Sediment Transport Effects Technical Report* (ACE 2019a), the following conclusions about the effects of Fort Collins’ Proposed Action on the Main Stem as evaluated under Future Conditions are as follows.

4.6.2.2.1 Channel Contraction

Under Fort Collins’ Proposed Action, average annual sediment transport potential would be reduced by less than three percent upstream of Interstate Highway 25 and by less than two percent downstream of the interstate.

4.6.2.2.2 Fining of Surficial Material

Upstream of Interstate Highway 25, flushing flow occurrence would be reduced by one to two years in the Laporte Reach. At 58 percent of the cross sections, the duration of channel maintenance flows would be predicted to be reduced by an average of two percent and as much as five percent under Fort Collins’ Proposed Action. For the remaining 45 percent of the cross sections, there would be either no flushing or no change in the duration of flushing flows.

4.6.2.2.3 Loss of Morphologic Complexity

Loss of morphologic complexity considers the totality of effects on channel contraction, fining of surficial material, and movement of bed material. At 28 percent of the cross sections upstream of Interstate Highway 25, there would be an average reduction in duration of bed material movement of 2.8 percent, with reductions at individual cross sections of as much as five percent. Downstream of Interstate Highway 25 there would be an average reduction in duration of two percent.
4.6.2.2.4 **Summary**

Effects of Fort Collins’ Proposed Action on geomorphology and sediment transport are expected to be negligible throughout the Main Stem.

### 4.6.3 Expanded Glade Alternative

#### 4.6.3.1 Effects on the North Fork

The Expanded Glade Alternative would have a negligible effect on flow in the North Fork, and therefore would have a negligible effect on stream morphology and sediment transport.

#### 4.6.3.2 Effects on the Main Stem

The Expanded Glade Alternative is contingent on permitting and construction of the NISP proposed Glade Reservoir. Therefore, the hydrologic model runs for the Expanded Glade Alternative include the NISP proposed Glade Reservoir and are referred to in this section as NISP Future Conditions. As a background for understanding effects of the Expanded Glade Alternative on the Main Stem when evaluated under NISP Future Conditions, the change in flow regimes would be as follows. There would be minimal changes to flow frequency throughout the system when compared to NISP Future Conditions. The two percent exceedance flow would be reduced by less than four percent and the 2-year flood would be reduced by two to four percent. The 10-year flood would be reduced by less than four percent.

Based on information presented in the *North Fork and Main Stem Stream Morphology and Sediment Transport Effects Technical Report* (ACE 2019a), the following conclusions about the effects of the Expanded Glade Alternative on the Main Stem stream morphology and sediment transport when compared with NISP Future Conditions are as follows.

##### 4.6.3.2.1 Channel Contraction

Under the Expanded Glade Alternative, the average annual sediment transport potential would be reduced by four to eight percent upstream of Interstate Highway 25 and less than two percent downstream of the interstate.

##### 4.6.3.2.2 Fining of Surficial Material

Upstream of Interstate Highway 25, the number of years of occurrence of flushing flows would be reduced by one year. At 58 percent of the cross sections, the duration of channel maintenance flows would be predicted to be reduced by an average of two percent and as much as 10 percent under the Expanded Glade Alternative. For the remaining 45 percent of the cross sections, there would be either no flushing or no change in the duration of flushing flows.

##### 4.6.3.2.3 Loss of Morphologic Complexity

Loss of morphologic complexity considers the totality of effects on channel contraction, fining of surficial material, and movement of bed material. At 28 percent of the cross sections upstream of Interstate
Highway 25, there would be an average reduction in duration of bed material movement of less than two percent, with reductions at individual cross sections of as much as five percent. Downstream of Interstate Highway 25, there would be an average of three percent increase in duration.

4.6.3.2.4 Summary
Effects of the Expanded Glade Alternative on geomorphology and sediment transport conditions are expected to be negligible throughout the Main Stem.

4.6.4 Gravel Pits Alternative

4.6.4.1 Effects on the North Fork
The Gravel Pits Alternative would have a negligible effect on flow in the North Fork, and therefore would have a negligible effect on its stream morphology and sediment transport.

4.6.4.2 Effects on the Main Stem
As a background for understanding effects of the Gravel Pits Alternative on the Main Stem when compared to Future Conditions, the change in flow regimes would be as follows. There would be minimal changes to flow frequency throughout the system. The two percent exceedance flow would be reduced by one to two percent. The two-year and ten-year floods would be reduced by less than one percent.

Based on information presented in the North Fork and Main Stem Stream Morphology and Sediment Transport Effects Technical Report (ACE 2019a), the effects of the Gravel Pits Alternative on the Main Stem stream morphology and sediment transport as compared to the Future Conditions baseline are as follows.

4.6.4.2.1 Channel Contraction
Under the Gravel Pits Alternative, average annual sediment transport potential would be reduced by less than two percent upstream of Interstate Highway 25 and by less than 0.5 percent downstream.

4.6.4.2.2 Fining of Surficial Material
Upstream of Interstate Highway 25, the number of years that flushing flows occur would be reduced by one year. At 58 percent of the cross sections, the duration of channel maintenance flows would be reduced by an average of less than two percent and as much as five percent at individual cross sections under the Gravel Pits Alternative. For the remaining 45 percent of the cross sections, there would be either no flushing or no change in the duration of flushing flows.

4.6.4.2.3 Loss of Morphologic Complexity
Loss of morphologic complexity considers the totality of effects on channel contraction, fining of surficial material, and movement of bed material. At 28 percent of the cross sections upstream of Interstate Highway 25, there would be an average reduction in duration of bed material movement of less than two
percent, with reductions at individual cross sections of as much as five percent. Downstream of Interstate Highway 25, there would be an average reduction in duration of two percent.

4.6.4.2.4 Summary

Effects of the Gravel Pits Alternative on stream morphology and sediment transport are expected to be negligible throughout the Main Stem.

4.6.5 Agricultural Reservoirs Alternative

4.6.5.1 Effects on the North Fork

The Agricultural Reservoirs Alternative would have a negligible effect on flow in the North Fork, and therefore would have a negligible effect on its stream morphology and sediment transport.

4.6.5.2 Effects on the Main Stem

As a background for understanding effects of the Agricultural Reservoirs Alternative on the Main Stem when compared to Future Conditions, the change in flow regimes would be as follows. There would be minimal changes to flow frequency throughout the system. The two percent exceedance flow would be reduced by one to three percent and the two-year and ten-year flood would be reduced by less than one percent.

Based on information presented in the North Fork and Main Stem Stream Morphology and Sediment Transport Effects Technical Report (ACE 2019a), the following conclusions about the effects of the Agricultural Reservoirs Alternative on the Main Stem stream morphology and sediment transport as compared to the Future Conditions baseline are as follows.

4.6.5.2.1 Channel Contraction

Under the Agricultural Reservoirs Alternative, average annual sediment transport potential would be reduced by less than 2.5 percent upstream of Interstate Highway 25 and by approximately one percent downstream of the interstate.

4.6.5.2.2 Fining of Surficial Material

Upstream of Interstate Highway 25, the number of years that flushing flows occur would be reduced by one year at one location in the Laporte Reach. At 58 percent of the cross sections, the duration of channel maintenance flows would be reduced by an average of two percent and as much as five percent under the Agricultural Reservoirs Alternative. For the remaining 45 percent of the cross sections, there would be either no flushing or no change in the duration of flushing flows.

4.6.5.2.3 Loss of Morphologic Complexity

Loss of morphologic complexity considers the totality of effects on channel contraction, fining of surficial material, and movement of bed material. Twenty-eight percent of cross sections upstream of Interstate Highway 25 would experience an average reduction in duration of bed material movement of less than
one percent, with reductions at individual cross sections of as much as five percent. Downstream of Interstate Highway 25, there would be an average of one percent increase in duration.

4.6.5.2.4 Summary
Effects of the Agricultural Reservoirs Alternative on geomorphology and sediment transport are expected to be negligible throughout the river.

4.6.6 No-Action Alternative
Based largely on an observational model of response to Future Conditions hydrology, the trends identified in the Future Conditions baseline assessment would be expected to continue throughout the North Fork and Main Stem with negligible difference under the No-Action Alternative. The No-Action Alternative would have less effect than Fort Collins’ Proposed Action and other alternatives.

4.6.7 Unavoidable Adverse Effects
Investigations described in the Mainstem Morphology Baseline Technical Report (2013) concluded that under the Current Conditions baseline, the Main Stem downstream of Interstate Highway 25 exhibits an active bio-geomorphic feedback loop and is on a trajectory leading to a shallower and narrower channel. Implementation of any of the Project Alternatives has a negligible potential to reinforce the current net depositional trend on the Main Stem downstream of Interstate Highway 25.

4.6.8 Effects Summary
The North Fork Stream Morphology Baseline Technical Report (ACE 2019b) describes the trajectory for the North Fork conditions. River morphology on the North Fork is substantially changed from its natural characteristics and the environmental functions that depend on morphology downstream of the North Poudre Canal Diversion at least as far as the Rabbit Creek confluence. The dominant change in these zones is deposition of silts and sands on channel margins associated with vegetation encroachment leading to reduced channel width. Based largely on an observational model of response to Future Conditions hydrology, the Project Alternatives would not be expected to change the river trajectory and would have negligible effect on morphology and sediment transport on the North Fork.

The Mainstem Morphology Baseline Technical Report (ACE 2013) describes the projected trajectory for the Main Stem conditions. This trajectory, which includes on-going channel contraction, fining of surficial material, and loss of channel complexity is expected to continue under Future Conditions hydrology. These predicted changes in river condition would be a fluvial response to historic and contemporary physical and hydrologic changes to the river, floodplain, and watershed. Based largely on an observational model of response to date, these changes in river condition would be expected to be more severe downstream than upstream of Interstate Highway 25 because:

- Sediment supply in the size fractions relevant for deposition is more limited upstream of Interstate Highway 25 than downstream
Bio-geomorphic processes involving vegetation establishment on benches and bars are more prevalent downstream than upstream of Interstate Highway 25.

The Future Conditions evaluation includes effects of the RFFAs other than the NISP and Seaman Projects. Under the Future Conditions baseline, the trends already identified in the Mainstem Morphology Baseline Technical Report are ratified and amplified. The Project Alternatives are expected to have a negligible effect on this trajectory of continuing channel contraction, fining of surficial material, and loss of channel complexity compared to the Future Conditions baseline (Table 4-32).

Table 4-32. Summary of effects on stream morphology and sediment transport from Fort Collins’ Proposed Action and Alternatives.

<table>
<thead>
<tr>
<th></th>
<th>Fort Collins’ Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
<th>No-Action Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>North Fork</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Future Conditions</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>comparisons (Run 2</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>[Baseline] vs Run 4</td>
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<td>[each alternative</td>
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<td>under future</td>
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<td>conditions)</td>
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<tr>
<td><strong>Main Stem</strong></td>
<td></td>
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</tr>
<tr>
<td>Future Conditions</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
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<tr>
<td>comparisons (Run 2</td>
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<tr>
<td>[Baseline] vs Run 4</td>
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<td>[each alternative</td>
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<td>under future</td>
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<td>conditions)</td>
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</tbody>
</table>

4.6.9 Mitigation Measures

Fort Collins did not propose any mitigation measures related to stream morphology and sediment transport.

4.7 Wetlands, Riparian Resources, and Other Waters

This section describes effects of the Project Alternatives on wetlands; other waters, including streams, canals, and ponds; and riparian resources. The Project Alternatives have the potential to directly affect these resources through inundation for reservoir enlargement, dam enlargement, new road construction, construction of pump stations and valve houses, and excavation, and indirectly through changes to stream flow on the North Fork and Main Stem. Additional details on the studies and effects assessment can be found in the following reports:

- Wetlands and Riparian Resources Baseline Report (ERO 2012b)
- Wetlands and Riparian Resources Effects Report (ERO 2014b)
4.7.1 Methods

An approach to effects analysis and descriptions of effect intensity was developed based on concepts in past EISs (e.g., NISP Supplemental Draft EIS), the Nationwide Permit framework, a review of recent Corps authorized projects in the Cache La Poudre HUC 8 watershed, and conditions present in the study areas of the Project Alternatives. From Oct 1, 2010 to Sep 30, 2015 (5 years), the Corps authorized in the Cache La Poudre HUC 8 watershed 202 impacts to streams and wetlands totaling 24.635 acres of permanent and temporary impacts. The Corps required 20.458 acres of stream and wetland mitigation for 10 of the 202 impacts in this watershed, but allowed for 4.177 acres of permanent wetland loss from the remaining 192 impacts authorized mainly by Nationwide Permits. The largest authorized impact in the Cache La Poudre HUC 8 watershed during that period was 7.75 acres. The NISP Final EIS concluded that the permanent loss of 62 acres and temporary loss of 22 acres of wetlands and other waters was a major adverse effect. The following thresholds were used to determine the change in intensity of direct effects resulting from Project Alternatives on wetlands, other waters, and riparian resources:

- **No effect:** No expected change from existing conditions.
- **Negligible:** Effects are at the lowest levels of detection, are barely measureable, have no perceptible consequences, and would have minimal adverse environmental effects. Many activities effecting 0.1 acre of wetlands or less are authorized by a Nationwide Permit and require no verification by the Corps and no mitigation because the Corps has already determined that those activities would have "minimal adverse environmental effects". Therefore the permanent loss or gain of less than 0.1 acre of wetlands will be a negligible effect for this EIS.
- **Minor:** Effects might result in a detectable change, but the change would be slight. Minor effects would be short-term, occur at low levels, and/or are not likely to have a long-term noticeable effect on wetlands, riparian areas, and other waters. Minor effects include temporary impacts during construction. A Nationwide Permit authorizes many activities eliminating up to 0.5 acre of wetlands after the Corps verifies those activities would have "minimal adverse environmental effects". Therefore, the permanent loss or gain of less than 0.5 acre of wetlands will be a minor effect for this EIS.
- **Moderate:** Effects would result in a clearly detectable change, with measureable consequences. Moderate effects would be noticeable, and the existing wetlands, riparian areas, or other waters would likely be lost or created. Moderate effects are typically long-term. For this EIS, the permanent loss or gain of 0.5 to 10 acres of wetlands will be a moderate effect.
- **Major:** Effects would result in readily apparent change, with substantial consequences. Major is used when permanent effects on large areas of wetlands, riparian areas, or other waters would occur. For this EIS, the permanent loss or gain of more than 10 acres of wetlands will be a major effect.
4.7.1.1 Direct Effects

4.7.1.1.1 Wetlands, Other Waters, and Riparian Resources

Wetlands and riparian areas were mapped based on field delineations, aerial photo interpretation, and field reconnaissance as described in Section 3.7.4.1. Direct effects were quantified by overlaying project features on maps of wetland and riparian cover types and areas mapped as other waters using ArcGIS. Direct long-term loss of such resources would occur in inundation areas or where new infrastructure would be built, such as dam footprints, permanent roads, pretreatment facilities, and pumping stations. Direct short-term effects were calculated primarily for construction disturbances that would be reclaimed, such as some borrow pits, pipelines, and access roads. Fort Collins did not provide specific alignments for access roads and pipelines, but rather a corridor was identified within which the road or alignment would be constructed. This approach allows Fort Collins flexibility in final project planning while providing areas for the Corps to analyze for potential effects. In these cases, effects were assessed by applying a buffer to the centerline of such features. The Corps used a 12.5-foot buffer for permanent effects from access roads, a 30-foot buffer for temporary effects from access roads, and a 75-foot buffer for pipeline corridors. Other features like the potential construction disturbance area at Halligan Reservoir were presented as a large polygon encompassing smaller potential staging areas and borrow areas. Construction activities would not occur throughout the entire large polygon but would be limited to the staging, borrow areas, and access roads. These areas likely represent a conservative over-estimate of effects; the actual disturbance footprint might be much smaller. Fort Collins is willing to move the locations of these areas within the larger polygon to avoid critical resources, if necessary. Fort Collins would use staging areas for construction site trailers, material stockpiles, and vehicles and equipment parking.

4.7.1.1.2 Ecological Function Loss or Lift Approach

Wetland functions were evaluated for the Project Alternatives using the FACWet Method Version 3.0 (Johnson and Beardsley 2015). A FACWet assessment results in a Functional Capacity Index score for the assessed wetland. The Functional Capacity Index is a unit-less measure that rates the wetland variables on a scale of zero to one. The Functional Capacity Index provides an indication of the relative ecological value provided by the wetland. Multiplying a wetland’s Functional Capacity Index by the acres of the wetland provides the number of Ecological Functional Units provided by the wetland. Determining the difference in Ecological Functional Units between baseline conditions and post-project conditions under each alternative represents the functional loss or lift for each alternative. This wetland functional assessment approach was used to determine the net ecological functional loss or lift for each of the Project Alternatives (Fort Collins 2017). The value of using the wetland functional approach is that it is based on wetland functions rather than strictly acreage and provides a common unit of measure to quantify functional loss and lift for each alternative.

4.7.1.2 Indirect Effects

The assessment of indirect effects focuses on changes in groundwater levels and changes in the frequency and duration of inundation of wetlands and riparian areas along the North Fork and Main Stem. Indirect effects to in-stream resources are discussed in other sections, such as Section 4.3 and Section 4.8.
4.7.1.2.1 Hydrologic Modeling

Effects on wetland and riparian resources along the North Fork and Main Stem are related to predicted changes in river flow, stage, and alluvial groundwater levels associated with operation of the alternatives. River flow and stage changes are predicted using the Common Technical Platform hydrology model by comparing various modeling runs. Predicted changes to river stage are derived from site-specific relationships to river flow. Information on the Common Technical Platform model can be found in Section 4.3 of the Draft EIS and in the *Surface Water Resources Technical Report* (CDM Smith 2017). The stream flows calculated in those hydrologic models were the basis for this effects analysis (WEST 2018).

Under Fort Collins’ Proposed Action Winter Release Plan a continuous three cubic feet per second release of water would be provided from Halligan Reservoir into the North Fork from October 1 to April 30. Winter Release Plans for other alternatives also would mandate release of three cubic feet per second from their respective storage facilities into the Main Stem. The Summer Plan is unique to Fort Collins’ Proposed Action and under this plan a minimum five cubic feet per second flow would be maintained from May 1 to September 30 each year. All releases made under the Winter Release and Summer Plans would be delivered into Fort Collin’s municipal water system. The Winter Release and Summer Plans would result in a year-round increase to stream flows in the North Fork between Halligan Reservoir and the confluence with the Main Stem. Because the Summer Plan was designed after this analysis was performed, the Corps did not model the new run so the potential benefits to wetlands and riparian resources are not quantified, but they are discussed qualitatively in Section 4.7.1.

4.7.1.2.2 Changes in Groundwater Levels

Maintenance of riverine wetland and riparian vegetation is largely dependent on river stage (the elevation of water associated with a given stream flow) and associated alluvial groundwater levels. Changes in river stage can affect wetland and riparian vegetation by altering surface water and alluvial groundwater interactions that support such vegetation. Data from the river stage and alluvial groundwater level monitoring at the vegetation study sites along the North Fork and Main Stem indicate that alluvial groundwater levels fluctuate with river stage but with a delay. The observed delay between peak and low river stages and peak and low groundwater levels is on the order of hours due primarily to the relatively high permeability and connectedness of the alluvium. Estimated changes in weekly average river stage were used to predict corresponding changes in alluvial groundwater levels at the vegetation study sites on the North Fork and Main Stem.

The analysis of groundwater levels used the predicted river stage changes associated with the Project Alternatives (ACE 2016a) and existing river stage and alluvial groundwater monitoring data. The Corps used river cross-sections at the groundwater monitoring well locations to develop rating curves relating river stage to stream flow at each of the vegetation study sites. For the modeled baseline and Project Alternative hydrologic condition for each vegetation study site, a time series of weekly average stream flows was then computed. Weekly average stream flow was computed using the daily stream flow hydrology data sets for the full period of record (November 1, 1986 to October 31, 2005 on the North Fork and November 1, 1979 to October 31, 2005 on the Main Stem). The rating curve relationship was applied to the stream flow values to calculate the corresponding river stages (ACE 2016a). Using the
weekly average river stage, the Corps compared the Project Alternatives under the hydrologic model runs listed in Section 4.3.1.1.3. In addition, the Corps compared the Project Alternatives with cumulative effects versus future conditions. The cumulative effects runs included RFFAs and assumed that the proposed Glade Reservoir would be authorized and constructed as part of the NISP. The Corps used this weekly average river stage data (ACE 2016a) and the relationship between river stage and alluvial groundwater levels (ERO 2012a, WEST 2016b) to assess potential effects of the Project Alternatives on herbaceous and shrub-dominated wetland and riparian plant communities, as well as cottonwood woodlands in the North Fork and Main Stem study areas.

4.7.1.2.2.1 Effects on Herbaceous and Shrub-dominated Wetland and Riparian Vegetation

Wetland plants are adapted to or more tolerant of recurrent, sustained saturation in the upper portion of the soil profile than upland plants. The Corps’ technical standard for wetland hydrology is that the wetland site is inundated (flooded or ponded) or the water table is within 12 inches of the soil surface for 14 or more consecutive days during the growing season at a minimum frequency of five years in 10 (greater than or equal to 50 percent probability; Corps 2005). Assuming an average midpoint of 0.5 foot for groundwater levels for wetlands, a decline of less than 0.5 foot would still meet the threshold for wetland hydrology. The National Research Council (1995) cited several studies in which the rooting depths of wetland plants were examined. They reported that wetland plant roots typically occur in the upper one to two feet of the soil profile, with the majority concentrated within one foot of the soil surface, and concluded that the evidence supports a depth of one foot as the critical zone for assessment of saturation (National Research Council 1995). Prolonged declines in river stages of four consecutive weeks or more could potentially stress shallow-rooted vegetation dependent on shallow groundwater, such as is present along the Main Stem and in some locations along the North Fork. The review of river stage declines for each alternative focused on:

- The number of years in the period of record (1987-2005 for the North Fork and 1980-2005 for the Main Stem) in which weekly average river stages declined by 0.5 foot or greater during the growing season for a minimum of two consecutive weeks
- The number of years in the period of record in which weekly average river stages declined by 0.5 foot or greater during the growing season for a minimum of four consecutive weeks or six weeks total (i.e., not consecutive)
- The percent of weeks for the period of record where weekly average river stages during the growing season declined by 0.5 foot or greater for two consecutive weeks
- The percent of weeks for the period of record where weekly average river stages during the growing season declined by 0.5 foot or greater for a minimum of four consecutive weeks or six weeks total (i.e., not consecutive)

These measures provide a relative comparison of river stage declines for all Project Alternatives. Prolonged weekly river stage declines of 0.5 foot or greater for four consecutive weeks or more could potentially stress shallow rooted vegetation that depends on shallow groundwater levels. This type of vegetation occurs along and near the banks of the North Fork and Main Stem. Weekly river stage and corresponding groundwater level declines persisting for two weeks during the growing season would not
result in measurable effects on herbaceous or shrub-dominated wetlands. On average, two weeks represent about 10 percent of the growing season on the Main Stem and about 12 percent on the North Fork; four weeks represents 19 percent of the growing season on the Main Stem and 24 percent on the North Fork. A river stage decline of 0.5 foot or greater for a four-week duration was identified as the effect threshold to determine a year with declines in groundwater levels substantial enough to have a negative effect on herbaceous or shrub-dominated wetlands. While shallow rooted vegetation could be affected by four consecutive weeks of groundwater level declines of at least 0.5 foot, such declines would likely only result in temporary water stress of plants. Many types of wetlands in the western U.S. experience periods of drought and water stress each growing season but are resilient when supportive hydrologic conditions return.

Nebraska sedge (*Carex nebrascensis*) is one of the dominant herbaceous wetland species along the North Fork and Main Stem. In their study of three riparian graminoids, Sala and Nowak (1997) report that root activity and root biomass of Nebraska sedge is typically concentrated in the upper 16 inches of the soil profile, but field observations indicate this species is able to reach shallow groundwater up to 51 inches deep or moist soil layers just above the shallow groundwater. They suggested that their ability to adjust rooting depth is an important means by which sedges maintain favorable gas exchange and water relations under declining water tables. Steed et al. (2002) cite studies indicating sedges possess mechanisms that allow them to survive soil water deficits associated with declining water tables, including reduction in leaf gas exchange, reduction in aboveground biomass, and growth of roots into saturated soil.

Reed canary grass (*Phalaris arundinacea*) is also a dominant herbaceous wetland species along the North Fork and Main Stem. It is an aggressive grass known to survive prolonged drought and flooding, and possesses rhizomes capable of extending to depths of 20 inches in the soil profile (The Nature Conservancy 2002). The rhizomes and senesced stems of reed canary grass can commonly form thick sod layers (greater than 1.6 feet), significantly inhibiting native plant species diversity in wetlands. Additionally, areas dominated by reed canary grass typically perpetuate themselves for many years and provide little food for desirable wildlife (The Nature Conservancy 2002).

### 4.7.1.2.2.2 Effects on Cottonwood Woodlands

Multiyear groundwater studies were conducted for the North Fork and the Main Stem in which alluvial groundwater levels were monitored at vegetation study sites. The maximum depth to groundwater was identified during the growing season for both study areas. Conservatively using the maximum depths to groundwater and maximum predicted stage changes for the 26-year period of record for the Main Stem and 19-year period of record for the North Fork, the maximum groundwater depth during each month of the growing season was predicted for each Project Alternative (WEST 2018). The maximum predicted groundwater depths were used to evaluate potential effects to cottonwood communities within the North Fork and Main Stem study areas.

The Corps used weekly average river stage elevation data (ACE 2016a) and the correlation of river stage data and alluvial groundwater monitoring data to predict how alluvial groundwater levels would change as a function of distance from the river. The relationship between groundwater levels, river stage, and distance from the river was determined by selecting datasets from the monitoring periods that provided clear river stage increases or decreases greater than one foot over a minimum period of two weeks during
the growing season. The groundwater level changes for the selected periods were recalculated as a percent of the river stage change during the same period. For example, if the river stage change was one foot and the groundwater level change was 0.5 foot, the result was recorded as 50 percent for that monitoring well. Percentages were calculated for each well along a given transect and plotted versus distance from the river. Groundwater level changes were plotted for transects at all four vegetation study sites on the North Fork (WEST 2018). Groundwater level changes were not plotted for the Eastman Park or 59th Avenue vegetation study site transects on the Main Stem because groundwater levels at the Eastman Park transect are controlled by outside water sources (i.e., nearby lakes) and groundwater levels at the 59th Avenue transect are controlled by a relic river meander (ERO 2012a). Because a clear relationship of change in groundwater levels, river stage, and distance from the river was not evident at Eastman Park and 59th Avenue, an average of the four other study sites was calculated to estimate the percent change.

Conservatively, the maximum predicted river stage declines for each month of the growing season (May-September) were selected and used to predict the maximum groundwater level declines for eight monitoring well sites on the North Fork and sixteen monitoring well sites on the Main Stem that occur within cottonwood woodlands. The maximum predicted groundwater level declines were used to evaluate potential effects on cottonwood woodlands.

In a four-year study of Coal Creek, located along the Front Range of Colorado, Scott et al. (1999) found that mature cottonwood forests would be directly affected by activities resulting in a sustained decline of the water table of greater than or equal to 3.2 feet. This study further reported more gradual declines of about 1.6 feet had no measurable effect on mortality, stem growth, or live crown volume and produced measurable reductions only in annual branch increments. Effects from stage declines less than one foot and subsequent water table declines were considered to be negligible.

4.7.1.2.3 Inundation of Wetland and Riparian Resources

4.7.1.2.3.1 North Fork

Wetland and riparian vegetation communities can be supported by inundation from river surface water. The Corps (2010) provides a technical standard for wetland hydrology requiring that a site be inundated (flooded or ponded) or the water table is within 12 inches of the soil surface for 14 or more consecutive days during the growing season at a minimum frequency of five years in ten. Based on the Corps technical standard, the Corps assumed sites inundated for about 14 consecutive days in at least half the years of the period of record were largely dependent on inundation for their supportive hydrology. A spells analysis was conducted at 18 elevation points on the North Fork that met or exceeded these criteria based on Future Conditions hydrology (WEST 2018). The 18 elevation points correspond to wetland and riparian cover types within the study area. Inundation parameters evaluated for each spells point include the number of years during the 19-year period of record in which a 14-consecutive day spells event occurs, the average duration of the spells, and the percent of the growing season for the period of record that the sites are inundated.

The effects analysis is focused on predicted changes in the average duration of spells and changes in the percent of the growing season that sites are inundated. The 18 spells points were located in three wetland or riparian vegetation cover types including willow-shrub (shrublands dominated by sandbar willow \textit{Salix}}
exigua), alder-shrub (shrublands dominated by thinleaf alder *Alnus tenuifolia*), and herbaceous (wetlands dominated by herbaceous hydrophytes).

### 4.7.1.2.3.2 Main Stem

The Corps conducted an analysis to determine the need for performing a spells analysis for the Main Stem to evaluate potential effects to herbaceous and scrub-shrub wetland and riparian cover types. For each alternative, the Corps conducted a Future Conditions comparison to calculate the percent change in flow during the growing season for all river segments on the Main Stem. The Corps compared these percent changes to the percent change in flow calculated for the Fort Collins’ Proposed Action on the North Fork, where the Corps conducted a spells analysis and concluded there would be negligible effects. Thus, if calculated flow reductions for all alternatives (including the Fort Collins’ Proposed Action) for all segments on the Main Stem during the growing season are lower than the reduction calculated for the Proposed Action on the North Fork, there would be even less effect on herbaceous and scrub-shrub wetland and riparian cover types on the Main Stem.

The percent change in stream flows on the North Fork was greater during the growing season than on any river segments on the Main Stem for all Project Alternatives. The calculated percent flow reduction on the North Fork during the growing season for the Fort Collins’ Proposed Action was 3.9 percent, while all flow reductions associated with the Project Alternatives (including the Fort Collins’ Proposed Action) for all river segments on the Main Stem were less than 3.9 percent, and most were considerably less. Only three out of 200 calculated percent changes on the Main Stem had reductions greater than three percent, but were still less than 3.9 percent. Because the spells analysis results on the North Fork predicted no effects to herbaceous and scrub-shrub wetland cover types from the Project Alternatives, and the comparison of flow reductions due to the Project Alternatives on the Main Stem indicated even lower flow reductions than for the North Fork, the Corps concluded that a spells analysis for the Main Stem was not warranted.

### 4.7.1.3 Uncertainty

Numerous uncertainties are inherent in predicting indirect effects on wetland and riparian vegetation. All modeling aspects of the evaluation have some uncertainty in attempting to model natural variability of the affected environment. The prediction of effects on river stage and groundwater levels relies primarily on hydrologic modeling with uncertainties discussed in Section 4.3. With models, the intent is not to replicate exactly what might happen in the future, because that cannot be known, but to predict tendencies and differences in tendencies between alternatives.

### 4.7.1.4 Data Adequacy

Section 3.7 describes the best available data for wetlands, other waters, and riparian resources in the study areas. The Corps determined that the data available and methods used are adequate to evaluate and describe the reasonably foreseeable significant adverse effects on wetlands, other waters, and riparian resources, and to enable the decision maker a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable wetland and riparian resource information as described in Section 4.2.1.5.
4.7.2 Fort Collins’ Proposed Action

4.7.2.1 Direct Effects

4.7.2.1.1 Wetlands
The new inundation areas of the enlarged Halligan Reservoir, Fort Collins’ Proposed Action would result in the long-term loss of about 16.74 acres of wetlands, including 10.92 acres of palustrine scrub-shrub wetlands, 4.89 acres of lacustrine littoral emergent wetlands, 0.021 acre of palustrine emergent wetlands, and 0.91 acre of forested wetlands (Table 4-33; Figure 4-49). Although the long-term loss of 16.74 acres of wetlands would be considered a major effect, the majority of the loss (89 percent; 14.9 acres) would occur to wetlands along or below the ordinary high water mark of the existing reservoir. An analysis was conducted to evaluate the soil, slope, and water level fluctuations at the ordinary high water mark of Halligan Reservoir to estimate the natural future reestablishment of wetlands that would likely occur at the expanded Halligan Reservoir (Fort Collins 2017; Appendix 1). Based on the analysis, the Corps expects that 10.9 acres of similar wetlands would reestablish over time along the ordinary high water mark of the new reservoir, thus reducing the severity of the loss. Considering the majority of the long-term loss of 16.74 acres would occur along or below the ordinary high water mark of the existing reservoir and the expectation for 10.9 acres to reestablish, the Corps considers the net effect would be approximately 5.84 acres and determined that to be a moderate effect.

4.7.2.1.2 Other Waters
A total of 4.29 acres of other waters, namely a portion of the existing North Fork upstream of Halligan Reservoir and associated tributaries, would be inundated due to reservoir enlargement (Table 4-33; Figure 4-49). This includes about 4.03 acres of perennial tributaries and about 0.26 acre of intermittent or ephemeral tributaries. Without considering the effect of the Fort Collins’ Proposed Action, the long-term loss of 4.03 acres of perennial streams, which includes 3.5 acres of riffle-and-pool complex (Section 4.8.2), would be considered a moderate effect because of the magnitude of loss. Loss of 0.26 acre of intermittent or ephemeral waters would be considered a minor effect.

4.7.2.1.3 Riparian Resources
Fort Collins’ Proposed Action would result in the long-term loss of 8.5 acres of riparian shrublands and 2.6 acres of riparian woodlands (Table 4-33; Figure 4-49). These riparian communities are relatively common in the region but because of their ecological importance and the magnitude of loss the permanent net effect would be considered moderate.

4.7.2.1.4 Wetland Ecological Function
Using baseline Functional Capacity Index scores from the FACWet analysis (Fort Collins 2017, Appendix 1), the number of baseline Ecological Functional Units was calculated for wetlands within Fort Collins’ Proposed Action study area (Table 4-33). Similarly, post-project Ecological Functional Units were calculated using post-project Functional Capacity Index scores. For all assessment areas, the post-
project Functional Capacity Index scores remain the same as the baseline. Assessment areas included wetlands along the North Fork upstream of the reservoir between the existing and proposed ordinary high water mark, fringe wetlands above and below the ordinary high water mark of Halligan Reservoir, wetlands along tributaries to Halligan Reservoir above the existing ordinary high water mark and wetlands along the North Fork inlet channel between the existing ordinary high water mark and Halligan fringe wetlands. The Fort Collins’ Proposed Action would result in a direct loss of 16.75 acres of wetlands which have 10.92 Ecological Function Units. However, it is anticipated that 10.92 acres of wetlands will reestablish (Section 4.7.2.1.1) resulting in a gain of 6.88 Ecological Functional Units. The overall difference between the baseline Ecological Functional Units and post-project Ecological Functional Units (i.e., net loss or lift) was calculated for each wetland and then totaled for all wetlands associated with direct impacts. Fort Collins’ Proposed Action would result in a net functional loss of 4.04 Ecological Functional Units (Table 4-34).

4.7.2.2 Indirect Effects

4.7.2.2.1 North Fork

4.7.2.2.1.1 Changes in Groundwater and River Stage

Effects on Herbaceous and Shrub-Dominated Wetland Vegetation
Under the Future Conditions comparison (see Section 4.3 for a description of this comparison), only one site (Halligan Dam) is predicted to have a weekly stage decline of 0.5 foot or greater for two-consecutive-week and four-consecutive-week periods with implementation of Fort Collins’ Proposed Action compared to the Future Conditions baseline. The decline is predicted to occur in only one year (one percent) of the period of record. One percent is well below the threshold of 24 percent, therefore it is unlikely to have an adverse effect on herbaceous and shrub-dominated wetlands throughout the North Fork.

In addition to evaluating weekly declines of 0.5 foot or greater, the Corps reviewed the growing season weekly average river stage data for declines greater than two feet occurring for two consecutive weeks and four consecutive weeks for the period of record. Under Future Conditions comparisons, there are no weeks of declines greater than two feet during the growing season for the period of record within any of the North Fork study sites with implementation of Fort Collins’ Proposed Action compared to Future Conditions (WEST 2018).

Based on a review of river stage data for the Future Conditions baseline, the weekly average river stage on the North Fork for the 19-year period of record showed periodic low flow events (one to four cubic feet per second) occurring primarily during the winter months (October – April). Although the events occur outside the growing season, winter low flows can have at least some effect on wetland and riparian functions. With the additional three cubic feet per second from the Winter Release Plan, the winter low flow events on the North Fork are predicted to be less frequent (Section 4.3.1). Benefits from the additional winter flow were determined qualitatively to possibly include an increase in alluvial groundwater recharge and enhancement of wetland and riparian communities along the North Fork.
### Table 4-33. Direct effects on wetlands, other waters, and riparian resources for Fort Collins’ Proposed Action.

<table>
<thead>
<tr>
<th>Effect Feature</th>
<th>Effect Type</th>
<th>Palustrine</th>
<th>Lacustrine</th>
<th>Other Waters</th>
<th>Riparian</th>
<th>Total Acres Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Scrub-shrub</td>
<td>Emergent</td>
<td>Forested</td>
<td>Littoral Emergent</td>
<td>Woodlands</td>
</tr>
<tr>
<td>Inundation area</td>
<td>Long-term</td>
<td>10.92</td>
<td>0.02</td>
<td>0.91</td>
<td>4.89</td>
<td>4.29</td>
</tr>
<tr>
<td>Total Acres</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16.74</td>
</tr>
</tbody>
</table>

### Table 4-34. Fort Collins’ Proposed Action baseline and post-project wetland acres, functional capacity index, ecological functional units, and net loss/lift.

<table>
<thead>
<tr>
<th>Assessment Area</th>
<th>Baseline Conditions</th>
<th>Post-Project Conditions</th>
<th>Net Loss/Lift</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline Wetland Acres</td>
<td>Baseline FCI¹</td>
<td>Baseline EFUs²</td>
</tr>
<tr>
<td>North Fork upstream above OHWM³</td>
<td>1.51</td>
<td>0.92</td>
<td>1.39</td>
</tr>
<tr>
<td>North Fork upstream below OHWM³</td>
<td>2.99</td>
<td>0.76</td>
<td>2.27</td>
</tr>
<tr>
<td>Halligan fringe above OHWM³</td>
<td>3.2</td>
<td>0.72</td>
<td>2.30</td>
</tr>
<tr>
<td>Halligan fringe below OHWM³</td>
<td>8.64</td>
<td>0.53</td>
<td>4.58</td>
</tr>
<tr>
<td>Halligan small tributaries above existing OHWM³</td>
<td>0.41</td>
<td>0.92</td>
<td>0.38</td>
</tr>
<tr>
<td>Total</td>
<td>16.75</td>
<td>3.85</td>
<td>10.92</td>
</tr>
</tbody>
</table>

¹FCI = Functional Capacity Index, ²EFU = Ecological Functional Unit, ³OHWM = ordinary high water mark
*Based on an estimated distribution of Pioneer Environmental Services’ (2016) 10.9 acres of predicted wetland re-establishment.

**Post-Project FCI includes Fort Collins’ Summer Plan.
Table 4-35. Fort Collins’ Proposed Action baseline and post-project wetland acres, functional capacity index, ecological functional units, and net loss/lift for indirect impacts on the North Fork downstream of Halligan Dam.

<table>
<thead>
<tr>
<th>Assessment Area</th>
<th>Baseline Conditions</th>
<th>Post-Project Conditions</th>
<th>Net Loss/Lift</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Baseline</td>
<td>Post-Project</td>
</tr>
<tr>
<td></td>
<td>Wetland Acres</td>
<td>FCI&lt;sup&gt;1&lt;/sup&gt;</td>
<td>EFUs&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>North Fork downstream of Halligan</td>
<td>46.89</td>
<td>0.80</td>
<td>37.51</td>
</tr>
<tr>
<td>Reservoir</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>46.89</td>
<td>0.80</td>
<td>37.51</td>
</tr>
</tbody>
</table>

<sup>1</sup>FCI = Functional Capacity Index,  <sup>2</sup>EFU = Ecological Functional Unit

*Based on an estimated distribution of Pioneer Environmental Services (2016) 10.9 acres of predicted wetland re-establishment.

**Post-Project FCI includes Fort Collins’ Summer Plan.
Figure 4-49. Fort Collins’ Proposed Action effects to wetlands, other waters, and riparian resources.
The Summer Plan would ensure a minimum base flow of five cubic feet per second in the study area, resulting in an increase in stream width and saturated area compared to the Future Conditions Baseline. The minimum flow would eliminate dry-ups along the North Fork channel, resulting in increased soil moisture available to adjacent wetland and riparian vegetation and increased stream continuity. The minimum five cubic feet per second flow would also reduce the extent that groundwater fluctuates during the growing season, which may assist in reestablishment of more desirable wetland plants less tolerant of large fluctuations in the water table. Overall, the Winter Release and Summer Plans would provide a minor benefit to herbaceous and shrub-dominated wetland vegetation along the North Fork.

Effects on Cottonwood Woodlands
Cottonwood woodlands were mapped only at the Eagle’s Nest North Fork vegetation study site. Based on evaluation of maximum predicted stage changes during the growing season for the 19-year period of record, the largest predicted groundwater level declines for Fort Collins’ Proposed Action, when compared to the Future Conditions baseline, were predicted to occur at the Eagles Nest groundwater monitoring well within the cottonwood woodland. When compared to the Future Conditions baseline, groundwater levels at the Eagles Nest monitoring well would be slightly more than 0.5 foot lower (0.58 foot and 0.56 foot) during one week in the months of May and June; 0.17 foot lower in July; 0.06 foot lower in August; and no different in September (WEST 2018). The two predicted declines greater than 0.5 foot represent less than one percent of the growing season for the 19-year period of record and their effects to cottonwood woodlands are considered negligible. The water table in this area fluctuates over 3.5 feet during the growing season and a 0.58-foot decline is well within this normal fluctuation. The Corps concludes that effects would likely be comparable for any cottonwood woodland with similar natural hydrology within the North Fork study area.

4.7.2.2.1.2 Change in Duration of Inundation during the Growing Season
The change in the average duration of inundation during the growing season was determined for the vegetation cover types represented by the 18 spells points for Fort Collins’ Proposed Action as compared to the Future Conditions baseline. Based on the spells results for the Future Conditions comparison, the higher-elevation alder-shrub vegetation cover type was inundated for an average of 12.5 days per year for the 19-year period of record, the willow-shrub cover type was inundated for an average of 21.7 days and the herbaceous vegetation cover type was inundated for an average of 45.4 days. None of the cover types showed a decrease in the average duration of inundation events; instead the average duration of inundation events increased by 0.8 day across all cover types. Inundation increased by an average of 0.3 day for the alder-shrub cover type, 0.6 day for the willow-shrub cover type, and 0.8 day for the herbaceous cover type.

Any large decreases (several days to a week) in the average duration of inundation events associated with Fort Collins’ Proposed Action would be expected to have a negative effect on wetland and riparian cover types within the North Fork study area. Such effects could include increased water stress on existing plants by reducing soil saturation, mortality of wetland and riparian plants, and change in species composition toward plant species more intolerant of inundation and/or soil saturation. Based on only slight changes in the average duration of inundation events, the Corps considers effects from Fort Collins’ Proposed Action compared to the Future Conditions baseline to be negligible.
4.7.2.2.1.3 Wetland Ecological Function

Similar to direct impacts, indirect impacts on the North Fork were calculated using baseline Functional Capacity Index scores from the FACWet analysis (Fort Collins 2017, Appendix 1), and the number of baseline Ecological Functional Units was calculated for wetlands along the North Fork study area (Table 4-35). Post-project Ecological Functional Units also were calculated using post-project Functional Capacity Index scores. The Summer Plan would benefit wetlands along the North Fork downstream of Halligan Reservoir, as these wetlands had slightly increased post-project Functional Capacity Index scores compared to baseline. The difference between the baseline and post-project Ecological Functional Units (i.e., net loss or lift) was calculated for each wetland and then totaled for all wetlands associated with indirect impacts. Fort Collins’ Proposed Action would result in a net functional lift of 1.41 Ecological Functional Units (Table 4-34).

4.7.2.2 Upper Poudre and Main Stem

4.7.2.2.1 Upper Poudre

Fort Collins’ Proposed Action would result in slightly reduced annual stream flows (averaging one percent) on the Upper Poudre between the Munroe Canal and Fort Collins intake to the confluence with the North Fork (approximately 0.5 mile). The greatest reductions would occur during June and July. Wetlands would potentially be effected by reduced flows that resulted in an extended dry period. As described in Section 4.3.3.3.4, the percent of years with extremely low flows would not change; however, the duration of flows less than 10 and five cubic feet per second would extend from 16 to 25 and four to five days, respectively, which may result in a negligible change to wetlands along this reach of the Upper Poudre.

4.7.2.2.2 Changes in Groundwater and River Stage

Effects to Herbaceous and Shrub-Dominated Wetland Vegetation

Fort Collins’ Proposed Action would result in river stage declines of 0.5 foot or greater for two consecutive weeks at the Martinez Park and 59th Avenue vegetation study sites for less than one percent and at the Eastman Park study site for one percent of the period of record compared to the Future Conditions baseline. The evaluation also indicated a decline of 0.5 foot or greater for four consecutive weeks or more in one year and less than one percent of the 26-year period of record for the Eastman study area. These declines in river stage and corresponding declines in groundwater are well below the threshold of 19 percent, and are therefore unlikely to have an adverse effect on herbaceous and shrub-dominated wetlands along the Main Stem.

The Corps also compared the growing season weekly average river stage data for Fort Collins’ Proposed Action to the Future Conditions baseline and found no declines greater than two feet occurring for two consecutive weeks and four consecutive weeks for the period of record (WEST 2018). Based on this evaluation of the predicted weekly stage declines of 0.5 foot or greater and two feet or greater, potential effects to herbaceous wetlands and shrub-dominated riparian vegetation occurring along or near the river within the six Main Stem study sites are negligible under Fort Collins’ Proposed Action. Furthermore, herbaceous and shrub wetlands along the Main Stem are predominantly composed of reed canarygrass.
and sandbar willow (ERO 2012b). Both of these species are known to tolerate prolonged periods of
inundation as well as drought, and sandbar willow can access groundwater at much greater depths than
herbaceous vegetation.

**Effects to Cottonwood Woodlands**

Under the Future Conditions comparison of Fort Collins’ Proposed Action, most of the predicted river
stage declines are less than one foot, and the majority are less than 0.5 foot (WEST 2018). The predicted
decreases greater than 0.5 foot typically occur during one month of the May through September growing
season and represent one percent or less of the growing season for the period of record. These declines are
well within the observed range of groundwater levels during the growing season recorded in monitoring
wells associated with plains cottonwood at the Main Stem study sites. The effects associated with these
decreases are considered to be negligible.

### 4.7.2.2.2.3 Inundation of Wetland and Riparian Resources

Because the spells analysis results on the North Fork predicted negligible effects to herbaceous and scrub-
shrub wetland cover types from Fort Collins’ Proposed Action, and the comparison of flow reductions
due to the Project Alternatives on the Main Stem indicated even lower flow reductions than for the North
Fork, the Corps concluded that a spells analysis for the Main Stem was not warranted. Refer to the
discussion in Section 4.7.1 for more details.

### 4.7.3 Expanded Glade Alternative

#### 4.7.3.1 Direct Effects

##### 4.7.3.1.1 Wetlands

Construction of the proposed Glade Reservoir as part of the NISP Alternative 2 in the NISP Supplemental
Draft EIS (Corps 2015) would inundate 41.6 acres of wetlands. The Expanded Glade Alternative would
result in an additional loss of 0.1 acre of emergent wetlands due to inundation (Table 4-36; Figure 4-50).
Long-term loss of 0.1 acre of emergent wetland would be considered a minor effect. It is reasonable that
additional wetlands could establish along the Expanded Glade shoreline. Access roads and pipeline
buffers would result in short-term effects to 1.12 acres of emergent wetlands, which would be considered
a minor effect.

##### 4.7.3.1.2 Other Waters

Access road construction would result in the long-term loss of about 0.6 acre of ditches or canals (other
waters; Table 4-36; Figure 4-50), which are artificial water conveyance features excavated in uplands.
This would be considered a minor effect based on the small size of impact.

About 2.2 acres of other waters, including ponds, creeks, and ditches, would be temporarily affected by
access road and pipeline buffers. This would be considered a minor effect.
4.7.3.1.3 Riparian Resources

The Expanded Glade Alternative would permanently inundate 0.01 acre of riparian woodland (Table 4-36; Figure 4-50). Long-term loss of 0.01 acre of riparian woodland would be considered a minor effect as the loss would not substantially affect the overall distribution or abundance of riparian woodland in the area.

The Expanded Glade Alternative would include the Glade Release Pipeline that would be constructed across under the Main Stem using an open trench method. Construction associated with pipeline installation would temporarily affect about 2.5 acres of riparian woodlands (Table 4-36; Figure 4-50). The vegetation would be removed during construction and the disturbance area would be revegetated with appropriate species following construction. Replacement of the riparian woodland canopy currently present would likely take decades after construction. Temporary effects on riparian woodlands are considered moderate because of the length of time required for successful revegetation of these woodlands.

4.7.3.1.4 Wetland Ecological Functions

The Functional Capacity Index was calculated as 0.89 for the 0.1 acre of wetlands within the Expanded Glade Alternative study area that would have long-term effects (Section 3.1.6.4). The Ecological Functional Units for these wetlands (the Functional Capacity Index multiplied by the acres of the wetland) is 0.081. Therefore, the Expanded Glade Alternative would result in a loss of 0.081 Ecological Functional Units.

4.7.3.2 Indirect Effects

4.7.3.2.1 North Fork

When compared to the Future Conditions baseline, the Expanded Glade Alternative would have a negligible effect on stream flow in the North Fork (CDM Smith 2016) and therefore was not evaluated for changes in groundwater and resulting effects on herbaceous and shrub-dominated wetland vegetation. Similarly, due to the negligible effect on stream flow in the North Fork, the evaluation related to inundation was not conducted on the North Fork.
Table 4-36. Direct effects on wetlands, other waters, and riparian resources for the Expanded Glade Alternative.

<table>
<thead>
<tr>
<th>Effect Feature</th>
<th>Effect Type</th>
<th>Wetlands</th>
<th>Other Waters</th>
<th>Riparian</th>
<th>Total Acres Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Palustine Emergent</td>
<td></td>
<td>Woodlands</td>
<td>Shrublands</td>
</tr>
<tr>
<td>Inundation area</td>
<td>Long-term</td>
<td>0.1</td>
<td>0</td>
<td>0.01</td>
<td>0</td>
</tr>
<tr>
<td>Access roads</td>
<td>Long-term</td>
<td>0</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td><strong>Long-term</strong></td>
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<td><strong>0.6</strong></td>
<td><strong>0.01</strong></td>
<td><strong>0</strong></td>
</tr>
<tr>
<td>Pipeline</td>
<td>Short-term</td>
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<td>1.2</td>
<td>2.5</td>
<td>0</td>
</tr>
<tr>
<td>Access roads</td>
<td>Short-term</td>
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<td>1.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td><strong>Short-term</strong></td>
<td><strong>1.12</strong></td>
<td><strong>2.2</strong></td>
<td><strong>2.5</strong></td>
<td><strong>0.0</strong></td>
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<tr>
<td><strong>Total Acres</strong></td>
<td></td>
<td>1.22</td>
<td>2.8</td>
<td>2.51</td>
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</tbody>
</table>
Figure 4-50. Expanded Glade Alternative effects to wetlands, other waters, and riparian resources.
4.7.3.2.2 Upper Poudre and Main Stem

4.7.3.2.2.1 Upper Poudre

As a result of the Expanded Glade Alternative, annual stream flow on the Upper Poudre between the Munroe Canal and Fort Collins intake to the confluence with the North Fork (approximately 0.5 mile) would be slightly reduced (averaging 0.8 percent). The greatest reductions would occur during May, June and July. Wetlands would potentially be affected by reduced flows that result in an extended dry period. As described in Section 4.3.4.3.4, the percent of years with extremely low flows would not change; however, the duration of flows less than 10 cubic feet per second would decrease from 56 to 45 days while the duration of days with five cubic feet per second would remain constant at 11 days, which may result in a negligible change to wetlands along this reach of the Upper Poudre.

4.7.3.2.2.2 Changes in Groundwater and River Stage

Herbaceous and Shrub-Dominated Wetland Vegetation

Under the Future Conditions comparison, the Expanded Glade Alternative is predicted to have the highest occurrences of declines of 0.5 foot or greater during the growing season. At the Martinez Park study site, 0.5-foot declines for two consecutive weeks are predicted to occur for 13 years, or seven percent of the 26-year period of record and 0.5 foot declines for four consecutive weeks are predicted to occur for five years, or four percent of the period of record. At the Eastman Park study site, 0.5-foot declines for two consecutive weeks are predicted to occur for five years, or three percent of the 26-year period of record and 0.5 foot declines for four consecutive weeks are predicted to occur for three years, or two percent of the period of record. Even though the Expanded Glade Alternative in the Future Conditions comparison is predicted to have the largest declines of 0.5 foot or greater during the growing season compared to the other Project Alternatives, the predicted declines are well below the established threshold of 19 percent. Therefore, the Expanded Glade Alternative is unlikely to have an adverse effect on herbaceous and shrub-dominated wetlands along the Main Stem. The Corps also compared the growing season weekly average river stage data for the Expanded Glade Alternative to Future Conditions with NISP and found no declines greater than two feet occurring two consecutive weeks and four consecutive for the period of record (WEST 2018).

Based on this evaluation of the predicted weekly stage declines of 0.5 foot or greater and two feet or greater, potential effects to herbaceous wetlands and shrub-dominated riparian vegetation occurring along or near the river within the six Main Stem study sites are negligible under the Expanded Glade Alternative. As stated for the Fort Collins’ Proposed Action, herbaceous and shrub wetlands along the Main Stem are predominantly composed of reed canarygrass and sandbar willow (ERO 2012b). Both of these species are known to tolerate prolonged periods of inundation as well as drought, and sandbar willow can access groundwater at much greater depths than herbaceous vegetation.

Cottonwood Woodlands

The highest overall predicted maximum river stage declines of 0.5 foot or greater would occur at Martinez Park under the Expanded Glade Alternative compared to Future Conditions with NISP (WEST 2018). River stage declines of two weeks are predicted to occur for seven percent (13 years) of the period of record (26 years). River stage declines of four consecutive weeks or six total non-consecutive weeks
within the growing season are predicted to occur for four percent (five years) of the 26-year period of record at Martinez Park (WEST 2018). Four percent of the period of record is well below the effect threshold of 19 percent established for herbaceous and shrub-dominated wetlands. Additionally, the predicted declines typically occur during one month of the May through September growing season and are well within the observed range of groundwater levels during the growing season recorded in monitoring wells associated with plains cottonwood at the Main Stem study sites. The effects associated with these declines are considered to be negligible.

4.7.3.2.3 Inundation of Wetland and Riparian Resources

Because the spells analysis results on the North Fork predicted negligible effects to herbaceous and scrub-shrub wetland cover types from Fort Collins’ Proposed Action, and the comparison of flow reductions due to the Project Alternatives on the Main Stem indicated even lower flow reductions than for the North Fork, the Corps concluded that a spells analysis for the Main Stem was not warranted. Refer to the discussion in Section 4.7.1 for more details.

4.7.4 Gravel Pits Alternative

4.7.4.1 Direct Effects

4.7.4.1.1 Wetlands

A total of 4.3 acres of wetlands around the perimeter of the Gravel Pits would be permanently lost either from inundation or physical removal to facilitate lining and shoreline erosion protections (i.e., placement of rip-rap). These wetlands are composed of lacustrine forested (1.7 acres), lacustrine scrub-shrub (1.5 acres), and lacustrine emergent (1.1 acres) wetlands (Table 4-37; Figure 4-51). Long-term loss of these wetlands would be considered a moderate effect because of the magnitude of the loss.

Temporary effects to wetlands would occur due to construction activities associated with the proposed pipeline crossing on the Main Stem. These include 0.19 acre of scrub-shrub wetlands and 0.07 acre of forested wetlands (Table 4-37; Figure 4-51). At these locations the vegetation would be temporarily removed during construction and disturbed areas would be revegetated with appropriate species following construction. Temporary effects to the scrub-shrub wetlands at the pipeline crossing are considered minor because the sandbar willows that dominate these wetlands are very common along the Main Stem and would likely reestablish rapidly. Temporary effects to the 0.07 acre of forested wetlands are considered moderate because of the length of time required for reestablishment of these wetlands and their infrequency along the Main Stem in the region. Additional temporary effects on wetlands in the Gravel Pits Alternative study area include about 0.017 acre of emergent wetlands, which would be considered a minor effect.
4.7.4.1.2 Other Waters

A total of 0.3 acre of other waters (ponds and ditches) would be permanently lost due to access road construction (Table 4-37; Figure 4-51). These are artificial water storage and conveyance features excavated entirely in an upland setting, and their loss would be considered a minor effect.

Temporary effects would occur to 2.9 acres of other waters, including ponds, creeks, and ditches. This would be considered a minor effect.

4.7.4.1.3 Riparian Resources

Temporary effects to riparian resources would occur from construction activities associated with the proposed pipeline crossing on the Main Stem. These include 0.03 acre of riparian shrublands and 2.1 acres of riparian woodlands (Table 4-37; Figure 4-51). At these locations the vegetation would be temporarily removed during construction and disturbed areas would be revegetated with appropriate species following construction. However, full replacement of the black willow and plains cottonwood forest canopy currently present would not occur for decades. Temporary effects on riparian shrublands and woodlands would be considered moderate because of the length of time required for their successful revegetation.

4.7.4.1.1 Wetland Ecological Functions

The Functional Capacity Index was calculated as 0.64 for the 4.3 acres of wetlands within the Gravel Pits Alternative study area that would have long-term impacts (Section 3.1.7.4). The Ecological Functional Units for these wetlands (the Functional Capacity Index multiplied by the acres of the wetland) is 2.75. No wetlands are expected to form around the gravel pits after construction. Therefore, the Gravel Pits Alternative would result in a loss of 2.75 Ecological Functional Units.

4.7.4.2 Indirect Effects

4.7.4.2.1 North Fork

When compared to the Future Conditions baseline, the Gravel Pits Alternative would have a negligible effect on stream flow in the North Fork (CDM Smith 2016) and therefore was not evaluated for changes in groundwater and resulting effects on herbaceous and shrub-dominated wetland vegetation. Similarly, due to the negligible effect on stream flow in the North Fork, the evaluation related to inundation was not conducted on the North Fork.
Table 4-37. Direct effects on wetlands, other waters, and riparian Resources for the Gravel Pits Alternative.

<table>
<thead>
<tr>
<th>Effect Feature</th>
<th>Effect Type</th>
<th>Wetlands</th>
<th></th>
<th></th>
<th>Riparian</th>
<th>Total Acres Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Palustrine</td>
<td>Lacustrine</td>
<td>Other Waters</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Forested</td>
<td>Scrub-Shrub</td>
<td>Emergent</td>
<td>Forested</td>
<td>Scrub-Shrub</td>
</tr>
<tr>
<td>Inundation area</td>
<td>Long-term</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.7</td>
<td>1.5</td>
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<tr>
<td>Access roads</td>
<td>Long-term</td>
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<td>0.0</td>
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<td>0.0</td>
</tr>
<tr>
<td>Sub-total</td>
<td>Long-term</td>
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<td>0.0</td>
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<td>1.7</td>
<td>1.5</td>
</tr>
<tr>
<td>Access roads</td>
<td>Short-term</td>
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</tr>
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<td>Pipeline</td>
<td>Short-term</td>
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<td>Sub-total</td>
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<td>0.017</td>
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<tr>
<td>Total Acres</td>
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<td>0.07</td>
<td>0.19</td>
<td>0.017</td>
<td>1.7</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Figure 4-51. Gravel Pits Alternative effects to wetlands, other waters, and riparian resources.
4.7.4.2.2 Upper Poudre and Main Stem

4.7.4.2.2.1 Upper Poudre

Under the Gravel Pits Alternative annual stream flow on the Upper Poudre between the Munroe Canal and Fort Collins intake to the confluence with the North Fork (approximately 0.5 mile) would be slightly reduced (averaging 0.5 percent). The greatest reductions would occur during May, June and July. The change in extreme stream flow metrics for this alternative (Section 4.3.5.3.4) would be similar to Fort Collins’ Proposed Action and result in a negligible change to wetlands along this reach of the Upper Poudre.

4.7.4.2.2.2 Changes in Groundwater and River Stage

Herbaceous and Shrub-Dominated Wetland Vegetation

Under the Future Conditions comparison, the only river stage declines of 0.5-foot or greater were at Martinez Park and Eastman Park. At the Martinez Park study site, 0.5-foot declines for two consecutive weeks are predicted to occur for one year, or one percent of the 26-year period of record, and 0.5 foot declines for four consecutive weeks are predicted for one year, or four percent of the period of record. At the Eastman Park study site, 0.5-foot declines for two consecutive weeks are predicted to occur for two years, or one percent of the 26-year period of record, and declines of four consecutive weeks are predicted for one year, or less than one percent of the period of record. When compared to the Future Conditions baseline, the predicted declines are well below the established threshold of 19 percent. Therefore, the Gravel Pits Alternative would have a negligible effect on herbaceous and shrub-dominated wetlands along the Main Stem under the Future Conditions comparison.

The review of the growing season weekly average river stage data for declines compared to Future Conditions indicated no weeks of declines greater than two feet for the period of record (WEST 2018) for the Gravel Pits Alternative. Based on this evaluation of the predicted weekly stage declines of 0.5 foot or greater and two feet or greater, potential effects to herbaceous and shrub-dominated riparian vegetation occurring along or near the river within the six Main Stem study sites are negligible under the Gravel Pits Alternative. As stated for Fort Collins’ Proposed Action, herbaceous and shrub wetlands along the Main Stem are predominantly composed of reed canarygrass and sandbar willow (ERO 2012b). Both of these species are known to tolerate prolonged periods of inundation as well as drought, and sandbar willow can access groundwater at much greater depths than herbaceous vegetation.

Cottonwood Woodlands

Under the Future Conditions comparison, the Gravel Pits Alternative would have the lowest predicted stage declines compared to the other alternatives, with only two declines greater than one foot. These occur at Martinez Park in May (1.62 feet) and August (1.52 feet). Additionally, the predicted declines typically occur during one month of the May through September growing season and are well within the observed range of groundwater levels during the growing season recorded in monitoring wells associated with plains cottonwood at the Main Stem study sites. The effects associated with these declines are considered to be negligible.
4.7.4.2.3 Inundation of Wetland and Riparian Resources

Because the spells analysis results on the North Fork predicted negligible effects to herbaceous and scrub-shrub wetland cover types from Fort Collins’ Proposed Action, and the comparison of flow reductions due to the Project Alternatives on the Main Stem indicated even lower flow reductions than for the North Fork, the Corps concluded that a spells analysis for the Main Stem was not warranted. Refer to the discussion in Section 4.7.1 for more details.

4.7.5 Agricultural Reservoirs Alternative

4.7.5.1 Direct Effects

4.7.5.1.1 Wetlands

A total of 0.32 acre of palustrine emergent wetlands would be permanently lost due to the placement of a pipeline in the ditch extending from the Agricultural Reservoirs to the Larimer County Canal (Table 4-38; Figure 4-52 through Figure 4-55). This long-term loss of palustrine emergent wetlands would be considered a minor effect.

Similar to the Gravel Pits Alternative, temporary effects to wetlands would occur from construction activities associated with the proposed pipeline crossing on the Main Stem. These include 0.19 acre of scrub-shrub wetlands and 0.07 acre of forested wetlands (Table 4-38; Figure 4-52 through Figure 4-55). Temporary effects to the scrub-shrub wetlands at the pipeline crossing are considered minor because the sandbar willows that dominate these wetlands are very common along the Main Stem and would likely reestablish rapidly. Temporary effects to the 0.07 acre of forested wetlands are considered moderate because of the length of time required for reestablishment of these wetlands and their infrequency along the Main Stem in the region. Additional temporary effects on wetlands in the Agricultural Reservoirs Alternative study area include about 2.3 acres of emergent wetlands from pipeline construction and clearing for staging areas. This would be considered a minor effect.

4.7.5.1.2 Other Waters

A total of 5.8 acres of other waters, including ponds, creeks, and ditches, would be temporarily affected from access road and pipeline buffers and staging areas (Table 4-38; Figure 4-52 through Figure 4-55). This would be considered a minor effect.

4.7.5.1.3 Riparian Resources

Temporary effects to riparian resources would occur from construction activities associated with the proposed pipeline crossing on the Main Stem. These include 0.03 acre of riparian shrublands and 2.1 acres of riparian woodlands (Table 4-38; Figure 4-52 through Figure 4-55). Temporary effects on riparian shrublands and woodlands would be considered moderate because of the length of time required for their successful revegetation.
Table 4-38. Direct effects on wetlands, other waters, and riparian resources for the Agricultural Reservoirs Alternative.

<table>
<thead>
<tr>
<th>Effect Feature</th>
<th>Effect Type</th>
<th>Wetlands</th>
<th>Other Waters</th>
<th>Riparian</th>
<th>Total Acres Affected</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Palustrine</td>
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<td>Lacustine</td>
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<td></td>
<td>Forested</td>
<td>Scrub-shrub</td>
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<td>Forested</td>
</tr>
<tr>
<td>Pipeline</td>
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<td>0.32</td>
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</tr>
<tr>
<td>Sub-total</td>
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<td>0.32</td>
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</tr>
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<td>Access road buffers</td>
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<td>0.0</td>
</tr>
<tr>
<td>Pipeline</td>
<td>Short-term</td>
<td>0.07</td>
<td>0.19</td>
<td>2.29</td>
<td>0.0</td>
</tr>
<tr>
<td>Staging areas</td>
<td>Short-term</td>
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<td>0.0</td>
<td>2.595</td>
<td>0.0</td>
</tr>
<tr>
<td>Sub-total</td>
<td>Short-term</td>
<td>0.07</td>
<td>0.19</td>
<td>4.885</td>
<td>0.0</td>
</tr>
<tr>
<td>Total Acres</td>
<td></td>
<td>0.07</td>
<td>0.19</td>
<td>5.205</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Figure 4-52. Agricultural Reservoirs Alternative effects on wetlands, other waters, and riparian resources.
Figure 4-53. Agricultural Reservoirs Alternative effects on wetlands, other waters, and riparian resources, continued.
Figure 4-54. Agricultural Reservoirs Alternative effects on wetlands, other waters, and riparian resources, continued.
Figure 4-55. Agricultural Reservoirs Alternative effects on wetlands, other waters, and riparian resources, continued.
4.7.5.1.4  **Wetland Ecological Functions**

The Functional Capacity Index scores were calculated as 0.63 for the 0.32 acre of ditch wetlands within the Agricultural Reservoirs Alternative study area that would have long-term effects (Section 3.1.7.4). The Ecological Functional Units for these wetlands (the Functional Capacity Index multiplied by the acres of the wetland) is 0.2 (Table 4-34). Under the Agricultural Reservoirs Alternative, wetland fringes around the two reservoirs are expected to remain unchanged. Therefore, the Agricultural Reservoirs Alternative would result in a loss of 0.20 Ecological Functional Units.

4.7.5.2  **Indirect Effects**

4.7.5.2.1  **North Fork**

When compared to Future Conditions baseline, the Agricultural Reservoirs Alternative would have a negligible effect on stream flow in the North Fork (CDM Smith 2016), and therefore was not evaluated for changes in groundwater and resulting effects on herbaceous and shrub-dominated wetland vegetation. Similarly, due to the negligible effect on stream flow in the North Fork, the evaluation related to inundation was not conducted on the North Fork.

4.7.5.2.2  **Upper Poudre and Main Stem**

4.7.5.2.2.1  **Upper Poudre**

The change in annual stream flow on the Upper Poudre between the Munroe Canal and Fort Collins intake to the confluence with the North Fork (approximately 0.5 mile) as a result of the Agricultural Reservoirs Alternative would result in slightly reduced annual stream flows (averaging 1.5 percent). The greatest reductions would occur during May, June and July. The change in extreme stream flow metrics for this alternative (Section 4.3.6.3.4) would be similar to the Fort Collins’ Proposed Action and result in a negligible change to wetlands along this reach of the Upper Poudre.

4.7.5.2.2.2  **Changes in Groundwater and River Stage**

**Herbaceous and Shrub-Dominated Wetland Vegetation**

Under the Future Conditions comparison, the only river stage declines of 0.5-foot or greater were at the Eastman Park and 59th Avenue sites. At the Eastman Park study site, 0.5-foot declines for two consecutive weeks are predicted to occur for four years, or two percent of the 26-year period of record, and 0.5 foot declines for four consecutive weeks are predicted for one year, or less than one percent of the period of record. At the 59th Avenue study site, 0.5-foot declines for two consecutive weeks are predicted to occur for eight years, or five percent of the 26-year period of record, and 0.5 foot declines for four consecutive weeks are predicted for two years, or one percent of the period of record. When compared to the Future Conditions baseline, the predicted declines are well below the established threshold of 19 percent. Therefore, the Agricultural Reservoirs Alternative would have a negligible effect on herbaceous and shrub-dominated wetlands throughout the Main Stem under the Future Conditions comparison.
The review of the growing season weekly average river stage data for declines compared to Future Conditions indicated no weeks of declines greater than two feet for the period of record (WEST 2018) for the Agricultural Reservoir Alternative. Based on this evaluation of the predicted weekly river stage declines of 0.5 foot or greater and two feet or greater, potential effects to herbaceous wetlands and shrub-dominated riparian vegetation occurring along or near the river within the six Main Stem study sites are negligible under the Agricultural Reservoirs Alternative. As stated for Fort Collins’ Proposed Action, herbaceous and shrub wetlands along the Main Stem are predominantly composed of reed canarygrass and sandbar willow (ERO 2012b). Both of these species are known to tolerate prolonged periods of inundation as well as drought, and sandbar willow can access groundwater at much greater depths than herbaceous vegetation.

**Cottonwood Woodlands**

Under the Future Conditions comparison, the Agricultural Reservoirs Alternative would have the largest predicted decline at Eastman Park. River stage is predicted to decline 2.68 feet for the month of June at Eastman Park, with declines of less than one foot for the rest of the growing season. There are only four weeks of predicted declines at Eastman Park greater than one foot (including the 2.68-foot decline) for the 26-year period of record and represent less than one percent of the growing season for the period of record. No other alternatives are predicted to have river stage declines greater than two feet.

Based on the analysis for the Main Stem, there are no predicted water table declines greater than 1.4 feet during the growing season for all study sites under all alternatives for the Future Conditions. Based on groundwater levels recorded at monitoring wells within cottonwood woodlands at the Main Stem study sites, only one groundwater table decline greater than one foot (1.4 feet) is predicted. Furthermore, it is estimated to occur for less than one percent of the 26-year period of record, representing one week during the growing season in one of the 26 years of the period (WEST 2018). Effects from stage declines less than one foot and subsequent water table declines are considered to be negligible.

### 4.7.5.2.2 Inundation of Wetland and Riparian Resources

Because the spells analysis results on the North Fork predicted negligible effects to herbaceous and scrub-shrub wetland cover types from Fort Collins’ Proposed Action, and the comparison of flow reductions due to the Project Alternatives on the Main Stem indicated lower flow reductions than for the North Fork, the Corps concluded that a spells analysis for the Main Stem was not warranted. Refer to the discussion in Section 4.7.1 for more details.

### 4.7.6 No-Action Alternative

#### 4.7.6.1 Direct Effects

The No-Action Alternative, unlike the other Project Alternatives, does not involve structural changes to existing infrastructure or development of new structures associated with the Fort Collins water supply system. The No-Action Alternative is an administrative approach to try to meet as much of the City’s purpose and need as possible with the three following measures. First, Fort Collins would change its operational procedures at their existing Joe Wright Reservoir to store more water over the winter. Second,
Fort Collins would acquire additional NPIC shares either through direct purchase of shares or by requiring residential and commercial developers to provide dedicated shares. Finally, Fort Collins would implement mandatory water use restrictions during drought periods and system failures. Reoperation of Joe Wright Reservoir would provide no new storage capacity for Fort Collins. All components of the No-Action Alternative are non-structural and require no ground disturbance of any type, and therefore would not affect wetlands, other waters, or riparian resources.

4.7.6.2 Indirect Effects

4.7.6.2.1 North Fork

4.7.6.2.1.1 Changes in Groundwater and River Stage

Herbaceous and Shrub-Dominated Wetland Vegetation
The analysis of potential effects to herbaceous and shrub-dominated wetlands associated with predicted river stage declines for the North Fork showed that for the No-Action Alternative there are no stage declines of 0.5 foot or greater for two consecutive weeks or more during the 19-year period of record compared to the Future Conditions baseline (Tables B3-B6; WEST 2018). Based on this evaluation, predicted river stage declines would have no effect on herbaceous and shrub-dominated wetlands along the North Fork.

In addition to evaluating declines of 0.5 foot or greater, the Corps reviewed the growing season weekly average river stage data for declines greater than two feet occurring for two consecutive weeks or more for the 19-year period of record. For the No-Action Alternative, compared to the Future Conditions baseline, there are no weeks of declines greater than two feet during the growing season within any of the North Fork study sites (Tables B3-B6; WEST 2018).

Cottonwood Woodlands
Based on maximum predicted stage changes, the maximum predicted depths to groundwater would be well within the normal fluctuations recorded at the monitoring well within the cottonwood woodland community at the Eagle’s Nest study site, with the exception of one week in one year for the 19-year period of record. For the No-Action Alternative under the Future Conditions comparison, the maximum recorded groundwater depth would be exceeded by 0.1 foot for one week of the period of record (Table B2 in WEST 2018). Exceeding the maximum recorded groundwater depth by 0.1 foot for one week in one year of the 19-year period of record would cause no adverse effects to this woodland community at the Eagle’s Nest study site. The Corps considers predicted changes in groundwater for the No-Action Alternative under the Future Conditions comparison to have no effect on cottonwood woodlands at Eagle’s Nest, and concludes that effects would likely be comparable for any cottonwood woodland with similar natural hydrology within the North Fork study area.

4.7.6.2.1.2 Inundation of Wetland and Riparian Resources

Change in Duration of Inundation during the Growing Season
The average duration of spells events during the growing season for the No-Action Alternative increased slightly when compared to the Future Conditions baseline. The average duration of inundation across all
cover types for the No-Action Alternative increased by 0.6 day. Inundation increased by 0.6 day, 0.3 day, and 0.9 day for the willow-shrub, alder-shrub, and herbaceous vegetation cover types, respectively.

Any large decreases (several days to a week) in the average duration of inundation events associated with the No-Action Alternative would be expected to have a negative effect on wetland and riparian cover types within the North Fork study area. Such effects could include increased water stress on existing plants by reducing soil saturation, mortality of wetland and riparian plants, and change in species composition toward plants more intolerant of inundation or soil saturation. Based on only slight increases in the average duration of inundation events, the Corps considers effects of the No-Action Alternative to be negligible.

4.7.6.2.2 Upper Poudre and Main Stem

4.7.6.2.2.1 Upper Poudre

Annual stream flow on the Upper Poudre between the Munroe Canal and Fort Collins intake to the confluence with the North Fork (approximately 0.5 mile) as a result of the No-Action Alternative would be slightly reduced (averaging 0.2 percent) throughout the year (Section 4.3.7.2.2). The change in extreme stream flow metrics for this alternative would be similar to the Fort Collins’ Proposed Action and result in a negligible change to wetlands along this reach of the Upper Poudre.

4.7.6.2.2.2 Changes in Groundwater and River Stage

Herbaceous and Shrub-Dominated Wetland Vegetation

The analysis of potential effects to herbaceous and shrub-dominated wetlands associated with predicted river stage declines for the Main Stem showed that for the No-Action Alternative, when compared to the Future Conditions baseline, there are no stage declines of 0.5 foot or greater for two consecutive weeks or more during the 26-year period of record, with the exception of the Martinez Park vegetation study site (Tables B3-B6; WEST 2018). At Martinez Park, river stage declines were greater than 0.5 foot for one two-week period in one year (1994) for the 26-year period of record (Table A-4 in WEST 2018). This decline represents less than one percent of the period of record. Based on this evaluation, predicted river stage declines would have no effect on herbaceous and shrub-dominated wetlands along the Main Stem.

In addition to evaluating declines of 0.5 foot or greater, the Corps reviewed the growing season weekly average river stage data for declines greater than two feet occurring for two consecutive weeks or more for the 26-year period of record. For the No-Action Alternative, compared to the Future Conditions baseline, there are no weeks of declines greater than two feet during the growing season within any of the Main Stem study sites (Tables A3-A14 in WEST 2018).

Cottonwood Woodlands

Under the No-Action Alternative, compared to the Future Conditions baseline, all of the predicted river stage declines are less than one foot, and all but three are less than 0.5 foot (Table A-2 in WEST 2018). Martinez Park would have declines of 0.77 foot in July and Eastman Park would have declines of 0.61 foot in May and 0.52 foot in June. The predicted declines greater than 0.5 foot would occur during one month of the May to September growing season at Martinez Park and during two months at Eastman.
Park, and represent one percent or less of the growing season for the 26-year period of record. These declines are well within the observed range of groundwater levels during the growing season recorded in monitoring wells associated with plains cottonwood at the Main Stem study sites. The Corps considers effects from the stage declines greater than one foot described above and the subsequent water table declines to be negligible.

### 4.7.6.2.2.3 Inundation of Wetland and Riparian Resources

Because the spells analysis results on the North Fork predicted no effects to herbaceous and scrub-shrub wetland cover types from Fort Collins’ Proposed Action, and the comparison of flow reductions due to the Project Alternatives on the Main Stem indicated even lower flow reductions than for the North Fork, the Corps concluded that a spells analysis for the Main Stem was not warranted. Refer to the discussion in Section 4.7.1 for more details.

### 4.7.7 Unavoidable Adverse Effects

All Project Alternatives would have unavoidable direct effects on wetlands and other waters associated with construction of facilities or inundation from reservoirs. These direct effects vary by alternatives and would result in the loss of wetlands, waters, and the functions they perform.

### 4.7.8 Mitigation Measures

Fort Collins has proposed the following compensatory mitigation measures related to wetlands, other waters, and riparian resources for their Proposed Action:

- Fort Collins would monitor shoreline wetlands for five years to evaluate the progress of natural wetland establishment around the shoreline. Based on results of the monitoring Fort Collins would, where appropriate, assist the progress of naturally-developing shoreline wetlands with measures such as installing wave-breaks, interseeding or interplanting within the wetlands, and minor grading or soil amendments. These measures would only occur as needed to assist shoreline wetland re-establishment.

- Fort Collins may consider improvements to wetland function in the North Fork through grazing protection and other vegetative or grade modifications. Fort Collins would assess and coordinate with local landowners to identify specific opportunities for wetland and habitat restoration, enhancement, and establishment. The locations for these improvements have yet to be determined.

- Fort Collins would create, restore, or enhance wetlands on- or off-site, with the location(s) to be determined. This measure would require further coordination and approvals with agencies and landowners. This measure would provide additional compensatory mitigation if needed, and would be considered in combination with the following mitigation measure to ensure necessary compensatory mitigation.
In the event other mitigation measures do not adequately compensate for wetland effects, Fort Collins might purchase wetland mitigation bank credits at one of three banks currently under development in the Poudre River watershed.

Furthermore, operational flows under the Proposed Action would improve baseline hydrology of the near-bank riparian zone, which is expected to have a beneficial effect on the health of the existing riparian wetlands along the North Fork and may also expand the wetland component of the riparian zone.

4.7.9 Effect Summary

All the alternatives except the Agricultural Reservoirs Alternative would result in some amount of wetland inundation. For Fort Collins’ Proposed Action, an estimated 10.9 acres would re-establish. The Fort Collins’ Proposed Action is the only alternative that would inundate a natural stream (upstream of Halligan Reservoir); this would be a moderate effect. Fort Collins’s Proposed Action is the only alternative that would provide a beneficial flow in the North Fork through the Winter Release Plan and Summer Plan. The Summer Plan would result in an ecological functional lift for the wetlands along the North Fork (Table 4-39).
Table 4-39. Summary of net effects on wetlands, other waters, and riparian resources by Alternative.

<table>
<thead>
<tr>
<th></th>
<th>Fort Collins’ Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
<th>No-Action Alternative</th>
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<td><strong>DIRECT EFFECTS</strong></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Wetland determination</td>
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<td>Minor</td>
<td>Moderate</td>
<td>Minor</td>
<td>No effect</td>
</tr>
<tr>
<td>Acreage</td>
<td>5.84*</td>
<td>0.1</td>
<td>4.3</td>
<td>0.32</td>
<td>0.0</td>
</tr>
<tr>
<td>Other waters determination</td>
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<td>Minor</td>
<td>Minor</td>
<td>Minor</td>
<td>No effect</td>
</tr>
<tr>
<td>Acreage</td>
<td>4.03 (North Fork) &amp; 0.26 (intermittent streams)</td>
<td>0.6 (ditches and canals)</td>
<td>0.3 (ponds and ditches)</td>
<td>5.8 (ponds, creeks, and ditches)</td>
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</tr>
<tr>
<td>Riparian Determination</td>
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<td>Moderate</td>
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<td>Acreage</td>
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<tr>
<td>Wetland ecological function – net loss(-)/lift(+)</td>
<td>-4.04</td>
<td>-0.081</td>
<td>-2.75</td>
<td>-0.20</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>INDIRECT EFFECTS</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Fork</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes in Groundwater and River Stage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effects on herbaceous and shrub-dominated wetland</td>
<td>Minor beneficial</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>No effect</td>
</tr>
<tr>
<td>Effects on cottonwood woodlands</td>
<td>Negligible</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>No effect</td>
</tr>
<tr>
<td><strong>Inundation of Wetland and Riparian Resources</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in duration of inundation during the growing season</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Negligible</td>
</tr>
<tr>
<td>Wetland ecological function</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Main Stem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes in Groundwater and River Stage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effects on herbaceous and shrub-dominated wetland</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>No effect</td>
</tr>
<tr>
<td>Effects on cottonwood woodlands</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td><strong>Inundation of Wetland and Riparian Resources (N/A)</strong></td>
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<td></td>
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</tr>
</tbody>
</table>

*16.74 acres of wetland would be inundated, but 10.90 acres would re-establish thus the net effect is 5.84.
4.8 AQUATIC BIOLOGICAL RESOURCES

This section describes effects of the Project Alternatives on aquatic biological resources including fish, benthic macroinvertebrate (macroinvertebrates), periphyton, and aquatic plant communities and their habitat. The effect analysis of the Project Alternatives focused on suitability of the habitat to support higher or lower diversity and abundance of fish, macroinvertebrates, periphyton, and plants or to change composition of the communities.

Because flow changes can affect habitat and riffle and pool complexes (a special aquatic site identified in the 404(b)(1) guidelines) used by aquatic organisms, project effects are evaluated by predicting the changes in available habitat. Fish habitat availability was assessed for each alternative using Future Conditions hydrology. The suitability of a stream to support aquatic resources also is influenced by water quality, geomorphology, and riparian vegetation. Those components of the aquatic environment are evaluated in other sections of the Draft EIS.

The following technical reports provide more details regarding aquatic resources relative to baseline conditions, methods, and results of the analyses:

- Common Technical Platform Main Stem Aquatic Baseline Technical Report (GEI 2013)
- North Fork Aquatic Resources Baseline Report (GEI 2019a)
- Aquatic Resources Effects Technical Report (GEI 2019b)

Qualitative evaluations of the effects of changes to other resources were also considered in the effect evaluation. These evaluations were conducted using results presented in the following technical reports:

- Surface Water Quality Technical Report (CDM Smith 2018b)

4.8.1 Methods

The methods for predicting effects are described in detail in the Aquatic Resources Effects Technical Report (GEI 2019b). A reservoir’s ability to support a fishery depends on multiple physical and chemical characteristics. The Corps evaluated potential effects to reservoir fisheries using a model developed by McConnell et al. (1984), which provides a method for predicting fishery quality for several game species in the absence of extensive data for a new reservoir.
To evaluate potential effects on aquatic resources on the North Fork and the Main Stem, the Corps conducted three types of analyses on defined segments of the North Fork and the Main Stem (Figure 4-56 and Figure 4-57). For the first type of analysis, two-dimensional hydrodynamic fish modeling was used to simulate the relationship between habitat availability and flow in each segment for specific species and life stages of fish known to currently inhabit the drainage as described in the *North Fork Aquatic Resources Baseline Technical Report* (GEI 2019a) and the *Common Technical Platform Main Stem Aquatic Baseline Technical Report* (GEI 2013). This approach is based on concepts used in the Instream Flow Incremental Methodology and the Physical Habit Simulation System (Bovee 1986, Bovee et al. 1994). The second type of analysis used two-dimensional hydraulic data to simulate availability and spatial arrangement of shallow, slow current velocity habitat required for spawning and rearing habitat by many of the native warmwater fish present in the study area. The third type of analysis evaluated specific hydrologic metrics to summarize potential changes in flow that might be relevant to fish, macroinvertebrates, and plants (GEI 2019b). Qualitative evaluations of the effects of changes to other resources were also considered in the effect evaluation.

In the absence of a quantitative means of analysis of changes to the various resources, professional judgement based on available information in the scientific literature was used to evaluate relative effects. For macroinvertebrates, periphyton, and aquatic plants, professional judgment was used to evaluate effects based on changes in flow, water quality, sediment, and channel morphology. Colorado macroinvertebrate multimetric index scores are used by the Colorado Water Quality Division to assess attainment of the aquatic life use in streams. Therefore, changes in the multimetric index scores with the alternatives and associated aquatic life use designations are predicted using professional judgement.

Fish habitat availability modeling was conducted for four segments on the North Fork and six segments on the Main Stem as described in the *North Fork Aquatic Resources Baseline Technical Report* (GEI 2019a) and the *Common Technical Platform Main Stem Aquatic Baseline Technical Report* (GEI 2013); effects analyses presented are summarized for these segments. Fish habitat availability analyses as represented by weighted useable area habitat availability metrics are presented in Appendix E of the *Aquatic Resources Effects Technical Report* (GEI 2019b) for two coldwater species, brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*), and two coldwater tolerant species, longnose dace (*Rhinichthys cataractae*) and longnose sucker (*Catostomus catostomus*). Additionally, the time series analyses of habitat availability illustrate the seasonal patterns of habitat and are found in Appendix C of the *Aquatic Resources Effects Technical Report* (GEI 2019b).
Figure 4-56. Two-dimensional hydraulic modeling sites, hydrologic nodes, and segments 1 through 3 on the North Fork.
Figure 4-57. Two-dimensional hydraulic modeling sites and segments A through F on the Main Stem and Segment 1 on the South Platte River.
Effects were determined on a segment-by-segment basis for the Future Conditions comparison (Run 2 [Future Conditions Baseline] vs Run 4 [each alternative under Future Conditions]) for each alternative. Effects were determined by considering the effects on all separate components of the aquatic community evaluated in each segment (i.e., fish, macroinvertebrates, aquatic plants and their habitat). The overall effect was categorized as negligible, minor, moderate or major according to professional judgement by taking into account individual effects on components of the aquatic environment based on magnitude of the changes, risk of crossing an ecological threshold or tipping point, changes in habitat availability for other species and life stages in that segment, and predicted changes to other relevant aspects such as water quality, temperature, channel geomorphology, sedimentation, and riparian vegetation. Crossing an ecological threshold or tipping point would be a fundamental change in the functioning of a stream segment such as an increase in water temperature that would change dominant species composition, drying up a flowing section of stream, or other fundamental changes.

4.8.1.1 Uncertainty

There were numerous uncertainties inherent in predicting effects on aquatic organisms. All of the modeling aspects of the evaluation had some uncertainty in attempting to model natural variability in the real world. The prediction of effects on aquatic organisms relied primarily on hydrologic modeling with uncertainties discussed in the Hydrologic Modeling Report (CDM Smith and DiNatale Water Consultants 2016). Prediction of effects also relied on modeling of water quality, water temperatures, channel geomorphology, and sedimentation with uncertainties in those processes. With all these models, the intent was not to replicate exactly what would happen in the future, because that cannot be known, but to predict tendencies and differences in tendencies between alternatives based on historical data and changes in river management.

The two-dimensional hydraulic modeling and simulation of fish habitat availability also had uncertainty in many steps in the process. To address this uncertainty, several approaches were used to predict effects. For fish habitat availability, different species and life stages with different habitat preferences were modeled to evaluate effects from several different perspectives. Habitat also was evaluated in terms of both weighted useable area habitat availability and shallow, slow current velocity habitat availability. Hydrologic metrics were also evaluated. Weighted useable area habitat availability and shallow, slow current habitat availability and hydrologic metrics for Future Conditions were presented with 95 percent confidence intervals to better evaluate changes with respect to existing variability. Finally, the effects determinations also took into account results from other resource area analyses. All of these approaches were used in an attempt to minimize the uncertainty in predicting effects on aquatic organisms.

4.8.1.2 Data Adequacy

Section 3.8 describes the best available data for aquatic biological resources in the study area. The Corps determined the data available and methods used are adequate to evaluate and describe reasonably foreseeable significant adverse effects on aquatic biological resources in the study area and to enable decision makers to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable aquatic biological resource information, as described in Section 4.2.1.5. Effects of the Project Alternatives on aquatic biological resources are described below.
4.8.2 Halligan Dam Rehabilitation

Due to the age and condition of the existing Halligan Dam, it would be rehabilitated under all Project Alternatives, regardless of which one is chosen. Rehabilitation of Halligan Dam would result in the short-term disruption of a short section of Segment 1 of the North Fork. The effect would be minor because this would only temporarily disrupt the functions of aquatic resources including fish, macroinvertebrates, and periphyton and their habitat.

4.8.3 Fort Collins’ Proposed Action

4.8.3.1 Direct Effects

Direct effects of Fort Collins’ Proposed Action would include elimination of a small segment of the North Fork where concrete is added to expand the existing dam base and the inundation and elimination of approximately 0.75 mile of the North Fork upstream of the existing Halligan Reservoir with the enlarged Halligan Reservoir. The inundation would represent a major adverse effect by replacing the free-flowing riffle and pool complexes in the river with reservoir habitat. This section of the North Fork contains a coldwater stream community of fish, benthic macroinvertebrates, and algae that would be replaced with a reservoir community.

There also would be temporary, direct effects to a short section of Segment 1 of the North Fork during construction of the enlarged Halligan Dam. During this period, there would be a disruption to the aquatic community. The long-term direct effects to on the community in this short section of Segment 1 are expected to be negligible.

4.8.3.2 Halligan Reservoir

At present, the reservoir contains mostly a coldwater fish community of trout and suckers (GEI 2019a). Halligan Reservoir is used for recreation, including fishing, but is not open to public access. At an elevation of 6,383 feet when full, the enlarged reservoir would continue to be suitable for coldwater fish species recreationally important and possibly some warmwater species as well. Enlargement of Halligan Reservoir would represent a minor to moderate beneficial effect of Fort Collins’ Proposed Action for aquatic organisms. The enlarged reservoir would provide new habitat to sustain the species of fish and other organisms already present in the reservoir.

The enlarged Halligan Reservoir would stratify during summer and could have low dissolved oxygen concentrations in the hypolimnion that would limit the use of this layer of the reservoir by coldwater fish. There could also be a few days with low dissolved oxygen near the surface. The enlarged reservoir would tend to be somewhat cooler, although the difference would be very small (CDM Smith 2018b).

Results of the McConnell et al. (1984) reservoir fishery productivity model indicate the enlarged Halligan Reservoir would support a fair recreational fishery. Productivity scores for the enlarged Halligan Reservoir were low for black crappie (*Pomoxis nigromaculatus*) and rainbow trout, and medium-low for common carp (*Cyprinus carpio*), white sucker (*Catostomus commersoni*), and yellow perch (*Perca flavescens*).
Halligan Reservoir would have seasonal fluctuations each year. Under Fort Collins’ Proposed Action, Halligan Reservoir would fill or nearly fill in late spring and early summer in most years and continue to seasonally be drawn down through the summer and early fall. During some drought periods, the reservoir would be substantially less than full for periods of one to three consecutive years as described in the Operations Report (Fort Collins 2019). Fluctuations in water levels, combined with newly inundated vegetation, can lead to elevated levels of methylmercury in fish tissue. This suggests that fish in the enlarged Halligan Reservoir could have high body burdens of methylmercury, and like many other Front Range reservoirs such as Horsetooth Reservoir, the reservoir could eventually have a mercury-based fish consumption advisory.

4.8.3.3 Nuisance Species

The distribution and abundance of nuisance species would not be affected by Fort Collins’ Proposed Action. Common carp and mosquitofish (Gambusia affinis) would continue to thrive in the altered habitats of the Main Stem. Neither species has been collected from Halligan Reservoir and their distribution would not be affected by enlarging the reservoir. Whirling disease presence and infectivity in the Main Stem would likely not change because water temperatures would not change substantially under this alternative. Didymo blooms would be unaffected by the negligible changes in spring runoff flows. New Zealand mud snails were recently found in College Lake in Fort Collins but are currently absent from the Poudre River and all of the drainages connected to it through trans-basin diversions. This would not change with Fort Collins’ Proposed Action.

In Larimer and Weld counties, the mosquito species that can transmit West Nile virus include Culex tarsalis and Culex pipiens. Both species are already well established in the state, including records from Larimer and Weld counties (Cockerell 1918, Harmston 1949, Harmston and Lawson 1976). Both Culex species vary little in aspects of their ecology (Means 1987, Center for Disease Control 2013). In general, mosquitoes actively avoid flowing water and waterbodies with predators, such as fish or predaceous invertebrates (Vonesh and Blaustein 2010), and Van Dam and Walton (2008) found that even just the odor from predatory fish can deter egg-laying by Culex species. Culex larvae can tolerate poor water quality and can be found in a wide variety of standing-water habitats without fish such as natural off-channel ponds and pools, roadside ditches, rain-filled hoof prints of livestock, water barrels, stock ponds, discarded tires, cemetery urns, birdaths, and wells. Fort Collins’ Proposed Action would not create any new mosquito habitat along the North Fork or Main Stem. Mosquitoes would not be expected to live in the enlarged reservoir due to the presence of fish and other predators. Given the widespread occurrence of suitable habitat for mosquitoes throughout northern Colorado and the fact that Culex mosquitoes are already known from Larimer and Weld counties, the prevalence of West Nile virus would not change under Fort Collins’ Proposed Action.
4.8.3.4 North Fork

4.8.3.4.1 Fish

4.8.3.4.1.1 Upstream of Halligan Reservoir

Fort Collins’ Proposed Action would not change flow in the North Fork upstream of Halligan Reservoir. However, the enlarged reservoir would inundate approximately 0.75 mile of stream habitat containing riffle and pool complexes. Using an average width measurement of 39 feet at a site upstream of the reservoir taken in October 2003 (MEC 2009) during relatively low flow conditions, it was calculated that 3.5 acres of riffle and pool complexes would be inundated. This would change the character of the section such that it would no longer maintain many of the functions of stream habitat. Many of the fish species, such as the recreationally important brown and rainbow trout, would still be able to use the reservoir habitat; however, some functions such as spawning would be precluded or substantially limited in the inundated section. Other species, such as longnose dace, prefer stream habitat and likely would not use the reservoir. Other functions, such as connectivity to upstream sections of the North Fork, would still remain. Loss of 3.5 acres of riffle and pool complexes would represent a major adverse effect of Fort Collins’ Proposed Action.

4.8.3.4.1.2 Downstream of Halligan Reservoir – Segments 1, 2b, and 3

With Fort Collins’ Proposed Action, the total amount of water flowing in the North Fork in these segments downstream of Halligan Reservoir would change very little; however, the timing of flows would change with reduced flows during the runoff period and higher flows in winter and other traditionally low-flow periods. The Winter Release Plan would result in an increase to stream flows in the North Fork between Halligan Reservoir and the Main Stem confluence. Under the Summer Plan reservoir operations would be adjusted to maintain a flow of at least five cubic feet per second in 22 miles of the North Fork between Halligan Dam and Seaman Reservoir from May 1 to September 30 each year (Section 4.3.3.1). These releases would eliminate zero flow days and result in fewer extreme flow fluctuations. Peak flows would not change substantially.

For almost all adult and juvenile life stages of fish modeled in all Segments of the North Fork (with the exception of Segment 2a discussed below), changes in flow evaluated with the Future Conditions comparison would increase the minimum weighted useable area during winter low flows at the time of the year with lowest habitat availability which can act as a limiting bottleneck period to the fish community. However, in almost all cases, this increase is from extremely low levels of habitat availability to only slightly higher levels; the minimum habitat levels would still be much lower than average levels. Average weighted useable areas would not increase appreciably in most years. The increased levels of minimum habitat availability and elimination of zero flow days would result in a moderate beneficial effect for fish in Segment 1 with Fort Collins’ Proposed Action by making the period of low flow and minimum habitat availability and extreme flow fluctuations less severe. Benefits to fish in Segments 2b and 3 would be minor and negligible to minor, respectively.
4.8.3.4.1.3 Segment 2a – North Poudre Diversion to Rabbit Creek

For all adult and juvenile life stages of fish modeled in North Fork Segment 2a, the change in flow would result in substantial increases in fish habitat availability in all years and indicates the beneficial effect would be major compared to the Future Conditions Baseline. The Winter Release Plan and the Summer Plan would permanently maintain water in this stretch of the North Poudre that currently experiences dry ups due to the North Poudre Diversion.

With a median of 104 zero flow days in a typical year under the Future Conditions baseline in Segment 2a, the functions of this section of the North Fork are substantially disrupted and limited each year and precluded for long periods under the Future Conditions baseline. The segment essentially functions only as temporary habitat for many organisms. The elimination of zero flow days with Fort Collins’ Proposed Action, in effect, is restoring permanent stream habitat for aquatic organisms. This represents a major beneficial effect of the project.

By restoring permanent habitat, many functions of Segment 2a also would be restored. Most importantly, aquatic organisms would be able to use the segment throughout the year instead of having to recolonize dry habitat when flow returns. Connectivity of this segment to Segment 1 and Segment 2b also would allow movement of organisms, especially fish, among the segments, although upstream movements would still be precluded past the North Poudre Diversion. The connectivity would also allow energy flow, such as with organic material, downstream through the North Fork.

The length of Segment 2a restored with the elimination of zero flow days depends on the length that is periodically dry under the Future Conditions baseline. The distance between the North Poudre Diversion and the first tributary that adds substantial flow, Rabbit Creek, is approximately four miles. However, a return ditch from the North Poudre Canal sometimes adds water to the North Fork at a point approximately 1.9 miles downstream of the diversion. According to Colorado Parks and Wildlife there apparently are groundwater inputs downstream of this point that add flow as well. Between the North Poudre Diversion and the return ditch, there apparently are short sections of groundwater inputs and pools that may be maintained and could support fish and other aquatic organisms through the dry periods. Therefore, the extent of the dry section of this segment is uncertain.

The dry section would be 1.9 miles from the diversion to the return ditch. Using an average width of 25 feet at a minimum flow of three cubic feet per second from MEC (2017), about 5.8 acres of riffle and pool complexes would have continuous flow within this restored 1.9-mile section of Segment 2a under Fort Collins’ Proposed Action. This assumes all of the 1.9-mile length is currently dry. The total dry area may be somewhat less than this taking into account isolated wet sections and pools. Using the total length of Segment 2a of four miles, about 12.1 acres of riffle and pool complexes would have continuous flow and no zero flow days.

4.8.3.4.2 Macroinvertebrates

Fort Collins’ Proposed Action would have similar effects on macroinvertebrates when evaluated with the Future Condition comparison (Run 2 [Future Conditions Baseline] vs Run 4 [each alternative under Future Conditions]). The Winter Release Plan and Summer Plan under Fort Collins’ Proposed Action would eliminate zero flow days in Segment 1 of the North Fork. This would increase the wetted perimeter
of the channel bottom through the low flow parts of the year that represent an important time for maintaining the community of macroinvertebrates. This would result in more favorable conditions through the long low-flow period in winter and other traditionally low-flow periods for many species which would likely result in increased abundance and may allow more species to be maintained in Segment 1 of the North Fork. Reductions in the incidences of extreme low flows and in flow fluctuations would be favorable as well. There would be negligible changes in water quality and water temperature that would likely have little effect on macroinvertebrates. Runoff flows would maintain the ongoing accumulation of sediment and channel encroachment but there would be minor to negligible increases in sedimentation (ACE 2019b) and riparian vegetation (WEST 2018) with the project that would have a negligible effect.

Overall, changes in sedimentation and water quality are not sufficient to have more than a negligible effect on macroinvertebrates. However, increased low flows and reduced fluctuations may result in greater abundance and species diversity. Therefore, Fort Collins’ Proposed Action would have a moderate beneficial effect on macroinvertebrates in Segment 1, 2b, and 3. The elimination of zero flow days would result in greater abundance and more species and therefore have a major beneficial effect on macroinvertebrates in Segment 2a.

Multimetric index scores from three samples collected by GEI in 2015 in Segment 1 presented in the North Fork Aquatic Resources Baseline Technical Report (GEI 2019a) ranged from 70 to 82, well above the threshold score of 52 for attaining the aquatic life use. Segment 1 supports a high proportion of rheophilic species but also supports many other sensitive species of mayflies, stoneflies, caddisflies, and beetles that prefer more moderate current and result in high multimetric index scores. A score from a single multimetric index sample collected by CDPHE in 2011 was 43, in the gray zone for indicating attainment and the supplemental metrics had low values that indicate nonattainment of the aquatic life use. The majority of the scores, and the most recent scores, would be higher than the threshold to indicate attainment and this segment of the North Fork has not been listed by CDPHE for nonattainment of the aquatic life use. The moderate increases in abundance and number of species under Fort Collins’ Proposed Action in Segment 1 indicates multimetric index scores would be above the threshold and indicate attainment.

Multimetric index scores from three samples collected by GEI in 2015 near the downstream end of Segment 2a presented in the North Fork Aquatic Resources Baseline Technical Report (GEI 2019a) ranged from 76 to 79, well above the threshold score of 52 for attaining the aquatic life use. The samples were collected from an isolated section of upwelling groundwater just downstream of the Calloway Ditch diversion on a day when much of the channel in Segment 2a was dry. The data and multimetric index scores indicate that water quality is sufficient to support sensitive species and a balanced community when water is present. The sections of Segment 2a that are periodically dry with Current Conditions and where macroinvertebrates are very limited or absent would experience substantial increases in abundance and number of species when flow is restored to the majority of the surface area of the segment. Segment 2a supports rheophilic species but also supports many other sensitive species of mayflies, stoneflies, caddisflies, and beetles that prefer more moderate current and result in high multimetric index scores. The scores from GEI exceed the threshold to indicate attainment and the major increases in abundance and number of species under Fort Collins’ Proposed Action in Segment 2a indicates multimetric index scores would continue to be above the threshold and indicate attainment.
The score from a multimetric index sample collected by CDPHE in 2007 near Livermore in Segment 2b was 67, exceeding the attainment threshold (GEI 2019a). An earlier score at this site from 2004 was 47, in the gray zone. The scores from CDPHE indicate attainment is not always reached in Segment 2b. Elimination of zero flow days and increases in abundance and number of species under Fort Collins’ Proposed Action in Segment 2b indicates multimetric index scores likely would consistently be above the threshold and indicate attainment.

Multimetric index scores from three samples collected by GEI in 2015 in Segment 3 presented in the North Fork Aquatic Resources Baseline Technical Report (GEI 2019a) ranged from 64 to 72, well above the threshold score of 52 for attaining the aquatic life use. Segment 3 supports a high proportion of rheophilic species but also supports many other sensitive species of mayflies, caddisflies, and beetles that prefer more moderate current and result in high multimetric index scores. Stoneflies were absent from Segment 3 whereas there were several species in Segments 1 and 2 of the North Fork. An earlier multimetric index score from a site at the Filter Plant from 2003 was 46, in the gray zone (GEI 2019a). The most recent scores from GEI indicate attainment. The minor to moderate increases in abundance and number of species under Fort Collins’ Proposed Action in Segment 3 indicate multimetric index scores would continue to be above the threshold and indicate attainment under Fort Collins’ Proposed Action.

4.8.3.4.3 Periphyton

Changes in flows under Fort Collins’ Proposed Action, when analyzed under the Future Conditions comparison (Run 2 [Future Conditions Baseline] vs Run 4 [each alternative under Future Conditions]) throughout all segments on the North Fork, would not change water quality or sedimentation conditions to an extent that would affect periphyton or aquatic plants. However, the higher and more favorable winter flows and reduced fluctuations may allow periphyton abundance to increase. These changes would have a moderate effect on periphyton and aquatic plants that could be considered beneficial in terms of increased abundance for all segments. In Segment 2a, elimination of zero flow days would allow periphyton abundance and perhaps species diversity to increase with the consistent flows. These changes would have a major beneficial effect in Segment 2a on periphyton and aquatic plants.

4.8.3.4.4 Summary

Under Fort Collins’ Proposed Action, the enlarged Halligan Reservoir would inundate 0.75 mile of the North Fork including approximately 3.5 acres of riffle and pool complexes, a major adverse effect. The changes in flow and resulting changes in other aspects of habitat in Segments 1, 2b, and 3 of the North Fork downstream of the reservoir would respectively have a moderate, minor, and negligible to minor beneficial effect on aquatic organisms compared to the Future Conditions baseline. Water quality and temperature changes would be negligible. Changes in sedimentation would be negligible and have negligible effects on riffle and pool complexes. In Segment 2a, the Winter Release and Summer Plans would maintain habitat for aquatic organisms throughout the year and would result in a major beneficial effect compared to the Future Conditions baseline. In the 1.9-mile dry section from the diversion to the return ditch, about 5.8 acres of riffle and pool complexes would have continuous flow. Using the total length of Segment 2a of four miles, about 12.1 acres of riffle and pool complexes would have continuous flow and no zero flow days.
Fort Collins’ Proposed Action would not cause aquatic resources and their habitat to cross a tipping point in North Fork Segments 1, 2b, and 3. Segment 1 would continue to function as a coldwater stream segment supporting coldwater species of fish and macroinvertebrates, while Segments 2b and 3 would support some warmwater species of fish as well as macroinvertebrates. Brown trout, rainbow trout, longnose dace, white suckers, and longnose suckers are expected to remain as the dominant fish species in Segments 1, 2b, and 3.

The overall major beneficial effects on aquatic resources and their habitat with Fort Collins’ Proposed Action would cause the crossing of a tipping point in Segment 2a. With the elimination of zero flow days, much of the channel not functioning as habitat for aquatic organisms for long periods of the year would be able to be support fish, macroinvertebrates, and algae. Otherwise, Segment 2a would continue to function as a coldwater stream segment supporting coldwater species of fish and macroinvertebrates. Brown trout, longnose dace, and longnose suckers are expected to remain as the dominant fish species and recent information from Colorado Parks and Wildlife indicates creek chubs (*Semotilus atromaculatus*) are also common in this segment.

### 4.8.3.5 Main Stem

In the 0.5-mile Exchange Reach of Segment A of the Main Stem between the Fort Collins Intake and the confluence with the North Fork, Fort Collins’ Proposed Action would reduce flows slightly on most days and would increase flows compared to the Future Conditions baseline on some days. The changes in flows would have a minor to moderate adverse effect due to prolonged low flow periods in dry years.

Fort Collins’ Proposed Action results in negligible changes in flow on the Main Stem downstream of the North Fork in Segment A and in all segments further downstream (Section 4.3.3). The aquatic effects analyses show corresponding negligible changes in fish habitat availability, water temperature, water quality, riparian vegetation, and channel geomorphology would have an overall negligible effect on aquatic organisms compared to the Future Condition baseline in all segments of the Main Stem.

There would be a negligible effect on the macroinvertebrate community with Fort Collins’ Proposed Action throughout the Main Stem. In some Segments of the Main Stem, such as Segment D, there may be a minor increase in abundance of periphyton and aquatic plants.

The negligible effects on aquatic resources and their habitat with Fort Collins’ Proposed Action would not cause the crossing of a tipping point in Main Stem Segments A through D. The Main Stem would continue to function as a coldwater and warmwater stream supporting coldwater species of fish and macroinvertebrates in Segment A and warmwater species of fish downstream in Segments B through D. There would be negligible changes in species relative abundance, and brown trout, longnose dace, and suckers are expected to remain as the dominant fish species in Segments A and B along with numerous warmwater species. Downstream the numerous warmwater species would continue to be the dominant component of the fishery in Segments C and D. Ongoing localized channel narrowing and vegetative encroachment would continue throughout the Main Stem.

The fish community in Segments E and F is likely near a tipping point. Nonnative species such as common carp, largemouth bass (*Micropterus salmoides*), and mosquitofish are common. A few native species such as fathead minnow (*Pimephales promelas*), red shiner (*Cyprinella lutrensis*), sand shiner
(Notropis stramineus), and white suckers continue to be common. Other native species such as bigmouth shiner (Notropis dorsalis) and Johnny darter (Etheostoma nigrum) continue to be present in low numbers (GEI 2013). The negligible effects on most aquatic resources and their habitat with Fort Collins’ Proposed Action would not cause Segments E and F to cross this tipping point. Segments E and F would continue to function as a warmwater stream segment supporting a wide variety of native and nonnative warmwater species of fish and a somewhat degraded community of macroinvertebrates.

### 4.8.4 Expanded Glade Alternative

#### 4.8.4.1 Direct Effect

The NISP proposed Glade Reservoir would be created off the channel of the Main Stem northwest of Fort Collins. The Expanded Glade Alternative would not directly affect the Main Stem, North Fork, or any tributaries from either expansion of the dam or reservoir.

#### 4.8.4.2 Expanded Glade Reservoir

At an elevation of 5,521 feet when full, the NISP proposed Glade Reservoir would be suitable to support both coldwater and warmwater recreationally important fish species. The expanded portion of the proposed Glade Reservoir would represent a minor beneficial effect of the Expanded Glade Alternative for aquatic organisms. The expanded portion of the proposed Glade Reservoir would provide new habitat to sustain populations of a variety of organisms. The NISP proposed Glade Reservoir would also be suitable for the establishment and management of a recreational fishery that could support populations of both stocked and self-sustaining fish species.

Conditions in other northern Colorado Front Range reservoirs provide a frame of reference for conditions that would exist in the NISP proposed Glade Reservoir by assuming that similar basic conditions in these existing reservoirs would apply to the NISP proposed Glade Reservoir. Horsetooth Reservoir, Seaman Reservoir, and Carter Lake all stratify during the summer and have limited concentrations of dissolved oxygen in the hypolimnion. The NISP proposed Glade Reservoir would be somewhat smaller than Horsetooth Reservoir and much larger than the other two reservoirs. As is typical for Front Range reservoirs, these reservoirs support a mixed warmwater and coldwater fish assemblage, but fluctuations in water level limit the reproductive success of fishes that require shallow, near shore littoral spawning habitats, such as bass and sunfishes. The NISP proposed Glade Reservoir would probably stratify during summer and may have low dissolved oxygen concentrations in the hypolimnion that limits use of this layer of the reservoir by coldwater fish.

Results of the McConnell et al. (1984) reservoir fishery productivity model indicate that the NISP proposed Glade Reservoir fishery would support a fair recreational fishery. Productivity scores for the NISP proposed Glade Reservoir were low for black crappie, rainbow trout, and common carp and medium-low for white sucker and yellow perch. This assessment of low to medium fishery quality agrees with the conclusions of Bartholow and Bergersen (2012), who ran the McConnell model with similar results and referred to the proposed Glade Reservoir fishery as being “mediocre at best.”
Fluctuations in water level, combined with newly inundated vegetation, can lead to elevated levels of methylmercury in fish tissue. This suggests fish in the NISP proposed Glade Reservoir would have high body burdens of methylmercury, and like many other Front Range reservoirs such as Horsetooth Reservoir, the proposed Glade Reservoir may eventually have a mercury-based fish consumption advisory.

Information in the Stream Temperature and Dissolved Oxygen Analysis for the NISP Draft Supplemental EIS (Hydros 2014) is consistent with the predictions above for the NISP proposed Glade Reservoir. The Hydros (2014) memo summarizes conditions in the proposed Glade Reservoir as low to moderate productivity (oligotrophic to mesotrophic), stratifying in summer with low dissolved oxygen in the hypolimnion, and likely to have a mercury consumption advisory for fish.

4.8.4.3 Nuisance Species

Similar to Fort Collins’ Proposed Action, the distribution and abundance of nuisance species in existing waterbodies would not be affected by the Expanded Glade Alternative. Whirling disease, didymo blooms, and New Zealand mud snails would all be unaffected. No new habitat for mosquitoes would be created by this alternative, thus no change to the prevalence of West Nile virus would be expected.

The NISP proposed Glade Reservoir could provide habitat for zebra mussels or quagga muscles and recreational activities proposed for the site (e.g., boating) would provide a mechanism for introducing these species to the reservoir. However, with current state regulations that require boat inspections and disinfection to prevent the spread of these species the potential for introductions is reduced. The expansion of the NISP proposed Glade Reservoir under this alternative would not change these conditions.

4.8.4.4 North Fork

4.8.4.4.1 Fish

The Expanded Glade Alternative assumes that the NISP Project and proposed Glade Reservoir exist and are operating. Flow in the North Fork would not change much under the Future Conditions Comparison with this alternative as the activities with this alternative would mostly be downstream of the North Fork. The Expanded Glade Alternative would include diversions of water from the Main Stem at the Poudre Valley Canal into an expanded Glade Reservoir. With the Expanded Glade Alternative, water primarily would be diverted from the Main Stem during the high flow months of May, June, and July as discussed in more detail in the Surface Water Resources Technical Report (CDM Smith 2017) and Operations Report (Fort Collins 2019). Under the Winter Release Plan water would be released from the proposed Glade Reservoir to the Main Stem and flows in the North Fork would not be affected (Fort Collins 2019).

4.8.4.4.1.1 Upstream of Halligan Reservoir

The Expanded Glade Alternative would not change flow in the North Fork upstream of Halligan Reservoir.
4.8.4.4.1.2 Segment 1 – Below Halligan Dam to North Poudre Diversion

Under Future Conditions with the Expanded Glade Alternative, negligible changes in flow and resulting changes in other aspects of habitat would have an overall negligible effect on aquatic organisms compared to Future Conditions in Segment 1. For all life stages of fish modeled at the three sites in North Fork Segment 1, these changes in flow would result in negligible changes in habitat availability. Water quality and temperature changes would be negligible. Changes in sedimentation and riparian vegetation conditions would be negligible and have negligible effects on riffle and pool complexes. There would also be negligible effects on macroinvertebrates and periphyton.

The mostly adverse effects on aquatic resources and their habitat with the Expanded Glade Alternative when evaluated with Baseline Condition comparisons would not cause the crossing of a tipping point in Segment 1. Similarly, the negligible effect on aquatic resources and their habitat with the Expanded Glade Alternative when evaluated with Future Condition comparisons would not cause the crossing of a tipping point in Segment 1. Segment 1 would continue to function as a coldwater stream segment supporting coldwater species of fish and macroinvertebrates. Brown trout, rainbow trout, longnose dace, white suckers, and longnose suckers are expected to remain as the dominant fish species.

4.8.4.4.1.3 Downstream of Halligan Reservoir – Segments 2a, 2b, and 3

With the Expanded Glade Alternative, the total amount of water flowing in the North Fork downstream of Halligan Reservoir would not change; however, the timing of flows would change with less water flowing on some days in winter. Under the Future Condition comparison, flow metrics in Segments 2a, 2b, and 3 had negligible changes resulting in negligible changes in weighted useable area metrics for all modeled fish species and life stages. Water quality and temperature changes also would be negligible. Changes in sedimentation and riparian vegetation would be negligible and have negligible effects on riffle and pool complexes. There would be negligible effects on most aquatic organisms, but declines in fish habitat availability during winter of dry years in Segment 3 under the Future Conditions comparison would have a minor adverse effect.

The negligible to minor effects of the Expanded Glade Alternative on aquatic resources and their habitat when evaluated with the Future Condition comparison would not cause the crossing of a tipping point in Segments 2a, 2b, or 3. All three Segments would continue to function as a coldwater stream segment supporting coldwater species of fish and macroinvertebrates. Brown trout, rainbow trout, longnose dace, creek chubs, white suckers, and longnose suckers are expected to remain as the dominant fish species with rainbow trout and several other species present as well.

4.8.4.4.2 Macroinvertebrates

Under the Future Condition comparison, the negligible change in flow with the Expanded Glade Alternative would have a negligible effect on benthic macroinvertebrates in Segment 1. There would be negligible changes in water quality that would likely have little effect on macroinvertebrates. Runoff flows would still be sufficient to prevent accumulation of sediment and there would be minor to negligible changes in sedimentation (ACE 2019b) that would have a negligible effect on macroinvertebrates. Therefore, the Expanded Glade Alternative would have a negligible effect on macroinvertebrates in Segment 1.
Multimetric scores for Segment 1 were discussed for the Fort Collins’ Proposed Action in Section 0. In summary, the majority of the scores and the most recent scores indicate attainment and this segment of the North Fork has not been listed by CDPHE for nonattainment of the aquatic life use. Under the Future Conditions comparison, the negligible changes to macroinvertebrates with the Expanded Glade Alternative in Segment 1 indicate multimetric index scores likely would continue to be high enough to indicate attainment.

The negligible change in flow with the Expanded Glade Alternative would have a negligible effect on benthic macroinvertebrates in Segment 2b and 3. There would be negligible changes in water quality that would likely have little effect on macroinvertebrates. Runoff flows would still be sufficient to prevent accumulation of sediment and there would be minor to negligible changes in sedimentation (ACE 2019b) that would have a negligible effect on macroinvertebrates. Therefore, the Expanded Glade Alternative would have a negligible effect on macroinvertebrates in Segment 2b and 3. The negligible effects with the Expanded Glade Alternative in Segment 2b and 3 indicate multimetric index scores would continue to be above the threshold and indicate attainment.

4.8.4.4.3 Periphyton
The Expanded Glade Alternative when analyzed under the Future Conditions comparison (Run 2 [Future Conditions Baseline] vs Run 4 [each alternative under Future Conditions]) concluded that there would be negligible changes in flows throughout all segments on the North Fork. Additionally, the Expanded Glade Alternative would not change water quality or sedimentation conditions to an extent that would affect periphyton or aquatic plants on the North Fork. Therefore, the Expanded Glade Alternative would have a negligible effect on periphyton and aquatic plants.

4.8.4.5 Main Stem
In the 0.5-mile Exchange Reach of Segment A of the Main Stem between the Fort Collins Intake and the confluence with the North Fork, the Expanded Glade Alternative would reduce flows slightly on most days and would increase flows compared to the Future Conditions baseline on some days. Changes in flows would have a negligible to minor adverse effect due to prolonged low flow periods in dry years. The adverse effect would be somewhat less than that predicted for Fort Collins’ Proposed Action.

Effects of the Expanded Glade Alternative on flows in much of the Main Stem would be similar to those of Fort Collins’ Proposed Action when compared to the Future Conditions baseline. Effects of the Expanded Glade Alternative on aquatic organisms would be negligible for all segments on the Main Stem.

The Expanded Glade Alternative would have an overall negligible effect on aquatic organisms. Changes to the magnitude and duration of low flow periods with the Expanded Glade Alternative would be negligible. Water quality and temperature changes also would be negligible. Changes in sedimentation conditions would be negligible and have negligible effects on riffle and pool complexes. Ongoing localized channel narrowing and vegetative encroachment would continue.

Changes in flows would have a negligible effect on most fish species although some species may benefit from small changes in flows in late winter. Small-bodied fish species may benefit from increases in
shallow, slow current habitat in median and dry years. There would be mostly negligible effects on macroinvertebrates and periphyton but they could experience a minor increase in abundance in some segments, such as C and D, with ongoing channel narrowing.

The mostly negligible effects on aquatic resources and their habitat with the Expanded Glade Alternative would not cause the crossing of a tipping point in Main Stem Segments A through D. The Main Stem would continue to function as a coldwater and warmwater stream supporting coldwater species of fish and macroinvertebrates in Segment A and warmwater species of fish downstream in Segments B through D. There would be negligible changes in species relative abundance, and brown trout, longnose dace, and suckers are expected to remain as the dominant fish species in Segments A and B along with numerous warmwater species. Downstream the numerous warmwater species would continue to be the dominant component of the fishery in Segments C and D. Ongoing localized channel narrowing and vegetative encroachment would continue throughout the Main Stem.

The fish community in Segments E and F is near a likely tipping point. Nonnative species such as common carp, largemouth bass (*Micropterus salmoides*), and mosquitofish are common. A few native species such as fathead minnow, red shiner, sand shiner, and white suckers continue to be common. Other native species such as bigmouth shiner and johnny darter continue to be present in low numbers (GEI 2013). The negligible effects on most aquatic resources and their habitat with the Expanded Glade Alternative would not cause Segment E to cross this tipping point. Segment E would continue to function as a warmwater stream segment supporting a wide variety of native and nonnative warmwater species of fish and a somewhat degraded community of macroinvertebrates.

### 4.8.5 Gravel Pits Alternative

#### 4.8.5.1 Direct Effect

The Gravel Pits Alternative would function as off-channel storage. The Gravel Pits Alternative would only directly affect the Main Stem at one proposed below grade pipeline crossing of the Main Stem. A trench would be excavated across the Main Stem, the pipeline laid in the trench, and the trench refilled and the river bed restored to its preexisting condition so there would be no long-term effect.

#### 4.8.5.2 Gravel Pits

Storage in the Overland Gravel Pits would include a series of eight pits with a total surface area of 207 acres and a total capacity of 3,875 acre-feet. The pits would fill completely in the spring and early summer of most years but may not fill for up to two or three years during drought periods. The gravel pits are not currently proposed to be used for recreation including fishing. However, the pits would likely support a community of aquatic invertebrates, algae, and fish including species introduced from the Main Stem. The aquatic community would be limited due to the constant changes in water level and storage volume as the pits are operated for water supply. The overall effect on aquatic organisms would be a minor beneficial effect due to the increase in reservoir habitat available to aquatic organisms.
4.8.5.3 Nuisance Species

Similar to the Fort Collins’ Proposed Action, the distribution and abundance of most nuisance species in existing waterbodies would not be affected by this alternative. Whirling disease, didymo blooms, and New Zealand mud snails would all be unaffected by the Gravel Pits Alternative. No new habitat for mosquitoes would be created by this alternative, thus no change to the prevalence of West Nile virus would be expected. Common carp may become established in the gravel pits. Without boating or other recreational activities, there would be limited mechanisms for the introduction of zebra mussels or quagga mussels into the gravel pits.

4.8.5.4 North Fork

4.8.5.4.1 Fish

4.8.5.4.1.1 Upstream of Halligan Reservoir

The Gravel Pits Alternative would not change flow in the North Fork upstream of Halligan Reservoir.

4.8.5.4.1.2 Downstream of Halligan Reservoir – Segments 1, 2a, 2b, and 3

Flow in the North Fork would not change much when evaluated with the Future Condition comparison for this alternative as the activities with this alternative would mostly be downstream of the North Fork and the Winter Release Plan would not affect flows in the North Fork. Therefore, effects of the Gravel Pits Alternative on aquatic resources in the North Fork compared to the Future Condition baseline would be different than those described for Fort Collins’ Proposed Action, but would be very similar to those described for the Expanded Glade Alternative which would be a negligible effect. In Segment 1, effects under Future Condition comparisons for Segment 1, 2a, and 2b would be very similar to those described for the Expanded Glade Alternative, which would be a negligible effect.

The Gravel Pit Alternative would have a unique effect on Segment 3 under Future Conditions comparison. Changes in minimum and maximum flow metrics with the Gravel Pits Alternative would be negligible in the Future Conditions comparison, as all changes would be one percent or less. The mostly negligible changes in flow in Segment 3 of the North Fork would result in mostly negligible changes in fish habitat availability. Most changes in weighted useable area metrics with the Gravel Pits Alternative would be one percent or less and all but one change would be six percent or less. Brown trout adult minimum habitat availability would decrease by 18 percent in 80th percentile years, but this would occur in years with relatively high habitat availability and likely have a negligible effect. The overall effect on the fish community with the Gravel Pits Alternative compared to Future Conditions would be negligible.

4.8.5.4.2 Macroinvertebrates

The Gravel Pits Alternative would have a negligible effect on macroinvertebrates in Segment 1 under the Future Condition comparison as described under the Expanded Glade Alternative. The negligible to minor beneficial changes in flow under the Future Condition comparison with the Gravel Pits Alternative would have a negligible effect on benthic macroinvertebrates for Segments 2a, 2b, and 3. There would be
negligible changes in water quality that would likely have little effect on macroinvertebrates. The runoff flows would still be sufficient to prevent accumulation of sediment and there would be insignificant changes in sedimentation (ACE 2019b) that would have a negligible effect on macroinvertebrates. The most recent scores indicate attainment and the negligible changes with the Gravel Pits Alternative throughout the North Fork indicate multimetric index scores would continue to be above the threshold and indicate attainment.

### 4.8.5.4.3 Periphyton

The Gravel Pits Alternative, when analyzed under the Future Conditions comparison (Run 2 [Future Conditions Baseline] vs Run 4 [each alternative under Future Conditions]), would have negligible changes in flows throughout all segments on the North Fork. Additionally, the Gravel Pits Alternative would not change water quality or sedimentation conditions to an extent that would affect periphyton or aquatic plants on the North Fork. Therefore, the Gravel Pits Alternative would have a negligible effect on periphyton and aquatic plants.

### 4.8.5.5 Main Stem

Under the Future Conditions comparison, effects of the Gravel Pits Alternative on flow in much of the Main Stem would be similar to the effects of Fort Collins’ Proposed Action and the Expanded Glade Alternative. Effects on aquatic organisms with the Gravel Pits Alternative would be very similar to those for Fort Collins’ Proposed Action with negligible effects in segments A, B, C, E, and F of the Main Stem and are not evaluated further in this section.

The Gravel Pits Alternative would have somewhat different effects than Fort Collins’ Proposed Action and the Expanded Glade Alternative in Segment D of the Main Stem under the Future Conditions comparison due to exchanges and to changes in return flows to the river. There would be changes in minimum weighted usable area for all species, especially in 20th percentile years. The increases would result from changes in habitat availability due to changes in very low flows in spring prior to runoff and in late summer after runoff when habitat availability is very low. The changes would be largest in 20th percentile years, from 12 to 87 percent for all of the modeled species except longnose dace. Longnose dace would have increases in minimum weighted usable area of 11 and 43 percent in median and 80th percentile years, respectively. Both suckers and fathead minnows would have decreases of 19 percent in minimum weighted usable area in median years, but they would also have increases of 87 percent in 20th percentile years when habitat availability is relatively low, which would likely result in a net benefit for these two species. Changes in minimum weighted usable area indicate there would be a minor beneficial effect on fish in Segment D with the Gravel Pits Alternative.

### 4.8.6 Agricultural Reservoirs Alternative

#### 4.8.6.1 Direct Effect

The Agricultural Reservoirs Alternative would acquire a portion of the active capacity of NPIC Reservoirs Number 5 and 6. There would be no changes to dam height and pipelines would use existing
diversion structures and mostly would not affect streams although there would be one proposed below grade pipeline crossing of the Main Stem. A trench would be excavated across the Main Stem, the pipeline laid in the trench, and the trench refilled and the river bed restored to its preexisting condition so that there would be no long-term effect. During this period, there would be a disruption to the aquatic community. The long-term direct effects on the community in this short section of the Main Stem are expected to be negligible.

4.8.6.2 Agricultural Reservoirs

The Agricultural Reservoirs Alternative would use 6,475 acre-feet (36 percent) of the existing active capacity of NPIC Reservoirs Number 5 and 6; the reservoirs would not need to be modified. The two reservoirs would fill completely in the spring and early summer of most years but may not fill for up to two or three years during drought periods. The reservoirs currently support a community of aquatic invertebrates, algae, and fish and a recreational fishery managed by the local boating clubs. The Agricultural Reservoirs Alternative would have a minor beneficial overall effect on aquatic organisms due to the average increase in reservoir volume and area available as habitat for aquatic organisms.

4.8.6.3 Nuisance Species

Similar to the Fort Collins’ Proposed Action, the distribution and abundance of nuisance species in existing waterbodies would not be affected by this alternative. Whirling disease, didymo blooms, and New Zealand mud snails would all be unaffected by the Agricultural Reservoir Alternative. No new habitat for mosquitoes would be created by this alternative, thus no change to the prevalence of West Nile virus would be expected.

4.8.6.4 North Fork

4.8.6.4.1 Fish

4.8.6.4.1.1 Upstream of Halligan Reservoir

Agricultural Reservoirs Alternative would not change flow in the North Fork upstream of Halligan Reservoir.

4.8.6.4.1.2 Downstream of Halligan Reservoir – Segments 1, 2a, 2b, and 3

Effects on aquatic resources under the Future Condition comparison with the Agricultural Reservoirs Alternative would be different than those described for Fort Collins’ Proposed Action and similar to the effects described for the Expanded Glade Alternative and the Gravel Pits Alternative. In the North Fork, there would be a negligible effect in all three segments. Effects in the North Fork are not described further in this section.
4.8.6.4.2 Macroinvertebrates
The Agricultural Reservoirs Alternative would have a negligible effect on macroinvertebrates in Segment 1 under the Future Condition comparison as described under the Expanded Glade Alternative.

The negligible to minor beneficial changes in flow under the Future Condition comparisons with the Agricultural Reservoirs Alternative would have a negligible effect on benthic macroinvertebrates for Segments 2a, 2b, and 3. There would be negligible changes in water quality that would likely have little effect on invertebrates. The runoff flows would still be sufficient to prevent the accumulation of sediment and there would be insignificant changes in sedimentation (ACE 2019b) that would have a negligible effect on macroinvertebrates. The most recent scores indicate attainment and the negligible changes with the Agricultural Reservoirs Alternative throughout the North Fork, indicates multimetric index scores would continue to score above the threshold and indicate attainment.

4.8.6.4.3 Periphyton
The Agricultural Reservoirs Alternative, when analyzed under the Future Conditions comparison (Run 2 [Future Conditions Baseline] vs Run 4 [each alternative under Future Conditions]), would have a negligible effect on flows throughout all segments on the North Fork. Additionally, the Agricultural Reservoirs Alternative would not change water quality or sedimentation conditions to an extent that would affect periphyton or aquatic plants on the North Fork. Therefore, the Agricultural Reservoirs Alternative would have a negligible effect on periphyton and aquatic plants.

4.8.6.5 Main Stem
The Agricultural Reservoirs Alternative under the Future Conditions comparison would have similar effects on flow in much of the Main Stem as Fort Collins’ Proposed Action, the Expanded Glade Alternative, and the Gravel Pits Alternative. Effects on aquatic organisms with the Agricultural Reservoirs Alternative would be nearly the same as those for Fort Collins’ Proposed Action in all six segments of the Main Stem including the 0.5-mile bypass reach of Segment A of the Main Stem between the Fort Collins Intake and the confluence with the North Fork and are not evaluated further in this section.

4.8.7 No-Action Alternative

4.8.7.1 Direct Effect
The No-Action Alternative is an administrative approach and therefore does not involve structural changes to existing infrastructure or development of new structures associated with the Fort Collins water supply system. Therefore, it would have no direct effects on aquatic resources.

4.8.7.2 North Fork
In the North Fork, changes in flow with the No-Action Alternative would be negligible and very similar to those for the Gravel Pits Alternative and the Agricultural Reservoirs Alternative (CDM Smith 2017).
and result in similar effects on aquatic resources compared to the Future Conditions baseline. This includes negligible effects in all three segments of the North Fork.

### 4.8.7.3 Main Stem

In the Main Stem, annual changes in flow with the No-Action Alternative would be one percent or less, commonly less than 0.3 percent (CDM Smith 2017). This would result in negligible effects in all six segments of the Main Stem.

### 4.8.8 Unavoidable Adverse Effects

All Project Alternatives, with the exception of the No-Action Alternative, would change flows on the North Fork and Main Stem in the study area. The changes would generally result in a negligible to minor adverse or minor beneficial effects to fish, macroinvertebrates, periphyton, and aquatic plants in most segments. Fort Collins’ Proposed Action would eliminate a small section of the North Fork with the enlarged footprint of the dam. Fort Collins’ Proposed Action would also inundate a 0.75-mile section of the North Fork and transform it from stream habitat to reservoir habitat.

### 4.8.9 Effects Summary

#### 4.8.9.1 Direct and Other Effects Not Related to Flow

Fort Collins’ Proposed Action would eliminate a small segment of the North Fork where the existing dam is expanded and inundate another 0.75 mile of the North Fork upstream of the existing Halligan Reservoir. This would transform the free-flowing riffle and pool complexes (a special aquatic site identified in the 404(b)(1) guidelines) in the river (approximately 3.5 acres) into reservoir habitat and would be a major adverse effect. There would also be a temporary direct effect on a short section of Segment 1 of the North Fork during construction of the enlarged Halligan Dam. The other alternatives do not involve any long-term on-stream activity that would directly affect any aquatic biological resources (Table 4-40).

**Table 4-40. Summary of direct and other effects on aquatic biological resources that are not related to flow.**

<table>
<thead>
<tr>
<th>Other Effects</th>
<th>Halligan Dam Rehabilitation</th>
<th>Fort Collins’ Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct effect on streams</td>
<td>No effect</td>
<td>Major adverse</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
</tr>
<tr>
<td>Effect on Reservoirs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halligan</td>
<td>No effect</td>
<td>Minor to moderate beneficial</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
</tr>
<tr>
<td>NISP Proposed Glade Reservoir</td>
<td>No effect</td>
<td>No effect</td>
<td>Minor beneficial</td>
<td>No effect</td>
<td>No effect</td>
</tr>
</tbody>
</table>
Fort Collins’ Proposed Action would also enlarge Halligan Reservoir and create new habitat to sustain the species of fish and other organisms already present in the reservoir. These are mostly non-native species that are recreationally important. Enlargement of Halligan Reservoir would represent a minor to moderate beneficial effect on aquatic biological resources (Table 4-40).

The Expanded Glade Alternative would provide a small increase in new habitat to sustain populations of aquatic organisms. The reservoir would be suitable for the establishment and management of a recreational fishery that could support populations of both stocked and self-sustaining fish species. The Expanded Glade Alternative would represent a minor beneficial effect on aquatic biological resources (Table 4-40).

The Gravel Pits Alternative would create about 207 acres of open water that would likely support only a limited community of aquatic organisms due to the constant changes in water level and storage volume. The gravel pits are not currently proposed to be used for recreation. The overall effect of the Gravel Pits Alternative on aquatic biological resources would be a minor beneficial effect (Table 4-40).

The Agricultural Reservoirs Alternative would not change the size of NPIC Reservoirs Number 5 and 6 but would slightly increase the average annual volume of water stored in the reservoirs and therefore the average area available as habitat for aquatic organisms. This would represent a minor beneficial effect on aquatic biological resources (Table 4-40).

### 4.8.9.2 Flow Related Effects

Final effects were determined on a segment-by-segment basis for each alternative under the Future Conditions comparison. Effects were determined by taking into account the effects on all of the separate components of the aquatic environment evaluated in each segment (Table 4-41). The Future Conditions comparisons indicate that the Winter Release Plan and the Summer Plan in the North Fork with Fort Collins’ Proposed Action would result in negligible to major beneficial effects. In the 1.9 mile dry section from the diversion to the return ditch about 5.8 acres of riffle and pool complexes would have continuous flow. Using the total length of Segment 2a of four miles, about 12.1 acres of riffle and pool complexes would have continuous flow and no zero flow days. Many functions of Segment 2a would be restored including use by aquatic organisms throughout the year, connectivity to Segment 1 and Segment 2b, and
energy flow. The other alternatives would have mostly negligible effects in the North Fork and the Main Stem.

Table 4-41. Summary of flow-related effects on aquatic biological resources by river segment for each alternative under the Future Condition comparison.

<table>
<thead>
<tr>
<th>Segment/Reservoir</th>
<th>Halligan Dam Rehabilitation</th>
<th>Fort Collins’ Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>North Fork</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Segment 1</td>
<td>Minor adverse</td>
<td>Moderate beneficial</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Segment 2a</td>
<td>No effect</td>
<td>Major beneficial</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Segment 2b</td>
<td>No effect</td>
<td>Minor beneficial</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Segment 3</td>
<td>No effect</td>
<td>Negligible to minor beneficial</td>
<td>Negligible to minor adverse</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td><strong>Main Stem</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Segment A, Exchange Reach</td>
<td>No effect</td>
<td>Negligible</td>
<td>Negligible to minor adverse</td>
<td>Negligible to minor adverse</td>
<td>Negligible to minor adverse</td>
</tr>
<tr>
<td>Segment A</td>
<td>No effect</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Segment B</td>
<td>No effect</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Segment C</td>
<td>No effect</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Segment D</td>
<td>No effect</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Minor beneficial</td>
<td>Negligible</td>
</tr>
<tr>
<td>Segment E</td>
<td>No effect</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>Segment F</td>
<td>No effect</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
</tbody>
</table>

4.8.10 Mitigation Measures

Fort Collins has proposed two options for fisheries enhancements on the North Fork. Either option is considered a voluntary enhancement measure and is related to Fort Collins’ Proposed Action:

- Option A, considered the more likely option, involves reconnecting larger habitat segments of the North Fork by removing or providing passage around structures in the North Fork that currently obstruct movement of fish. These potential enhancement measures would allow for greater movement and habitat availability for the existing populations of benthic macroinvertebrates and native fish as well as brown, brook, and rainbow trout. Option A could include using fish ladders or ramps, or potentially could remove water diversion structures no longer in use, such as the Calloway Diversion structure. Option A may include periodic modification of flows to help manage non-native fish populations and increase survival of small-bodied native fish. Fort Collins would conduct fish population surveys and field surveys of the amount and quality of available physical habitat for fish species in representative reaches of the North Fork between Halligan Dam and Seaman Reservoirs. Frequency, location, and scope of surveys would be determined annually in consultation with the Adaptive Management Committee.
• Option B would take advantage of the unique circumstances presented by the Proposed Action's operational flows, which would restore base flows to the isolated 6-mile Phantom Canyon Reach of the North Fork below Halligan Dam. Under Option B, this 6-mile reach would remain isolated between Halligan Dam and the North Poudre Canal diversion structure and a native pure-strain greenback cutthroat trout population would be introduced in the 6-mile segment. The North Poudre Canal diversion structure would be retrofitted to isolate the greenback cutthroat trout population and to exclude interbreeding and competition with other non-native trout species. To be effective, passage of non-native trout from Halligan Reservoir into the 6-mile segment would need to be prevented using nets and screens and increased capacity of the dam outlet works to decrease spill frequency.

Selection of one of the options described above is subject to evaluation of fatal flaws and agreements with pertinent agencies.

**4.9 GEOLOGY**

Potential effects to geologic resources include permanent loss of accessibility to construction material resources (i.e., crushed rock, gravel, fill dirt, and sand) and mineral resources (i.e., gold, silver, oil, and gas) as a result of inundation by reservoir enlargements, placement of permanent infrastructure, and excavation of materials from borrow areas. There is also the potential for the Project Alternatives to be affected by geologic hazards. Subsurface mining could potentially be used to access certain geologic resources made otherwise inaccessible due to development of an alternative.

**4.9.1 Methods**

To evaluate potential effects to geology, the acreage of construction material resources or minerals resources that would become inaccessible to surface mining due to implementation of each alternative was determined by overlaying Geographic Information System (GIS) layers containing mineral and geological features on maps of proposed infrastructure and construction areas for each alternative. Direct, long-term loss of construction material resources or mineral resources would occur in inundation areas or where new infrastructure, such as dam footprints, permanent roads, pretreatment facilities and pumping stations, would be built. Each alternative map was compared to a geological hazards map to assess geologic hazards.

**4.9.1.1 Data Adequacy**

Section 3.9.3 describes the best available data for geologic resources in the study areas. The Corps determined that the data available and methods used were adequate to evaluate and describe reasonably foreseeable significant adverse effects on geologic resources and to enable the decision maker to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable geologic resource information as described in Section 4.2.1.5. The effects of the alternatives on geologic resources are described below.
4.9.2 Halligan Dam Rehabilitation

Due to the age and condition of the existing Halligan Dam, it would be rehabilitated under all of the alternatives, regardless of which one is chosen. The following effects to geologic resources are common to all alternatives.

4.9.2.1 Material Sources

Rehabilitation of Halligan Dam would result in the long-term loss of accessibility to approximately 0.5 acre due to the dam footprint, and five acres due to access roads. Borrow material for dam construction would be excavated from an additional 22.4 acres. The specific borrow materials required to rehabilitate Halligan Dam would depend on the final design and could include core, shell, filter/drain, riprap and bedding material, and concrete aggregate. Geologic reconnaissance and a detailed exploration program would be needed to confirm the availability and quantity of suitable materials at the designated borrow areas. Tests completed to characterize and evaluate the materials could include determination of geotechnical properties, shear strength tests, and aggregate durability tests.

4.9.2.2 Mineral Resources

No known mineral resources or oil or gas resources would be affected by rehabilitation of Halligan Dam.

4.9.2.3 Geologic Hazards

Halligan Dam rehabilitation would be located in an area designated as having a low incidence of landslide occurrence potential; i.e., less than 1.5 percent of the area surrounding the dam footprint has been affected by documented landslides (Radbruch-Hall et al. 1982).

4.9.3 Fort Collins’ Proposed Action

4.9.3.1 Construction Material Resources

Fort Collins' Proposed Action would result in a long-term loss of accessibility to approximately 132.5 acres of construction material resources due to inundation, in addition to the acreage affected by the dam rehabilitation described in Section 4.9.2.1. This long-term loss is a minor effect.

4.9.3.2 Mineral Resources

Through inundation, Fort Collins’ Proposed Action would result in a loss of surface accessibility to a maximum of nine acres of the Halligan 1-4 placer mining claims owned by Cubic Carbon LLC and situated on Bureau of Land Management land. Fort Collins and Cubic Carbon LLC have entered into an agreement permitting Fort Collins to inundate these claims. Fort Collins applied to Bureau of Land Management on December 21, 2016 for a perpetual FLPMA right-of-way to inundate up to nine acres of Bureau of Land Management land. Fort Collins holds existing right-of-way COD-0-12781 dated February 23, 2016 from the Bureau of Land Management, which permits the existing Halligan Reservoir to inundate approximately 11 acres of Bureau of Land Management land. There are no other known mineral,
oil, or gas resources identified within the enlarged Halligan Reservoir footprint, potential borrow areas, or disturbance areas that would be affected by construction of Fort Collins’ Proposed Action.

4.9.3.3 Geologic Hazards

Fort Collins’ Proposed Action would be located in an area designated as having a low incidence of landslide occurrence potential. Low incidence occurrence indicates less than 1.5 percent of the area surrounding the alternative footprint has been affected by documented landslides (Radbruch-Hall et al. 1982).

4.9.4 Expanded Glade Alternative

4.9.4.1 Construction Material Resources

The Expanded Glade Alternative would result in a long-term loss of approximately 63 acres of construction material resources due to inundation and three acres due to access roads. No new borrow areas are associated with construction of this alternative; on-site materials would be sourced from the proposed Glade Reservoir borrow pit proposed as part of NISP. Therefore, there would be no additional loss of construction material resources due to extraction.

4.9.4.2 Mineral Resources

There are no known mineral or oil and gas resources identified within the Expanded Glade Alternative footprint or disturbance areas. Therefore, no mineral resources would be affected by construction of the alternative.

4.9.4.3 Geologic Hazards

Although Quaternary landslides previously have occurred within the footprint of the alternative, the majority of the alternative footprint is located in an area designated as having a low incidence of documented landslide occurrence (Radbruch-Hall et al. 1982). Low incidence occurrence indicates less than 1.5 percent of the area surrounding the alternative footprint has been affected by landslides (Radbruch-Hall et al. 1982). A portion of the western side of the enlarged area and a portion of the pipeline system and associated disturbed areas are located within an area designated as having a medium incidence of landslide occurrence potential. Medium incidence occurrence indicates between 1.5 and 15 percent of the area surrounding the alternative footprint has been affected by documented landslides (Radbruch-Hall et al. 1982).

4.9.5 Gravel Pits Alternative

4.9.5.1 Construction Material Resources

The development of this alternative would result in a long-term loss of surface accessibility to six acres of construction material resources due to construction of berms around potential proposed storage pit areas
at the Overland Gravel Pit complex. Additionally, about 5.5 acres of the alternative conveyance system and associated construction and disturbance areas overlies Quaternary alluvial sand and gravel deposits. There would be an additional long-term loss of 12.5 acres due to construction of permanent access roads associated with this alternative.

The potential borrow materials for this alternative are located within the existing footprint of excavation to achieve the desired water storage capacity. The specific borrow materials required to complete the alternative would depend on the final design, and could include core, shell, filter/drain, riprap and bedding material, and concrete aggregate. Geologic reconnaissance and a detailed exploration program would be needed to confirm the availability and quantity of suitable materials at the designated borrow areas. Tests completed to characterize and evaluate the materials could include determination of geotechnical properties, shear strength tests, and aggregate durability tests.

### 4.9.5.2 Mineral Resources

There are no known mineral, oil, or gas resources identified within the alternative study area construction areas, potential borrow areas, or disturbance areas that would be affected by construction of the alternative.

### 4.9.5.3 Geologic Hazards

There have been documented landslides and debris slides within the footprint of the western-most potential staging area associated with construction of the alternative conveyance system, and the Gravel Pits Alternative is located within an area designated as having a medium incidence of landslide occurrence potential. Medium incidence occurrence indicates between 1.5 and 15 percent of the area surrounding the alternative footprint has been affected by documented landslides (Radbruch-Hall et al. 1982).

### 4.9.6 Agricultural Reservoirs Alternative

#### 4.9.6.1 Construction Material Resources

Development of this alternative would result in a long-term loss of accessibility to nine acres of construction material resources due to construction of permanent access roads associated with the alternative. Another 2.5 acres of construction material resources would become inaccessible due to construction of a pump station, pretreatment facility, valve house, and river turnout associated with the alternative. There are no proposed borrow areas for construction, and no identified borrow areas or requirements for this alternative.

#### 4.9.6.2 Mineral Resources

A portion of the alternative conveyance system and associated construction and disturbance areas overlies Quaternary alluvial sand and gravel deposits. However, there are no known mineral, oil, or gas resources identified within the alternative study area construction areas or disturbance areas that would be affected by this alternative.
4.9.6.3 Geologic Hazards

The Agricultural Reservoirs Alternative is located between two landslide potential designated areas. The western portion of the alternative is located within an area designated as a medium incidence of landslide occurrence potential where between 1.5 and 15 percent of the area surrounding the alternative footprint has been documented to be affected by landslides (Radbruch-Hall et al. 1982). The eastern portion of the alternative is located within an area designated as having high susceptibility to landslides but low incidence of documented landslide occurrence (Radbruch-Hall et al. 1982).

4.9.7 No-Action Alternative

The No-Action Alternative would not require any structural concepts, construction activities, or disturbance of any geologic resources beyond those associated with the Halligan Dam rehabilitation (Section 4.9.2.1).

4.9.8 Effects Summary

Effects to geologic resources resulting from implementation of Fort Collins’ Proposed Action and each of the alternatives would be associated with a long-term loss of accessibility or material resources loss within the footprint of inundation areas, infrastructure, storage areas, or borrow areas. Additional geotechnical studies would be performed for final design of any alternative permitted. Table 4-42 provides a summary of the acreages that would experience long-term accessibility loss under each of the alternatives. These effects are considered to be irreversible or irretrievable commitments of geologic resources.

Table 4-42. Summary of effects to geologic resources by alternative.

<table>
<thead>
<tr>
<th>Alternative Feature</th>
<th>Halligan Dam Rehabilitation*</th>
<th>Fort Collins’ Proposed Action</th>
<th>Expanded Glade</th>
<th>Gravel Pits</th>
<th>Agricultural Reservoirs</th>
<th>No Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acreage of long-term loss of accessibility to geologic resources by alternative</td>
<td>0.0 132.5 63.0 0.0 0.0 0.0</td>
<td>5.0 0.0 3.0 12.5 9.0 0.0</td>
<td>0.0 0.0 0.0 6.0 0.0 0.0</td>
<td>0.0 0.0 0.0 5.5 2.5 0.0</td>
<td>0.0 0.0 0.0 0.0 0.0 0.0</td>
<td></td>
</tr>
<tr>
<td>Excavation/inundation area</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>Berm Construction</td>
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<td>0.0</td>
<td>6.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Conveyance/pump stations/pretreatment</td>
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<td>0.0</td>
<td>5.5</td>
<td>2.5</td>
<td>0.0</td>
</tr>
<tr>
<td>Halligan Dam rehabilitation footprint</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
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<td>Borrow areas</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>27.9</td>
<td>132.5</td>
<td>66.0</td>
<td>24.0</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mineral Resources</td>
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<td>Minor</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
</tr>
</tbody>
</table>
**4.9.9 Unavoidable Adverse Effects**

Under all alternatives, there would be an unavoidable loss of geologic resources (i.e., bedrock and sand and gravel deposits) and alterations of topography associated with the use of borrow materials for construction.

**4.9.10 Mitigation Measures**

No specific mitigation measures have been determined necessary at this time by Fort Collins for geologic resources.

**4.10 SOILS**

Potential effects to soils from implementation of the Project Alternatives include the long-term loss of soils within inundation areas, erosion during construction, shoreline erosion at enlarged reservoirs, reservoir or stream sedimentation, and soil suitability for revegetation of disturbed areas. The preliminary nature of each of the alternative designs conservatively estimates the maximum footprint extents for the inundation areas, borrow areas, staging areas, and infrastructure such as pipeline corridors; therefore, the estimated disturbance areas are presented as maximum possible disturbances.

Additionally, potential effects on prime and unique farmland soils, if present, were evaluated within the footprints of the Project Alternatives. Fort Collins’ Proposed Action or the other alternatives would not be a federal program; the definition of which does not include federal permitting for activities on private or non-federal lands. Effects on prime farmland consequently are not evaluated under the Farmland Protection Policy Act. Effects on prime farmland, however, are evaluated in this EIS under the National Environmental Policy Act as a natural or depletable resource [40 Code of Federal Regulations 1502.16(f)].

**4.10.1 Methods**

Soil loss (i.e., excavation of, construction on, or inundation of soils) was determined from the amount of project-related disturbance within the footprints for Fort Collins’ Proposed Action and the alternatives. The distribution of soil mapping units in the footprints was analyzed; relevant information regarding soil characteristics was evaluated to determine the potential for effects to soils. The potential for erosion was evaluated for each of the soils within the study areas of Fort Collins’ Proposed Action and the alternatives. The potential of wind erosion for a soil is based on the wind erodibility group, which is
determined based on soil characteristics such as soil texture, vegetation cover, and slope. The potential for water erosion is determined by the erosion hazard classification for each soil map unit and the K factor. The K factor is a soil erodibility factor that characterizes the susceptibility of soil to erosion and the rate of runoff. The K factor is based primarily on percent of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity.

Losses of prime farmland were assessed by reviewing the Natural Resources Conservation Service’s mapping of prime farmland soils in Larimer County (Natural Resources Conservation Service 2017) and lands known to be irrigated relative to long-term project features or changes in management that would affect prime farmland soils. The intensity of effects for each alternative is correlated to the acreage of prime farmland predicted to be permanently effected compared to the total acreage of prime farmland in Larimer County, as follows:

- **No effect**: No effect on prime farmland
- **Negligible**: Effects that would be short-term and the disturbed land would be reclaimed to pre-construction condition with no loss of prime farmland
- **Minor**: Less than one percent of prime farmland within Larimer County would be affected
- **Moderate**: One to 10 percent of prime farmland within Larimer County would be affected
- **Major**: Greater than 10 percent of prime farmland within Larimer County would be affected; within the study areas evaluated, soils are designated prime farmland only if irrigated.

### 4.10.1.1 Data Adequacy

Section 3.10.3 describes the best available data for soils in the study areas. The Corps determined the data available and methods used were adequate to evaluate and describe reasonably foreseeable significant adverse effects on soils and to enable the decision maker to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable soils information as described in Section 4.2.1.5. The effects of the alternatives on soils are described below.

### 4.10.2 Halligan Dam Rehabilitation

Due to the age and condition of the existing Halligan Dam, it would be rehabilitated under all of the alternatives for safety purposes, regardless of which one is chosen. The following effects to soils are common to all Project Alternatives.

#### 4.10.2.1 Soil Loss and Disturbance

Rehabilitation of Halligan Dam would result in the long-term loss of less than 0.5 acre due to the dam footprint, five acres due to access roads, and 22.4 acres for borrow material. Additional short-term soil disturbance of 29.4 acres would be likely at reservoir construction and staging area locations. None of these affected soils are prime farmland soils; therefore, prime farmland would not be affected by Halligan Dam rehabilitation.
4.10.2.2 Soil Erosion

The majority of soil types subject to short-term wind erosion within potential construction disturbance areas for Halligan Dam rehabilitation are classified as having a moderate to severe susceptibility to erosion. These disturbed areas have medium to rapid runoff potential and the potential for water erosion is generally severe due to the steeper slopes.

4.10.2.3 Revegetation Potential

Soils present in the areas temporarily disturbed by rehabilitation of Halligan Dam have limited revegetation potential since they are composed primarily of outcrop complexes that are limited because of steep slopes, shallow soils, and the amount of rock in the soil. During rehabilitation, recovery of topsoil from areas of short-term disturbance could increase revegetation potential following construction, but generally recovered soils have lower productivity after reapplication. Once rehabilitation of the dam is complete, a new soil evaluation would need to be conducted to determine the current revegetation potential of the soil and a revegetation plan developed based on the new conditions. Fort Collins intends to fully revegetate any disturbed soils associated with the alternative once construction is complete.

4.10.3 Fort Collins’ Proposed Action

4.10.3.1 Soil Loss and Disturbance

Fort Collins’ Proposed Action would result in a long-term loss of approximately 132.5 acres of soils due to inundation from the expanded Halligan Reservoir. The soils within the inundation area are not prime farmland soils. Therefore, Fort Collins’ Proposed Action would not affect prime farmland soils.

4.10.3.2 Soil Erosion

4.10.3.2.1 Shoreline/Bank Erosion

Enlarging the current Halligan Reservoir would inundate soils along the reservoir shoreline and would increase the potential for water erosion initially after implementation. Water erosion potential of the majority of soils located along the shoreline and banks along the existing and anticipated shoreline is severe. Although the K factors for soils are generally moderate, the presence of steeper slopes indicates greater susceptibility to erosion.

4.10.3.2.2 Sedimentation

The enlarged Halligan Reservoir would be filled with direct flows from the North Fork. The primary source of stream flow in the North Fork is the upper basin, which is largely forested and undeveloped, thus sedimentation inputs from the surrounding soils are at natural erosion rates. The upstream soils have a severe erosion rating that is slightly minimized by the surrounding natural forested areas. In general, sediment accumulation in Halligan Reservoir would be minor as a result of overall low sediment productivity of the drainage basin and effective sediment management upstream of the reservoir. A detailed sediment budget analysis was previously completed for Halligan Reservoir and is documented in
Halligan Reservoir Sediment Budget 2002 and 2003, prepared for North Poudre Irrigation Company (Telesto Solutions 2003). Shoreline water erosion and areas of soil disturbance from construction also would potentially contribute sediment to the reservoir.

4.10.3.3 Revegetation Potential

The revegetation potential for areas that would be disturbed during dam construction is discussed in Section 4.10.2.3.

4.10.4 Expanded Glade Alternative

4.10.4.1 Soil Loss and Disturbance

The Expanded Glade Alternative would result in a long-term loss of approximately 63 acres of soils due to inundation. Construction of permanent access roads and the river turnout would result in an additional long-term loss of approximately three acres of soils. No additional borrow areas are associated with construction of this alternative and, therefore, no soil loss or disturbance due to extraction of material for dam construction or other infrastructure. Additional short-term soil disturbance of approximately 70 acres would likely occur where temporary access roads, pipelines, and staging areas are placed.

Most of the areas affected long-term by the Expanded Glade Alternative are not considered prime farmland. However, approximately 10 acres of Nunn, Harlan, and Satanta soils in the northern and southwestern portions of the Expanded Glade Alternative footprint are considered prime farmland if irrigated. These 10 acres constitute 0.02 percent of prime farmland in Larimer County; therefore, effects to prime farmland are considered minor because less than one percent of prime farmland within Larimer County would be affected.

Approximately 47 acres of soils within the proposed short-term disturbance areas are considered prime farmland. Effects to this prime farmland are considered negligible because they would be short-term and the disturbed land would be reclaimed to pre-construction condition with no loss of prime farmland.

4.10.4.2 Soil Erosion

4.10.4.2.1 Short-Term Erosion

An estimated 70 acres of soils underlying temporary access roads, pipeline disturbance areas, and staging areas would be disturbed temporarily during construction of the Expanded Glade Alternative. The potential for wind erosion for most soils within the temporarily disturbed areas ranges from slight to moderate. Over half of the soils within the temporarily disturbed areas located at the southwestern portion of the Expanded Glade Alternative are composed of Satanta and Poudre soils and other gentle-sloping soil series. The surface runoff potential of these soils is slight to moderate and the potential for water erosion is generally slight to moderate. The remaining soils generally have a severe potential for short-term wind erosion within disturbed areas. The surface runoff potential of soils within these areas is medium to rapid and the potential for water erosion generally is severe due to the steeper slopes.
4.10.4.2.2 Shoreline/Bank Erosion
The Expanded Glade Alternative would increase the potential for shoreline erosion. The water erosion potential of the soils located along the eastern, southern, and western shorelines and banks generally is severe. Although the K factors generally are moderate, the slopes are steep enough to be susceptible to erosion because of wave action and water surface fluctuation. The water erosion potential of soils located along the northern shoreline and bank is moderate where soils are medium-textured and moderately susceptible to detachment.

4.10.4.2.3 Sedimentation
Slopes surrounding the Expanded Glade Alternative footprint generally are moderate, coarse in texture, and the drainage is ephemeral, which indicates surface runoff and sediment transport from surrounding areas would be low. The water source for storage in the proposed enlarged reservoir would be the North Fork through the Poudre Valley Canal. The primary source of stream flow in the North Fork is the upper basin, which is largely forested and undeveloped; thus, sedimentation inputs from the surrounding soils would occur at natural or current erosion rates. The upstream soils have a severe erosion rating that is slightly minimized from the surrounding natural forested areas. Shoreline water erosion and areas of soil disturbance from construction also would contribute sediment to the reservoir. However, revegetation of short-term disturbances would reduce the potential for erosion from these sites. Overall sedimentation would be minor for the Expanded Glade Alternative.

4.10.4.3 Revegetation Potential
Soils in the temporarily disturbed areas are designated as prime farmland if irrigated, which indicates they would likely have good potential for revegetation. Once construction of the alternative is complete, a new soil assessment would be needed to determine the current revegetation potential of the soil, and a revegetation plan would be developed based on the new conditions. Fort Collins intends to fully revegetate any disturbed soils associated with the alternative once construction is complete.

4.10.5 Gravel Pits Alternative

4.10.5.1 Soil Loss and Disturbance
Development of this alternative would not result in long-term loss or disturbance of soils at the gravel pit storage units identified for use under this alternative, as they are located at the Overland Gravel Pit complex, and it is assumed these gravel pits would be excavated prior to implementation of this alternative. However, berm construction may be necessary on some of the gravel pits to accommodate the needed water storage capacity, which may result in the long-term loss and disturbance of six acres of soils. Similarly, the proposed conveyance system structures, such as the pump stations, could result in the potential loss and disturbance of five acres of soils. The proposed location of the pipeline corridor was selected to follow existing roads and easements with the intention of limiting potential short- and long-term disturbance and large-grade changes, and to avoid areas that could be problematic for obtaining easements. Long-term and temporary access roads would result in loss and disturbance of 12.5 and
17.5 acres of soil, respectively. An additional short-term soil disturbance of 94 acres is likely to occur at conveyance system construction and staging area locations (Figure 2-4).

Approximately 74 acres of soils within the pipeline disturbance area and the staging area footprints have prime farmland designation. Of these 74 acres, 18 acres would be affected long-term and 56 acres would be affected short-term. The long-term effects are considered minor because the 18 acres constitute 0.04 percent of prime farmland in Larimer County; effects to prime farmland are considered minor when less than one percent of prime farmland within Larimer County would be affected. The temporary effects to 56 acres are considered negligible because they would be short-term and the disturbed land would be reclaimed to pre-construction condition with no loss of prime farmland.

4.10.5.2 Soil Erosion

4.10.5.2.1 Short-Term Erosion
The proposed alignment of the pipeline corridor was selected to follow existing roads and easements to limit potential short- and long-term disturbance of soils. An estimated 111.5 acres of soils would be temporarily disturbed during construction of the alternative due to temporary access roads, pipeline disturbance areas, and staging areas. The potential for short-term wind erosion of most soils within the construction disturbance areas ranges from slight to moderate (Moreland 1980). The principal soils within the potential disturbance and construction areas generally are gently-sloping soil series. The surface runoff of these soils is slow to moderate, and the potential for water erosion generally is slight to moderate.

4.10.5.2.2 Shoreline/Bank Erosion
Shoreline and bank erosion would be minimal due to use of constructed berms that would be designed to minimize erosion.

4.10.5.2.3 Sedimentation
Sedimentation from areas surrounding the gravel pit reservoirs would be minor, since limited or no runoff would enter from surrounding areas. The slopes surrounding the proposed gravel pit reservoirs are gentle, which indicates surface runoff and sediment transport from the surrounding areas would be low. Water for this alternative would be diverted from the Poudre River through the existing Larimer County Number 2 Canal diversion structure, and conveyed using excess capacity in the canal. The primary source of stream flow in the river is the upper basin, which is largely forested and undeveloped; thus, sedimentation inputs from the surrounding soils would be at natural erosion rates. The upstream soils have a severe erosion rating that is slightly minimized from the surrounding natural forested areas. The constructed gravel pit reservoirs would have minimal potential for shoreline erosion. Revegetation of temporary disturbances could reduce the potential for erosion at these sites.
4.10.5.3 Revegetation Potential

In general, existing soils in areas temporarily disturbed are designated as prime farmland if irrigated, which indicates they may be suitable for revegetation. Once construction of the alternative is complete, a new soil assessment would be needed to design the reclamation program. Fort Collins intends to fully revegetate any disturbed soils associated with the alternative once construction is complete.

4.10.6 Agricultural Reservoirs Alternative

4.10.6.1 Soil Loss and Disturbance

Development of the Agricultural Reservoirs Alternative would not result in a long-term loss or disturbance of soils within the agricultural reservoir footprints because these agricultural reservoirs existed prior to implementation of this alternative. Similarly, no long-term loss of soil would result from the proposed pipeline because the pipeline corridor follows existing roads and easements. However, development of this alternative would result in the potential long-term loss of two acres of soils from construction of the proposed conveyance system structures, such as the pump station. Long- and short-term access roads would result in a loss of 9.0 and 12.5 acres of soils, respectively. Additional short-term soil disturbance of 360 acres is likely at the conveyance system construction and staging area locations.

The majority of soils within the footprint of the short-term disturbance areas and conveyance system have prime farmland designation. As such, approximately eight acres of soils with prime farmland designation would be affected long-term, and 236 acres would be affected short-term. The long-term effect would be considered minor because the eight acres constitute less than 0.02 percent of prime farmland in Larimer County; effects to prime farmland are considered minor when less than one percent of prime farmland within Larimer County would be affected. The effects to the 236 acres would be considered negligible because they would be short-term and the disturbed land would be reclaimed to pre-construction condition with no loss of prime farmland.

4.10.6.2 Soil Erosion

4.10.6.2.1 Short-Term Erosion

An estimated 372.5 acres of soils would be temporarily disturbed during construction of the alternative due to temporary access roads, pipeline disturbance areas, and staging areas. The potential for short-term wind erosion of most soils within the alternative construction disturbance area generally ranges from slight to moderate. The soils within these areas occur on gentle to moderate slopes. The surface runoff potential of these soils is slow to medium, and the potential for water erosion is generally slight to moderate (Moreland 1980).

4.10.6.2.2 Shoreline/Bank Erosion

The existing agricultural reservoirs would not be altered with implementation of the alternative, and the shoreline and bank erosion rates are stable and would not change with implementation of the alternative.
4.10.6.2.3 Sedimentation

Most slopes surrounding the proposed Agricultural Reservoirs Number 5 and 6 are gentle to moderate, ranging from one to five percent slope, which indicates surface runoff and sediment transport from the surrounding areas would be low to moderate. Water to fill Agricultural Reservoirs Number 5 and 6 would be diverted from the Poudre River at the Munroe Canal diversion structure, and conveyed by gravity to the Agricultural Reservoir Number 6 outlet structure. The primary source of stream flow in the river is the upper basin, which is largely forested and undeveloped; thus, sedimentation inputs from the surrounding soils would be at natural erosion rates. The upstream soils have a severe erosion rating that is slightly minimized from the surrounding natural forested areas.

Shoreline water erosion rates would not change with implementation of the alternative as it uses existing storage reservoir units; however, temporary soil disturbance in areas surrounding the reservoirs from construction of the conveyance system could contribute sediment to the reservoir. These effects would be short-term; revegetation of temporary disturbance areas is expected to reduce erosion from these sites to natural erosion rates. Overall sedimentation effects would be minor from the Agricultural Reservoirs Alternatives.

4.10.6.3 Revegetation Potential

In general, existing soils in areas of the conveyance system and temporary disturbance areas are designated as prime farmland if irrigated, which indicates they may be suitable for revegetation at the completion of the alternative construction. Once construction of the alternative is complete, a new soil assessment would be required to design the reclamation program. Fort Collins intends to fully revegetate any disturbed soils associated with the alternative once construction is complete.

4.10.7 No-Action Alternative

The No-Action Alternative would not require any structural concepts, construction activities, or disturbance of any soils beyond those associated with the Halligan Dam rehabilitation; effects to soils resulting from the Halligan Dam rehabilitation are discussed in Section 4.10.2. Although this alternative involves acquisition of additional NPIC shares by Fort Collins and could result in the removal of some prime farmland from irrigation, it is not anticipated to result in effects to prime farmland.

4.10.8 Effects Summary

Most of the effects associated with Fort Collins’ Proposed Action and alternatives that would result in long-term soil loss and disturbance are due to reservoir enlargement, access roads, permanent infrastructure, or borrow areas. The preliminary nature of each of the alternative designs conservatively estimates the maximum footprint extents for the inundation areas, borrow areas, staging areas, and infrastructure such as pipeline corridors; therefore, the estimated disturbance areas are maximum possible disturbances. Table 4-43 shows the total maximum long-term loss and disturbance acreages for soils under each alternative. Some of the soils within the permanent loss and disturbance areas for each alternative are designated as prime farmland, which would likely result in an irreversible or irretrievable
commitment of soils where permanent impacts occur. Permanent losses may occur to prime farmland due to inundation, erosion, removal of materials, and accessibility limitation.

Table 4-43. Effects to soil resources by alternative.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Halligan Dam Rehabilitation*</th>
<th>Fort Collins’ Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
<th>No-Action Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-term loss and disturbance areas (acreage)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inundation area</td>
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<td>132.5</td>
<td>63.0</td>
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<td>0.0</td>
</tr>
<tr>
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<tr>
<td>Gravel pits storage (surrounding berms)</td>
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<td>0.0</td>
<td>6.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Pump stations/pretreatment</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>5.0</td>
<td>2.0</td>
<td>0.0</td>
</tr>
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<td>River turnout</td>
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<td>&lt;0.5</td>
<td>&lt;0.5</td>
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<tr>
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<td>&lt;0.5</td>
<td>&lt;0.5</td>
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<td>0.0</td>
<td>0.0</td>
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<tr>
<td>Borrow areas – Halligan Dam rehabilitation</td>
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<td>0.0</td>
<td>0.0</td>
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</tr>
<tr>
<td>Total (acres)</td>
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<td>66.0</td>
<td>23.5</td>
<td>11.0</td>
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<td>Prime farmland (effect determination)</td>
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<td>Negligible</td>
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</tr>
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<td>Minor</td>
<td>Minor</td>
<td>No effect</td>
</tr>
<tr>
<td>Soil erosion (effect determination)</td>
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</tr>
<tr>
<td>Wind erosion (short term)</td>
<td>Moderate to severe</td>
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<td>Slight to moderate</td>
<td>Slight to moderate</td>
<td>Slight to moderate</td>
<td>No effect</td>
</tr>
<tr>
<td>Water erosion (short term)</td>
<td>Severe</td>
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<td>Slight to moderate</td>
<td>Slight to moderate</td>
<td>Slight to moderate</td>
<td>No effect</td>
</tr>
<tr>
<td>Shoreline/bank erosion (long term)</td>
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<td>Severe</td>
<td>Moderate to severe</td>
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<td>No effect</td>
<td>No effect</td>
</tr>
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<td>Sedimentation (long term)</td>
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<td>Minor</td>
<td>Minor</td>
<td>Minor</td>
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<td>Other</td>
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<td>Revegetation potential</td>
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<td>Limited</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
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</tr>
</tbody>
</table>

*These effects would occur under all alternatives

4.10.9 Unavoidable Adverse Effects

All alternatives would result in unavoidable adverse effects on soils from construction activities. In all alternatives, some loss of soil material from wind and water erosion would be likely during construction and until disturbed areas are revegetated. Mitigation measures described below in Section 4.10.10 would minimize soil loss. Operations of the reservoirs or gravel pits would result in shoreline erosion associated with fluctuating water levels.
4.10.10 Mitigation Measures

Fort Collins has proposed the following construction-related avoidance/minimization measures for all alternatives related to soils:

- **Stormwater Management Plan**: Development, prior to construction, of a Stormwater Management Plan including best management practices. The plan would include provisions for temporary sediment and erosion control during construction as well as medium-term sediment and erosion control during re-establishment of vegetation.

- **Best Management Practices**: Fort Collins proposes to employ standard construction Best Management Practices included in federal, state, and local permit requirements. Best Management Practices would include standard erosion control measures such as installing silt fence and check structures, and implementing a spill prevention plan.

- **Revegetation of Disturbed Areas**: Fort Collins is considering revegetating with native grass and forbs any existing areas stripped of soil or left with exposed aggregate, including all staging areas and borrow pits.

Under Fort Collins’ Proposed Action, they would place topsoil and revegetate construction areas and tailing piles left from the original construction of Halligan Dam with native grass and forbs.

4.11 VEGETATION

Potential effects to upland vegetation include direct effects on vegetation associated with proposed project facilities and indirect effects that might occur due to establishment of noxious weeds and soil erosion. Long-term effects are associated with footprints and alternative facilities, such as the reservoirs, dam, forebay, pump stations, associated facilities, pipeline connections, and realigned roads. Short-term effects include removal of vegetation that would be restored following construction. Wetland and riparian vegetation are discussed in Section 0.

4.11.1 Methods

Direct effects to vegetation were quantified by overlaying project features on maps of vegetation cover types using ArcGIS. Direct long-term loss of vegetation resources would occur in inundation areas or where new infrastructure would be built, such as dam footprints, permanent roads, pretreatment facilities, and pumping stations. Direct short-term effects to plant communities were calculated primarily for construction disturbances that would be reclaimed, such as some borrow pits, pipelines, and access roads. Fort Collins did not provide specific alignments for access roads and pipelines, but rather a corridor was identified within which the road or alignment would be constructed. This approach allows Fort Collins flexibility in final project planning while providing areas to analyze for potential effects. In these cases, effects were assessed by applying a buffer to the centerline of such features; a 12.5-foot buffer for long-term effects from access roads, a 30-foot buffer for short-term effects from access roads, and a 75-foot buffer for pipeline corridors. Other features, like the potential construction disturbance area at Halligan Dam, were presented as a large polygon encompassing smaller potential staging areas and borrow areas. Construction activities would not occur throughout the entire large polygon but would be limited to the
staging, borrow areas, and access roads. These larger areas likely represent a conservative over-estimate of effects, and the actual disturbance footprint might be much smaller. Fort Collins is willing to move the locations of these areas within the larger polygon to avoid critical resources, if necessary. Fort Collins would use staging areas for construction site trailers, material stockpiles, and vehicles and equipment parking.

An approach to effects analysis and descriptions of effect intensity was developed based on concepts in previous similar EISs and conditions in the study areas of the Project Alternatives. The following thresholds were used to determine the change in intensity of direct effects resulting from a Project Alternative on vegetation communities:

- **Negligible**: Effects to individual native plants or native plant communities would have no measurable or perceptible effect on size, viability, integrity, or function of the plant community.
- **Minor**: Effects to individual native plants or native plant communities would be measurable or perceptible but would not affect the size, distribution, viability, integrity, or function of the plant community.
- **Moderate**: Effects to individual native plants or native plant communities would be measurable or perceptible and would affect the overall size, distribution, viability, integrity, or function of the plant community.
- **Major**: Effects to plant communities would be readily apparent and would substantially affect the natural function and character of the plant community, including its overall size, distribution, viability, integrity, or function in the area.

The analysis of indirect effects to vegetation resources was primarily focused on effects associated with erosion and noxious weed establishment. Erosion and noxious weed establishment could occur in areas where soil is removed for construction activities, while additional noxious weed species could be introduced by straw mulch, construction equipment, and vehicular traffic.

### 4.11.1 Data Adequacy

Section 3.11.3 describes the best available data for vegetation in the study areas. The Corps determined the data available and methods used were adequate to evaluate and describe reasonably foreseeable significant adverse effects on vegetation in the study areas and to enable the decision maker to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable vegetation information as described in Section 4.2.1.5. Effects of the alternatives on vegetation are described below.

### 4.11.2 Halligan Dam Rehabilitation

Due to the age and condition of the existing Halligan Dam, it would be rehabilitated under all Project Alternatives, regardless of which one is chosen. Therefore, the following effects are common to all alternatives.
4.11.2.1 Direct Effects

Halligan Dam rehabilitation would directly affect approximately 56.1 acres of upland vegetation, including approximately 27.3 acres of long-term vegetation loss and approximately 28.8 acres of short-term vegetation disturbance (Table 4-44; Figure 4-58). Loss of vegetation at borrow areas was considered long-term because of the improbability of achieving successful restoration and revegetation of the sensitive plant communities present on site. Excavation of borrow areas in the shallow soils would expose granite bedrock, a difficult substrate for revegetation. Observations of the floristic composition within the existing borrow area used for Halligan Dam construction in 1910 supports this conclusion, as this area is dominated by sparse vegetation characteristic of disturbed sites.

Table 4-44. Direct effects on upland vegetation cover types for Halligan Dam Rehabilitation.

<table>
<thead>
<tr>
<th>Effect Feature</th>
<th>Effect Type</th>
<th>Foothill Grasslands</th>
<th>Foothill Shrublands</th>
<th>Foothill Woodlands</th>
<th>Total Acres Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access roads</td>
<td>Long-term</td>
<td>3.5</td>
<td>1.4</td>
<td>0.0</td>
<td>4.9</td>
</tr>
<tr>
<td>Borrow areas</td>
<td>Long-term</td>
<td>4.0</td>
<td>18.0</td>
<td>0.4</td>
<td>22.4</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td>Long-term</td>
<td>7.5</td>
<td><strong>19.4</strong></td>
<td>0.4</td>
<td><strong>27.3</strong></td>
</tr>
<tr>
<td>Access road buffers</td>
<td>Short-term</td>
<td>2.2</td>
<td>1.6</td>
<td>0.0</td>
<td>3.8</td>
</tr>
<tr>
<td>Staging areas</td>
<td>Short-term</td>
<td>21.3</td>
<td>3.7</td>
<td>0.0</td>
<td>25.0</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td>Short-term</td>
<td><strong>23.5</strong></td>
<td><strong>5.3</strong></td>
<td>0.0</td>
<td><strong>28.8</strong></td>
</tr>
<tr>
<td><strong>Total acres</strong></td>
<td></td>
<td>31.0</td>
<td>24.7</td>
<td>0.4</td>
<td>56.1</td>
</tr>
</tbody>
</table>

About 7.5 acres of foothill grasslands would be affected long-term. An estimated 60 percent (4.5 acres) of these grasslands meet the criteria for the *Hesperostipa comata – Bouteloua gracilis* Herbaceous Vegetation Association (Colorado Natural Heritage Program-ranked S2S3). Long-term effects would occur to about 19.4 acres of foothill shrublands. Two shrubland associations tracked by the Colorado Natural Heritage Program occur within the study area for Fort Collins’ Proposed Action, including the *Cercocarpus montanus – Hesperostipa comata* Shrubland Association (mountain mahogany association, S2) and *Purshia tridentata – Hesperostipa comata* Shrubland Association (antelope bitterbrush association, S1/S2). An estimated 20 percent (3.9 acres) of the foothill shrublands in the Halligan Dam rehabilitation disturbance areas meets the description of the mountain mahogany association and five percent (one acre) meets the description of the antelope bitterbrush association.
Figure 4-58. Halligan Dam Rehabilitation and Fort Collins’ Proposed Action vegetation effects.
Long-term loss of about 0.4 acre of foothill woodlands would occur from excavation of borrow areas. One state-imperiled (S2) woodland association tracked by the Colorado Natural Heritage Program, *Juniperus scopulorum/Cercocarpus montanus* Woodland Association, occurs within areas mapped as foothill woodland in the Halligan Dam rehabilitation disturbance areas. An estimated 20 percent (0.08 acre) of the foothill woodlands meets the description of this association.

Although the acreage of Colorado Natural Heritage Program-tracked native vegetation communities that would experience long-term effects is small, the relative effect is more significant but still minor to moderate because those communities are designated as critically imperiled or imperiled in the state and their loss would affect the overall size and distribution of these plant communities in the area. Long-term effects on foothill grasslands, foothill shrublands, and foothill woodlands that do not meet the Colorado Natural Heritage Program criteria for critically imperiled or imperiled communities would be minor because of the magnitude of loss.

Halligan Dam rehabilitation would temporarily affect about 28.8 acres of native vegetation from staging area and access road effects, including about 23.5 acres of foothill grasslands and 5.3 acres of foothill shrublands. The Colorado Natural Heritage Program tracks two sensitive plant communities that occur within the areas mapped as foothill grasslands and shrublands. Short-term effects on the native foothill grasslands and shrublands would be a minor to moderate effect because of the magnitude of disturbance and the potential for the introduction or further spread of noxious or invasive weed species following construction.

### 4.11.2.2 Indirect Effects

Indirect effects associated with Halligan Dam rehabilitation include the introduction or establishment of noxious weeds and soil erosion. Grading and other construction-related activities have the potential to create suitable habitat for noxious weed colonization and spread noxious weed seeds to uninfested areas prior to restoration. Although no importation of fill material would be required, additional noxious weed species could be introduced by straw mulch, vehicular traffic, and construction equipment.

### 4.11.3 Fort Collins’ Proposed Action

#### 4.11.3.1 Direct Effects

Fort Collins’ Proposed Action would directly affect approximately 100.2 acres of upland vegetation (wetland and riparian acreage is not included) due to inundation (Table 4-45; Figure 4-58); effects associated with reconstructing Halligan Dam are discussed in Section 4.11.2.

<table>
<thead>
<tr>
<th>Effect Feature</th>
<th>Effect Type</th>
<th>Foothill Grasslands</th>
<th>Foothill Shrublands</th>
<th>Foothill Woodlands</th>
<th>Total Acres Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inundation area</td>
<td>Long-term</td>
<td>72</td>
<td>26</td>
<td>2.2</td>
<td>100.2</td>
</tr>
<tr>
<td>Total acres</td>
<td></td>
<td>72</td>
<td>26</td>
<td>2.2</td>
<td>100.2</td>
</tr>
</tbody>
</table>
About 72 acres of foothill grasslands would be affected long-term. An estimated 60 percent (48.8 acres) of these grasslands meet the criteria for the *Hesperostipa comata – Bouteloua gracilis* Herbaceous Vegetation Association (Colorado Natural Heritage Program-ranked S2S3). Long-term effects would occur to about 26 acres of foothill shrublands within the study area. Two shrubland associations tracked by the Colorado Natural Heritage Program occur within the study area for Fort Collins’ Proposed Action, including the *Cercocarpus montanus – Hesperostipa comata* Shrubland Association (mountain mahogany association, S2) and *Purshia tridentata – Hesperostipa comata* Shrubland Association (antelope bitterbrush association, S1/S2). An estimated 20 percent (5.6 acres) of the foothill shrublands in the study area meets the description of the mountain mahogany association and five percent (1.4 acres) meets the description of the antelope bitterbrush association.

Long-term loss of about 2.2 acres of foothill woodlands would occur from reservoir enlargement. One state-imperiled (S2) woodland association tracked by the Colorado Natural Heritage Program, *Juniperus scopulorum/Cercocarpus montanus* Woodland Association, occurs within areas mapped as foothill woodland in the study area for Fort Collins’ Proposed Action. An estimated 20 percent (0.48 acre) of the foothill woodlands mapped in the study area meets the description for this association.

Although the acreage of Colorado Natural Heritage Program-tracked native vegetation communities that would experience long-term effects is small, the relative effect is more significant, but still moderate because they are designated as critically imperiled and/or imperiled in the state, and their loss would affect the overall size and distribution of these plant communities in the area. Long-term effects on foothill grasslands, foothill shrublands, and foothill woodlands that do not meet the Colorado Natural Heritage Program criteria for critically imperiled or imperiled communities would be minor because of the magnitude of loss.

### 4.11.3.2 Indirect Effects

Indirect effects to upland vegetation would be the same as described in Section 4.11.2.2 for effects common to all alternatives.

### 4.11.4 Expanded Glade Alternative

#### 4.11.4.1 Direct Effects

The Expanded Glade Alternative would directly affect approximately 125.1 acres of vegetation, including approximately 62.2 acres of long-term vegetation loss and approximately 62.9 acres of short-term disturbance (Table 4-46; Figure 4-59). It would result in the long-term loss of about 41.6 acres of foothill grasslands and 20.6 acres of foothill shrublands within the study area. Two shrubland associations tracked by the Colorado Natural Heritage Program occur within the Expanded Glade Alternative study area; the *Cercocarpus montanus/Hesperostipa comata* Shrubland Association (S2) and *Cercocarpus montanus/Hesperostipa neomexicana* Shrubland Association (S2/S3). It is estimated that 0.35 acre (15 percent) of the foothill shrublands within the study area meets the description for these two associations.
A portion of the Expanded Glade Alternative study area occurs within the Hook and Moore Glade Potential Conservation Area. The Potential Conservation Area is rated as an area of high biodiversity significance by the Colorado Natural Heritage Program because of the presence of the *Cercocarpus montanus/Hesperostipa neomexicana* Shrubland Association. Permanent effects on the Colorado Natural Heritage Program-tracked native vegetation communities described above would be moderate because of the small size of the effect. Combined effects on native foothill grasslands and foothill shrublands not tracked by the Colorado Natural Heritage Program would be a moderate effect because of the magnitude of loss.

Short-term effects on vegetation totaling 62.9 acres would result from construction of the Expanded Glade Alternative release pipeline, access roads, and staging areas. About 25.2 acres of foothill grasslands and 1.1 acres of foothill shrublands would be temporarily affected. Short-term effects to foothill grasslands were considered to be minor to moderate because of the magnitude of the effect and the potential for the introduction or further spread of exotic species. About 36.6 acres of agricultural lands within the study area would be temporarily affected. This was considered a minor effect.
Table 4-46, Direct effects on upland vegetation cover types for the Expanded Glade Alternative.

<table>
<thead>
<tr>
<th>Effect Feature</th>
<th>Effect Type</th>
<th>Foothill Grasslands</th>
<th>Foothill Shrublands</th>
<th>Foothill Woodlands</th>
<th>Non-native Grasslands</th>
<th>Agricultural Lands</th>
<th>Developed Lands</th>
<th>Disturbed Lands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inundation area</td>
<td>Long-term</td>
<td>41.1</td>
<td>20.6</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Access roads</td>
<td>Long-term</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.04</td>
<td>0.0</td>
</tr>
<tr>
<td>Valve house</td>
<td>Long-term</td>
<td>0.002</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>River turnout</td>
<td>Long-term</td>
<td>0.02</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td>Long-term</td>
<td>41.6</td>
<td>20.6</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.04</td>
<td>0.9</td>
</tr>
<tr>
<td>Access road buffers</td>
<td>Short-term</td>
<td>1.2</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Pipeline buffer</td>
<td>Short-term</td>
<td>10.4</td>
<td>0.9</td>
<td>0.0</td>
<td>0.0</td>
<td>12.7</td>
<td>0.01</td>
<td>0.0</td>
</tr>
<tr>
<td>Staging areas</td>
<td>Short-term</td>
<td>13.6</td>
<td>0.18</td>
<td>0.0</td>
<td>0.0</td>
<td>23.9</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td>Short-term</td>
<td>25.2</td>
<td>1.1</td>
<td>0.0</td>
<td>0.0</td>
<td>36.6</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total acres</strong></td>
<td></td>
<td>66.8</td>
<td>21.7</td>
<td>0.0</td>
<td>0.0</td>
<td>36.6</td>
<td>0.1</td>
<td>0.9</td>
</tr>
</tbody>
</table>

*Developed and disturbed lands are not considered to be vegetated and are thus not included in acreage estimates for permanent and temporary effects on vegetation discussed in the text.
Figure 4-59. Expanded Glade Alternative vegetation effects.
4.11.4.2 Indirect Effects

Indirect effects to upland vegetation would be the same as described in Section 4.11.2.2 for effects common to all alternatives.

4.11.5 Gravel Pits Alternative

4.11.5.1 Direct Effects

The Gravel Pits Alternative would directly affect approximately 78.6 acres of vegetation, including approximately 9.0 acres of long-term vegetation loss and approximately 69.6 acres of short-term disturbance (Table 4-47; Figure 4-60). Long-term effects would result from construction of access roads, valve houses, and pump stations. The majority of this long-term loss, about 8.8 acres, would occur to agricultural lands and non-native grasslands. Effects on these habitats were considered to be minor. About 0.2 acre of foothill grasslands would be affected from access road construction. An estimated 20 percent (0.04 acre) of this grassland meets the Colorado Natural Heritage Program description for the *Hesperostipa comata – Bouteloua gracilis* Herbaceous Vegetation Association, which is considered vulnerable to imperiled in the state (S2S3) by the Colorado Natural Heritage Program. The native foothill grasslands that occur within the Gravel Pits Alternative study area have been degraded due to an abundance of non-native, invasive species, including cheatgrass and smooth brome. Permanent loss of this grassland association would be a minor effect because of the small size of the loss and the degraded condition of the grassland.

Pipeline installation and construction of staging areas and access roads would temporarily affect about 5.4 acres of foothill grasslands. An estimated 20 percent (1.08 acres) of these grasslands meets the Colorado Natural Heritage Program description for the *Hesperostipa comata – Bouteloua gracilis* Herbaceous Vegetation Association, which is considered vulnerable to imperiled in the state (S2S3). The foothill grasslands in this area have been degraded by invasions of non-native plant species. The Corps considered short-term effects on these grasslands to be minor and the affected areas would be replanted with native vegetation. About 43.6 acres of non-native grasslands would be temporarily affected. Most of the area mapped as non-native grasslands is adjacent to developed areas. The Corps considered temporary effects on this vegetation cover type to be minor and such areas would be revegetated with appropriate plant species.

4.11.5.2 Indirect Effects

Indirect effects to upland vegetation would be the same as described above in Section 4.11.2.2 for effects common to all alternatives.
Table 4-47. Direct effects on upland vegetation cover types for the Gravel Pits Alternative.

<table>
<thead>
<tr>
<th>Effect Feature</th>
<th>Effect Type</th>
<th>Foothill Grasslands</th>
<th>Foothill Shrublands</th>
<th>Foothill Woodlands</th>
<th>Non-native Grasslands</th>
<th>Agricultural Lands</th>
<th>Developed* Lands</th>
<th>Disturbed* Lands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access roads</td>
<td>Long-term</td>
<td>0.2</td>
<td>0.0</td>
<td>0.0</td>
<td>1.4</td>
<td>3.9</td>
<td>2.4</td>
<td>4.4</td>
</tr>
<tr>
<td>Pump station</td>
<td>Long-term</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>2.6</td>
<td>0.9</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>Valve house</td>
<td>Long-term</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.002</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>River turnout</td>
<td>Long-term</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.01</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td><strong>Long-term</strong></td>
<td><strong>0.2</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.0</strong></td>
<td><strong>4.012</strong></td>
<td><strong>4.8</strong></td>
<td><strong>2.7</strong></td>
<td><strong>5.0</strong></td>
</tr>
<tr>
<td>Access road buffers</td>
<td>Short-term</td>
<td>0.3</td>
<td>0.0</td>
<td>0.0</td>
<td>2.2</td>
<td>5.4</td>
<td>3.5</td>
<td>5.8</td>
</tr>
<tr>
<td>Pipeline buffer</td>
<td>Short-term</td>
<td>2.0</td>
<td>0.0</td>
<td>0.0</td>
<td>34.3</td>
<td>3.3</td>
<td>10.9</td>
<td>11.4</td>
</tr>
<tr>
<td>Staging areas</td>
<td>Short-term</td>
<td>3.1</td>
<td>0.0</td>
<td>0.0</td>
<td>7.1</td>
<td>11.9</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td><strong>Short-term</strong></td>
<td><strong>5.4</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.0</strong></td>
<td><strong>43.6</strong></td>
<td><strong>20.6</strong></td>
<td><strong>14.4</strong></td>
<td><strong>17.2</strong></td>
</tr>
<tr>
<td><strong>Total acres</strong></td>
<td></td>
<td><strong>5.6</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.0</strong></td>
<td><strong>47.612</strong></td>
<td><strong>25.4</strong></td>
<td><strong>17.1</strong></td>
<td><strong>22.2</strong></td>
</tr>
</tbody>
</table>

*Developed and disturbed lands are not considered to be vegetated and are thus not included in acreage estimates for permanent and temporary effects on vegetation discussed in the text.
Figure 4-60. Gravel Pits Alternative vegetation effects.
4.11.6 Agricultural Reservoirs Alternative

4.11.6.1 Direct Effects

The Agricultural Reservoirs Alternative would directly affect approximately 275.1 acres of vegetation, including approximately 10.7 acres of long-term vegetation loss and approximately 264.4 acres of short-term vegetation disturbance (Table 4-48; Figure 4-61 through Figure 4-64). Long-term effects would result from construction of access roads, valve houses, pump stations, and a river turnout. About 5.3 acres of non-native grassland and 5.4 acres of agricultural lands would be affected from these activities. Because these cover types are common in the area and composed primarily of non-native, ruderal species, these effects would be minor.

The majority of short-term effects on vegetation (264.4 acres) would occur in non-native grasslands (102.8 acres) and agricultural lands (151.4 acres). These areas would be recontoured and revegetated with appropriate species to approximate their pre-construction condition. The Corps considers short-term effects on these habitats to be minor. Short-term effects from pipeline installation, staging areas, and access roads would occur to about 2.1 acres of foothill grasslands. An estimated 20 percent (0.4 acre) of these grasslands meets the Colorado Natural Heritage Program description for the Hesperostipa comata – Bouteloua gracilis Herbaceous Vegetation Association, which is considered vulnerable to imperiled in the state (S2S3). Short-term effects on this grassland association would be minor because of the small size of the effect and the degraded condition of these grasslands.

About 8.1 acres of foothill shrublands would be temporarily affected by a staging area west of Claymore Lake. The foothill shrublands mapped within the staging area meets the description of an association considered to be vulnerable to imperiled in the state (S2S3 by the Colorado Natural Heritage Program, the Cercocarpus montanus – Rhus trilobata/Andropogon gerardii Shrubland Association. Additionally, the staging area would be located on the edge of the Horsetooth Reservoir Hogbacks Potential Conservation Area. The Potential Conservation Area is considered an area of very high biodiversity significance by the Colorado Natural Heritage Program because of the presence of sensitive species and sensitive plant communities that support those species. The Corps considered short-term effects on these foothill shrublands to be major because of their status in the state and the unlikelihood of successful restoration.

4.11.6.2 Indirect Effects

Indirect effects to upland vegetation would be the same as described above in Section 4.11.2.2 for effects common to all alternatives.
### Table 4-48. Direct effects on upland vegetation cover types for the Agricultural Reservoirs Alternative.

<table>
<thead>
<tr>
<th>Effect Feature</th>
<th>Effect Type</th>
<th>Foothill Grasslands</th>
<th>Foothill Shrublands</th>
<th>Foothill Woodlands</th>
<th>Non-native Grasslands</th>
<th>Agricultural Lands</th>
<th>Developed* Lands</th>
<th>Disturbed* Lands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access roads</td>
<td>Long-term</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>2.7</td>
<td>4.5</td>
<td>1.5</td>
<td>0.0</td>
</tr>
<tr>
<td>Pump station</td>
<td>Long-term</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>2.6</td>
<td>0.9</td>
<td>0.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Valve house</td>
<td>Long-term</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.004</td>
<td>0.0</td>
<td>0.002</td>
<td>0.0</td>
</tr>
<tr>
<td>Outlet</td>
<td>Long-term</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>River turnout</td>
<td>Long-term</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.01</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td><strong>Long-term</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.0</strong></td>
<td><strong>5.314</strong></td>
<td><strong>5.4</strong></td>
<td><strong>2.002</strong></td>
<td><strong>0.0</strong></td>
</tr>
<tr>
<td>Access road buffers</td>
<td>Short-term</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>4.1</td>
<td>6.7</td>
<td>2.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Pipeline buffer</td>
<td>Short-term</td>
<td>2.0</td>
<td>0.0</td>
<td>0.0</td>
<td>83.9</td>
<td>52.5</td>
<td>55.0</td>
<td>1.7</td>
</tr>
<tr>
<td>Staging areas</td>
<td>Short-term</td>
<td>0.09</td>
<td>8.1</td>
<td>0.0</td>
<td>14.8</td>
<td>92.2</td>
<td>0.001</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td><strong>Short-term</strong></td>
<td><strong>2.09</strong></td>
<td><strong>8.1</strong></td>
<td><strong>0.0</strong></td>
<td><strong>102.8</strong></td>
<td><strong>151.4</strong></td>
<td><strong>57.201</strong></td>
<td><strong>1.7</strong></td>
</tr>
<tr>
<td>Total acres</td>
<td></td>
<td>2.09</td>
<td>8.1</td>
<td>0.0</td>
<td>108.114</td>
<td>156.8</td>
<td>59.203</td>
<td>1.7</td>
</tr>
</tbody>
</table>

*Developed and disturbed lands are not considered to be vegetated and are thus not included in acreage estimates for permanent and temporary effects on vegetation discussed in the text.
Figure 4-61. Agricultural Reservoirs Alternative vegetation effects.
Figure 4-62. Agricultural Reservoirs Alternative vegetation effects, continued.
Figure 4-63. Agricultural Reservoirs Alternative vegetation effects, continued.
Figure 4-64. Agricultural Reservoirs Alternative vegetation effects, continued.
4.11.7 No-Action Alternative

4.11.7.1 Direct Effects
The No-Action Alternative would not demonstrably affect vegetation as no ground disturbing activities, no additional areas of inundation, and no changes to human activity at Fort Collins’ water supply facilities would result from the initiation of this alternative.

4.11.7.2 Indirect Effects
The No-Action Alternative would result in additional acquisitions or conversions of agricultural water rights to municipal use and mandatory water restrictions in Fort Collins. Conversions of agricultural water rights would likely result in the loss of additional agricultural lands. Based on given demands, the acquisition of additional NPIC shares would result in the conversion of about 800 currently irrigated agricultural acres to dryland farming (Harvey Economics 2016). Mandatory water restrictions in Fort Collins would likely result in water-stressed landscaped areas, including residential lawns, city parks and, possibly, golf courses.

4.11.8 Effects Summary

4.11.8.1 Direct Effects
The alternative resulting in the greatest long-term effect to upland vegetation would be Fort Collins’ Proposed Action. The expansion of Halligan Reservoir would result in the long-term loss of about 100.2 acres of native plant communities, including 72.0 acres of foothill grasslands, 26.0 acres of foothill shrublands, and 2.2 acres of foothill woodlands (Table 4-49). The Corps considers this to be a moderate effect (Table 4-50).

The Expanded Glade Alternative would result in about 62.2 acres of long-term effects on vegetation. The majority of these long-term effects would occur to native foothill grasslands (41.6 acres) and foothill shrublands (20.6 acres). The Corps considered this to be a moderate effect.

The Gravel Pits Alternative would result in about 9.0 acres of long-term effects on vegetation. The majority of this long-term loss (8.8 acres) would occur in agricultural lands and non-native grasslands. The remainder of the long-term effects (0.2 acre) would occur in foothills grasslands. The Corps considers this to be a minor effect.

The Agricultural Reservoirs Alternative would result in long-term effects on vegetation of about 10.7 acres. These effects would occur in agricultural lands and non-native grasslands at the Agricultural Reservoirs study area. The Corps considered this to be a minor effect. One of the proposed staging areas within the Agricultural Reservoirs Alternative study area would temporarily affect about 8.1 acres of a Colorado Natural Heritage Program tracked native foothill shrubland community. The Corps considers this to be a major effect.
Table 4-49. Summary of effects to upland vegetation cover types by alternative.

<table>
<thead>
<tr>
<th>Vegetation Cover Type</th>
<th>Halligan Dam Rehabilitation*</th>
<th>Fort Collins’ Proposed Action*</th>
<th>Expanded Glade Alternative*</th>
<th>Gravel Pits Alternative*</th>
<th>Agricultural Reservoirs Alternative*</th>
<th>No-Action Alternative*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Long-Term</td>
<td>Short-Term</td>
<td>Long-Term</td>
<td>Short-Term</td>
<td>Long-Term</td>
<td>Short-Term</td>
</tr>
<tr>
<td>Foothill grasslands</td>
<td>7.5</td>
<td>23.5</td>
<td>72.0</td>
<td>0.0</td>
<td>41.6</td>
<td>25.2</td>
</tr>
<tr>
<td>Non-native grasslands</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Foothill shrublands</td>
<td>19.4</td>
<td>5.3</td>
<td>26.0</td>
<td>0.0</td>
<td>20.6</td>
<td>1.1</td>
</tr>
<tr>
<td>Foothill woodlands</td>
<td>0.4</td>
<td>0.0</td>
<td>2.2</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Agricultural Lands</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>36.6</td>
</tr>
<tr>
<td>Total direct effects on vegetation</td>
<td>27.3</td>
<td>28.8</td>
<td>100.2</td>
<td>0.0</td>
<td>62.2</td>
<td>62.9</td>
</tr>
</tbody>
</table>

*These effects would occur under all alternatives.
NOTE: See Section 4.7 for effects to wetland and riparian resources

Table 4-50. Summary of permanent effects determination on upland vegetation cover types by alternative.

<table>
<thead>
<tr>
<th>Colorado Natural Heritage Program-tracked native vegetation communities</th>
<th>Halligan Dam Rehabilitation</th>
<th>Fort Collins’ Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor to moderate</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Minor</td>
<td>No effect</td>
<td>No effect</td>
</tr>
<tr>
<td>Foothills grasslands</td>
<td>Minor</td>
<td>Minor</td>
<td>Moderate</td>
<td>No effect</td>
<td>No effect</td>
</tr>
<tr>
<td>Foothill shrublands</td>
<td>Minor</td>
<td>Minor</td>
<td>Moderate</td>
<td>No effect</td>
<td>No effect</td>
</tr>
<tr>
<td>Foothill woodlands</td>
<td>Minor</td>
<td>Minor</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
</tr>
<tr>
<td>Agricultural lands</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
<td>Minor</td>
<td>No effect</td>
</tr>
<tr>
<td>Non-native grasslands</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
<td>Minor</td>
<td>No effect</td>
</tr>
</tbody>
</table>
4.11.9 Unavoidable Adverse Effects

All alternatives would result in unavoidable adverse effects on vegetation resources from construction activities that would involve removal of vegetation within areas of inundation and other long- and short-term losses of vegetation. All alternatives would unavoidably create favorable conditions for establishment of noxious weeds because of construction.

4.11.10 Mitigation Measures

Fort Collins has proposed the following construction-related avoidance/minimization measures for all alternatives related to vegetation effects:

- **Best Management Practices**: To minimize potential construction effects to vegetation, all standard construction Best Management Practices accompanying federal, state, and local permitting activities would be employed.

- **Revegetation of Disturbed Areas**: To minimize the potential for construction disturbance to introduce or spread noxious weeds or other undesirable vegetation, areas stripped of soil or left with exposed aggregate would have topsoil replaced and then revegetated with native grasses and forbs.

- **Noxious and Invasive Weed Control**: Fort Collins would develop a noxious and invasive weed management plan for construction activities. Noxious weed Best Management Practices, including chemical, cultural, and mechanical measures, would be implemented during all construction phases for all disturbance areas, such as access roads and buffers. The disturbance areas would be monitored after construction.

- **Stormwater Management Plan**: Development, prior to construction, of a Stormwater Management Plan including best management practices. The plan would include treatment of disturbed areas for re-establishment of vegetation.

- No mitigation measures are proposed for operation of any alternatives.

Under Fort Collins’ Proposed Action, Fort Collins proposes the following mitigation measures related to vegetation effects:

- **Revegetation of Existing Tailings**: Fort Collins is considering revegetating with native grass and forbs any existing areas stripped of soil or left with exposed aggregate, including all staging areas, borrow pits, and tailing piles left from the original construction of Halligan Dam.

- **Traffic Impact Minimization**: To minimize the potential for construction disturbance to introduce or spread noxious weeds or other undesirable vegetation, existing access road from U.S. Highway 287 would be used. A temporary bridge over the North Fork below the dam might possibly be constructed to limit road construction to the west bank of the river. Access road widths would be minimized. Widened areas of existing roads would be reclaimed. Road buffers would be regraded and revegetated following construction.
4.12 WILDLIFE

Potential effects to wildlife would include direct effects on wildlife and wildlife habitat associated with proposed project facilities and indirect effects, both short- and long-term. Indirect effects to wildlife resources were evaluated based on effects to wetlands, riparian vegetation communities, and effects to other vegetation resources caused by changes in water flows. Effects to wildlife associated with altered flows were analyzed in the *Altered Flows Technical Report* (WEST 2018). Short-term indirect effects were also inferred to occur from noise and construction activities associated with an action alternative. Long-term effects would include long-term loss of wildlife habitat associated with footprints of the reservoir and dam, forebay, pump stations, associated facilities, pipeline connections to the reservoir, and realigned roads. Short-term effects would include removal of vegetation around the dam, reservoirs, pump stations, realigned roads, and other facilities; access roads; borrow areas; staging areas; and pipelines that would be restored following construction. Long-term effects on aquatic habitat would occur from placement of permanent fill; short-term effects would occur where pre-construction contours and drainage would be restored after construction.

4.12.1 Methods

Potential effects to wildlife were evaluated by identifying suitable habitat and limiting range types for key and common species. The acreage of habitat lost due to implementation of each alternative was determined by overlaying GIS layers containing spatial habitat and wildlife range data on maps of proposed infrastructure and construction areas for each alternative.

4.12.1.1 GIS Analysis

Various electronic databases with information pertinent to wildlife resources potentially occurring within the alternative study areas were accessed. Big game range types, including overall range, winter range, concentration areas, production areas, and highway crossings, were reviewed using both Google Earth™ KMZ files and GIS shapefiles (Colorado Parks and Wildlife 2019) accessed from the Colorado Parks and Wildlife website May 15, 2019. The KMZ and shapefiles available from the Colorado Parks and Wildlife also included data on some migratory birds and raptors, reptiles and amphibians, and other wildlife species.

Fort Collins provided maps and supporting shapefiles depicting the conceptual layout of infrastructure and construction areas associated with each action alternative. Fort Collins did not provide specific alignments for access roads and pipelines, but instead identified a corridor within which the road or pipeline alignment would be constructed. This approach allowed Fort Collins flexibility in final project planning while providing areas to analyze for potential effects. In these cases, effects were assessed by applying a buffer to the centerline of such features, using a 12.5-foot buffer for permanent effects from access roads, a 30-foot buffer for temporary effects from access roads, and a 75-foot buffer for pipeline corridors. Construction areas were presented as large polygons, encompassing smaller potential staging areas and borrow areas. In this case, construction activities would not occur within the entire construction disturbance area but would be limited to the staging, borrow areas, and access roads.
4.12.1.2 Limiting Range Types

Colorado Parks and Wildlife manages big game by defined big game Data Analysis Units. The boundary of each Data Analysis Unit encompasses the year-around range of a single herd of a species and includes all seasonal ranges used by that herd. These seasonal ranges may overlap or be a subset of other seasonal ranges. For example, severe winter range may be a smaller subset of the larger winter range. Colorado Parks and Wildlife prepares a Data Analysis Unit plan that provides a blueprint for big game management in the unit, identifies suitable habitat, provides information on herd history and current status, and discusses issues and problems. In general, Colorado Parks and Wildlife manages big game to achieve a target population size and sex ratio identified in these plans and developed by Colorado Parks and Wildlife and interested entities. Colorado Parks and Wildlife updates these plans as needed or at least once every 10 years.

The Corps reviewed all Colorado Parks and Wildlife publically available range maps for big game species likely to be found at or near the Project Alternatives (WEST 2019); however, the analysis for big game species focused on range that is a limiting factor for a given species. Limiting factors are a resource or seasonal range that primarily limits the growth, abundance, or distribution of an individual or population. Some types of habitat or seasonal ranges are crucial for survival during specific seasons or life stages of different wildlife species; the availability of these habitat types or ranges can limit the growth, abundance, or distribution of a population (Parker et al. 2009). Limiting range identified for wildlife species in this analysis included big game severe winter range and concentration areas (Table 4-51). For example, severe winter weather can deplete elk energy reserves and decrease weight; however, weather-related elk mortality usually has little effect on populations of the Red Feather Lakes herd in and around the Poudre Canyon because of the presence of severe winter range that provides forage and protection from the elements during this critical period (Colorado Parks and Wildlife 2009a). These winter ranges are critical to winter survival for elk in the region. On the other hand, concentration areas are corridors of suitable habitat (e.g., along a river or stream course) that support higher populations of wildlife, serve as travel corridors, and are considered critical habitat. Therefore, a loss of habitat of a limiting range type would translate to a direct effect to local populations of wildlife that depend upon such habitat. Colorado Parks and Wildlife mapping of big game ranges are at a fairly coarse scale. In an effort to accurately calculate a loss of limiting ranges, the Corps considered the suitable habitat (Table 4-51) for each big game species that exists within the limiting ranges using the vegetation mapping.

Table 4-51. Limiting range types identified for big game species.

<table>
<thead>
<tr>
<th>Species</th>
<th>Limiting Range Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elk</td>
<td>Severe winter range</td>
</tr>
<tr>
<td>Mule deer</td>
<td>Severe winter range</td>
</tr>
<tr>
<td>White-tailed deer</td>
<td>Concentration area</td>
</tr>
<tr>
<td>Pronghorn</td>
<td>Severe winter range</td>
</tr>
<tr>
<td>Bighorn sheep</td>
<td>Severe winter range</td>
</tr>
<tr>
<td>Black bear</td>
<td>Fall concentration area</td>
</tr>
</tbody>
</table>

Loss of limiting range types could decrease the carrying capacity of the Data Analysis Unit, increase mortality rates and decrease the population size, or reduce the overall health of the population. The relative effect of each alternative on each big game species was assessed by identifying the ratio of the
upper targeted big game species population level to the acres of the limiting range type for that species within the Data Analysis Unit. Knowing the number of existing acres of the limiting range type needed to sustain each animal, the Corps then determined approximately how many animals would be eliminated by the long-term loss of the limiting range type as a result of the alternative by multiplying the upper population target by the number of acres affected long-term by a Project Alternative, and then dividing that number by the number of acres in the Data Analysis Unit for the limiting range type.

### 4.12.1.3 Suitable Habitat

Game and non-game species profiles from Colorado Parks and Wildlife’s website (Colorado Parks and Wildlife 2015) were reviewed for range and habitat requirements (Table 4-52). It should be noted that Colorado Parks and Wildlife’s website contains publicly available range maps, but provides limited written descriptions of some wildlife habitats. While “range” and “habitat” are similar and related characteristics of individual species, the two terms cannot be used interchangeably as they have very different meanings. Range refers to the geographic location a species is likely to be found, either overall or seasonally. An example would be that elk (*Cervus elaphus*) range would include broad areas within the Poudre River basin. Habitat, however, refers to the physical setting within that range that the elk would regularly use, such as foothills grasslands or rocky, north facing, slopes. Long- and short-term direct effects to suitable habitat were assessed by overlaying GIS seasonal range layers for a species (obtained from Colorado Parks and Wildlife), GIS vegetative community layers (WEST 2017a), and GIS alternative feature layers provided by Fort Collins.

**Table 4-52. Suitable habitat for big game species.**

<table>
<thead>
<tr>
<th>Species</th>
<th>Vegetation Communities Providing Suitable Habitat for Species Affected by Alternatives.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Foothills Grasslands</td>
<td>Foothills Shrublands</td>
</tr>
<tr>
<td>Elk</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mule deer</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>White-tailed deer</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Pronghorn</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Bighorn sheep²</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

1 Big game species may be found in vegetation communities not identified in Table 4-52, but identified vegetation communities represent the suitable and preferred habitat where a species is most likely to be present.

2 Bighorn sheep suitable habitat also requires abiotic components of steep rocky slopes with ample escape routes.

If GIS range layers were not available for a species, such as some raptor and bat species, effects were inferred by examining effects to vegetation types providing potential habitat for those species. Direct and relatively long-term negative effects to wildlife resources would occur in areas of new inundation or where Fort Collins proposed to construct new infrastructure, such as dam footprints, permanent roads, and
pumping stations. Short-term effects to wildlife resources would occur in areas such as pipeline corridors and staging areas that Fort Collins would return to pre-construction contours and revegetate.

Indirect effects to wildlife resources are based on effects to wetland, riparian, and other vegetation communities as a result of water flow changes. Effects to wildlife associated with altered flows are addressed in the *Altered Flows Technical Report* (WEST 2018). Short-term indirect effects are also inferred as a result of noise and construction activities associated with an action alternative.

Effects are classified as negligible, minor, moderate, and major based on the amount of suitable habitat or limiting range type lost.

- **Negligible**: Effects would be at the lowest levels of detection, barely measurable, with no perceptible consequences.
- **Minor**: Effects result in a detectable change, but the change would be slight.
- **Moderate**: Effects would result in a clearly detectable change, with measurable effects.
- **Major**: Effects would be readily apparent with substantial consequences.

### 4.12.1.4 Data Adequacy

Section 3.12.3 describes the best available data for wildlife in the study areas. The Corps determined the data available and methods used are adequate to evaluate and describe reasonably foreseeable significant adverse effects on vegetation in the study areas and to enable the decision maker to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable wildlife information as described in Section 4.2.1.5. The effects of the alternatives on wildlife are described below.

### 4.12.2 Halligan Dam Rehabilitation

Due to the age and condition of the existing Halligan Dam, it would be rehabilitated under all Project Alternatives, regardless of which one is chosen. Therefore, the following effects are common to all alternatives.

#### 4.12.2.1 Direct Effects

Most long-term direct effects on big game range and habitat due to rehabilitation of Halligan Dam would result from the access road, borrow pits, and dam footprint (approximately 27 acres). In addition, staging areas and access road buffers would create short-term effect areas (approximately 29.4 acres; Table 4-53 and Figure 4-65). The Corps assumed long-term effects to a limiting range type was the most relevant for big game species, but recognizes big game range maps are at a coarse scale (Table 4-53). Therefore, the Corps calculated the amount of suitable habitat within the limiting range types affected by the dam rehabilitation (Table 4-54).
Table 4-53. Long- and short-term direct effects of Halligan Dam Rehabilitation on big game range types.

<table>
<thead>
<tr>
<th>Range Type</th>
<th>Range Type in the Data Analysis Unit (acres)</th>
<th>Long-term Effects (acres)</th>
<th>Short-term Effects (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elk-overall range</td>
<td>208,771</td>
<td>27.3</td>
<td>29.4</td>
</tr>
<tr>
<td>Mule deer-overall range</td>
<td>1,145,320</td>
<td>27.3</td>
<td>29.4</td>
</tr>
<tr>
<td>Mule deer-severe winter range</td>
<td>128,724</td>
<td>27.3</td>
<td>29.4</td>
</tr>
<tr>
<td>Mule deer-winter range</td>
<td>613,074</td>
<td>27.3</td>
<td>29.4</td>
</tr>
<tr>
<td>White-tailed deer-overall range</td>
<td>239,940</td>
<td>23.3</td>
<td>13.6</td>
</tr>
<tr>
<td>Pronghorn-overall range</td>
<td>109,535</td>
<td>27.3</td>
<td>29.4</td>
</tr>
<tr>
<td>Pronghorn-winter range</td>
<td>174,203</td>
<td>27.3</td>
<td>29.4</td>
</tr>
<tr>
<td>Bighorn sheep-overall range</td>
<td>208,771</td>
<td>27.3</td>
<td>29.4</td>
</tr>
</tbody>
</table>

Table 4-54. Halligan Dam Rehabilitation effects on suitable habitat within limiting range types for big game species.

<table>
<thead>
<tr>
<th>Species</th>
<th>Limiting Range Type</th>
<th>Effects to Suitable Habitat(^1) within Limiting Range Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Long-term</td>
</tr>
<tr>
<td>Elk</td>
<td>Severe winter range</td>
<td>0.0</td>
</tr>
<tr>
<td>Mule deer</td>
<td>Severe winter range</td>
<td>27.3</td>
</tr>
<tr>
<td>White-tailed deer</td>
<td>Concentration area</td>
<td>0.0</td>
</tr>
<tr>
<td>Pronghorn</td>
<td>Severe winter range</td>
<td>0.0</td>
</tr>
<tr>
<td>Bighorn sheep</td>
<td>Severe winter range</td>
<td>0.0</td>
</tr>
</tbody>
</table>

\(^1\)See Table 4-52 for species-specific suitable habitats.
Figure 4-65. Halligan Dam Rehabilitation and Fort Collins’ Proposed Action effects on big game ranges.
Short-term effects to severe winter range would include approximately 29 acres of foothills grasslands and foothills shrublands, or about 0.02 percent of the mapped mule deer severe winter range within the Data Analysis Unit, and would support 3.38 individual mule deer. Grasslands could be expected to recover in a few growing seasons; however, depending on species composition, shrub communities might require several years to a decade or more to re-establish. Rate of growth for plants and vegetation communities is influenced by numerous variables such as soil type, drainage patterns, precipitation, fertility, light, exposure, human effort expended, and other factors. In general, grassland recovery could be considered a short-term temporary effect, requiring only a few years to re-establish, while shrub community recovery could require three to 10 years, possibly longer depending on species and the defined threshold for “recovery”. This term of possibly three to 10 years for shrubland recovery is considered a mid-term temporary effect. The temporary effects to grasslands and shrublands might reduce available habitat for 3.38 mule deer over the short- and mid-term; however, this temporary loss of suitable habitat within mapped mule deer severe winter range would have a minor short- to mid-term effect on the Red Feather-Poudre Canyon mule deer.

There are no white-tailed deer concentration areas, a limiting range type for this species, in the areas affected by Halligan Dam rehabilitation. Because there would be no loss of white-tailed deer concentration areas, the effects of Halligan Dam rehabilitation would be negligible with no perceptible effect to the Red Feather-Poudre Canyon white-tailed deer herd.

4.12.2.1.1 Pronghorn

Severe winter range is a limiting range type for pronghorn; however, there is no pronghorn severe winter range in the area affected by Halligan Dam rehabilitation. Because there is no loss of pronghorn severe winter range, effects of Halligan Dam rehabilitation would be negligible with no measurable or perceptible consequences to the Cherokee Park pronghorn herd.

4.12.2.1.2 Rocky Mountain Bighorn Sheep

Severe winter range is a limiting range type for Rocky Mountain bighorn sheep (bighorn sheep); however, there is no bighorn sheep severe winter range in the area affected by Halligan Dam rehabilitation. Because there is no loss of bighorn sheep severe winter range, the direct effects of Halligan Dam rehabilitation would be negligible with no measurable or perceptible consequences to habitat of the Poudre/Rawah/Lone Pine bighorn sheep herd.

4.12.2.1.3 Other Mammals

Halligan Dam rehabilitation would result in the long-term loss of about 27 acres of black bear range. The limiting range type for black bear is fall concentration areas, but no black bear fall concentration areas would be affected by Halligan Dam rehabilitation. Therefore, effects of the project would be negligible with no measurable or perceptible effect to habitat of the Northern Front-Range black bear population.

Mountain lions are unique in that effects to their range in general are not considered a good indicator of the effect mountain lions would experience. However, effects to mountain lion prey, primarily deer and elk, would influence the health and survival of mountain lions. Armstrong et al. (2011) suggest that a
mountain lion needs to kill from 14 to 20 deer or five to seven elk to survive winters, and that a female lion with kittens needs to kill more frequently. Anderson and Lindzey (2003) suggested single mountain lions have a predation rate of one kill, either elk or deer, every seven to 10 days, while female lions with young need to kill once every five to six days. Halligan Dam rehabilitation would have a negligible effect on elk, and reduce the Red Feather-Poudre Canyon mule deer herd by at most 3.15 mule deer. A reduction of 3.15 mule deer would affect between 0.16 and 0.22 mountain lions; therefore, the effects on the Northern Front Range mountain lions would be negligible with no perceptible consequences.

Small mammals associated with the vegetative communities found in the area affected by Halligan Dam rehabilitation include woodrats, chipmunks, rock squirrels, rabbits, and bats. These terrestrial mammals are generally highly mobile and considered prey species; because of this, they have a heightened flight response. Due to their mobility and flight response, such species would not suffer significant direct loses associated with construction. Additionally, in wetter environments such as riparian areas and wetlands, small rodents, voles, muskrats, and raccoons may be present. While the loss of habitat might reduce the reproductive potential for these species in the local area, Halligan Dam rehabilitation would unlikely result in a measurable effect to populations or trigger a need to protect these species. Small, medium, and large mammals might suffer minor effects, loss of habitat, and loss of individuals during construction activities; however, the project would likely have a negligible effect on terrestrial mammals.

Several species of bats may use the Halligan Reservoir area for roosts and foraging. Potential bat roosts in the area include rock outcrops and trees, while foraging areas may include open meadows, woodlands, wetlands, and open water bodies. Disturbance of rock crevices as part of borrow pit operations and the removal of approximately three acres of riparian woodland vegetation communities where bats may roost and forage would potentially affect bats. Bats which occur in the area are relatively common inhabitants of riparian areas in Colorado and Halligan Dam rehabilitation would affect only a small amount of habitat long- and short-term; therefore, effects on bats would be negligible.

Halligan Dam rehabilitation would temporarily affect approximately 5.3 acres of foothills shrublands that may provide habitat for small mammals. These effects would be eliminated once these areas have recovered. The short-term effects to grassland, shrub, and scrub-shrub wetland communities might reduce available habitat for some wildlife over the short or mid-term; however, the short-term loss would have negligible effect on wildlife over the life of the rehabilitated Halligan Dam.

4.12.2.1.4 Birds

Halligan Dam rehabilitation would affect potential foraging and nesting areas for several migratory birds and raptors. Foothills grassland and shrubland vegetation communities would be affected, which are foraging areas for raptors such as great horned owl and red-tailed hawk. Other species such as western meadowlark, spotted towhee, and Woodhouse’s scrub-jay may use these resources for nesting. The disturbance of about 29 acres of various vegetation communities at staging areas and other areas of temporary construction activities would have a short-to mid-term effect on potential bird habitat until site revegetation has occurred. No raptor nests were observed within the construction areas during surveys.

Halligan Dam rehabilitation would temporarily affect approximately 5.3 acres of foothills shrublands. These short-term effects to shrublands might reduce available habitat for some raptors and migratory
birds over the short and mid-term. However, the short-term loss would have negligible effects on birds and raptors over the life of the rehabilitated Halligan Dam.

Halligan Dam rehabilitation might affect a variety of bird species from raptors to songbirds and waterfowl. However, the action would likely have only a negligible to minor effect on these species as significant quantities of viable raptor and migratory bird habitat would be left intact near Halligan Reservoir.

4.12.2.1.5 Amphibians and Reptiles

Some mortality of adults, eggs, tadpoles, and larvae might occur during construction, but this would not likely result in a long-term decline of amphibians at Halligan Reservoir or along the North Fork. The removal of vegetation for construction, both long- and short-term, would potentially remove cover and foraging resources for some reptiles and amphibians. Still other reptiles and amphibians might be killed or displaced as a result of construction activities.

Halligan Dam rehabilitation would temporarily affect approximately 5.3 acres of foothills shrublands. These effects would be short-term and vegetation would be re-established. The temporary effects to shrublands might reduce available habitat for some reptiles and amphibians over the short- and mid-term; however, the temporary loss would have negligible effect on reptiles and amphibians over the life of Halligan Dam.

Halligan Dam rehabilitation might locally reduce species abundance during construction; however, it would not be likely lead to large-scale species loss or require species protection due to habitat loss. Halligan Dam rehabilitation would have a negligible to minor effect on amphibians and reptiles.

4.12.2.2 Indirect Effects

Indirect effects would consist of displacement of wildlife due to noise and disturbance from construction activities, transportation of people and materials, and general human activity in the area of Halligan Reservoir. In addition, vehicle and equipment emissions and fugitive dust also might displace wildlife. There might be a shift in the movement of some big game species as a result of construction activities and disturbances that could increase collisions with vehicles. This displacement and disturbance of big game might result in additional stress being placed on individuals of these species; however, it is likely to have a negligible effect on elk, mule deer, white-tailed deer, or pronghorn populations.

Wildlife resources at Halligan Reservoir could be indirectly affected by the possible introduction or establishment of noxious weeds, soil erosion, and potential alteration of stream flows in the North Fork. The potential effects of altered flows on wetland and riparian resources along the North Fork are discussed in the Altered Flows Technical Report (WEST 2018). Noxious weed establishment and soil erosion, if they occurred, would affect native vegetation communities. A change in vegetation due to establishment of noxious weeds and soil erosion might result in a lower carrying capacity for some species in the area; however, it would be unlikely to result in formation of completely unsuitable habitat.

A potential indirect effect of Halligan Dam rehabilitation is stress related die-off of bighorn sheep. In the fall of 1980 and spring of 1981, a die-off of bighorn sheep occurred in Waterton Canyon along the South Platte River upstream from Littleton, Colorado (Spraker et al. 1984). The cause of death for dozens of
bighorn sheep was linked to bronchopneumonia, a parasite (lungworm *Dictyocaulus filaria*), and bacterial infections (*Pasteurella sp.*, *P. multocida*, *Corynebacterium pyogenes*, and *Protostrongylus stilesi*; Spraker et al. 1984). However, Spraker et al. (1984) concluded that short-term, high intensity stressors were a contributing factor in the die-off. The construction of a large dam within Waterton Canyon introduced increased human activity, high levels of dust, increased noise from construction traffic, and blasting, and might have deterred bighorn sheep from drinking from the river. The bighorn sheep, presumably predisposed to the identified parasite and bacteria, were further weakened by the additional stress of a year-long construction schedule. The predisposition of the bighorn sheep and increased stress are both suspected to have contributed to the bighorn sheep die-off at Waterton Canyon. In all, it was estimated that 75 to 85 percent of the Waterton Canyon bighorn sheep herd died between October 1980 and March 1981 (Spraker et al. 1984). Additionally, the herd experienced 100 percent lamb mortality during the summer of 1981 and approximately 67 percent lamb mortality in the summers of 1982 and 1983, decimating the bighorn sheep herd (Spraker et al. 1984).

Similar pre-existing infections and parasitic infestation may exist within the bighorn sheep herd in the Halligan Dam area. While it does not appear that bighorn sheep use in the area near Halligan Dam is as high as Waterton Canyon, dam construction could potentially result in an unintentional and indirect effect to bighorn sheep. Population estimates from Colorado Parks and Wildlife indicate that the bighorn sheep herd in Waterton Canyon has rebounded since the 1980-1983 die-off. Populations increased from 14 in 1987 to 22 in 1990, and then climbed to 25 by 1997 where they remained stable through 2007 (George et al. 2009). Recent populations were 60 in 2014, 65 in 2015 and 75 in 2016 (Colorado Parks and Wildlife 2017). Based on the intensity of the die-off (75 to 85 percent of the herd) and two-year continued lamb mortality (Spraker et al. 1984), a similar result near Halligan Dam and reservoir would be a major effect. However, there are differences between the two sites. There is limited bighorn sheep use in the vicinity of Halligan Dam, whereas bighorn sheep use of Waterton Canyon is well-documented and the affected herd was a resident herd. Although Waterton Canyon bighorn sheep numbers eventually recovered after the die-off, if a die-off occurred as a result of Halligan Dam rehabilitation, it would be a long-term (greater than 20 years) indirect effect to the local bighorn sheep herd that may or may not be permanent. Given the lack of site specific data on bighorn sheep use of the site, the Corps recognizes that it is difficult to predict the risk to bighorn sheep. The Corps also recognizes that if effects similar to those at Waterton Canyon should occur, other factors unrelated to Halligan Dam rehabilitation, such as disease or drought, could potentially hinder the rebound of the bighorn sheep population and it is possible that the effects could be permanent. Because of the limited documentation of bighorn sheep in the vicinity of Halligan Reservoir and because the project area is outside the resident bighorn sheep concentration area and a small part of their overall range, the Corps has determined that indirect effects due to Halligan Dam Rehabilitation would be moderate.

### 4.12.3 Fort Collins’ Proposed Action

#### 4.12.3.1 Direct Effects

Under Fort Collins’ Proposed Action, long-term direct effects on big game range would result from habitat inundation (approximately 133 acres; Figure 4-65); short-term direct effects would be related to
Halligan Dam rehabilitation and are discussed in Section 4.12.2.1. The Corps assumed long-term effects to limiting range types, and suitable habitat within those range types, were the most relevant effects for big game species (Table 4-55 and Table 4-56).

Table 4-55. Long-term direct effects of Fort Collins’ Proposed Action on big game range types.

<table>
<thead>
<tr>
<th>Range Type</th>
<th>Range Type in the Data Analysis Unit (acres)</th>
<th>Long-term Effects (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elk-overall range</td>
<td>208,771</td>
<td>132.5</td>
</tr>
<tr>
<td>Mule deer-overall range</td>
<td>1,145,320</td>
<td>132.5</td>
</tr>
<tr>
<td>Mule deer-severe winter range</td>
<td>128,724</td>
<td>132.5</td>
</tr>
<tr>
<td>Mule deer-winter range</td>
<td>613,074</td>
<td>132.5</td>
</tr>
<tr>
<td>White-tailed deer-overall range</td>
<td>239,940</td>
<td>22.7</td>
</tr>
<tr>
<td>Pronghorn-overall range</td>
<td>109,535</td>
<td>132.5</td>
</tr>
<tr>
<td>Pronghorn-winter range</td>
<td>174,203</td>
<td>132.5</td>
</tr>
<tr>
<td>Bighorn sheep-overall range</td>
<td>208,771</td>
<td>129.0</td>
</tr>
</tbody>
</table>

Table 4-56. Fort Collins’ Proposed Action effects on suitable habitat within limiting range types for big game species.

<table>
<thead>
<tr>
<th>Species</th>
<th>Limiting Range Type</th>
<th>Long-term Effects to Suitable Habitat(^1) within Limiting Factor Range Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Long-term</td>
</tr>
<tr>
<td>Elk</td>
<td>Severe winter range</td>
<td>0.0</td>
</tr>
<tr>
<td>Mule deer</td>
<td>Severe winter range</td>
<td>118.7</td>
</tr>
<tr>
<td>White-tailed deer</td>
<td>Concentration area</td>
<td>0.0</td>
</tr>
<tr>
<td>Pronghorn</td>
<td>Severe winter range</td>
<td>0.0</td>
</tr>
<tr>
<td>Bighorn sheep</td>
<td>Severe winter range</td>
<td>0.0</td>
</tr>
</tbody>
</table>

\(^1\)See Table 4-52 for species-specific suitable habitats.

4.12.3.1.1 Elk

No elk severe winter range, the limiting habitat range type for elk, would be affected by Fort Collin’s Proposed Action. Therefore, work associated with dam rehabilitation would be negligible with no measurable or perceptible demographic effect on the Red Feather-Poudre Canyon elk herd.

4.12.3.1.2 Deer

Fort Collins’ Proposed Action would result in permanent loss of about 133 acres of overall range, severe winter range, and winter range for mule deer due to inundation (Table 4-55). When consideration is given to suitable habitat within the severe winter range for mule deer the permanent loss of habitat is reduced to about 118 acres (Table 4-49). The Data Analysis Unit includes over 128,724 acres of severe winter range that support the proposed revised upper population target level of 15,000 deer, including both mule deer and white-tailed deer. If it is assumed that all 15,000 deer proposed as the upper population target are mule deer (a worst case scenario), the long-term loss of approximately 118 acres is about 0.09 percent of the Data Analysis Unit’s mule deer severe winter range and would support 15.5 individual mule deer.

This long-term loss of severe winter range would have a minor effect on the Red Feather-Poudre Canyon mule deer herd.
Fort Collins’ Proposed Action would inundate 3,215 feet of the North Fork and approximately 34.05 acres within the Cherokee State Wildlife Area Middle Unit. The inundation would be long-term but seasonal. According to the *Operations Report* (Fort Collins 2019), new inundation is predicted to occur from March through July when the largest water diversions are anticipated. New inundation on the southeast corner of the Cherokee State Wildlife Area Middle Unit would result in a seasonal long-term loss of approximately 0.7 percent of the 4,826-acre Cherokee State Wildlife Area Middle Unit. Colorado Parks and Wildlife expressed concern that additional inundation of the Cherokee State Wildlife Area Middle Unit could affect mule deer movement. Mule deer migrate from wintering grounds to summer range as temperatures warm and nutritious new green growth becomes available (Lendrum et al. 2013 and Garrott et al. 1987). Inundation of Halligan Reservoir would also coincide with warming spring temperatures that melt the snow pack and cause high flows in the North Fork, which might inhibit migration across the river. Colorado Parks and Wildlife mapping does not indicate any known mule deer migration corridors in the area of new inundation. Effects to mule deer movement from Fort Collins’ Proposed Action would be negligible to minor, because known migration corridors would not be affected. It is likely that mule deer currently do not cross the North Fork at this location during spring migration because high flows in the North Fork form an impediment to migration, and deer likely use alternate spring migration routes.

There are no white-tailed deer concentration areas, a limiting range type for this species, in the areas affected by Fort Collin’s Proposed Action. Because there would be no loss of white-tailed deer concentration areas, effects of Fort Collin’s Proposed Action would be negligible with no measurable or perceptible effect to the Red Feather-Poudre Canyon white-tailed deer herd.

### 4.12.3.1.3 Pronghorn

Severe winter range is a limiting range type for pronghorn; however, there is no pronghorn severe winter range in the area affected by Fort Collin’s Proposed Action. Because there is no loss of pronghorn severe winter range, effects of Fort Collin’s Proposed Action would be negligible with no measurable or perceptible consequences to the Cherokee Park pronghorn herd.

### 4.12.3.1.4 Rocky Mountain Bighorn Sheep

Severe winter range is a limiting range type for bighorn sheep; however, there is no bighorn sheep severe winter range in the area affected by Fort Collin’s Proposed Action. Because there is no loss of bighorn sheep severe winter range, the effects of Fort Collin’s Proposed Action would be negligible with no measurable or perceptible consequences to the Poudre/Rawah/Lone Pine bighorn sheep herd.

### 4.12.3.1.5 Other Mammals

The limiting range type for black bear is fall concentration areas, but no black bear fall concentration areas are affected by Fort Collin’s Proposed Action. Therefore, the effects of Fort Collin’s Proposed Action would be negligible with no measurable or perceptible effect to Northern Front Range black bear. Mountain lions are unique in that effects to mountain lion prey, primarily deer and elk, rather than range types, have the greatest influence on health and survival of mountain lions. Armstrong et al. (2011)
suggest that a mountain lion needs to kill from 14 to 20 deer or five to seven elk to survive winters, and that a female lion with kittens needs to kill more frequently. Anderson and Lindzey (2003) suggested single mountain lions have a predation rate of one kill, either elk or deer, every seven to 10 days, while female lions with young need to kill once every five to six days. Fort Collin’s Proposed Action would have a negligible effect on elk, and would reduce the Red Feather-Poudre Canyon deer herd by at most 15.50 mule deer. A reduction of 15.50 mule deer would affect between 0.78 to 1.11 mountain lions; therefore, the effects on the Northern Front Range mountain lions would be negligible with no measurable or perceptible consequences.

Small mammals associated with the vegetative communities found in the study area include woodrats, chipmunks, rock squirrels, rabbits, and bats. The terrestrial mammals are generally highly mobile and considered prey species; because of this, they have a heightened flight response. Due to their mobility and flight response, such species would not suffer significant direct loses associated with inundation. Additionally, in wetter environments such as riparian areas and wetlands, small rodents, voles, muskrats, and raccoons may be present. While the loss of habitat might reduce the reproductive potential for these species in the local area, Fort Collins’ Proposed Action would unlikely result in a measurable effect to populations or trigger a need to protect these species. Small, medium, and large mammals might suffer minor effects, loss of habitat, and loss of individuals due to inundation; however, Fort Collins’ Proposed Action would likely have a negligible effect on small, medium, and large terrestrial mammals.

Several species of bats may use the Halligan Reservoir area for roosts and foraging. Potential bat roosts in the study area include rock outcrops and trees, while foraging areas may include open meadows, woodlands, wetlands, and open water bodies. Inundation of rock crevices and approximately three acres of riparian woodland vegetation communities where bats may roost and forage would potentially affect bats. Bats which occur in the area are relatively common inhabitants of riparian areas in Colorado and Fort Collins’ Proposed Action would permanently and temporarily affect only a small amount of habitat; therefore, the effect on bats would be negligible.

4.12.3.1.6 Birds

Fort Collins’ Proposed Action would affect potential foraging and nesting areas for several migratory birds and raptors. There would be a long-term loss of about 100.2 acres of foothills grassland, shrubland, and woodland vegetation communities, which are foraging areas for raptors such as great horned owl and red-tailed hawk. Other species such as western meadowlark, spotted towhee, and Woodhouse’s scrub-jay may use these resources for nesting. The long-term loss of approximately 11.1 acres of riparian vegetation communities and 16.74 acres of wetlands would reduce potential foraging, breeding, and nesting areas for migratory birds such as American dipper, black-capped chickadee, yellow-rumped warbler, red-winged and yellow-headed blackbird, American bittern, and several waterfowl species. No raptor nests were observed within the inundation area or the construction areas during surveys. The new reservoir inundation area would result in a beneficial long-term effect for bird species that use open water for foraging or loafing. Raptors such as osprey and bald eagle, and waterfowl such as mallards, Canada geese, and gadwalls, might benefit from the additional open water.
Fort Collins’ Proposed Action might affect a variety of bird species from raptors to songbirds and waterfowl. However, the action would likely have only a negligible effect on these species as significant quantities of viable raptor and migratory bird habitat would be left intact near Halligan Reservoir.

4.12.3.1.7 Amphibians and Reptiles

Fort Collins’ Proposed Action would permanently affect about 11.1 acres of riparian vegetation communities and 16.74 acres of wetlands, which are important resources for amphibians. However, the expansion of Halligan Reservoir would likely create additional riparian vegetation communities and wetlands as the overall water footprint of the reservoir is increased. Some mortality of adults, eggs, tadpoles, and larvae might occur during inundation of the enlarged reservoir, but this would not likely result in a long-term decline of amphibians at Halligan Reservoir or along the North Fork. The inundation of nearly 100.2 acres of upland vegetation communities including foothills grasslands, shrublands and woodlands would be a slow process and would allow time for resident turtles or western tiger salamanders to relocate. Some individual reptiles and amphibians might be killed as a result of inundation, but it would not likely lead to a loss of species diversity at the landscape level or listing of species as threatened or endangered.

Fort Collins’ Proposed Action might locally reduce species abundance due to operation of the enlarged reservoir; however, it would not be likely lead to large-scale species loss or require species protection due to habitat loss. Fort Collins’ Proposed Action would have a negligible to minor effect on amphibians and reptiles.

4.12.3.2 Indirect Effects

The enlarged reservoir would not be expected to have a measurable increase in recreational use but it is likely that the enlarged reservoir would affect wildlife movement patterns in the vicinity. For example, enlargement of Halligan Reservoir would flood portions of the North Fork upstream from the reservoir. If existing wildlife trails were also inundated as a result, species that normally use these trails to cross the North Fork might have to move further upstream to a location where they can cross. This effect to wildlife movement behavior and patterns would likely be negligible to minor. The Corps anticipates wildlife would acclimate quickly to these changes in the inundation level as the existing reservoir’s water level varies seasonally.

Wildlife resources at Halligan Reservoir could be indirectly affected by the possible introduction or establishment of noxious weeds, soil erosion, and potential alteration of stream flows in the North Fork. The potential effects of altered flows along the North Fork are expected to have a minor effect on wetland and riparian vegetation. These effects are discussed in Section 4.7.2.2.1.1 and the Altered Flows Technical Report (WEST 2018). Noxious weed establishment and soil erosion, if they occurred, would affect native vegetation communities. A change in vegetation due to establishment of noxious weeds and soil erosion might result in a lower carrying capacity for some species in the area; however, it would be unlikely to result in formation of completely unsuitable habitat.
4.12.3.3 Effects of Mitigation Measures

Fort Collins is considering the possibility of the following measures as mitigation for the loss of recreation (primarily fishing) along about a one-mile reach of the North Fork upstream of Halligan Reservoir (about 0.41 mile of that reach is currently accessible to the public) and as mitigation for the inundation of portions of the Cherokee State Wildlife Area Middle Unit:

- **Public Recreation – Reservoir Area**: Fort Collins is considering providing public access to the western portion of Halligan Reservoir beyond the current limited access to the tail end of the reservoir. The proposed recreational uses of the reservoir may include shoreline and surface water fishing with human-propelled watercraft such as kayak or belly boat and wildlife viewing. The recreation concept is currently being evaluated and subject to change. Public access to Halligan Reservoir would be provided either by City establishment of a natural area or by lease to a third party for management.

- **Parking and Boat Launch**: Fort Collins is evaluating the potential of providing primitive parking and a pit toilet near the area where the Access Road meets the enlarged reservoir.

Given public interest in flatwater boating and the general lack of other public flatwater boating opportunities in northern Colorado, these mitigation measures would provide a recreational benefit to the region. However, the remote location of Halligan Reservoir, the envisioned unimproved road access only during summer months and the limited types of recreational activities that would be available would likely result in somewhat limited visitation. It is estimated that as many as several thousand visitors per year might recreate at the enlarged Halligan Reservoir. Members of the Landowners Association would continue to have access to the reservoir for recreation, but would share reservoir space with other visitors. Fort Collins would work with those landowners to minimize any potential conflicts (e.g., trespassing) with future visitors. Fort Collins would also work to prevent visitors to Halligan Reservoir from intruding into the Cherokee State Wildlife Area Middle Unit for purposes other than hunting and fishing. That effort might include signage or other indications of State Wildlife Area boundaries. Fort Collins would prohibit hunting at Halligan Reservoir.

The primitive parking and ancillary facilities associated with recreation and public access enhancement would directly affect overall big game habitat. Final design of these facilities would occur after project approval if Fort Collins’ Proposed Action is the selected alternative.

The influx of people at Halligan Reservoir due to expanded recreational opportunities would result in moderate indirect effects to big game, disrupting natural behavior patterns. Noise and increased human presence could cause some individuals to avoid the area, displacing them to other nearby habitat where habitat may be less favorable and where resource competition may be higher. Some individuals could become habituated to human presence, which could increase big game-human conflicts.
4.12.4 Expanded Glade Alternative

4.12.4.1 Direct Effects

Under the Expanded Glade Alternative, most of the long-term direct effects on big game range and habitat would occur as a result of new inundation associated with enlarging the reservoir (approximately 63 acres) while the access road, valve house, and river turnout would have a smaller long-term effect (approximately 1.2 acres). In addition, there would be short-term effects caused by pipeline installation, staging areas, and access road buffers (Figure 4-66). The Corps assumed long-term effects to limiting range types were the most relevant effect for big game species, but only if suitable habitat for the specific species is present (Table 4-57 and Table 4-58).

Table 4-57. Long- and short-term direct effects of the Expanded Glade Alternative on big game range types.

<table>
<thead>
<tr>
<th>Range Type</th>
<th>Range Type in the Data Analysis Unit (acres)</th>
<th>Long-Term Effects (acres)</th>
<th>Short-Term Effects (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elk-overall range</td>
<td>208,771</td>
<td>63.9</td>
<td>68.7</td>
</tr>
<tr>
<td>Elk winter range</td>
<td>435,151</td>
<td>7.4</td>
<td>28.0</td>
</tr>
<tr>
<td>Elk severe winter range</td>
<td>98,446</td>
<td>0.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Mule deer-overall range</td>
<td>1,145,320</td>
<td>63.9</td>
<td>68.7</td>
</tr>
<tr>
<td>Mule deer-winter range</td>
<td>613,074</td>
<td>63.9</td>
<td>68.7</td>
</tr>
<tr>
<td>Mule deer severe winter range</td>
<td>128,724</td>
<td>0.7</td>
<td>60.5</td>
</tr>
<tr>
<td>White-tailed deer-overall range</td>
<td>239,940</td>
<td>63.9</td>
<td>68.7</td>
</tr>
<tr>
<td>White-tailed deer concentration area</td>
<td>26,815</td>
<td>2.4</td>
<td>60.0</td>
</tr>
<tr>
<td>Pronghorn-overall range</td>
<td>109,535</td>
<td>7.9</td>
<td>0.0</td>
</tr>
<tr>
<td>Pronghorn winter range</td>
<td>174,203</td>
<td>7.9</td>
<td>0.0</td>
</tr>
<tr>
<td>Pronghorn severe winter range</td>
<td>174,203</td>
<td>13.4</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Table 4-58. Expanded Glade Alternative effects on suitable habitat within limiting range types for big game species.

<table>
<thead>
<tr>
<th>Species</th>
<th>Limiting Range Type</th>
<th>Effects to Suitable Habitat within Limiting Range Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Long-Term</td>
</tr>
<tr>
<td>Elk</td>
<td>Severe winter range</td>
<td>0.3</td>
</tr>
<tr>
<td>Mule deer</td>
<td>Severe winter range</td>
<td>0.7</td>
</tr>
<tr>
<td>White-tailed deer</td>
<td>Concentration area</td>
<td>2.4</td>
</tr>
<tr>
<td>Pronghorn</td>
<td>Severe winter range</td>
<td>13.4</td>
</tr>
<tr>
<td>Bighorn sheep</td>
<td>Severe winter range</td>
<td>0.0</td>
</tr>
</tbody>
</table>

*See Table 4-52 for species-specific suitable habitats.
Figure 4-66. Expanded Glade Alternative effects on big game ranges.
4.12.4.1.1 Elk
The Expanded Glade Alternative would result in the long-term loss of 0.3 acre of elk severe winter range, which is considered the limiting factor for elk. All of the 0.3 acre of long-term losses would occur in severe winter range with suitable habitat for elk. The Data Analysis Unit includes 98,446 acres of severe winter range that support the upper population target level of 4,200 elk; the Expanded Glade Alternative would have a long-term effect on 0.3 acre or about 0.0005 percent of the Data Analysis Unit’s severe winter range that would have supported about 0.02 individual elk (Table 4-58). This long-term loss of severe winter range would be negligible with no perceptible consequences to the Red Feather-Poudre Canyon elk herd.

4.12.4.1.2 Deer
The Expanded Glade Alternative would result in the long- and short-term loss of 0.7 acre and 60.5 acres, respectively, of mule deer severe winter range, all of which is suitable habitat (Table 4-57 and Table 4-58). Severe winter range is the limiting range type for mule deer. The Data Analysis Unit includes 128,724 acres of severe winter range that support the proposed revised upper population target level of 15,000 deer, including both mule deer and white-tailed deer. If it is assumed that all 15,000 deer proposed as the upper population target are mule deer (a worst case scenario), the Expanded Glade Alternative would permanently effect about 0.002 percent of the mapped mule deer severe winter range within the Data Analysis Unit that would have supported about 0.23 individual mule deer. This long-term loss of severe winter range would be negligible with no perceptible consequences to the Red Feather-Poudre Canyon mule deer herd.

Short-term effects to severe winter range would include approximately 25.2 acres of foothills grasslands, 1.1 acres of foothills shrubland, 36.6 acres of agricultural lands, and approximately 2.5 acres of riparian woodlands. If it is assumed that all 15,000 deer proposed as the upper population target are mule deer (a worst case scenario), the 60.5 acres of short-term effects is 0.05 percent of mapped mule deer severe winter range within the Data Analysis Unit and would have supported about 7.05 individual mule deer. Grasslands and agricultural lands could be expected to recover in a few growing seasons; however, depending on the species composition, shrub communities might require several years, a decade, or more to re-establish. Riparian woodland recovery might require two, three, or more decades to re-establish tree stands with similar structure and function as current conditions. Planting and re-establishing 2.5 acres of riparian woodlands could require decades, this duration could be considered a long-term, but temporary, effect. The short-term effects to grasslands, agricultural lands, shrublands, and riparian woodlands from the Expanded Glade Alternative might temporarily reduce available habitat for some mule deer over the short-, mid-, and long-term; however, it would have a minor short- to mid-term effect on the Red Feather-Poudre Canyon mule deer herd.

The Expanded Glade Alternative would have a long-term effect on 2.4 acres and short-term effect on 60.0 acres of white-tailed deer concentration areas, all of it suitable habitat (Table 4-58). Concentration areas are considered the limiting range type for white-tailed deer. The Data Analysis Unit includes 26,815 acres of concentration areas for white-tailed deer. If it is assumed that all 15,000 deer proposed as the upper population target are white-tailed deer (a worst case scenario), the Expanded Glade Alternative would permanently affect approximately 0.01 percent of the mapped white-tailed deer concentration areas.
within the Data Analysis Unit that would have supported about 1.95 individual white-tailed deer. This long-term loss of concentration areas would be negligible with no perceptible consequences to the Red Feather-Poudre Canyon white-tailed deer herd.

Short-term effects to white-tailed deer concentration area would include approximately 22.3 acres of foothills grasslands, 36.6 acres of agricultural lands, and approximately 1.2 acres of riparian woodlands. If it is assumed that all 15,000 deer proposed as the upper population target are white-tailed deer (a worst case scenario), the 60.0 acres of short-term effects is approximately 0.22 percent of mapped white-tailed deer concentration area within the Data Analysis Unit that would have supported about 33.56 individual white-tailed deer. The short-term effects to grasslands, agricultural lands, and riparian woodlands from the Expanded Glade Alternative might temporarily reduce available habitat for about 33.56 white-tailed deer over the short- and mid-term, however, it would have minor effects on the Red Feather-Poudre Canyon white-tailed herd.

4.12.4.1.3 Pronghorn

The Expanded Glade Alternative would result in the long-term loss of about 13.4 acres of severe winter range (Table 4-58), which is the limiting range type for pronghorn. The Data Analysis Unit includes about 174,203 acres of severe winter range that supports the upper population target of 1,200 pronghorn. Approximately 13.4 acres represents about 0.007 percent of the severe winter range within the Data Analysis Unit that would have supported about 0.15 pronghorn individuals. This permanent loss of pronghorn severe winter range would have a negligible effect on the Cherokee Park pronghorn herd.

4.12.4.1.4 Rocky Mountain Bighorn Sheep

The Expanded Glade Alternative study area does not include any bighorn sheep ranges; however, bighorn sheep may occasionally use the area. Under normal conditions, the Expanded Glade Alternative study area does not provide suitable habitat for bighorn sheep and bighorn sheep would not experience any effects in association with the Expanded Glade Alternative.

4.12.4.1.5 Other Mammals

The Expanded Glade Alternative would result in the long-term loss of about 0.2 acre and short-term loss of about 0.8 acre of black bear fall concentration areas within suitable habitat. Fall concentration areas are the limiting range type for black bear. Long-term loss of 0.2 acre is about 0.00002 percent of the 938,500 acres of mapped black bear fall concentration area within the Data Analysis Unit. This long-term loss of fall concentration areas would affect less than 0.01 bears; therefore, the effects would be negligible with no perceptible consequences to the Northern Front Range black bear population.

Mountain lions are unique in that effects to mountain lion prey, primarily deer and elk, rather than range types, have the greatest influence on health and survival of mountain lions. Armstrong et al. (2011) suggest that a mountain lion needs to kill from 14 to 20 deer or five to seven elk to survive winters, and that a female lion with kittens needs to kill more frequently. Anderson and Lindzey (2003) suggested single mountain lions have a predation rate of one kill, either elk or deer, every seven to 10 days, while female lions with young need to kill once every five to six days. The Expanded Glade Reservoirs
Alternative would reduce white-tailed deer by 1.95 individuals, mule deer by 0.23 individuals and elk by 0.02 individuals. A reduction of 2.18 deer (combined) would affect between 0.11 to 0.16 mountain lions and a reduction of 0.02 elk would affect between 0.001 and 0.002 mountain lion. Therefore, effects on the Northern Front Range mountain lion population would be negligible with no perceptible consequences.

Small mammals associated with vegetative communities in the study area for the Expanded Glade Alternative included woodrats, chipmunks, rock squirrels, and bats in the rocky upland terrains, and jackrabbits, kangaroo rats, bats, and ground squirrels in agricultural land. These terrestrial mammals are generally highly mobile and considered prey species; because of these traits, they have a heightened flight response. Due to their mobility and flight response, such species would not likely suffer significant direct losses associated with construction or inundation. Additionally, in wetter environments such as riparian areas and wetlands, small rodents, voles, muskrats, and raccoons may be present. While the loss of habitat might reduce the reproductive potential for these species in the local area, the Expanded Glade Alternative would unlikely result in a measurable effect to populations or trigger a need to protect these species. Small, medium, and large mammals might suffer minor effects, the loss of habitat, and loss of individuals during construction activities, but the Expanded Glade Alternative would likely have a negligible effect on small, medium, and large terrestrial mammals.

Bat species that may use the Expanded Glade Alternative study area for nightly roosting and foraging include the little brown myotis and big brown bat. Disturbance of rock crevices and removal of 2.5 acres of riparian woodlands where bats may roost and forage might affect bats, but the effect to the little brown myotis would be negligible because this species is a relatively common inhabitant of the extensive riparian areas in Colorado. Big brown bats may use trees or rock crevices as roosts but are also known to use manmade structures such as barns, sheds, and even attics of occupied homes. The Expanded Glade Alternative would disturb some rock outcrops but would not disrupt any existing manmade structures. While the disturbance of the natural environment might affect some big brown bats, leaving man-made roosts intact would allow the bats to relocate to other roost sites in the area. Therefore, the Expanded Glade Alternative would likely have a negligible effect on little brown myotis, big brown bats, and other bats species that may be present in the affected area.

The Expanded Glade Alternative would temporarily affect less than 1.1 acre of foothills shrublands and 2.5 acres of riparian woodlands. While these effects would be short-term and vegetation would be re-established, revegetation of shrublands and woodlands would require more time than grasslands. The short-term effects to grasslands, shrublands, and woodlands within the Expanded Glade Alternative might temporarily reduce available habitat for some wildlife over the short-, mid- and long-term; however, the temporary loss would have negligible effect on mammals over the life of the Expanded Glade Alternative.

4.12.4.1.6 Birds

The Expanded Glade Alternative would affect foraging and nesting areas for several migratory birds and raptors. This alternative would result in long-term impacts to about 62.2 acres of foothills grassland and shrubland vegetation communities, which are used for foraging by raptors such as great horned owl and red-tailed hawk. Other species such as western meadowlark, spotted towhee, and Woodhouse’s scrub-jay may use these resources for nesting. The loss of approximately 0.11 acre of riparian vegetation and wetlands from inundation would reduce potential foraging and breeding habitat for migratory birds such
as American dipper, black-capped chickadee, yellow-rumped warbler, red-winged and yellow-headed blackbirds, and American bittern. The long-term losses associated with the Expanded Glade Alternative would have a negligible effect on bird species as inundation would occur slowly and leave ample unaffected additional habitat. It is expected that over time, new riparian areas and wetlands would become established along the edge of the new inundation area. The new riparian areas and wetlands would likely provide new habitat for some bird species.

Osprey and bald eagle foraging areas would be directly but temporarily disturbed at the proposed pipeline crossing of the Main Stem for the Expanded Glade Alternative. The short-term loss of foraging area as a result of installing a pipeline would have a negligible to minor negative effect. The new reservoir would result in a long-term benefit to bald eagles and osprey by creating new open water foraging areas. No raptor nests were observed within the inundation area or the construction areas during surveys; therefore, no effects to nesting raptors are anticipated.

The Expanded Glade Alternative would temporarily affect 1.1 acres of foothills shrublands and would temporarily affect 2.5 acres of riparian woodlands. While these effects would be short-term and vegetation would re-establish, restoration of riparian woodlands would likely require several years to decades. The short-term effects to shrublands and woodlands within the Expanded Glade Alternative might temporarily reduce available habitat for some raptors and migratory birds over the mid- and long-term; however, the temporary loss of habitat would have negligible effect on birds and raptors over the life of the Expanded Glade Alternative.

Disturbance of about 68.7 acres of various vegetation communities at the site of staging areas, access roads, and other temporary activities would have a short-term effect on bird habitat until these sites were revegetated. The proposed pipeline would cross agricultural lands on the south end of the proposed Glade Reservoir. The grassland dominated fields and pastures in this area may provide suitable habitat for lark sparrows, mourning doves and other birds. The presence of these migratory birds may attract some avian predators such as Cooper’s and sharp-shinned hawk that prey on these species. Crop fields also may provide foraging and loafing grounds for resident and migratory waterfowl such as Canada geese and mallards. However, the short-term loss of agricultural lands would likely have only negligible effects to avian species that use these resources.

4.12.4.1.7 Amphibians and Reptiles

The Expanded Glade Alternative would affect approximately 0.01 acre of riparian woodlands long-term and would not affect any wetlands. In the long-term, the Expanded Glade Alternative would likely create additional riparian communities and wetlands used by these species as the overall water footprint of the reservoir is enlarged. Mortality of adults, eggs, tadpoles, and larvae might occur during construction and inundation of the reservoir, but this would not likely result in a long-term decline of amphibians in the area. The additional inundation of approximately 63.0 acres of uplands associated with the Expanded Glade Alternative would be a slow process and would therefore allow amphibians and reptiles time to relocate. Some individual reptiles and amphibians might be killed by inundation, but it would not likely lead to a loss of species diversity at the landscape level or listing of species for protection. Removal of vegetation for construction, both as a long- and a short-term effect, would take away cover and foraging resources for some reptiles and amphibians, and make some individuals more susceptible to predation and
exposure to the elements. Some individual reptiles and amphibians also might perish or be displaced by construction activities.

The Expanded Glade Alternative would affect less than one acre of foothills shrublands and 2.5 acres of riparian woodlands short-term. While these effects would be temporary and vegetation would be re-established, restoration of shrublands and woodlands would likely require several years to decades. The short-term effects to shrublands and woodlands within the Expanded Glade Alternative might temporarily reduce available habitat for some reptiles and amphibians over the mid- and long-term; however, the short-term loss would have negligible effects on reptiles and amphibians over the life of the Expanded Glade Alternative.

The Expanded Glade Alternative might locally reduce relative abundance of amphibians and reptiles during construction and operation of the expanded reservoir; however, it would unlikely lead to large-scale population declines or require species protection measures due to habitat loss. The Expanded Glade Alternative would have a negligible to minor effect on amphibians and reptiles.

4.12.4.2 Indirect Effects

Indirect effects would consist of displacement of wildlife due to noise and disturbance from construction activities, transportation of people and materials, and general human activity in the Expanded Glade Alternative. In addition, vehicle and equipment emissions and fugitive dust might also displace wildlife. There might be a shift in the movement of some big game species as a result of construction activities and disturbances that could increase collisions with vehicles along local roads. This displacement and disturbance of big game species might result in additional stress being placed on individuals of these species; however, it is likely to have a negligible effect on elk, mule deer, white-tailed deer, and pronghorn populations.

Wildlife resources at the Expanded Glade could be indirectly affected by the possible introduction or establishment of noxious weeds, soil erosion, and potential alteration of stream flows in the Main Stem. The potential effects of altered flows on wetland and riparian resources are discussed in the North Fork Wetland Technical Report (WEST 2016) and North Fork Aquatic Resources Baseline Technical Report (GEI 2019a). Noxious weed establishment and soil erosion, if they occurred, would affect native vegetation communities. A change in vegetation due to establishment of noxious weeds and soil erosion might result in a lower carrying capacity for some species in the area; however, it is unlikely to result in formation of completely unsuitable habitat. Erosion might also affect water flows and quality of the Main Stem as it relates to possible changes in sediment flows and depositions and stream morphology. Sedimentation and stream morphology issues are discussed in the North Fork Stream Morphology and Sediment Transport Baseline Technical Report (ACE 2019b), and North Fork Aquatic Resources Baseline Technical Report (GEI 2016a).
4.12.5 Gravel Pits Alternative

4.12.5.1 Direct Effects

Under the Gravel Pits Alternative, most of the long-term direct effects on big game range and habitat would occur as a result of the new access road, pump station, and pre-treatment facility (approximately 17.0 acres) while the valve house and river turnout would have long-term effects (approximately 0.02 acre or 850 square feet; Figure 4-67). Short-term effects for this alternative would be limited to construction staging areas and pipeline installation. Fort Collins would try to install the majority of the pipelines within existing road rights of way, where possible, to minimize effects to wildlife habitat. The excavation of gravel pits was not considered an effect for this analysis. Fort Collins would presumably only take ownership of the gravel pit complex after gravel extraction operations have ceased at the facility; therefore, Fort Collins would receive the property with pre-excavated pits. The pits and additional disturbances to the gravel pit complex would therefore be an existing condition and not calculated as a new effect associated with Fort Collins’ actions in the Gravel Pits Alternative. The Corps assumed long-term effects to limiting habitat was the most relevant effect for big game species, but recognizes big game range maps are prepared at a coarse scale (Table 4-59). Therefore, the Corps calculated the amount of suitable habitat within the limiting range types affected by the alternative (Table 4-60).

<table>
<thead>
<tr>
<th>Range Type</th>
<th>Range Type in the Data Analysis Unit (acres)</th>
<th>Long-Term Effects (acres)</th>
<th>Short-Term Effects (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mule deer-overall range</td>
<td>1,145,320</td>
<td>21.3</td>
<td>111.7</td>
</tr>
<tr>
<td>Mule deer severe winter range</td>
<td>128,724</td>
<td>2.3</td>
<td>43.2</td>
</tr>
<tr>
<td>Mule deer-winter range</td>
<td>613,074</td>
<td>24.6</td>
<td>111.7</td>
</tr>
<tr>
<td>White-tailed deer concentration area</td>
<td>26,816</td>
<td>4.6</td>
<td>21.5</td>
</tr>
<tr>
<td>White-tailed deer-overall range</td>
<td>239,940</td>
<td>24.6</td>
<td>111.7</td>
</tr>
</tbody>
</table>

Table 4-59. Long- and short-term direct effects of the Gravel Pits Alternative on big game range types.

<table>
<thead>
<tr>
<th>Species</th>
<th>Limiting Range Type</th>
<th>Effects to Suitable Habitat(^1) within Limiting Range Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mule deer</td>
<td>Severe winter range</td>
<td><img src="#" alt="Table showing effects to suitable habitat for mule deer" /></td>
</tr>
<tr>
<td>White-tailed deer</td>
<td>Concentration area</td>
<td><img src="#" alt="Table showing effects to suitable habitat for white-tailed deer" /></td>
</tr>
</tbody>
</table>

\(^1\)See Table 4-52 for species-specific suitable habitats
Figure 4-67. Gravel Pits Alternative effects on big game ranges.
4.12.5.1.1 Deer

The Gravel Pits Alternative would result in 2.3 acres of long-term and 43.2 acres of short-term effects to severe winter range for mule deer with suitable habitat. Severe winter range is the limiting range type for mule deer. The Data Analysis Unit includes 128,724 acres of severe winter range for mule deer. If it is assumed that all 15,000 deer proposed as the upper population target are mule deer (a worst case scenario), the Gravel Pits Alternative would permanently affect 0.0002 percent of the Data Analysis Unit severe winter range for mule deer that would support 0.23 individual mule deer. This long-term loss of severe winter range and the mule deer it would support would be negligible with no perceptible consequences to the Red Feather-Poudre Canyon mule deer herd.

Short-term effects to severe winter range for mule deer would include approximately 11.7 acres of foothills grasslands, 6.5 acres of disturbed or developed lands, and 1.7 acres of riparian woodlands, which represent 0.02 percent of mule deer severe winter range within the Data Analysis Unit. Grasslands could be expected to recover in a few growing seasons; however, depending on the species composition, shrub communities might require several years, a decade, or more to re-establish. Riparian woodland recovery might require two, three, or more decades to re-establish tree stands with similar structure and function as current conditions. The temporary effects to grasslands, riparian shrublands, and riparian woodlands from the Gravel Pits Alternative might temporarily reduce available habitat for some mule deer over the short-, mid, and long-term; however, the temporary loss of suitable habitat within mapped severe winter range would have a negligible effect on the Red Feather-Poudre Canyon mule deer herd.

The Gravel Pits Alternative would have a long-term effect on 4.3 acres of concentration areas and a short-term effect on an additional 21.5 acres, all of it suitable habitat (Table 4-59). Concentration areas are the limiting range type for white-tailed deer. The Data Analysis Unit includes 26,815 acres of concentration areas for white-tailed deer. If it is assumed all 15,000 deer proposed as the upper population target are white-tailed deer (a worst case scenario), the Gravel Pits Alternative would permanently affect 0.01 percent of white-tailed deer concentration areas within the Data Analysis Unit that would have supported about 1.68 individual white-tailed deer. The long-term loss of concentration areas and the white-tailed deer it would support would be negligible with no perceptible consequences to the Red Feather-Poudre Canyon white-tailed deer herd.

Short-term effects to white-tailed deer concentration areas would include approximately 5.4 acres of foothills grasslands, 7.1 acres of non-native grasslands, and approximately 0.03 acre of riparian shrublands. Assuming all 15,000 deer proposed as the upper population target are white-tailed deer (a worst-case scenario), the short-term effects of the Gravel Pits Alternative on white-tailed deer concentration areas with suitable habitat would be approximately 0.1 percent of white-tailed deer concentration areas within the Data Analysis Unit that would support 14.26 individual white-tailed deer. The short-term effects to grasslands and riparian shrublands within the Gravel Pits Alternative might reduce available habitat for white-tailed deer over the short- and mid-term, but would have a minor effect on the Red Feather-Poudre Canyon white-tailed deer herd.
4.12.5.1.2 Elk, Pronghorn, and Bighorn Sheep

Based on range maps, elk, pronghorn, and bighorn sheep ranges do not occur within the Gravel Pits Alternative study area; however, these species might occasionally use the area. Under normal conditions, the Gravel Pits Alternative study area does not support suitable habitat for these species and no effects would therefore be anticipated.

4.12.5.1.4 Other Mammals

The Gravel Pits Alternative would have a long-term effect on about 4.3 acres of black bear fall concentration areas with suitable habitat. Fall concentration areas are the limiting range type for black bear. Long-term losses of 4.3 acres would be 0.0004 percent of the more than 938,500 acres of mapped black bear fall concentration areas within the Data Analysis Unit. This long-term loss of fall concentration areas and the black bears it would support would be negligible with no perceptible consequences to Northern Front Range black bear populations.

Short-term effects to fall concentration areas with suitable habitat would include approximately 5.4 acres of foothills grasslands, 5.95 acres of agricultural lands, and 1.7 acres of riparian woodlands. The approximate 13.0 acres of short-term effects would be 0.005 percent of the black bear fall concentration areas within the Data Analysis Unit. The short-term effects to grasslands, riparian shrublands, and riparian woodlands from the Gravel Pits Alternative might temporarily reduce available habitat for some black bears over the short-, mid, and long-term; however, the temporary loss of suitable habitat within mapped fall concentration areas would have negligible effects on Northern Front Range black bear populations.

Mountain lions are unique in that effects to mountain lion prey, primarily deer and elk, rather than range types, would have the greatest effect on health and survival of mountain lions. Armstrong et al. (2011) suggest that a mountain lion needs to kill from 14 to 20 deer or five to seven elk to survive winters, and that a female lion with kittens needs to kill more frequently. Anderson and Lindzey (2003) suggested single mountain lions have a predation rate of one kill, either elk or deer, every seven to 10 days, while female lions with young need to kill once every five to six days. The Gravel Pits Alternative would have a negligible effect on elk, and reduce the Red Feather-Poudre Canyon deer herd by at most 0.23 mule deer and 14.26 white-tailed deer. A reduction of 14.49 deer (combined) would affect between 0.72 to 1.03 mountain lions; therefore, the effects on the Northern Front Range mountain lions would be negligible with no perceptible consequences.

Small mammals associated with the vegetative communities of this alternative include cottontails, jackrabbits, kangaroo rats, bats, ground squirrels, and other species. The terrestrial mammals are generally highly mobile and are considered prey species. Because of these attributes, they have a heightened flight response. Due to their mobility and high flight response, such species would not suffer significant direct losses associated with construction. Additionally, in wetter vegetation communities such as riparian areas and wetlands, smaller rodents, voles, muskrats, and raccoons may be present. While the loss of habitat might reduce the reproductive potential for these species, the Gravel Pits Alternative is unlikely to result in a measurable effect to populations or trigger a need to protect these species. Small, medium, and large mammals might suffer minor effects, loss of habitat, and loss of individuals during construction activities,
but the Gravel Pits Alternative would likely have a negligible effect on small, medium, and large terrestrial mammals.

Bat species that may use the Gravel Pits Alternative for nightly roosts and foraging include the little brown myotis and big brown bat. The short-term disturbance of 2.1 acres of riparian woodlands as part of the Gravel Pits Alternative would not likely result in a significant effect to the little brown myotis as this species is a relatively common inhabitant of riparian areas in Colorado. Big brown bats may roost in trees or rock crevices and in manmade structures like barns, sheds, and even attics of occupied homes. This alternative would not disrupt any existing manmade structures, so while disturbances to the natural environment might affect some big brown bats, leaving man-made roosts intact would allow the bats to relocate roost sites in the area. Additionally, large areas of riparian woodlands along the Main Stem would persist and remain available for both the little brown myotis and big brown bat. Therefore, the Gravel Pits Alternative would likely have a negligible effect on little brown myotis and big brown bats as well as other bat species that may be present in the affected area.

The Gravel Pits Alternative would temporarily affect less than 0.5 acre each of scrub-shrub wetlands, forested wetlands, and riparian shrublands, and 2.1 acres of riparian woodlands. Short-term effects to shrublands, scrub-shrub wetlands, forests and woodlands within the Gravel Pits Alternative might temporarily reduce available habitat for some wildlife over the mid- and long-term; however, the temporary loss would have a negligible effect on wildlife over the life of the Gravel Pits Alternative.

4.12.5.1.3 Birds

The Gravel Pits Alternative includes large areas of rural residential, suburban, lightly developed properties, agricultural lands, and an active gravel operation. Bird species identified in the Gravel Pits Alternative study area included species that generally are associated with human activity or are cosmopolitan in distribution. Construction of the Gravel Pits Alternative would result in the long-term loss of approximately 0.2 acre of foothills grassland; however, these resources have been significantly degraded due to previous disturbances (WEST 2017). As a result, while species such as western meadowlarks, spotted towhee, and Woodhouse’s scrub-jays that are generally associated with foothill grasslands may be expected to occur in the area, species like house sparrows, American robins, and European starlings are also expected to be present and disturbed by this alternative. The 2.4 acres of riparian vegetation and wetlands potentially disturbed by the proposed Main Stem pipeline crossing would be revegetated, but development of a dense cottonwood and willow canopy might take decades after construction has occurred. A lack of this specific vegetative structure would likely displace some avian species until the canopy can redevelop. While effects to vegetation communities might displace some avian species, the Gravel Pits Alternative would not result in significant declines of any bird species or the listing of species due to significant habitat loss. Therefore, the Gravel Pits Alternative would have a negligible to minor effect on migratory birds.

The Gravel Pits Alternative would temporarily affect less than 0.5 acre each of scrub-shrub wetlands, forested wetlands, and riparian shrublands, and 2.1 acres of riparian woodlands. Short-term effects to scrub-shrub wetlands, shrubland, forest, and woodlands within the Gravel Pits Alternative might temporarily reduce available habitat for some birds over the mid- and long-term, however, the short-term
loss of habitat would have negligible effect on migratory birds and raptors over the life of the Gravel Pits Alternative.

4.12.5.1.4 Amphibians and Reptiles

The Gravel Pits Alternative would permanently affect approximately 4.3 acres of wetlands. The Gravel Pits Alternative would result in a short-term effect to nearly 2.4 acres of riparian and wetland communities from the Main Stem pipeline crossing. Excavation of the riverbed to install pipe would significantly disturb potential habitat for numerous species, including reptiles and amphibians. This disturbance would affect habitat and potentially destroy individuals, larvae, tadpoles, or eggs of amphibians in the immediate area of construction. However, the overwhelming majority of the Main Stem would remain undisturbed. During construction, some loss of habitat might occur but it is anticipated to be short-term and amphibians would use the area again once the area is revegetated.

The Gravel Pits Alternative would permanently affect 9.0 acres of upland vegetation including foothills grasslands, non-native grasslands, and agricultural lands. A wide variety of reptiles including various snakes, lizards, and turtles use these vegetation communities. The loss of upland cover would be minimal compared to the area of vegetation left intact. Furthermore, native vegetative cover has been noticeably degraded due to disturbance of the general area. Removal of vegetation for construction, both long- and short-term, would remove cover and foraging resources for some reptiles and amphibians, and make some individuals more susceptible to predation and exposure to the elements. Still other reptiles and amphibians might perish or be displaced as a result of construction activities.

The Gravel Pits Alternative would temporarily affect less than 0.5 acre each of scrub-shrub wetlands, forested wetlands, and riparian shrublands, and 2.1 acres of riparian woodlands. These short-term effects to shrublands, scrub-shrub wetlands, forest, and woodlands within the Gravel Pits Alternative might temporarily reduce available habitat for some reptiles and amphibians over the mid- and long-term, however, the temporary loss of habitat would have a negligible effect on reptiles and amphibians over the life of the Gravel Pits Alternative.

4.12.5.2 Indirect Effects

Indirect effects consist of displacement of wildlife due to noise and disturbance from construction activities, transportation of people and materials, and general human activity in the Gravel Pits Alternative. In addition, vehicle and equipment emissions and fugitive dust might displace wildlife. There might be a shift in the movement of some big game species as a result of construction activities and disturbances that could increase collisions with vehicles. This displacement and disturbance of big game species might result in additional stress being placed on individuals; however, it is likely to have a negligible effect on elk, mule deer, white-tailed deer, and pronghorn populations.

Indirect effects to wildlife resources at the proposed Gravel Pits Alternative also include the possible introduction or establishment of noxious weeds, soil erosion, and potential alteration of stream flows in the Main Stem. Potential effects of altered flows on wildlife resources are described in the Altered Flows Technical Report (WEST 2018). Noxious weed establishment and soil erosion, if they occurred, would affect native vegetation communities. A change in vegetation due to establishment of noxious weeds and
soil erosion might result in a lower carrying capacity for some species in the area; however, it is unlikely to result in formation of completely unsuitable habitat.

4.12.6 Agricultural Reservoirs Alternative

4.12.6.1 Direct Effects

Under the Agricultural Reservoirs Alternative, most of the long-term direct effects on big game range and habitat would occur as a result of access road and pump station construction (approximately 11.0 acres), while construction of the river turnout and valve house would have only minor long-term effects (approximately 0.02 acre or 850 square feet). In addition to long-term effects, installation of a pipeline, staging areas, and access road buffers would create short-term effects of 334.0 acres (Figure 4-68). Fort Collins would try to install the majority of pipelines within existing road rights of way, where possible, to minimize effects to big game habitat. The Corps assumed long-term affect to limiting habitat was the most relevant effect for big game species (Table 4-61 and Table 4-62).

Table 4-61. Long- and short-term direct effects of the Agricultural Reservoirs Alternative on big game range types.

<table>
<thead>
<tr>
<th>Range Type</th>
<th>Range Type in the Data Analysis Unit (acres)</th>
<th>Long-Term Effects (acres)</th>
<th>Short-Term Effects (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mule deer-overall range</td>
<td>1,145,320</td>
<td>11.0</td>
<td>334.0</td>
</tr>
<tr>
<td>Mule deer severe winter range</td>
<td>128,724</td>
<td>2.5</td>
<td>52.0</td>
</tr>
<tr>
<td>Mule deer winter range</td>
<td>613,074</td>
<td>5.6</td>
<td>161.2</td>
</tr>
<tr>
<td>White-tailed deer concentration area</td>
<td>26,816</td>
<td>2.0</td>
<td>47.0</td>
</tr>
<tr>
<td>White-tailed deer-overall range</td>
<td>239,940</td>
<td>11.0</td>
<td>334.0</td>
</tr>
</tbody>
</table>

Table 4-62. Agricultural Reservoirs Alternative effects on suitable habitat within limiting range types for big game species.

<table>
<thead>
<tr>
<th>Species</th>
<th>Limiting Range Type</th>
<th>Effects to Suitable Habitat(^1) within Limiting Range Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Long-term Effects</td>
</tr>
<tr>
<td>Mule deer</td>
<td>Severe winter range</td>
<td>2.5</td>
</tr>
<tr>
<td>White-tailed deer</td>
<td>Concentration area</td>
<td>3.4</td>
</tr>
</tbody>
</table>

\(^1\)See Table 4-52 for species-specific suitable habitats.
Figure 4-68. Agricultural Reservoirs Alternative effects on big game ranges.
4.12.6.1 Deer

The Agricultural Reservoirs Alternative would result in 2.5 acres of long-term and 20.8 acres of short-term effects to severe winter range for mule deer within suitable habitat. Severe winter range is the limiting range type for mule deer. The Data Analysis Unit includes 128,724 acres of severe winter range for mule deer. If it is assumed all 15,000 deer proposed as the upper population target are mule deer (a worst case scenario), the long-term loss of 2.5 acres is about 0.002 percent of the Data Analysis Unit’s mule deer severe winter range and would support 0.25 individual mule deer. This long-term loss of severe winter range and the mule deer it would support would be negligible with no perceptible consequences to the Red Feather-Poudre Canyon mule deer herd.

Short-term effects to mapped severe winter range would include approximately 14.6 acres of foothills grasslands, 4.7 acres of developed land, and 1.4 acres of riparian woodlands. Short-term effects to severe winter range for mule deer would be 0.04 percent of the mule deer severe winter range within the Data Analysis Unit. The short-term effects to grasslands, shrublands, and riparian woodlands from the Agricultural Reservoirs Alternative might temporarily reduce available habitat for some mule deer over the short-, mid, and long-term; however, the short-term loss of severe winter range would have negligible effect on the Red Feather-Poudre Canyon mule deer herd.

The Agricultural Reservoirs Alternative would have a long-term effect on 3.4 acres and short-term effect on 20.8 acres of concentration areas for white-tailed deer, all of it suitable habitat (Table 4-62). Concentration areas are the limiting range type for white-tailed deer. The Data Analysis Unit includes over 26,815 acres of concentration areas for white-tailed deer. If it is assumed all 15,000 deer proposed as the upper population target are white-tailed deer (a worst case scenario) the Agricultural Reservoirs Alternative would permanently affect 0.007 percent of the mapped white-tailed deer concentration area within the Data Analysis Unit (Table 4-61) that would support 1.85 individual white-tailed deer. This long-term loss of concentration areas and the white-tailed deer it would support would be negligible with no measurable or perceptible consequences to the Red Feather-Poudre Canyon white-tailed deer herd.

Short-term effects to mapped white-tailed deer concentration areas include approximately 14.6 acres of foothills grasslands, 4.7 acres of developed land, and 1.4 acres of riparian shrubland. Short-term effects to white-tailed deer concentration areas would be 0.18 percent of the white-tailed deer concentration area mapped within the Data Analysis Unit (Table 4-61). Short-term effects to grasslands and shrublands from the Agricultural Reservoirs Alternative might temporarily reduce available habitat for some white-tailed deer over the short-, and mid-term; however, the short-term loss of concentration areas would have a negligible effect on the Red Feather-Poudre Canyon white-tailed deer herd.

4.12.6.1.2 Elk, Pronghorn, and Bighorn Sheep

Based on range maps, elk, pronghorn, and bighorn sheep ranges do not occur within the Agricultural Reservoirs Alternative study area; however, these species may occasionally use the area. Under normal conditions, the Agricultural Reservoirs Alternative study area does not provide suitable habitat for these species and therefore no effects would be anticipated.
4.12.6.1.3 Other Mammals

The Agricultural Reservoirs Alternative would permanently affect 2.0 acres of fall concentration areas with suitable black bear habitat. Fall concentration areas are the limiting range type for black bear. Long-term loss of 2.0 acres is 0.0002 percent of the more than 938,500 acres of mapped black bear fall concentration area within the Data Analysis Unit. This long-term loss of fall concentration areas would be negligible with no measurable or perceptible consequences on Northern Front Range black bear populations.

The Agricultural Reservoirs Alternative would result in a short-term effect to 20.8 acres of fall concentration areas for black bear. Short-term effects to fall concentration areas would include approximately 14.6 acres of foothills grasslands, 4.7 acres of developed land, and 1.4 acres of riparian shrubland. The approximate 20.8 acres of short-term effects would be 0.005 percent of the mapped black bear fall concentration areas within the Data Analysis Unit. Short-term effects to grasslands, riparian shrublands, and riparian woodlands from the Agricultural Reservoirs Alternative might temporarily reduce available habitat for some black bears over the short-, mid, and long-term; however, the temporary loss of suitable habitat within mapped fall concentration areas would have negligible effects on Northern Front Range black bear populations.

Mountain lions are unique in that effects to mountain lion prey, primarily deer and elk, rather than range types have the greatest influence on health and survival of mountain lions. Armstrong et al. (2011) suggest that a mountain lion needs to kill from 14 to 20 deer or five to seven elk to survive winters, and that a female lion with kittens needs to kill more frequently. Anderson and Lindzey (2003) suggested single mountain lions have a predation rate of one kill, either elk or deer, every seven to 10 days, while female lions with young need to kill once every five to six days. The Agricultural Reservoirs Alternative would have no effect on elk and reduce mule deer by 0.25 individuals and white-tailed deer by 1.85 individuals. The reduction of 2.1 deer (combined) would affect from 0.11 to 0.15 mountain lion; therefore, effects on the Northern Front Range mountain lion population would be negligible with no measurable or perceptible consequences.

Small mammal species associated with vegetative communities of this alternative include cottontails, jackrabbits, kangaroo rats, bats, and ground squirrels. These terrestrial mammals are generally highly mobile and considered to be prey species; because of these traits, they have a heightened flight response. Due to their mobility and flight response, such species would not suffer significant direct losses associated with construction or inundation. Additionally, in wetter environments like riparian areas and wetlands, smaller rodents, voles, muskrats, and raccoons may be present. While the loss of habitat might reduce reproductive potential of these species in the local area, the Agricultural Reservoirs Alternative is unlikely to result in a measureable effect to populations or trigger a need to protect these species. Small, medium, and large mammals might suffer minor effects, loss of habitat, and loss of individuals during construction activities, but the Agricultural Reservoirs Alternative would likely have a negligible effect on small, medium, and large terrestrial mammals.

Bat species that may use the Agricultural Reservoirs Alternative for nightly roosts and foraging include the little brown myotis and big brown bat. Little brown myotis roost just under the bark of trees. The removal of less than 0.5 acre of riparian woodlands where the bat may roost and forage would potentially affect the bat. However, the overwhelming majority of available roosts would be left undisturbed. The
little brown myotis, being a relatively common inhabitant of riparian areas in Colorado, is not expected to be significantly affected by the short-term disturbance of riparian woodlands as part of the Agricultural Reservoirs Alternative. Big brown bats may also roost in trees and in manmade structures such as barns, sheds, and even attics of occupied homes. This alternative is not expected to disrupt any existing manmade structures and, as mentioned above, would leave abundant natural roosts intact. The Agricultural Reservoirs Alternative would likely have a negligible effect on little brown myotis and big brown bats and other bat species that may be present in the affected area.

The Agricultural Reservoirs Alternative would temporarily affect less than 0.5 acre each of scrub-shrub wetlands, forested wetlands, and riparian shrublands, 2.1 acres of riparian woodlands, and 8.1 acres of foothills shrublands. Short-term effects to shrublands, scrub-shrub wetlands, forest, and woodlands within the Agricultural Reservoirs Alternative might temporarily reduce available habitat for some wildlife over the mid- and long-term; however, the short-term loss would have negligible effect on wildlife over the life of the Agricultural Reservoirs Alternative.

4.12.6.1.4 Birds

The Agricultural Reservoirs Alternative would affect nesting and foraging areas for migratory birds and raptors. The study area for this alternative includes a large area of rural residential, suburban, developed properties, and agricultural lands. Bird species identified in this study area include species that generally are associated with human activity or are cosmopolitan in distribution. Construction of the Agricultural Reservoirs Alternative would result in the long-term loss of about 5.3 acres of non-native grasslands and 5.4 acres of agricultural land and the short-term loss of 102.8 acres of non-native grasslands and 151.4 acres of agricultural land. Species such as house sparrows, American robins, and European starlings would be disturbed by this alternative. The 2.1 and 2.5 acres of riparian and wetland vegetation communities temporarily affected by the proposed Main Stem pipeline crossing would be revegetated, but development of a dense cottonwood and willow canopy might take decades after construction has occurred. A lack of this specific vegetative structure would displace some avian species until the canopy can redevelop. While effects to habitat might displace avian species, the Agricultural Reservoirs Alternative would not likely result in population declines of any bird species and would have a negligible to minor effect on raptors and migratory birds.

The Agricultural Reservoirs Alternative would temporarily affect less than 0.5 acre each of scrub-shrub wetlands, forested wetlands, and riparian shrublands, 2.1 acres of riparian woodlands, and 8.1 acres of foothills shrublands. Short-term effects to shrublands, scrub-shrub wetlands, forest, and woodlands within the Agricultural Reservoirs Alternative might temporarily reduce available habitat for some raptors and migratory birds over the mid- and long-term; however, the short-term loss would have negligible effect on birds and raptors over the life of the Agricultural Reservoirs Alternative.

4.12.6.1.5 Amphibians and Reptiles

The Agricultural Reservoirs Alternative would permanently affect less than 0.5 acre of riparian vegetation communities and would not permanently affect any wetlands. Riparian areas are of high importance to amphibians and the loss would likely have a short-term direct negative effect on amphibians that use the riparian resources within the Agricultural Reservoirs Alternative.
The Agricultural Reservoirs Alternative would also result in a short-term effect to approximately 2.1 acres of riparian vegetation communities and 2.5 acres of wetlands from the Main Stem pipeline crossing. Excavation of the riverbed to install pipe would significantly disturb potential habitat for numerous species, including reptiles and amphibians. However, the overwhelming majority of the Main Stem would be left undisturbed, affording available resources for individuals that might be displaced during and after pipeline installation.

The Agricultural Reservoirs Alternative would permanently affect approximately 12 acres of non-native vegetative cover, including 5.3 acres of non-native grasslands and 5.4 acres of agricultural lands. While these vegetation communities may not be native and pristine, they may be used by a wide variety of reptiles including various snakes, lizards, and turtles. The loss of upland vegetation would be minimal compared to the amount of vegetation left intact. Construction would result in both long- and short-term effects to vegetation which would remove cover and foraging resources for some reptiles and amphibians, and make some individuals more susceptible to predation and exposure to the elements. The Agricultural Reservoirs Alternative might locally reduce relative species abundance during construction; however, it is unlikely to lead to large-scale loss of individuals or require species protection due to habitat loss.

The Agricultural Reservoirs Alternative would temporarily affect less than 0.5 acre each of scrub-shrub wetlands, forested wetlands, and riparian shrublands, 2.1 acres of riparian woodlands, and 8.1 acres of foothills shrublands. The short-term effects to shrublands, scrub-shrub wetlands, forest, and woodlands within the Agricultural Reservoirs Alternative might temporarily reduce available habitat for some reptiles and amphibians over the mid- and long-term; however, the short-term loss would have a negligible effect on reptiles and amphibians over the life of the Agricultural Reservoirs Alternative.

### 4.12.6.2 Indirect Effects

Indirect effects consist of displacement of wildlife due to noise and disturbance from construction activities, transportation of people and materials, and general human activity in the Agricultural Reservoir Alternative. In addition, vehicle and equipment emissions and fugitive dust might displace wildlife. There might be a shift in the movement of some big game species as a result of construction activities and disturbances that could increase collisions with vehicles. This displacement and disturbance of big game species might result in additional stress being placed on individuals; however, it is likely to have a negligible effect on elk, mule deer, white-tailed deer, and pronghorn populations.

Wildlife resources in the Agricultural Reservoir Alternative study area could be indirectly affected by the possible introduction or establishment of noxious weeds, soil erosion, and potential alteration of stream flows in the Main Stem. The potential effects of altered flows on wildlife resources are discussed in the *Altered Flows Technical Report* (WEST 2018). A change in vegetation due to establishment of noxious weeds and soil erosion might result in a lower carrying capacity for some species in the area; however, it is unlikely to result in formation of completely unsuitable habitat.

### 4.12.7 No-Action Alternative

The No-Action Alternative would not involve any new land disturbance or construction activities so it would not cause the loss of any wildlife habitat, either long- or short-term. Under the first measure of its
No-Action Alternative, Fort Collins would conduct fewer single-use water transactions with the NPIC to maintain a higher water level at the Joe Wright Reservoir over the winter. Joe Wright Reservoir is operated and maintained in part for year-round recreational fishing, and the reservoir is therefore rarely, if ever, drained dry. Maintaining a higher water lever at Joe Wright Reservoir over the winter might provide additional loafing areas and foraging opportunities for wildlife. However, as Joe Wright Reservoir is rarely if ever dry, maintaining a higher water level is unlikely to provide substantially greater wildlife benefits. Maintaining a higher water level might result in a change in vegetation communities and structure at the water’s edge; however, as water levels will be maintained at a higher level outside of the growing season, any possible effects to vegetation as a result of changes in water level would occur over the long-term. Potential effects to vegetation as a result of the higher water levels are discussed in the Altered Flows Technical Report (WEST 2018), but would be minimal. Maintaining a higher water level over winter at the Joe Wright Reservoir would be negligible with no measurable or perceptible consequences to wildlife.

Under the second measure of its No-Action Alternative, Fort Collins would either directly purchase NPIC shares or require future developers to dedicate NPIC shares to Fort Collins as a condition of future development. The timing and quantity of NPIC shares conversion is unknown at this time. If development slows, conversion of NPIC shares would likely slow too. Conversely, if a housing boom occurs in Fort Collins, share conversion might be accelerated. Conversion of NPIC shares at different rates might have substantially different effects on land use, vegetation communities, and wildlife. Furthermore, converting shares currently under agricultural use would likely reduce the acreage of agricultural lands. Converted agricultural land could be used for development, which might result in a loss of foraging habitat or escape cover for white-tailed deer and other wildlife. However, if NPIC shares currently used for agricultural are converted but the land is not developed, former agricultural fields might go fallow and actually provide better habitat for wildlife. The situation under which NPIC shares would be converted is highly speculative and effects are uncertain. However, effects to wildlife would likely be similar to other land based cumulative effects such as population growth and land development.

The third measure Fort Collins would enact as part of the No-Action Alternative is to impose more frequent and severe mandatory water restrictions. Fort Collins has already implemented a Water Supply Shortage Response Plan (2003; revised in 2014) to address drought and emergency water supply situations. Use of water would be limited during times of drought or water system failure or shut down. Water system failure and shut down are unlikely to last longer than a few days or perhaps weeks. If water restrictions were implemented in the case of a water system failure, the short duration of those restrictions would have a negligible effect with no measurable or perceptible consequences to wildlife. If water restrictions were necessary under drought conditions, it is assumed wildlife also would be under the stress of drought. Depending on the duration and severity of the drought, wildlife might be unaffected and able to adapt, or might suffer heath and population declines. In any event, reducing residential and municipal use of water might limit available water, cover, and forage for species with a cosmopolitan distribution that take advantage of residential, commercial, and municipal irrigation of lawns and landscaping. Species such as Canada geese that commonly use maintained golf courses or commercial campuses for nesting, foraging, and loafing might be forced to congregate in more highly congested areas. Concentrating wildlife into smaller areas with greater numbers of individuals can create situations where disease is more easily spread and can quickly reduce the carrying capacity of an area. In both cases, these
circumstances could lead to a reduction in health and abundance of the affected species. The potential effects associated with overly concentrating wildlife might be negligible if drought conditions were short lived as wildlife could quickly recover. However, if drought conditions were to persist for months, years, or decades, wildlife might not be able sustain healthy populations and their populations might be reduced, never to recover to pre-drought conditions. Similar to the proposed conversion of NPIC shares for municipal use, implementation of water restrictions involves numerous variable circumstances and potential effects are highly speculative at this time. Generally, it can be assumed than if water restrictions were instituted due to drought conditions, wildlife would likely also be under stress and would likely suffer declines in health or abundance, either due to the drought alone or in conjunction with imposed water restrictions. However, the degree of potential effects in both duration and severity are unable to be qualitatively or quantitatively defined.

Application of the No-Action Alternative might have various levels of effects on wildlife, from negligible effects from an increase in stored water at Joe Wright Reservoir, to a possible substantial reduction in health, available habitat, or crash in abundance during droughts, or even an increase in available habitat if agricultural fields were allowed to go fallow. To draw specific conclusions would be highly speculative and subjective. However, it is assumed that effects from the No-Action Alternative would be similar in scale and intensity as some of the defined RFFAs; therefore, effects to wildlife from the No-Action Alternative would be negligible to minor across all species discussed in this section.

4.12.8 Effects Summary

The comparative summary of effects on big game species and black bears focuses on effects to limiting habitat compared to the total mapped limiting habitat within Data Analysis Units (Table 4-63). There would be some loss of areas within the range of bighorn sheep, elk, mule deer, pronghorn, and white-tailed deer. In general, neither Fort Collins’ Proposed Action nor any of the alternatives would likely have a measurable effect on big game species (Table 4-64).

The Expanded Glade Alternative would have the greatest long-term effects to elk severe winter range, with approximately 0.5 acre of permanent effects (Table 4-63). The other alternatives would not affect elk severe winter range.

Fort Collins’ Proposed Action would have the greatest long-term effect on mule deer severe winter range at 109.5 acres (Table 4-63). The remaining action alternatives would all permanently affect approximately 31.0 acres of severe winter range for mule deer and the No-Action Alternative would affect 29.0 acres due to Halligan Dam rehabilitation.

The Expanded Glade Alternative would have the greatest long-term effects to white-tailed deer concentration areas with approximately 3.5 acres of effects (Table 4-63). The Gravel Pits Alternative would have the next greatest long-term effect, with 3.0 acres, followed by the Agricultural Reservoirs Alternative, with 2.0 acres of effects. Fort Collins’ Proposed Action and the No-Action Alternative would not affect white-tailed deer concentration areas.
### Table 4-63. Summary of effects to wildlife and suitable habitat within limiting ranges by alternative.

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Halligan Dam Rehabilitation*</th>
<th>Fort Collins’ Proposed Action*</th>
<th>Expanded Glade Alternative*</th>
<th>Gravel Pits Alternative*</th>
<th>Agricultural Reservoirs Alternative*</th>
<th>No-Action Alternative*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Long-Term</td>
<td>Short-Term</td>
<td>Long-Term</td>
<td>Short-Term</td>
<td>Long-Term</td>
<td>Short-Term</td>
</tr>
<tr>
<td>Elk severe winter range</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Mule deer severe winter range</td>
<td>27.3</td>
<td>28.9</td>
<td>118.7</td>
<td>0.0</td>
<td>0.7</td>
<td>60.5</td>
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<tr>
<td>White-tailed deer concentration area</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>2.4</td>
<td>60.0</td>
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<tr>
<td>Pronghorn severe winter range</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>13.4</td>
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<td>Bighorn sheep severe winter range</td>
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<td>0.0</td>
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<td>Black bear fall concentration area</td>
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<td>NA</td>
<td>NA</td>
<td>0.2</td>
<td>0.8</td>
</tr>
</tbody>
</table>

*These effects would occur under all alternatives

### Table 4-64. Summary of effects determination for big game by alternative.

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Halligan Dam Rehabilitation*</th>
<th>Fort Collins’ Proposed Action*</th>
<th>Expanded Glade Alternative*</th>
<th>Gravel Pits Alternative*</th>
<th>Agricultural Reservoirs Alternative*</th>
<th>No-Action Alternative*</th>
</tr>
</thead>
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<tr>
<td>Elk</td>
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<td>White-tailed deer</td>
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<td>Negligible</td>
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</tr>
<tr>
<td>Pronghorn</td>
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<td>Negligible</td>
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<tr>
<td>Bighorn sheep</td>
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<td>No effect</td>
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<tr>
<td>Other mammals</td>
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<td>Negligible</td>
<td>Negligible</td>
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</tr>
<tr>
<td>Birds</td>
<td>Negligible to</td>
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### Habitat Type

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Halligan Dam Rehabilitation*</th>
<th>Fort Collins’ Proposed Action*</th>
<th>Expanded Glade Alternative*</th>
<th>Gravel Pits Alternative*</th>
<th>Agricultural Reservoirs Alternative*</th>
<th>No-Action Alternative*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amphibians and reptiles</td>
<td>minor</td>
<td>Negligible to minor</td>
<td>Negligible to minor</td>
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<td>Negligible</td>
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</table>

*These effects would occur under all alternatives.*
The Expanded Glade Alternative would have the greatest long-term effects to pronghorn severe winter range at approximately 5.0 acres of effect (Table 4-63). The remaining alternatives would not permanently affect pronghorn severe winter range. None of the alternatives would affect bighorn sheep severe winter range (Table 4-63).

The Expanded Glade Alternative would have the greatest long-term effect on black bear fall concentration areas at approximately 4.5 acres. The Gravel Pits Alternative would permanently affect approximately 3.0 acres of black bear fall concentration areas (Table 4-63). The Agricultural Reservoirs Alternative would permanently affect approximately 2.0 acres and Fort Collins’ Proposed Action and No-Action would not affect any black bear fall concentration areas.

A comparative summary of effects on mountain lions focuses on the effects of each proposed alternative on mountain lion prey, deer and elk. In general, none of the alternatives would likely have a measurable effect on deer or elk, therefore, no measurable effects on mountain lions are likely.

A comparative summary of range maps for four bird species of particular interest suggest that Fort Collins’ Proposed Action would affect Canada geese and great blue herons the least with possible temporary dispersal and avoidance of Halligan Reservoir during construction. However, Fort Collins’ Proposed Action also has the possibility to provide permanent new habitat in the form of additional surface water area. Osprey might be negatively affected by both Fort Collins’ Proposed Action and the Expanded Glade Alternative (Table 4-65). Again, these alternatives might cause osprey to temporarily avoid Halligan and the proposed Glade Reservoirs during construction, but both alternatives might provide new permanent habitat for osprey in the form of additional water surface area (Table 4-65). The Expanded Glade Alternative might provide new long-term habitat for American white pelicans in the form of additional water surface area (Table 4-65). The Gravel Pits Alternative and Agricultural Reservoirs Alternative both have the possibility of negatively affecting foraging opportunities, winter concentration areas, and production areas for Canada geese, great blue herons, osprey, and American white pelicans (Table 4-65). The Gravel Pits Alternative and Agricultural Reservoirs Alternative might also cause disturbance to nesting birds during construction activities (Table 4-65). Unlike the Agricultural Reservoirs Alternative, the Gravel Pits Alternative might provide additional permanent new habitat in the form of additional surface water area (Table 4-65).

Based on an effects analysis for 18 species of reptiles that Colorado Parks and Wildlife maintains range maps for and that are likely to be present in at least one of the proposed alternatives, all alternatives would likely have no measurable effect on reptiles (Table 4-66). All alternatives have the potential to disperse species and create a situation where individuals might avoid study areas during construction. Furthermore, all alternatives would affect, temporarily and permanently, habitat for some reptiles. However, due to its location, Fort Collins’ Proposed Action would likely affect fewer species, eight, than other alternatives (Table 4-66). The Expanded Glade Alternative would likely affect the second fewest species, 13, while the Gravel Pits Alternative and Agricultural Reservoirs Alternative would likely affect 16 and 18 species, respectively (Table 4-66).

Due to uncertainty regarding when the No-Action Alternative would be fully enacted, it is not possible to quantify effects to wildlife with any certainty. However, it is assumed effects from the No-Action Alternative would be similar in scale and intensity to some of the defined RFFAs; therefore, effects to
wildlife as a result of the No-Action Alternative would likely be negligible to minor across all species discussed herein.

4.12.9 Unavoidable Adverse Effects

All alternatives would result in unavoidable adverse loss of habitat for big game, migratory birds and raptors, reptiles, amphibians, and other wildlife species resulting from construction of various infrastructures. Under all alternatives, temporary displacement of wildlife during construction and temporary barriers to wildlife movement from construction activities would occur. Disturbed areas would not function as wildlife habitat until revegetated. All alternatives would unavoidably cause disturbance to existing vegetation in temporarily affected areas, but habitat value would be restored through successful revegetation.

4.12.10 Mitigation Measures

Fort Collins has proposed the following construction-related mitigation measures for all alternatives related to wildlife:

- **Big Game Interference Minimization**: Fort Collins would work with Colorado Parks and Wildlife to plan and manage construction staging to avoid work in big game congregation areas and sequence construction to avoid or minimize disruptive activities during fawning or calving periods. Construction activities with the potential to cause noise would be scheduled in consideration of big game activities.

- **Migrating Birds and Raptors Surveys**: To avoid potential adverse effects to new nesting or roosting sites, Fort Collins proposes to conduct nest surveys for all raptors and other migratory birds prior to construction. If eagle or other raptor nests are observed within a 0.5-mile buffer of construction activities, Colorado Parks and Wildlife would be consulted to determine measures to minimize the potential adverse effects of the construction activity.

- **If Fort Collins' Proposed Action is selected, as an added voluntary enhancement, Fort Collins would include placement of nesting/roosting platforms to encourage eagles and other raptors such as osprey to use the reservoir. The platforms would also minimize any temporary loss of perching locations from the inundation of shoreline trees while new shoreline habitat becomes established.**

Fort Collins would not be responsible for rehabilitating Halligan Dam under all alternatives to their Proposed Action so could not mitigate any effects on vegetation from rehabilitation of Halligan Dam.
Table 4-65. Summary of effects to four bird species by alternative.

<table>
<thead>
<tr>
<th>Species</th>
<th>Fort Collins’ Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
<th>No-Action Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada goose</td>
<td>Dispersal or avoidance during construction. New habitat might be provided in the form of additional water surface area.</td>
<td>Dispersal or avoidance during construction. Temporary loss of foraging opportunity. Temporary effects to winter concentration area. Temporary effects and permanent loss of winter range. New habitat might be provided in the form of additional water surface area.</td>
<td>Dispersal or avoidance during construction. Temporary loss of foraging opportunity. Temporary effects to winter concentration areas. Temporary effects to production areas might result in temporary reduction in recruitment. Temporary and permanent effects to winter range and winter concentration areas. New habitat might be provided in the form of additional water surface area.</td>
<td>Dispersal or avoidance during construction. Temporary loss of foraging opportunity. Temporary effects to winter concentration areas. Temporary effects to production areas might result in temporary reduction in recruitment. Temporary and permanent effects to winter range and winter concentration areas. New habitat might be provided in the form of additional water surface area.</td>
<td>Dispersal or avoidance during Halligan Dam rehabilitation</td>
</tr>
<tr>
<td>Great blue heron</td>
<td>Dispersal or avoidance during construction. New habitat might be provided in the form of additional water surface area.</td>
<td>Dispersal or avoidance during construction. Temporary loss of foraging opportunity. Possible nest disturbance during construction. New habitat might be provided in the form of additional water surface area.</td>
<td>Dispersal or avoidance during construction. Temporary loss of foraging opportunity.</td>
<td>Dispersal or avoidance during construction. Temporary loss of foraging opportunity. New habitat might be provided in the form of additional water surface area.</td>
<td>Dispersal or avoidance during Halligan Dam rehabilitation</td>
</tr>
<tr>
<td>Species</td>
<td>Fort Collins’ Proposed Action</td>
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<td>No-Action Alternative</td>
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</tr>
<tr>
<td>Osprey</td>
<td>Dispersal or avoidance during construction. New habitat might be provided in the form of additional water surface area.</td>
<td>Dispersal or avoidance during construction. New habitat might be provided in the form of additional water surface area.</td>
<td>Dispersal or avoidance during construction. Temporary loss of foraging opportunity. Possible nest disturbance during construction and operation. New habitat might be provided in the form of additional water surface area.</td>
<td>Dispersal or avoidance during construction. Temporary loss of foraging opportunity. Possible nest disturbance during construction and operation. New habitat might be provided in the form of additional water surface area.</td>
<td>Dispersal or avoidance during Halligan Dam rehabilitation</td>
</tr>
<tr>
<td>American white pelican</td>
<td>Dispersal or avoidance during construction. New habitat might be provided in the form of additional water surface area.</td>
<td>Dispersal or avoidance during Halligan Dam rehabilitation. New effects to white pelican range. New habitat might be provided in the form of additional water surface area.</td>
<td>Dispersal or avoidance during construction. Temporary loss of foraging opportunity. New habitat might be provided in the form of additional water surface area.</td>
<td>Dispersal or avoidance during construction. Temporary loss of foraging opportunity. New habitat might be provided in the form of additional water surface area.</td>
<td>Dispersal or avoidance during Halligan Dam rehabilitation</td>
</tr>
<tr>
<td>Species</td>
<td>Fort Collins’ Proposed Action</td>
<td>Expanded Glade Alternative</td>
<td>Gravel Pits Alternative</td>
<td>Agricultural Reservoirs Alternative</td>
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<td>---------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Bullsnake</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td></td>
</tr>
<tr>
<td>Common garter snake</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td></td>
</tr>
<tr>
<td>Common lesser earless lizard</td>
<td>Not applicable</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td></td>
</tr>
<tr>
<td>Hernandez’s short-horned lizard</td>
<td>Not applicable</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td></td>
</tr>
<tr>
<td>Many-lined skink</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td></td>
</tr>
<tr>
<td>Milk snake</td>
<td>Not applicable</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td></td>
</tr>
<tr>
<td>Species</td>
<td>Fort Collins’ Proposed Action</td>
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<td></td>
</tr>
<tr>
<td>North American racer</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td></td>
</tr>
<tr>
<td>Northern water snake</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td></td>
</tr>
<tr>
<td>Ornate box turtle</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td></td>
</tr>
<tr>
<td>Painted turtle</td>
<td>Not applicable</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td></td>
</tr>
<tr>
<td>Plains garter snake</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td></td>
</tr>
<tr>
<td>Plains hog-nosed snake</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td></td>
</tr>
</tbody>
</table>
## Species Effects

<table>
<thead>
<tr>
<th>Species</th>
<th>Fort Collins’ Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plateau fence lizard</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
</tr>
<tr>
<td>Prairie lizard</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
</tr>
<tr>
<td>Six-lined racerunner</td>
<td>Not applicable</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
</tr>
<tr>
<td>Snapping turtle</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
</tr>
<tr>
<td>Terrestrial garter snake</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
</tr>
<tr>
<td>Western rattlesnake</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
<td>Dispersal or avoidance during construction. Might lose suitable habitat due to inundation and new infrastructure.</td>
</tr>
</tbody>
</table>
4.13 SPECIES OF CONCERN

Long-term effects on species of concern would occur in areas of new inundation or construction of infrastructure including but not limited to dam footprints, permanent roads, and pumping stations (Figure 1-1 through Figure 1-4). Temporary removal of vegetation associated with construction of pipelines, staging areas and access roads was considered to have potential short-term effects on species of concern until these areas were revegetated. Potential effects evaluated included habitat loss or disturbance and effects on foraging, reproduction, and distribution where sufficient information was available.

Indirect effects on species of concern were based on effects to wetlands, riparian vegetation communities, and other vegetation resources along the North Fork and Main Stem resulting from changes to the water regime as described in the Altered Flows Technical Report (WEST 2018) and Vegetation Technical Report (WEST 2017a). Short-term indirect effects resulting from construction activities (i.e., increased noise levels and human activity) associated with an action alternative were inferred based on details provided in Fort Collins’ Halligan−Seaman Water Management Project EIS Fort Collins Alternative Descriptions Action Alternatives Report (Alternative Descriptions Report; MWH Global 2015c).

4.13.1 Methods

Fort Collins provided maps and supporting shapefiles depicting the conceptual layout of infrastructure and construction areas associated with each action alternative. Fort Collins did not provide specific alignments for access roads and pipelines, but instead identified a corridor within which the road or pipeline alignment would be constructed. This approach allows Fort Collins flexibility in final project planning while providing areas to analyze for potential effects. In these cases, a buffer was applied to the centerline of such features to identify the study area for effects analysis, including a 12.5-foot buffer for long-term effects from access roads, a 30-foot buffer for short-term effects from access roads, and a 75-foot buffer for pipeline corridors. Other features, such as the potential construction disturbance area at Halligan Reservoir for dam rehabilitation, were presented as a large polygon encompassing smaller potential staging areas and borrow areas. In this case, construction activities would not occur throughout the entire construction disturbance area but would be limited to the staging, borrow areas, and access roads. Fort Collins indicated they are willing to move locations of these areas within the larger polygon to avoid critical resources if necessary. For the purposes of this analysis, it was assumed Fort Collins would use the locations depicted on Figures 1-1 through 1-4; Fort Collins would use staging areas to set up construction site trailers, stockpile materials, and park vehicles and equipment and borrow areas would be used for on-site construction material resources such as fill soils, aggregate, and sand.

An approach to effects analysis and descriptions of effect intensity were developed based on concepts in previous similar EISs and conditions present in the study areas of Fort Collins’ Proposed Action and the action alternatives. The following thresholds were used to determine the intensity of effects:

- **No effect**: The action would not affect a listed species or designated critical habitat.
- **Minor**: All effects of the action on a listed species are expected to be discountable, insignificant, or completely beneficial.
• **Major**: One or more individuals of a listed species or one or more essential features of critical habitats are likely to be affected by the action and are likely to result in a direct adverse effect.

4.13.1.1 *Data Adequacy*

Section 3.13.3 describes the best available data for special status species in the study areas. The Corps determined the data available and methods used were adequate to evaluate and describe reasonably foreseeable significant adverse effects on special status species in the study areas and to enable the decision maker to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable special status species information. The effects of the alternatives on special status species are described below.

4.13.2 **Halligan Dam Rehabilitation**

Due to the age and condition of the existing Halligan Dam, it would be rehabilitated under all Project Alternatives, regardless of which one is chosen. Therefore, the following effects are common to all alternatives. As described in Section 3.13.4, suitable habitat for 11 species of concern is present in the areas affected by Halligan Dam rehabilitation and these species have either been documented in or have ranges that overlap the study area. No suitable habitat is present for black-tailed prairie dog or burrowing owl; therefore, these species are not evaluated.

4.13.2.1 *Preble’s Meadow Jumping Mouse*

Colorado Parks and Wildlife data indicate Preble’s meadow jumping mouse range includes Halligan Dam, and their occurrence was documented around Halligan Reservoir in 2003 (Section 3.13.5.1). Designated critical habitat occurs along the North Fork from Halligan Dam downstream to Seaman Reservoir. Halligan Dam rehabilitation would affect approximately 0.09 acre of riparian shrubland (i.e., habitat for Preble’s meadow jumping mouse) due to construction of access roads. Dam foundation work would require rock excavation along the abutments and valley bottom outside the existing footprint by approximately eight to 12 feet; this work would partially occur in designated critical habitat. The Fish and Wildlife Service considers Preble’s meadow jumping mouse habitat to extend 300 feet from the 100-year floodplain because the species has been documented using these areas for foraging, day nesting, and other activities. The dam foundation work would occur in a relatively steep-walled canyon approximately 60 feet high and 150 feet wide. Due to the height and steepness of the canyon walls, it was assumed habitat effects would only occur in the 150-foot wide floodplain located in the canyon bottom and would not extend 300 feet to either side of the floodplain.

Dam construction would take place away from areas where Preble’s meadow jumping mice were detected (Pioneer Environmental Services [Pioneer] 2003), potentially reducing the direct effect from construction activities. Because of the small effect (0.09 acre) to suitable Preble’s meadow jumping mouse habitat from construction of access roads and because dam work would occur within the northernmost end of critical habitat along the North Fork, Halligan Dam enlargement would have a minor effect on the species and on designated critical habitat. However, all construction and staging areas with suitable habitat would be surveyed prior to construction to ensure Preble’s meadow jumping mice have not occupied the site and
to minimize effects associated with construction activities. The Corps would consult with the Fish and Wildlife Service under Section 7 of the Endangered Species Act regarding effects to Preble’s meadow jumping mouse or designated critical habitat resulting from dam rehabilitation.

### 4.13.2.2 Colorado Butterfly Plant

While some suitable habitat would be lost to construction of new dam facilities, it is not designated as critical habitat. Halligan Dam is at the upper known elevational limits for the Colorado butterfly plant, and none were recorded during three consecutive years (2006 to 2008) of surveys conducted within the Halligan Dam rehabilitation disturbance area. Based on the apparent absence of this species in suitable habitat based on three years of surveys, and because Halligan Reservoir is at the upper elevational limit for this species, Halligan Dam rehabilitation would have no effect on the Colorado butterfly plant. Suitable habitat would be surveyed prior to construction to confirm absence of this species; if found, avoidance and minimization measures would be taken to reduce potential effects.

### 4.13.2.3 Ute Ladies’-Tresses

Some suitable habitat would be lost due to dam rehabilitation; however, no Ute ladies’-tresses were recorded during three consecutive years (2006 to 2008) of surveys conducted within the Halligan Dam rehabilitation disturbance area. Furthermore, there has been no documented occurrence of Ute ladies’-tress within the study area (Colorado Natural Heritage Program 2015), and the study area is at the upper elevation limit for this species. Due to the apparent absence of this species in suitable habitat based on three years of surveys and because Halligan Reservoir is at the upper elevation limit of this species, rehabilitation of Halligan Dam would have no effect on the Ute ladies’-tresses. Suitable habitat would be surveyed again prior to construction to confirm absence of this species; if found, avoidance and minimization measures would be taken to reduce potential effects.

### 4.13.2.4 Rocky Mountain Bighorn Sheep

Effects of rehabilitation of Halligan Dam on Rocky Mountain bighorn sheep are evaluated in the big game portion of Wildlife Section 4.12.2.1.2. As described in that section, severe winter range is a limiting range type for bighorn sheep; however, there is no bighorn sheep severe winter range in the area affected by Halligan Dam rehabilitation. Because there is no loss of bighorn sheep severe winter range, effects of Halligan Dam rehabilitation would be negligible with no measurable or perceptible consequences to the 225 sheep in the Poudre/Rawah/Lone Pine bighorn sheep herd. However, construction activities could lead to indirect effects by causing stress to bighorn sheep, potentially making them more susceptible to disease as described in Section 4.12.2.2.

### 4.13.2.5 Northern Pocket Gopher

Halligan Dam is within the distributional range of the northern pocket gopher and some suitable habitat would be affected by rehabilitation of the dam. Northern pocket gophers have not been documented within the study area, but because some suitable habitat would be affected, Halligan Dam rehabilitation might have a minor effect on northern pocket gopher. Effects would be discountable and insignificant.
because they would not have a noticeable effect on populations within the surrounding area, and other suitable habitat is available.

### 4.13.2.6 River Otter

According to Colorado Parks and Wildlife data, the range of the river otter includes the Poudre River and a small section of the North Fork from the confluence of these rivers to approximately one mile upstream of Seaman Reservoir (Colorado Parks and Wildlife 2016b). Because the known range of the river otter does not extend to Halligan Reservoir, rehabilitation of Halligan Dam would have no effect on the river otter.

### 4.13.2.7 Townsend’s Big-Eared Bat

Rocky outcrops, ridges, and hogbacks are preferred roosting habitat for the Townsend’s big-eared bat, and these habitats exist near, but not at, Halligan Dam. Rocky outcrops and canyons downstream of the dam along the North Fork may provide roost habitat. This roost habitat would not be directly affected by rehabilitation of Halligan Dam, but construction noise may temporarily affect Townsend’s big-eared bats using the nearby roost habitat. Because of the potential for short-term, indirect effects, Halligan Dam rehabilitation would have a minor effect on Townsend’s big-eared bat. Effects would be discountable and insignificant because they would not have a noticeable effect on populations within the surrounding area.

### 4.13.2.8 Bald Eagle

Bald eagles rely on fish as their principal source of food, and typically nest and forage along rivers and lakes. Bald eagles have been observed at Halligan Reservoir; however, Colorado Parks and Wildlife did not identify important winter use areas or nest sites in the area and there would likely be no long-term direct effects on bald eagles as a result of Halligan Dam rehabilitation. Construction activities may temporarily disturb and affect individual eagles passing through or foraging in the area; therefore, dam rehabilitation could have a minor effect on bald eagles. Effects would be discountable and insignificant because they would not have a noticeable effect on populations within the surrounding area.

### 4.13.2.9 Golden Eagle

Golden eagles were observed during field surveys of the Halligan Reservoir and North Fork areas (WEST 2017). They primarily subsist on small mammals such as rabbits, hares, ground squirrels, and prairie dogs, and could use the area for hunting year-round. Construction activities associated with Halligan Dam rehabilitation may temporarily disturb and affect individual eagles passing through or foraging in the area; therefore, dam rehabilitation could have a minor effect on golden eagles. Effects would be discountable and insignificant because they would not have a noticeable effect on populations within the surrounding area. Long-term direct effects to golden eagles are not anticipated; once dam rehabilitation is complete, golden eagle use of the area is expected to return to pre-construction levels.
4.13.2.10 American White Pelican

American white pelicans were observed on Halligan Reservoir, so the reservoir is considered potential loafing and/or foraging habitat for the American white pelican. According to Colorado Parks and Wildlife, Halligan Reservoir is not within mapped American white pelican nesting areas. Halligan Dam rehabilitation would not affect American white pelicans because they are likely to avoid construction disturbance and, if present during construction, would use another area of the reservoir.

4.13.2.11 Northern Leopard Frog

Halligan Dam is located within the range of northern leopard frog and some suitable habitat would be affected. Rehabilitation of the dam would result in long-term loss of approximately 0.12 acre of open water on the downstream side of the existing dam; however, the remaining downstream portion of the North Fork would remain relatively unaffected and would continue to provide habitat for northern leopard frogs. Because of this minor loss of northern leopard frog habitat, Halligan Dam rehabilitation would have a minor effect on the northern leopard frog.

4.13.2.12 Common Garter Snake

Although Colorado Parks and Wildlife includes Larimer County within the range of common garter snake, they generally occur below 6,000 feet and Halligan Reservoir is at approximately 6,300 feet. If present, it is a mobile species and is likely to move away from the construction area. Because Halligan Reservoir is outside their elevation range and they are unlikely to be present in the construction area, Halligan Dam rehabilitation would have no effect on common garter snake.

4.13.2.13 Indirect Effects

As described in Section 4.7.2.2.1.1 of this Draft EIS, the Corps determined through spells analysis that wetlands and riparian habitats on the North Fork would not be significantly affected by the change in flow resulting from Fort Collins’ Proposed Action or action alternatives. The percent flow reduction during the growing season on the Main Stem was even less than the percent flow reduction on the North Fork; thus, the Corps concluded that wetlands and riparian vegetation on the Main Stem would not be affected by the change in flow under Fort Collins’ Proposed Action or any of the alternatives. Therefore, the Corps expects there will be no adverse effect to species of concern along the Main Stem as a result of any of the alternatives, including the No-Action Alternative.

The introduction or possible establishment of noxious weeds, soil erosion, and soil compaction are additional indirect effects that could result from Halligan Dam rehabilitation. Noxious weed establishment and soil erosion could potentially affect native vegetation communities. Changes in vegetation due to establishment of weeds, changes in water infiltration, and erosion may result in a lower carrying capacity for wildlife species, and weeds can out-compete and displace sensitive plant species. Erosion also may affect vegetation communities and individual plants by reducing germination or rooting success of plants. Soil compaction from construction activities and vehicle traffic may create a situation where some sensitive plant species may be unable to establish sufficient contact with soils to initiate germination or properly root. Furthermore, compacted soils can stress plants as additional energy would
be necessary to grow roots, weakening plants or even preventing establishment of some individuals of a species. Revegetation plans would identify best management practices to address the potential for compacted soils and invasive weeds post construction. Because best management practices would reduce the potential for introduction of noxious weeds, soil erosion, and soil compaction, these indirect effects would likely be negligible to minor on species of concern that use the Halligan Dam area or areas affected by the action alternatives.

### 4.13.3 Fort Collins’ Proposed Action

As described in Section 3.13.5, Fort Collins’ Proposed Action study area contains suitable habitat for 11 species of concern that have either been documented in or have ranges that overlap the study area. No suitable habitat is present for black-tailed prairie dog or burrowing owl; therefore, these species are not evaluated.

#### 4.13.3.1 Preble’s Meadow Jumping Mouse

Colorado Parks and Wildlife data indicate Fort Collins’ Proposed Action study area is within the range of Preble’s meadow jumping mouse, and their occurrence was documented there in 2003 (Section 3.13.5.1). Fort Collins’ Proposed Action would inundate approximately 11 acres of Preble’s meadow jumping mouse habitat, including approximately 2.6 acres of riparian woodlands and 8.5 acres of riparian shrublands. Additionally, approximately 87 acres of non-riparian habitat located within 330 feet of the 100-year floodplain, which may be used by the Preble’s meadow jumping mouse, occur within the inundation footprint (Figure 4-69). None of the affected habitat is designated as critical habitat. Once dam construction is completed, water levels would rise slowly enough that any Preble’s meadow jumping mice in the inundation area would be able to escape the rising water, but the rising water would eventually inundate existing Preble’s meadow jumping mouse nests in the area. In addition to inundating Preble's meadow jumping mouse nests and potentially drowning young during their active or nesting period (approximately May 1 through October 31), rising water levels would also inundate and drown individual mice hibernating during their inactive period, approximately November 1 to May 1.

Fort Collins’ Proposed Action would have a major effect on individual Preble’s meadow jumping mice through habitat loss from inundation and potential drowning. All suitable habitat would be surveyed prior to construction to determine if Preble’s meadow jumping mice are present; if so, effects associated with construction activities would be avoided or minimized.
Figure 4-69. Preble’s Meadow Jumping Mouse habitat buffer under Fort Collins’ Proposed Action.
4.13.3.2 Colorado Butterfly Plant

While some suitable habitat would be lost to inundation, none of the study area is designated as critical habitat for the Colorado butterfly plant. Fort Collins’ Proposed Action is at the upper known elevation limits for the plant, no Colorado butterfly plants were recorded during three consecutive years (2006 to 2008) of surveys conducted within the study area of Fort Collins’ Proposed Action, and the Colorado Natural Heritage Program (2015) has no records of this species in the study area. Due to their apparent absence based on three years of surveys and because Halligan Reservoir is at the upper elevation limit for this species, Fort Collins’ Proposed Action would have no effect on the Colorado butterfly plant. Suitable habitat would be surveyed prior to construction to confirm absence of this species; if found, avoidance and minimization measures would be taken to reduce potential effects.

4.13.3.3 Ute Ladies’-Tresses

Some suitable habitat would be lost due to inundation; however, no Ute ladies’-tresses were found during three consecutive years (2006 to 2008) of surveys conducted within the study area of Fort Collins’ Proposed Action. Fort Collins’ Proposed Action is at the upper known elevation limits for Ute ladies’-tresses, making their occurrence unlikely, and the Colorado Natural Heritage Program (2015) has no records of this species in the study area. Due to their apparent absence at Fort Collins’ Proposed Action study area based on three years of surveys and because Halligan Reservoir is at the upper elevation limit of this species, this alternative would have no effect on Ute ladies’-tresses. Suitable habitat would be surveyed again prior to construction to confirm absence of this species; if found, avoidance and minimization measures would be taken to reduce potential effects.

4.13.3.4 Rocky Mountain Bighorn Sheep

Effects of Fort Collins’ Proposed Action on Rocky Mountain bighorn sheep are evaluated in the big game portions of Wildlife Section 4.12.3.1.4. As described in that section, severe winter range is a limiting range type for bighorn sheep; however, there is no bighorn sheep severe winter range in the area affected by Fort Collin’s Proposed Action. Because there is no loss of bighorn sheep severe winter range, effects of Fort Collin’s Proposed Action would be negligible with no measurable or perceptible consequences to the Poudre/Rawah/Lone Pine bighorn sheep herd.

4.13.3.5 Northern Pocket Gopher

Fort Collins’ Proposed Action is within the distributional range of northern pocket gopher and some suitable habitat would be affected where approximately 26.0 acres of foothill shrublands would be inundated. Northern pocket gophers have not been documented within the study area, but because some suitable habitat would be affected, Fort Collins’ Proposed Action would have a minor effect on northern pocket gopher. These effects would be discountable and insignificant because they would not have a noticeable effect on populations within the surrounding area as other suitable habitat is available.
4.13.3.6 River Otter

According to Colorado Parks and Wildlife data, the overall range of the river otter includes the Poudre River and a small section of the North Fork from the confluence of these rivers to approximately one mile upstream of Seaman Reservoir (Colorado Parks and Wildlife 2016b). Because the known range of the river otter does not extend to Halligan Reservoir, expanding the reservoir would not adversely affect the river otter. However, the Winter Release Plan and the Summer Plan would provide for increased stream flows to the North Fork, which could provide a minor benefit to river otters. For example, elimination of the dry-ups and restored stream connectivity would improve the fishery health, which in turn would provide a larger, more stable food source for river otters.

4.13.3.7 Townsend's Big-Eared Bat

Rocky outcrops, ridges, and hogbacks are preferred roosting habitat for the Townsend's big-eared bat, and these habitats exist near, but not in, the study area of Fort Collins' Proposed Action. Rocky outcrops and canyons downstream of Halligan Dam along the North Fork may provide roost habitat. That roost habitat would not be directly affected by this alternative. The open water of Halligan Reservoir, vegetation communities containing fringed sagebrush, and wetlands may provide foraging habitat as Townsend’s big-eared bats usually forage over water, at the edge of different vegetation communities, and over sagebrush (Armstrong et al. 2011). Under Fort Collins’ Proposed Action, the area of open water habitat would expand, but some sagebrush and wetland communities would be inundated; with these offsets, overall effects to foraging habitat would be discountable and insignificant, and Fort Collins’ Proposed Action would have a minor effect on Townsend’s big-eared bat.

4.13.3.8 Bald Eagle

Bald eagles rely on fish as their principal source of food and typically nest and forage along rivers and lakes. Bald eagles have been observed at Halligan Reservoir; however, Colorado Parks and Wildlife did not identify important winter use areas or nest sites in the area and there would likely be no permanent direct effects on bald eagles. Some foraging sites around Halligan Reservoir may be altered due to inundation, but the water level change likely would create new foraging areas for bald eagles. Therefore, Fort Collins’ Proposed Action would have a minor beneficial effect on bald eagles.

4.13.3.9 Golden Eagle

Golden eagles were observed during field surveys of the Halligan Reservoir and North Fork areas (WEST 2017). They primarily subsist on small mammals such as rabbits, hares, ground squirrels, and prairie dogs, therefore, expansion of the reservoir would reduce habitat for their prey base. However, this is unlikely to affect golden eagles because they are wide-ranging and vast areas of open foothills shrubland and grassland would remain after reservoir expansion for foraging golden eagles. Effects would be discountable and insignificant because they would not have a noticeable effect on populations within the surrounding area. Long-term direct effects to golden eagles would be minor; once dam enlargement is complete, golden eagle use of the area is expected to return to pre-construction levels.
4.13.3.10 American White Pelican

American white pelicans were observed on Halligan Reservoir, so the reservoir is considered potential loafing or foraging habitat for the American white pelican. According to Colorado Parks and Wildlife, Halligan Reservoir is not within mapped American white pelican nesting areas. Because loafing or foraging habitat would be expanded, Fort Collins’ Proposed Action would result in a minor benefit for the American white pelican.

4.13.3.11 Northern Leopard Frog

Fort Collins’ Proposed Action is located within the range of northern leopard frog and some suitable habitat would be affected, as approximately 16.74 acres of wetlands would be inundated. This effect would be offset because new habitat would likely be created at the new water line after soils and vegetation acclimated to the new hydrology. In addition, the Winter Release Plan and the Summer Plan would result in increased stream flow to the North Fork, resulting in an expected net gain in habitat for northern leopard frog (Fort Collins 2017). Fort Collins’ Proposed Action would have a minor beneficial effect on northern leopard frog.

4.13.3.12 Common Garter Snake

Although Colorado Parks and Wildlife includes Larimer County within the range of the common garter snake, they generally occur below 6,000 feet and Halligan Reservoir is at approximately 6,300 feet. Because Halligan Reservoir is outside their elevation range, Fort Collins’ Proposed Action would likely have no effect on common garter snake.

4.13.3.13 Indirect Effects

Fort Collins’ Proposed Action includes the Summer Plan and Peak Bypass Plan that would maintain a flow of at least five cubic feet per second in the North Fork during the growing season and not divert some projected peak flows. The indirect potential effects of altered flows on wetland and riparian resources, including plant communities and wildlife, along the North Fork are discussed in Section 4.7.2.2.1.1. In summary, it was determined that change in flow on the North Fork as a result of Fort Collins’ Proposed Action would not affect existing wetlands and riparian habitats. The Summer Plan and the Peak Bypass Program would benefit to some degree the wetland and riparian habitats; however, the magnitude of that benefit to plant communities is undetermined. The additional flow would result in a more robust plant community, which would be a benefit to special-status species that use wetland and riparian habitats. Elimination of dry-ups and restored stream connectivity that would occur with the Summer Plan would improve the fishery health of the North Fork (Pioneer 2017), which in turn would provide a larger, more stable food source for the river otter as noted in Section 4.13.3.6. Improvement to fisheries in the 22-mile reach of the North Fork would potentially improve habitat for river otters. Additionally, the maintained flow in the North Fork from the Summer Plan would likely be beneficial for northern leopard frogs as noted in Section 4.13.2.11.
4.13.4 Expanded Glade Alternative

As described in Section 3.13.6, the Expanded Glade Alternative study area contains suitable habitat for nine species of concern that have either been documented in or have ranges that overlap the study area. No suitable habitat is present, or the Expanded Glade Alternative is outside the distributional range for Rocky Mountain bighorn sheep, river otters, northern pocket gophers, and American white pelicans.

4.13.4.1 Preble’s Meadow Jumping Mouse

Colorado Parks and Wildlife data indicate the Expanded Glade Alternative study area is within the range of Preble’s meadow jumping mouse, and their occurrence was documented there in 2004 (Section 3.13.6.1). Preble’s meadow jumping mice also are known to occur along portions of the Poudre River approximately three miles south of the proposed Glade Reservoir site (ERO 2008).

The Expanded Glade Alternative would inundate suitable habitat, including approximately 0.01 acre of riparian woodlands, and temporarily affect approximately 2.5 acres of riparian woodlands due to pipeline construction along the Poudre River. The Expanded Glade Alternative also would permanently affect about 0.07 acre and temporarily affect approximately 7.6 acres of developed lands, foothills grasslands, foothills shrublands, non-native grasslands, and agricultural lands within 330 feet of the 100-year floodplain, which may be used by the Preble’s meadow jumping mouse. None of the affected area is designated as critical habitat. Other possible effects include harm or death to individuals due to construction activity or inundation. However, because they are mobile, any Preble’s meadow jumping mice that might be present could likely avoid construction equipment or rising water levels.

The Expanded Glade Alternative would have a major effect on Preble’s meadow jumping mice because one or more individuals could be adversely affected and habitat loss would occur as a result of inundation, new access roads, and short-term disturbances associated with access road construction and pipeline installation in riparian vegetation communities. All suitable habitat would be surveyed prior to construction to determine if Preble’s meadow jumping mice are present; if so, effects associated with construction activities would be avoided or minimized.

4.13.4.2 Colorado Butterfly Plant

The Expanded Glade Alternative would not permanently affect any suitable habitat for Colorado butterfly plant. Approximately 2.5 acres of riparian woodlands that are potential habitat would be temporarily disturbed during pipeline construction near the Poudre River. No Colorado butterfly plants were detected during plant surveys conducted within the study area of the Expanded Glade Alternative in 2004 (ERO 2008) and again in 2008 (WEST 2008). Due to their apparent absence in suitable habitat in the Expanded Glade Alternative study area based on two years of surveys and because only temporary disturbance would occur to suitable habitat, this alternative would have no effect on the Colorado butterfly plant. Suitable habitat would be surveyed prior to construction to confirm absence of this species; if found, avoidance and minimization measures would be taken to reduce potential effects.
4.13.4.3 Ute Ladies’-Tresses
The Expanded Glade Alternative would not permanently affect any suitable habitat for Ute ladies’-tresses. Approximately 2.5 acres of suitable riparian habitat would be temporarily disturbed during pipeline construction near the Poudre River. No Ute ladies’-tresses were detected during plant surveys conducted within the study area of the Expanded Glade Alternative in 2004 (ERO 2008) and again in 2008 (WEST 2008). Due to their apparent absence in suitable habitat in the Expanded Glade Alternative study area based on two years of surveys, this alternative would have no effect on Ute ladies’-tresses. Suitable habitat would be surveyed again prior to construction to confirm absence of this species; if found, avoidance and minimization measures would be taken to reduce potential effects.

4.13.4.4 Black-Tailed Prairie Dog
The Expanded Glade Alternative is within the known range of black-tailed prairie dogs. There is one known black-tailed prairie dog colony within the inundation footprint of the proposed Glade Reservoir (ERO 2008), and black-tailed prairie dogs were observed approximately two miles north of the Expanded Glade Alternative (WEST 2008). Additionally, the Expanded Glade Alternative is located on the far western edge of a large tract (over 350,000 acres) of known black-tailed prairie dog habitat in Larimer County (Colorado Parks and Wildlife 2015). None of these locations would be affected by the Expanded Glade Alternative, although the colony within the proposed Glade Reservoir footprint would be inundated due to construction of the proposed Glade Reservoir.

This alternative would inundate approximately 41.6 acres of foothill grasslands, and the access roads, valve house, and river turnout would permanently affect an additional 0.02 acre of foothills grasslands, all suitable black-tailed prairie dog habitat. Access road buffers, pipeline buffers, and staging areas would temporarily disturb an additional 61.8 acres of grassland habitat and agricultural lands that are also suitable for black-tailed prairie dog colonies. Because of these long- and short-term effects to suitable black-tailed prairie dog habitat, the Expanded Glade Alternative would have a minor effect on black-tailed prairie dogs. These effects would be discountable and insignificant because they would not have a noticeable effect on populations within the surrounding area.

4.13.4.5 Townsend’s Big-Eared Bat
The Expanded Glade Alternative is within the range of Townsend’s big-eared bat and suitable roosting habitat including rocky outcrops, ridges, and hogbacks occurs nearby, as do caves and old buildings or dwellings. These potential roosting habitats would not be directly affected by this alternative; however, construction noise may temporarily affect Townsend’s big-eared bats using these structures nearby. Because of these potential temporary construction effects, the Expanded Glade Alternative would have a minor effect on Townsend’s big-eared bat. These effects would be discountable and insignificant because they would be temporary and not have a noticeable effect on populations within the surrounding area.

4.13.4.6 Bald Eagle
The Expanded Glade Alternative study area intersects bald eagle winter range, and large cottonwood trees associated with riparian woodlands near the Poudre River provide suitable foraging and nesting areas for
bald eagles. A bald eagle nest was documented within 0.5 mile of the Expanded Glade Alternative study area (Colorado Parks and Wildlife 2016a). Breeding bald eagles using this nest site could be disturbed by any construction activities that would take place within 0.5 mile. Construction activities could also temporarily disturb foraging or roosting bald eagles in the area. Colorado Parks and Wildlife recommends no human encroachment within 0.5 mile of active eagle nests from October 15 to July 31 and no human encroachment within 0.25 to 0.5 mile of any active winter roost sites from November 15 to March 15. These restrictions would be observed for all construction activities to minimize effects on bald eagles.

Due to the presence of bald eagle winter habitat, suitable nesting habitat, and a documented nest within 0.5 mile of the Expanded Glade Alternative study area, the Expanded Glade Alternative would have a minor effect to bald eagles. This effect is discountable and insignificant because Fort Collins would observe Colorado Parks and Wildlife restrictions.

### 4.13.4.7 Golden Eagle

Because golden eagles are wide-ranging and use a variety of habitats, they could occur at the Expanded Glade Alternative site. However, expansion of the proposed Glade Reservoir is unlikely to affect golden eagles because suitable habitat would remain in the area surrounding the expanded reservoir for foraging golden eagles. During construction, golden eagles might avoid the area due to construction noise and activity; however, avoidance is likely short-term, lasting only for the duration of construction. Any effects, long- or short-term, would be discountable and insignificant because they would not have a noticeable effect on populations within the surrounding area.

### 4.13.4.8 Burrowing Owl

Burrowing owls in Colorado generally inhabit prairie grassland ecosystems and are often closely associated with prairie dog colonies. As described in Section 4.13.4.4, this alternative would not directly affect known prairie dog colonies. It would, however, inundate approximately 41.1 acres of foothill grasslands, and the access roads, valve house, and river turnout would permanently affect an additional 0.02 acre of foothills grasslands, all suitable for prairie dogs and therefore burrowing owls. Access road buffers, pipeline buffers, and staging areas would temporarily disturb an additional 61.8 acres of foothill grasslands and agricultural lands that are potential prairie dog and burrowing owl habitat. Although no prairie dog towns would be directly affected by the Expanded Glade Alternative and burrowing owls have not been documented in the area, the Expanded Glade Alternative would have a minor effect on burrowing owls due to long-term effects to suitable habitat. This effect is discountable and insignificant because burrowing owls are not likely to be present given that prairie dog colonies are absent.

### 4.13.4.9 Northern Leopard Frog

The Expanded Glade Alternative is located within the range of northern leopard frog and some suitable habitat would be affected. Approximately 0.7 acre of wetlands and other waters would be permanently affected and 3.32 acres of wetlands and other waters would be temporarily disturbed due to access road and pipeline construction. However, the Expanded Glade Alternative would inundate approximately 63 acres of uplands, which could become new wetland or open water foraging habitat suitable for the
northern leopard frog. Overall, the Expanded Glade Alternative would have a minor beneficial effect on northern leopard frogs by creating suitable habitat.

### 4.13.4.10 Common Garter Snake

The Expanded Glade Alternative is within the range of common garter snake and preferred habitat in the form of wetlands and riparian areas are present. The Expanded Glade Alternative would permanently affect approximately 0.1 acre of wetlands and temporarily disturb approximately 3.62 acres of riparian habitat and wetlands. However, an equal or greater amount of riparian habitat and wetlands would likely develop along the new shoreline of the expanded reservoir. The common garter snake is a highly mobile species and would likely be able to avoid construction areas, so direct effects to individuals are unlikely. Because habitat effects would be offset by the creation of additional suitable habitat Fort Collins’ Proposed Action would have a minor beneficial effect on common garter snake.

### 4.13.5 Gravel Pits Alternative

As described in Section 3.13.7, the Expanded Glade Alternative study area contains suitable habitat for 11 species of concern that have either been documented in or have ranges that overlap the study area. No suitable habitat is present for, or the Gravel Pits Alternative is outside the distributional range of, Rocky Mountain bighorn sheep and northern pocket gophers.

#### 4.13.5.1 Preble’s Meadow Jumping Mouse

The Gravel Pits Alternative is located within the known range of the Preble’s meadow jumping mouse (Colorado Parks and Wildlife 2015), but surveys were not conducted due to lack of access and it is not known if they occur in the Gravel Pits Alternative study area. Some suitable riparian habitat would be affected by implementation of this alternative, including no long-term effects to riparian vegetation, 1.28 acres of non-native grasslands, 3.43 acres of disturbed lands, and 0.19 acre of developed lands within 330 feet of the 100-year floodplain. The Gravel Pits Alternative would also temporarily disturb 2.13 acres of riparian vegetation, 0.28 acre of wetlands, 14.4 acres of developed lands, 17.2 acres of disturbed lands, and 43.6 acres of non-native grasslands that may be suitable for the Preble’s meadow jumping mouse. None of the disturbed area is designated as critical habitat.

Although the mouse is not known to be present, the Gravel Pits Alternative could affect the Preble’s meadow jumping mouse due to effects to suitable habitat. Prior to construction, a survey would be conducted to determine if the suitable habitat is occupied. If so, effects associated with construction activities would be avoided or minimized.

#### 4.13.5.2 Colorado Butterfly Plant

Surveys were not conducted for Colorado butterfly plants at the Gravel Pits Alternative study area due to lack of access and it is not known if they occur there. Some suitable riparian habitat is present and would be affected during construction activities. No long-term loss of riparian habitat would occur but 2.13 acres of riparian habitat would be temporarily disturbed. Because suitable habitat would be temporarily affected and it is unknown whether Colorado butterfly plants occur in these habitats, the Gravel Pits Alternative
could have a minor effect on the Colorado butterfly plant. Suitable habitat would be surveyed prior to construction to confirm absence of this species; if found, measures would be taken to avoid or minimize effects such as minor adjustments to the pipeline corridor.

### 4.13.5.3 Ute Ladies'-Tresses

Surveys were not conducted for Ute ladies’-tresses at the Gravel Pits Alternative study area due to lack of access and it is not known if they occur there. However, the Colorado Natural Heritage Program reported an occurrence of Ute ladies’-tresses in a drainage located 1,950 feet from the pipeline corridor for the Gravel Pits Alternative. No long-term loss of riparian habitat would occur, but 1.1 acres of littoral emergent wetland and 2.13 acres of riparian vegetation would be temporarily disturbed; these areas could provide suitable habitat for Ute ladies’-tresses. Because potentially suitable habitat would be affected, a known population is within 1,950 feet of the pipeline corridor, and it is unknown whether Ute ladies’-tresses occur in suitable habitat that would be affected, the Gravel Pits Alternative could have a minor effect on the Ute ladies’-tresses. Suitable habitat would be surveyed prior to construction to confirm absence of this species; if found, measures would be taken to avoid or minimize effects such as minor adjustments to the pipeline corridor.

### 4.13.5.4 Black-Tailed Prairie Dog

The Gravel Pits Alternative is within the known range for the black-tailed prairie dog (Colorado Parks and Wildlife 2015), but no active black-tailed prairie dog colonies have been documented within the study area, primarily because most of the gravel pits have already been excavated or are currently being excavated and the remaining areas are largely otherwise disturbed. Suitable habitat does occur along pipeline corridors and within staging areas. The Gravel Pits Alternative would affect approximately 4.2 acres of grasslands and 4.8 acres of agricultural lands. Approximately 49.0 acres of grasslands and 20.6 acres of agricultural lands suitable for black-tailed prairie dog colonies would also be temporarily disturbed. Because of these long- and short-term effects to suitable black-tailed prairie dog habitat, the Gravel Pits Alternative would have a minor effect to black-tailed prairie dog. These effects would be discountable and insignificant because they would not have a noticeable effect on populations within the surrounding area.

### 4.13.5.5 River Otter

The range of the river otter includes the Poudre River; therefore, the pipeline crossing of the Poudre River, part of the Gravel Pits Alternative, could temporarily affect the river otter. However, the river otter is a mobile species and is likely to avoid the disturbance area during pipeline construction; therefore, direct effects are unlikely. Construction effects associated with installation of the pipeline would be temporary and the area disturbed where the pipeline crosses under the Poudre River would be reclaimed, therefore habitat effects are also unlikely. Overall, the Gravel Pits Alternative would have no effect on the river otter.
4.13.5.6 **Townsend’s Big-Eared Bat**

The Gravel Pits Alternative is within the distributional range of Townsend’s big-eared bats. Man-made structures within the study area provide potential roosting habitat for Townsend’s big-eared bats; however, none of these structures would be affected by implementation of this alternative. The Gravel Pits Alternative would temporarily disturb suitable foraging habitat for Townsend’s big-eared bats, including approximately 2.9 acres of open water (excluding ditches and canals) and wetlands at a crossing of an unnamed creek near Claymore Lake and the Poudre River. Although no effects to potential roosting habitat would occur, potential foraging areas would be temporarily disturbed and construction noise could temporarily affect local Townsend’s big-eared bats; therefore, the Gravel Pits Alternative could have a minor effect on Townsend’s big-eared bats. These effects would be discountable and insignificant because they would be temporary and would not have a noticeable effect on populations within the surrounding area.

4.13.5.7 **Bald Eagle**

The Gravel Pits Alternative study area is within bald eagle winter range (Colorado Parks and Wildlife 2016a). No nests are known to occur in the area. The Gravel Pits Alternative could affect bald eagles by potential alteration of winter roost sites or foraging areas, including large trees that might be removed for the Poudre River pipeline crossing. While the area near the pipeline river crossing would be revegetated after construction, it may take decades for mature trees to reestablish at the crossing. Construction activities also could temporarily disturb foraging or roosting bald eagles in the area. Due to the presence of bald eagle winter habitat, the Gravel Pits Alternative would have a minor effect on bald eagles. This effect is discountable and insignificant because the effects would be short-term and would not have a noticeable effect on populations within the surrounding area.

4.13.5.8 **Golden Eagle**

Golden eagles could occur at the Gravel Pits Alternative site. Development of the gravel pits is unlikely to affect golden eagles because suitable foraging habitat would remain in the area surrounding the gravel pits. During construction, golden eagles might avoid the area due to construction noise and activity, however, avoidance is likely short-term, lasting only for the duration of construction. Any effects, long- or short-term, would be discountable and insignificant because they would not have a noticeable effect on populations within the surrounding area.

4.13.5.9 **American White Pelican**

The Gravel Pits Alternative is within the migratory range and summer breeding range of the American white pelican (Knopf and Evans 2004). Across their range, the pelican uses various freshwater habitats, including marshes, lakes, and rivers, during the breeding season. American white pelicans could use the Poudre River, and installation of the pipeline under the river would temporarily affect the river habitat. However, this would have no effect on the American white pelican because other habitat is available along the length of the Poudre River if pelicans avoid the construction area.
4.13.5.10 Burrowing Owl

In Colorado, burrowing owls are closely associated with prairie dog colonies; as described in Section 4.13.5.4, no active black-tailed prairie dog colonies have been documented within the study area, but suitable habitat would be affected. Burrowing owls could also use burrows created by other mammals in grassland or shrubland communities. This alternative would permanently affect approximately 9.0 acres of grassland habitat and agricultural lands that could potentially support prairie dogs or other mammals with suitable dens for burrowing owl. Approximately 69.6 acres of grasslands and agricultural lands would also be temporarily disturbed during construction. Because of these long- and short-term effects to suitable burrowing owl habitat, the Gravel Pits Alternative would have a minor effect on the burrowing owl. These habitat effects are discountable and insignificant because burrowing owls are not likely to be present given that prairie dog colonies are absent.

4.13.5.11 Northern Leopard Frog

The Gravel Pits Alternative is located within the range of northern leopard frogs and some suitable habitat, including wetlands and open water, would be affected. This alternative would permanently affect approximately 0.3 acre of open water suitable for foraging and temporarily affect 3.2 acres of wetlands and open water within access road buffers, pipeline alignments, and staging areas. However, no permanent effects to wetlands are anticipated. Because the Gravel Pits Alternative would affect some suitable northern leopard frog habitat, it would have a minor effect on the species. This effect is discountable and insignificant because other suitable habitat occurs nearby and populations would not be noticeably affected.

4.13.5.12 Common Garter Snake

Wetlands and riparian areas are suitable habitat for the common garter snake and the Gravel Pits Alternative is within its distributional range. The Gravel Pits Alternative would permanently affect approximately 4.3 acres of wetland and no riparian habitat, while approximately 2.1 acres of riparian habitat and 0.28 acre of wetlands would be temporarily disturbed mostly during pipeline installation. The common garter snake is a highly mobile species and would likely be able to avoid construction areas, so direct effects to individuals are unlikely. Due to effects to suitable habitat, the Gravel Pits Alternative would have a minor effect on common garter snakes. This effect is discountable and insignificant because other suitable habitat occurs nearby and populations would not be noticeably affected.

4.13.6 Agricultural Reservoirs Alternative

As described in Section 3.13.8, the Agricultural Reservoirs Alternative study area contains suitable habitat for 11 species of concern that have either been documented in or have ranges that overlap the study area. No suitable habitat is present, or the Agricultural Reservoirs Alternative is outside the distributional range, for Rocky Mountain bighorn sheep and northern pocket gopher.
4.13.6.1 Preble’s Meadow Jumping Mouse

The Agricultural Reservoirs Alternative study area is located within the known range of the Preble’s meadow jumping mouse (Colorado Parks and Wildlife 2015), but surveys were not conducted due to lack of access and it is unknown if they occur in the study area. The Agricultural Reservoirs Alternative study area does contain some suitable habitat for this species, including approximately 0.01 acre of riparian habitat and 5.3 acres of non-native grasslands, which would be permanently affected. An additional 2.13 acres of riparian habitat, 5.2 acres of wetlands, 102.8 acres of non-native grasslands, and 151.4 acres of agricultural lands would be temporarily disturbed during construction. The non-riparian portions of Preble’s meadow jumping mouse habitat are within 330 feet of the 100-year floodplain, which may be used by the Preble’s meadow jumping mouse. None of the disturbed area is designated as critical habitat. Because of effects to suitable habitat, the Agricultural Reservoirs Alternative could have a minor effect on Preble’s meadow jumping mouse. Prior to construction, a survey would be conducted to determine if the suitable habitat is occupied. If so, effects associated with construction activities would be avoided or minimized.

4.13.6.2 Colorado Butterfly Plant

The Agricultural Reservoirs Alternative study area is located within the general range of the Colorado butterfly plant (Colorado Parks and Wildlife 2015), but surveys were not conducted due to lack of access and it is not known if they occur there. Some riparian habitat suitable for this species may be affected during construction of water conveyance infrastructure and access roads. The Agricultural Reservoirs Alternative would permanently affect 0.01 acre of riparian habitat, and an additional 2.13 acres of riparian habitat, and 5.2 acres of wetlands would be temporarily disturbed during pipeline installation. Because suitable habitat would be affected, the Agricultural Reservoirs Alternative could have a minor effect on the Colorado butterfly plant. Suitable habitat would be surveyed prior to construction to confirm absence of this species; if found, measures would be taken to avoid or minimize effects such as minor adjustments to the pipeline corridor.

4.13.6.3 Ute Ladies’-Tresses

The Agricultural Reservoirs Alternative is located within the general range of Ute ladies’-tresses (Colorado Parks and Wildlife 2015). Surveys were not conducted for Ute ladies’-tresses at the Agricultural Reservoirs Alternative study area due to lack of access and it is not known if they occur there. However, the Colorado Natural Heritage Program reported an occurrence of Ute ladies’-tresses in a drainage located 1,950 feet from the pipeline corridor for the Agricultural Reservoirs Alternative. Some suitable habitat would be affected. The Agricultural Reservoirs Alternative would permanently affect 0.01 acre of riparian habitat, and an additional 2.13 acres of riparian habitat and 5.2 acres of wetlands would be temporarily disturbed during pipeline installation. Because potentially suitable habitat would be affected and a known population is within 1,950 feet of the pipeline corridor, the Agricultural Reservoirs Alternative could have a minor effect on Ute ladies’-tresses. Suitable habitat would be surveyed prior to construction to confirm absence of this species; if found, measures would be taken to avoid or minimize effects such as minor adjustments to the pipeline corridor.
4.13.6.4 **Black-Tailed Prairie Dog**

The Agricultural Reservoirs Alternative is within the known range for the black-tailed prairie dog (Colorado Parks and Wildlife 2015), but no active black-tailed prairie dog colonies have been documented within the study area primarily because most of the study area consists of the existing agricultural reservoirs. Suitable habitat does occur along pipeline corridors and within staging areas. This alternative would permanently affect approximately 10.7 acres of non-native grasslands and agricultural lands suitable for black-tailed prairie dogs, and an additional 256 acres of grasslands (foothills and non-native) and agricultural lands would be temporarily disturbed during construction activities. Because of these long- and short-term effects to suitable black-tailed prairie dog habitat, the Agricultural Reservoirs Alternative could have a minor effect on black-tailed prairie dogs. These effects would be discountable and insignificant because they would not have a noticeable effect on populations within the surrounding area.

4.13.6.5 **River Otter**

The range of the river otter includes the Poudre River, therefore the pipeline crossing of the Poudre River, part of the Agricultural Reservoirs Alternative, could temporarily affect river otters. However, the river otter is a mobile species and is likely to avoid the disturbance area during pipeline construction; therefore, direct effects are unlikely. Construction effects associated with installation of the pipeline would be temporary and the area disturbed where the pipeline crosses under the Poudre River would be reclaimed, therefore habitat effects are also unlikely. Overall, the Agricultural Reservoirs Alternative would have no effect on the river otter.

4.13.6.6 **Townsend’s Big-Eared Bat**

The Agricultural Reservoirs Alternative is within the general range of Townsend’s big-eared bat. Man-made structures within the study area provide potential roosting habitat for the Townsend’s big-eared bat; however, none of these structures would be affected by implementation of this alternative. The Agricultural Reservoirs Alternative would permanently affect approximately 0.01 acre of riparian woodland, and temporarily disturb approximately 13.1 acres of open water, wetland, and riparian habitat, which are suitable foraging habitat for Townsend’s big-eared bat. Although no effects to potential roosting habitat would occur, potential foraging areas would be temporarily disturbed and construction noise could temporarily affect local Townsend’s big-eared bats; therefore, the Agricultural Reservoirs Alternative could have a minor effect on Townsend’s big-eared bats. These effects would be discountable and insignificant because they not have a noticeable effect on populations within the surrounding area.

4.13.6.7 **Bald Eagle**

Reservoirs Number 5 and 6 are winter foraging areas for bald eagles, and the large trees along the Poudre River near the proposed pipeline crossing are potential winter roost sites. Specific winter roost sites have not been identified in the study area, but could occur. Two nest sites are known to exist within 0.5 mile of the proposed bi-directional pipeline that would carry water to and from Reservoirs Number 5 and 6.
Long-term direct effects on bald eagle habitat include the alteration of winter roost sites or foraging areas, which would occur if large trees were removed for the Poudre River pipeline crossing. While the area near the pipeline river crossing would be revegetated after construction, it may take decades for mature trees to reestablish at the crossing. Short-term effects may occur to eagles foraging or roosting in the area due to disturbance by construction activities. Known nest sites may experience long-term effects if disturbed by facility construction or operations activities taking place within 0.5 mile of a nest. Colorado Parks and Wildlife recommends no human encroachment within 0.5 mile of active eagle nests from October 15 to July 31 and no human encroachment within 0.25 to 0.5 mile of any active winter roost sites from November 15 to March 15. These restrictions would be observed for all construction activities to minimize effects on bald eagles. Due to the presence of bald eagle winter habitat, suitable nesting habitat, and documented nests within 0.5 mile of the study area, the Agricultural Reservoirs Alternative would have a minor effect on bald eagles. This effect is discountable and insignificant because Fort Collins would observe Colorado Parks and Wildlife restrictions.

4.13.6.8 Golden Eagle

Because golden eagles are wide-ranging and use a variety of habitats, they could occur at the Agricultural Reservoirs Alternative site. However, this alternative is unlikely to affect golden eagles because suitable habitat for foraging golden eagles would not be affected long-term. During construction, golden eagles might avoid the area due to construction noise and activity, however, avoidance is likely short-term, lasting only for the duration of construction. Any effects, long-or short-term, would be discountable and insignificant because they would not have a noticeable effect on populations within the surrounding area.

4.13.6.9 American White Pelican

The Agricultural Reservoirs Alternative is within the migratory range and summer breeding range of the American white pelican (Knopf and Evans 2004). Across their range, the pelican uses various freshwater habitats, including marshes, lakes, and rivers, during the breeding season. American white pelicans could use Reservoirs Number 5 and 6 for foraging or as stopover habitat during migration. Use for breeding habitat is unlikely because of the surrounding development and recreational use of the reservoirs. Under this alternative, Fort Collins would purchase dedicated storage space in Reservoirs Number 5 and 6, but there would be no change to the existing reservoirs and, therefore, no affect to pelican use of the reservoirs. American white pelicans could also use the Poudre River, and installation of the pipeline under the river would temporarily affect the river habitat. However, this would have no effect on the American white pelican because other habitat is available along the length of the Poudre River if pelicans avoid the construction area.

4.13.6.10 Burrowing Owl

While there are no black-tailed prairie dog colonies, the preferred habitat for burrowing owls, documented in the study area (Colorado Parks and Wildlife 2015), the Agricultural Reservoirs Alternative would permanently affect approximately 10.7 acres of non-native grasslands and agricultural lands that are suitable for the burrowing owl. An additional 254 acres of grasslands and agricultural lands would be temporarily disturbed during construction activities. Although black-tailed prairie dogs are not known to
occur in the area, due to long- and short-term effects to suitable burrowing owl habitat, the Agricultural Reservoirs Alternative would have a minor effect on the burrowing owl. These habitat effects are discountable and insignificant because burrowing owls are not likely to be present given that prairie dog colonies are absent.

4.13.6.11 Northern Leopard Frog

The Agricultural Reservoirs Alternative is located within the range of northern leopard frog and some suitable habitat, which includes wetlands and open water, would be affected. This alternative would permanently affect 0.32 acre of wetland and temporarily disturb 4.9 acres of wetland during construction within access road buffers, pipeline alignments, and staging areas. Open water is foraging habitat for the northern leopard frog. This alternative would not permanently affect open water, but 5.8 acres of open water would be temporarily disturbed during construction activities. However, the northern leopard frog is a mobile species and would likely avoid construction areas. Due to long-term effects to suitable foraging habitat, the Agricultural Reservoirs Alternative would have a minor effect on northern leopard frog. This effect is discountable and insignificant because other suitable habitat occurs nearby and populations would not be noticeably affected.

4.13.6.12 Common Garter Snake

Wetlands and riparian areas are suitable habitat for the common garter snake. The Agricultural Reservoirs Alternative would permanently affect about 0.01 acre of riparian woodland habitat and 0.32 acre of emergent wetlands, while approximately 2.13 acres of riparian habitat and 5.2 acres of wetlands would be temporarily disturbed, mostly during pipeline installation. However, the common garter snake is a highly mobile species, and would likely be able to avoid construction areas. Due to long-term effects to suitable habitat, the Agricultural Reservoirs Alternative would have a minor effect on common garter snake. This effect is discountable and insignificant because other suitable habitat occurs nearby and populations would not be noticeably affected.

4.13.7 No-Action Alternative

The No-Action Alternative would not directly affect species of concern because there would be no ground disturbing activities, no additional areas of inundation, and no changes to human activity at Fort Collins’ water supply facilities. This alternative could indirectly affect species of concern through the transfer of agricultural water rights to municipal use, which could potentially dry up wetlands associated with agricultural return flows. Species whose habitat includes wetland and riparian communities, such as Preble’s meadow jumping mouse, Colorado butterfly plant, and Ute ladies’-tresses, would be most likely to experience indirect effects, although effects would be difficult to separate from overall drought stress. Furthermore, mandatory water restrictions in Fort Collins would likely result in water-stressed landscaped areas including residential lawns, city parks and, possibly, golf courses. Water restrictions would potentially affect urban wetlands and riparian areas supported by lawn irrigation return flows and elevated groundwater. It is possible that some of these areas support species of concern.
4.13.8 Effects Summary

The comparative summary of effects (Table 4-67) on species of concern focuses on the total number of federal and state species of concern affected by the Project Alternatives. The total number of species of concern likely affected by any of the Alternatives is a useful statistic to determine overall effects of the alternatives on species of concern.

Implementation of Fort Collins’ Proposed Action could affect one federal and state-threatened species with a major effect on Preble’s meadow jumping mice. Fort Collins’ Proposed Action would have no effect on the other federally threatened species (Colorado butterfly plants and Ute ladies-tresses). Fort Collins’ Proposed Action would result in a negligible effect to one Bureau of Land Management-sensitive species, Rocky Mountain bighorn sheep, and a minor effect to three state species of concern or Bureau of Land Management sensitive species: northern pocket gopher, Townsend’s big-eared bat, and golden eagle; effects would be beneficial for the river otter, bald eagle, American white pelican and northern leopard frog (Table 4-67).

The Expanded Glade Alternative also could affect one federal and state-threatened species with a major effect on the Preble’s meadow jumping mouse. The Expanded Glade Alternative would have no effect on the other federally threatened species. The Expanded Glade Alternative would result in a minor habitat effect for five state species of concern or Bureau of Land Management-sensitive species including black-tailed prairie dog, Townsend’s big-eared bat, bald eagle, golden eagle, and burrowing owl; effects would be beneficial for northern leopard frog and common garter snake (Table 4-67).

The Gravel Pits Alternative and the Agricultural Reservoirs Alternative could both have a minor effect on three federally threatened species: Preble’s meadow jumping mouse, Colorado butterfly plant, and Ute ladies’-tresses. Preble’s meadow jumping mouse is also a state-threatened species. These alternatives would both have a minor effect on seven state species of concern or Bureau of Land Management-sensitive species including black-tailed prairie dog, Townsend’s big-eared bat, bald eagle, golden eagle, burrowing owl, northern leopard frog, and common garter snake (Table 4-67).

4.13.9 Unavoidable Adverse Effects

Construction of either Fort Collins’ Proposed Action or the Expanded Glade Alternative would cause unavoidable loss of occupied Preble’s meadow jumping mouse habitat. All action alternatives would result in unavoidable adverse loss of habitat for other federal and Colorado special status species due to inundation or construction of various infrastructure. All action alternatives would temporarily displace special status species during construction and would unavoidably cause disturbance to existing vegetation in temporarily affected areas.
## Table 4-67. Summary of effects on species of concern by alternative.

<table>
<thead>
<tr>
<th>Species of Concern</th>
<th>Halligan Dam Rehabilitation*</th>
<th>Fort Collins' Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
<th>No-Action Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preble's meadow jumping mouse</td>
<td>Minor</td>
<td>Major</td>
<td>Major</td>
<td>Minor</td>
<td>Minor</td>
<td>No effect</td>
</tr>
<tr>
<td>Preble's meadow jumping mouse critical habitat</td>
<td>Minor</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
</tr>
<tr>
<td>Colorado butterfly plant</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
<td>Minor</td>
<td>Minor</td>
<td>No effect</td>
</tr>
<tr>
<td>Ute ladies'-tresses</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
<td>Minor</td>
<td>Minor</td>
<td>No effect</td>
</tr>
<tr>
<td>Bighorn sheep</td>
<td>Negligible</td>
<td>Negligible</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>No effect</td>
</tr>
<tr>
<td>Black-tailed prairie dog</td>
<td>N/A</td>
<td>N/A</td>
<td>Minor</td>
<td>Minor</td>
<td>Minor</td>
<td>No effect</td>
</tr>
<tr>
<td>Northern pocket gopher</td>
<td>Minor effect</td>
<td>Minor</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>No effect</td>
</tr>
<tr>
<td>River otter</td>
<td>No effect</td>
<td>Minor (beneficial)</td>
<td>N/A</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
</tr>
<tr>
<td>Townsend's big-eared bat</td>
<td>Minor effect</td>
<td>Minor</td>
<td>Minor</td>
<td>Minor</td>
<td>Minor</td>
<td>No effect</td>
</tr>
<tr>
<td>Bald eagle</td>
<td>Minor effect</td>
<td>Minor (beneficial)</td>
<td>Minor</td>
<td>Minor</td>
<td>Minor</td>
<td>No effect</td>
</tr>
<tr>
<td>Golden eagle</td>
<td>Minor effect</td>
<td>Minor</td>
<td>Minor</td>
<td>Minor</td>
<td>Minor</td>
<td>No effect</td>
</tr>
<tr>
<td>American white pelican</td>
<td>No effect</td>
<td>Minor (beneficial)</td>
<td>N/A</td>
<td>No effect</td>
<td>No effect</td>
<td>No effect</td>
</tr>
<tr>
<td>Burrowing owl</td>
<td>N/A</td>
<td>N/A</td>
<td>Minor</td>
<td>Minor</td>
<td>Minor</td>
<td>No effect</td>
</tr>
<tr>
<td>Northern leopard frog</td>
<td>Minor effect</td>
<td>Minor (beneficial)</td>
<td>Minor</td>
<td>Minor</td>
<td>Minor</td>
<td>No effect</td>
</tr>
<tr>
<td>Common garter snake</td>
<td>No effect</td>
<td>Minor (beneficial)</td>
<td>Minor</td>
<td>Minor</td>
<td>Minor</td>
<td>No effect</td>
</tr>
</tbody>
</table>

*These effects would occur under all alternatives.  
N/A – no suitable habitat present and not within the known range of the species.
4.13.10 Mitigation Measures

Fort Collins has proposed the following mitigation measures related to species of concern for their Proposed Action only:

- **Shoreline Habitat Monitoring and Adaptive Management**: Reestablishing shoreline wetlands and Preble’s meadow jumping mouse habitat is an inherent effect of the Proposed Action, but Fort Collins proposes to monitor the shoreline to ensure the full 5.16 plus acres of projected wetland and Preble’s habitat reestablishes as expected. If shoreline wetlands do not reestablish as projected, Fort Collins would consider implementing other measures to assist the progress of naturally-developing shoreline wetlands.

- **Habitat Enhancement, Restoration, and Establishment**: Fort Collins proposes to focus all compensatory mitigation on enhancing and restoring priority habitat for Preble’s meadow jumping mouse adjacent to the North Fork downstream of Halligan Reservoir and/or restoration of degraded Preble’s habitat within the conservation easement on Phase 1 Robert’s Ranch or the greater Livermore area. Phase 1 of the conservation easement includes approximately 400 acres of potentially suitable Preble’s habitat, including 295 acres of designated Preble’s critical habitat.

- **North Fork Habitat Enhancement Monitoring**: Post-construction, Fort Collins proposes to establish multiple monitoring locations along the North Fork downstream of Halligan Reservoir to track changes in the functional lift of wetlands and adjacent habitat. Fort Collins would monitor the changes in functional lift for a minimum of five years to show the predicted inherent benefits associated with the operational flows are realized. If necessary, Fort Collins would implement ecological management efforts to ensure the anticipated inherent benefits of the operational plan are realized.

- **Habitat Mitigation Bank Credits**: Currently, Preble’s habitat mitigation bank credits exist that would appropriately mitigate for the loss of locally significant habitat functions resulting from the Project, but several additional regional mitigation banks are expected to be developed and approved by the Corps and Fish and Wildlife Service prior to the initiation of Fort Collins’ Proposed Action. Therefore, off-site mitigation banking would be considered an option for mitigation only if other mitigation options prove unviable, or it is determined additional mitigation is needed to comply with permitting commitments.

Fort Collins has proposed the following mitigation measure related to species of concern for all alternatives:

- **Pre-construction Botanical Survey**: No Colorado butterfly plant or Ute ladies’-tresses orchid plants were located during previous botanical surveys in the Project areas. However, prior to construction, a survey would be conducted for these species in proposed disturbance areas with potential to support either species. This survey would include any direct construction-related impact areas. If surveys indicate the presence of Colorado butterfly plant or Ute ladies’-tresses orchid plants in the planned disturbance areas, a mitigation plan would be developed to avoid plants and the habitat or relocate the plants.
Pre-construction Bat Surveys: Preconstruction bat roosting surveys would be conducted in areas where activities could potentially affect suitable bat roosting habitat. If surveys indicate the presence of roosting bats, Fort Collins would consult with Colorado Parks and Wildlife on appropriate mitigation measures. The preconstruction survey would help to ensure noise and vibrations from construction would not adversely affect the Townsend’s big-eared bat or other bat species.

NPIC, rather than Fort Collins, would be responsible for rehabilitating Halligan Dam under all alternatives to Fort Collins’ Proposed Action. However, rehabilitation of Halligan Dam would require a Corps permit under Section 404 of the Clean Water Act and consultation under Section 7 of the Endangered Species Act.

4.14 CULTURAL, HISTORICAL, AND PALEONTOLOGICAL RESOURCES

Potential effects to cultural, historical, and paleontological resources include the loss, damage or destruction of these resources due to construction activities from Fort Collins’ Proposed Action and the alternatives. These activities include pipeline, staging area, and access road construction that result in earth disturbance. Additional earth disturbance could result from the potential relocation of existing power lines and roads. Such disturbances have the potential to affect historical or archaeological sites. Should relocation of roads or power lines be necessary for any alternative, that action would also constitute a direct effect to a cultural resource if the road or power line in question is historic in age.

4.14.1 Methods

The goal of cultural resource research was to gather preliminary data on the existence of cultural resources in areas potentially affected by Fort Collins’ Proposed Action and alternatives and to assess the relative potential for the occurrence of unrecorded cultural resources. The effect analysis consisted of identification of cultural, historical, and paleontological resources within affected areas for Fort Collins’ Proposed Action and the alternatives through a Class I survey and/or field reconnaissance. While these data serve as the basis for planning future studies of the chosen alternative required to comply with the National Historic Preservation Act of 1966, they do not replace the need for an intensive Class III survey of the alternative that is permitted by the Corps.

4.14.2 Halligan Dam Rehabilitation

Due to the age and condition of the existing Halligan Dam, it would be rehabilitated under all Project Alternatives, regardless of which one is chosen. Rehabilitation of Halligan Dam would potentially affect four unrecorded archaeological sites identified within the potential dam construction disturbance area, as well as both Halligan Dam and Halligan Reservoir, which are historic in age but have not been previously recorded and are currently unevaluated with regard to eligibility for the National Register of Historic Places.
4.14.3 Fort Collins’ Proposed Action

Fort Collins’ Proposed Action study area contains one previously recorded cultural resource. This resource is historic in age, is not eligible for the National Register of Historic Places, and located well outside of the dam construction disturbance area. During the field reconnaissance survey four previously unrecorded resources were documented within the potential dam construction disturbance area and 14 additional previously unrecorded resources were documented within and surrounding the enlarged reservoir pool. These resources have not been evaluated for eligibility for the National Register of Historic Places, and would need to be revisited and recorded using Colorado site forms for compliance with Section 106 of the National Historic Preservation Act should this alternative be selected. Fort Collins’ Proposed Action would directly affect three of the resources identified during the field reconnaissance survey through inundation by the expanded reservoir pool.

Considering the proximity to permanent water and the comparatively minimal development of this study area, as well as lack of public access, there is a very high potential for Fort Collins’ Proposed Action study area to contain additional cultural resources. Given that 18 cultural resources were documented during the field reconnaissance survey, it is likely that unrecorded archaeological sites are also present. Additionally, private collections of artifacts recovered from the Meadow Creek confluence with Halligan Reservoir demonstrate human occupation of this study area over a span of approximately 8,000-10,000 years (Sustad and Hill 2010). The attractiveness of this study area to native inhabitants further suggests that additional prehistoric resources are likely present. Although some artifact collection has taken place, restricted public access within this study area has minimized effects of artifact collecting by the general public and increased the likelihood that undisturbed archaeological materials are in this area. If this alternative was selected, an intensive Class III survey would be required for all affected areas for Section 106 compliance.

As mitigation for the loss of recreation (primarily fishing) along about a one-mile reach of the North Fork upstream of Halligan Reservoir (about 0.41 mile of that reach is currently accessible to the public) and as mitigation for inundation of portions of the Cherokee State Wildlife Area Middle Unit, Fort Collins is considering the possibility of allowing public recreation, including non-motorized boating, swimming, fishing, and wildlife watching, at Halligan Reservoir and along the shoreline. A small parking lot, gravel boat launch, and vault toilet would be developed to accommodate visitors. Minimal upgrades to the existing access road would be made and few other facilities would be constructed at the reservoir (no trails or picnic areas). The Corps estimated that as many as several thousand visitors per year might recreate at the enlarged Halligan Reservoir. With increased recreational use of an area comes the increased risk of unauthorized artifact collection, and vandalism to archaeological or historic sites.

4.14.4 Expanded Glade Alternative

The Expanded Glade Alternative study area contains 25 previously recorded cultural resources, including three sites that lack specific locational information. Nine of these sites are prehistoric in age, 14 are historic, one contains both prehistoric and historic resources, and one site is of an unspecified age. Five of these sites occur within the disturbance area for this alternative, two of which are eligible for the National Register of Historic Places, two of which are not eligible, and one that has not been evaluated for eligibility. The NISP Draft EIS did not provide locational information for the 86 resources identified
during the initial NISP field reconnaissance survey. However, the field reconnaissance for the NISP Draft EIS was confined to the reservoir pool footprint; thus, it was assumed the majority of these resources would be directly affected through inundation.

Direct effects to previously recorded sites as well as potential effects to unrecorded cultural resources in the study area would include inundation by the reservoir pool, and earth disturbance related to infrastructure construction, including pipelines, access roads, and staging areas. Potential indirect effects to previously recorded sites as well as unrecorded resources would include additional residential development around the new reservoir pool. Recreational use of the reservoir and surrounding shoreline could lead to increased artifact collection and vandalism of archaeological sites. Additionally, the visual effects associated with construction of a new reservoir would have the potential to adversely affect the integrity of setting and feeling of cultural resources in the area.

Results of the Class I survey combined with results of the field reconnaissance surveys conducted for the NISP Glade Alternative, and the large amount of undeveloped land in this area, suggest there is a high potential for additional historic and prehistoric resources to occur within the Expanded Glade Alternative study area. An intensive Class III survey of all affected areas would be required for Section 106 compliance should this alternative be selected.

### 4.14.5 Gravel Pits Alternative

The Gravel Pits Alternative study area contains 80 previously recorded cultural resources. Seventy-eight of these sites are historic in age, one is prehistoric, and one is of an unspecified age. Nine of these sites are located within the disturbance area for this alternative, six of which are eligible for the National Register of Historic Places, two of which is not eligible, and two evaluated as needing data.

Direct effects to these sites would consist of earth disturbance related to infrastructure construction, including pipelines, access roads, and staging areas. There would be no foreseeable indirect or cumulative effects to specific cultural resources within the study area for this alternative.

Examination of the 1906 U.S. Geological Survey topographic map and General Land Office survey plat suggests there are unrecorded cultural resources in close proximity to the disturbance area of this alternative, including historic roads, irrigation ditches, and possibly structures. An intensive Class III survey to document and evaluate any unrecorded resources affected by this alternative would be required for Section 106 compliance should this alternative be selected.

### 4.14.6 Agricultural Reservoirs Alternative

The Agricultural Reservoirs Alternative study area contains the largest number of previously recorded cultural resources of the four proposed alternatives. The large number of resources in this study area is due in part to its proximity to Fort Collins, which has seen intensive development over the past century, as well as the size of the study area, which is the largest of the four alternatives. Ninety-seven previously recorded sites exist within the Agricultural Reservoirs study area, of which 95 are historic in age, one is prehistoric, and one is of an unspecified age. Fifteen sites are located with the disturbance area for this...
alternative, including six eligible for the National Register of Historic Places, six which are not eligible, and one that need data.

Direct effects to these resources would consist of earth disturbances related to pipeline, access road, and staging area construction. There would be no foreseeable indirect or cumulative effects to specific cultural resources within the study area for this alternative.

The 1906 U.S. Geological Survey topographic map and General Land Office survey plat examined for the Class I study suggest that the Agricultural Reservoirs Alternative could affect numerous unrecorded historic resources. Unrecorded cultural resources include the agricultural reservoirs themselves, historic roads, irrigation ditches, and structures. There is also the potential for undisturbed or privately owned sections of the project area to contain additional prehistoric or historic resources. Should this alternative be selected, an intensive Class III survey would be required for Section 106 compliance.

4.14.7 No-Action Alternative

The No-Action Alternative would not require any structural concepts, construction activities, or any ground disturbance beyond those associated with the Halligan Dam rehabilitation; effects resulting from the Halligan Dam rehabilitation are discussed in Section 4.14.2.

4.14.8 Effects Summary

At a site-specific level, direct effects to previously recorded and unrecorded cultural resources within study areas for Fort Collins’ Proposed Action and the alternatives include the loss or destruction of cultural resources due to reservoir inundation or earth disturbance associated with dam rehabilitation or enlargement, pipelines, access roads, and staging area construction (Table 4-68).

4.14.9 Unavoidable Adverse Effects

All alternatives would unavoidably affect eligible and unevaluated historic properties, including the potentially eligible Halligan Dam and historic dam construction site.

4.14.10 Mitigation Measures

Fort Collins has proposed the following mitigation measures related to cultural, historical, and paleontological resources for all alternatives:

- **Cultural Resources Survey:** To minimize effects to cultural resources, a Class III survey would be conducted in the area of potential effect prior to construction of the chosen alternative.

- **Treatment Plan:** To mitigate adverse effects to eligible or listed archaeological resources, Fort Collins would prepare a treatment plan that outlines research, recovery, and treatment protocols for those resources.
- **Maintain Historic Features**: To mitigate possible effects if Halligan Dam and Halligan Reservoir are deemed historic properties, a Memorandum of Agreement would be prepared with the appropriate parties to resolve adverse effects and outline mitigation measures. Fort Collins supports appropriate mitigation, which could include incorporating design or aesthetic features into the project, and/or interpretive signage, to recall the dam’s historical features and significance.

- **Paleontological Resources**: If paleontological resources are uncovered during construction, contractors would be required to stop work, and a paleontologist would be immediately notified. NPIC, rather than Fort Collins, would be responsible for rehabilitating Halligan Dam under all alternatives to Fort Collins’ Proposed Action, and Fort Collins would not mitigate any effects on cultural, historical, and paleontological resources from rehabilitation of Halligan Dam. However, rehabilitation of Halligan Dam would likely require a Corps permit under Section 404 of the Clean Water Act and compliance with Section 106 of the National Historic Preservation Act.
Table 4-68. Effect summary for previously identified cultural resources for the four Halligan Project alternatives.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Site Number</th>
<th>Site Name</th>
<th>Significance</th>
<th>Direct Effects</th>
<th>Indirect Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halligan Dam Rehabilitation*</td>
<td>None assigned</td>
<td>Halligan Dam</td>
<td>Unevaluated</td>
<td>Dam rehabilitation</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>None assigned</td>
<td>Halligan Reservoir</td>
<td>Unevaluated</td>
<td>Dam rehabilitation</td>
<td>None</td>
</tr>
<tr>
<td>Fort Collins’ Proposed Action</td>
<td>5LR12985</td>
<td>Unnamed</td>
<td>Unevaluated</td>
<td>Inundation</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR12988</td>
<td>Unnamed</td>
<td>Unevaluated</td>
<td>Inundation</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR12994</td>
<td>Unnamed</td>
<td>Unevaluated</td>
<td>Inundation</td>
<td>None</td>
</tr>
<tr>
<td>Expanded Glade Alternative</td>
<td>5LR.772</td>
<td>Ingleside-Coombs Ranch</td>
<td>No assessment given</td>
<td>Inundation</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR.1347</td>
<td>Charles Hansen Canal</td>
<td>Not eligible</td>
<td>Canal enlargement</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR.1692</td>
<td>Yelek site</td>
<td>Eligible</td>
<td>Pipeline construction</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR.3980</td>
<td>North Poudre Supply Canal (Monroe Canal)</td>
<td>Not eligible</td>
<td>Inundation</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR.9649.1</td>
<td>Poudre Valley Canal</td>
<td>Eligible</td>
<td>Canal enlargement</td>
<td>None</td>
</tr>
<tr>
<td>Gravel Pits Alternative</td>
<td>5LR.10515</td>
<td>Fort Collins water line (segment)</td>
<td>Not eligible</td>
<td>Staging area construction</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR.782</td>
<td>Meldrum Stone Barn, Warren Farm, Stegner Brothers Dairy</td>
<td>Eligible</td>
<td>Access road construction</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR.789</td>
<td>Mandeville Farm</td>
<td>Eligible</td>
<td>Inundation, access road construction</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR.1817</td>
<td>Michaud Farm, Verstraeten Farm</td>
<td>Eligible</td>
<td>Pipeline construction</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR.749</td>
<td>Fort Collins Water Works</td>
<td>Listed-State Register of Historic Places</td>
<td>Access road construction</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR.9960.9</td>
<td>Greeley, Salt Lake, &amp; Pacific Railroad (segment)</td>
<td>Eligible</td>
<td>Staging area construction</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR.9960.11</td>
<td>Greeley, Salt Lake, &amp; Pacific Railroad (segment)</td>
<td>Eligible</td>
<td>Pipeline construction</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR.12394</td>
<td>Hyde Farm Complex</td>
<td>Not eligible</td>
<td>Pipeline construction</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR.12391.2</td>
<td>Taylor and Gill Ditch (segment)</td>
<td>Eligible</td>
<td>Pipeline construction</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR.12399.1</td>
<td>Bellvue 30-inch steel water pipeline</td>
<td>Needs data</td>
<td>Inundation, access road construction</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5LR.12398.1</td>
<td>Bellvue 27-inch concrete water pipeline</td>
<td>Needs data</td>
<td>Access road, pipeline construction</td>
<td>None</td>
</tr>
</tbody>
</table>
# Alternative Site Number Site Name Significance Direct Effects Indirect Effects

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Site Number</th>
<th>Site Name</th>
<th>Significance</th>
<th>Direct Effects</th>
<th>Indirect Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>5LR.9902</td>
<td>Rocky Mountain Adventures office</td>
<td>Not eligible</td>
<td>Pipeline construction</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>5LR.9903</td>
<td>Patrick residence</td>
<td>Not eligible</td>
<td>Pipeline construction</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>5LR.9904</td>
<td>Gutzwiller residence</td>
<td>Not eligible</td>
<td>Pipeline construction</td>
<td>None</td>
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<tr>
<td>5LR.9905</td>
<td>Martinez residence</td>
<td>Not eligible</td>
<td>Pipeline construction</td>
<td>None</td>
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<tr>
<td>5LR.1817</td>
<td>Michaud Farm, Verstraeten Farm</td>
<td>Eligible</td>
<td>Pipeline construction</td>
<td>None</td>
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</tr>
<tr>
<td>5LR.9960.9</td>
<td>Greeley, Salt Lake, &amp; Pacific Railroad (segment), Colorado &amp; Southern Railroad, Rex Branch</td>
<td>Eligible</td>
<td>Pipeline, access road construction</td>
<td>None</td>
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<tr>
<td>5LR.1815.4</td>
<td>Union Pacific Railroad, Fort Collins to Laramie Branch</td>
<td>Eligible</td>
<td>Pipeline construction</td>
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<tr>
<td>5LR.9906.1</td>
<td>Little Cache La Poudre Ditch (segment)</td>
<td>Not Eligible</td>
<td>Pipeline construction</td>
<td>None</td>
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</tr>
<tr>
<td>5LR.9960.11</td>
<td>Provost Homestead, Provost and Claymore Roadhouse and Ferry, Herring Ranch, Brinks Farm</td>
<td>Listed-National Register of Historic Places</td>
<td>Access road construction</td>
<td>None</td>
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<tr>
<td>5LR.8932.6</td>
<td>Greeley, Salt Lake, &amp; Pacific Railroad-Stout Branch (Segment)</td>
<td>Eligible</td>
<td>Pipeline, access road construction</td>
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</tr>
<tr>
<td>5LR.8932.6</td>
<td>Larimer County Ditch</td>
<td>Eligible</td>
<td>Pipeline, access road, staging area construction</td>
<td>None</td>
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</tr>
<tr>
<td>5LR.12394</td>
<td>Hyde Farm Complex</td>
<td>Not eligible</td>
<td>Pipeline construction</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>5LR.12391.2</td>
<td>Taylor and Gill Ditch (segment)</td>
<td>Eligible</td>
<td>Pipeline construction</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>5LR.12399.1</td>
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<td>Pipeline construction</td>
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<td></td>
</tr>
<tr>
<td>5LR.12398.1</td>
<td>Bellvue 27-inch concrete water pipeline</td>
<td>Needs data</td>
<td>Pipeline, access road construction</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

*These effects would occur under all alternatives.*
4.15 SOCIOECONOMIC

4.15.1 Methods

The following potential effects to socioeconomic resources resulting from implementation of Fort Collins’ Proposed Action and alternatives were evaluated:

- Changes in local or regional population growth or demographic characteristics
- Changes to local or regional housing availability, housing characteristics, or property values
- Effects to employment and associated income levels from project construction or operations
- Changes in economic activity and output for certain industries
- Agricultural effects, including losses of irrigation water or changes in the value of agricultural property or output
- Fiscal effects to local entities, including Fort Collins, Larimer County, or other entities
- Changes in water rates and tap fees for Fort Collins’ customers
- Changes in the value of recreational activity
- Other social effects including quality of life issues

The socioeconomic effect analyses relied heavily on alternative-specific information obtained from the Alternative Descriptions Report (MWH Global 2015c), interviews with Fort Collins, communications with engineering consultants and other resource specialists, and the recreation and land use effect analyses. Those sources provided information on alternative costs, construction and operational activities, traffic volumes, land purchases, acquisition of ditch company shares, and changes in recreational activity. Socioeconomic effects would generally result from construction activity and other land-based activity (i.e., traffic, local expenditures, and land purchases); however, the recreational economy can be affected by changes in stream flows.

4.15.1.1 Population, Demographics, and Housing

The potential for changes in population, regional demographic characteristics, and housing conditions were assessed based on the Corps’ knowledge of each alternative and experience and expertise with similar situations.

4.15.1.2 Project Costs

Fort Collins and its engineering consultants provided updated cost data in June 2018 based on information available at that time. The project cost data presented for each action alternative are divided into cost categories:

- Pre-construction costs, such as planning, permitting, engineering, and other design work
- Land and other acquisition costs
• Construction phase costs, including labor, equipment costs, materials, and supplies
• The present value of operations and maintenance costs over a 50-year period

The Alternative Descriptions Report (MWH Global 2015c) explains the assumptions used to estimate those costs. At the current level of engineering design, there is a range surrounding the estimated costs for each alternative. All cost estimates are in 2018 dollars.

The cost of the No-Action Alternative is based on the stated assumption that under the No-Action Alternative “Fort Collins would invest roughly the same amount of money budgeted for the Halligan Reservoir Enlargement Project into water acquisitions, specifically shares of North Poudre Irrigation Company” (MWH Global 2015c).

4.15.1.3 Employment, Income, and Economic Stimulus

The Corps obtained direct alternative-specific data on employment, worker earnings, and expenditures on materials and supplies from Fort Collins. The Corps then applied economic multipliers for the construction industry to those estimates to calculate total effects, as well as induced or indirect effects, to employment, earnings, and economic output. Total effects resulting from project activities, as reflected by economic output, were compared to Fort Collins’ retail sales data to evaluate the scale of effect. For the purposes of evaluating the economic effects of construction activities, the degree of effect is defined as follows:

• **Negligible**: Total annual economic stimulus (additional annual economic output) amounting to less than one percent of either Fort Collins or Larimer County retail sales.
• **Minor**: Total annual economic stimulus (additional annual economic output) amounting to more than one percent and up to five percent of either Fort Collins or Larimer County retail sales.
• **Moderate**: Total annual economic stimulus (additional annual economic output) amounting to more than five percent and up to 10 percent of either Fort Collins or Larimer County retail sales.
• **Major**: Total annual economic stimulus (additional annual economic output) amounting to more than 10 percent of either Fort Collins or Larimer County retail sales.

4.15.1.4 Traffic and Road Maintenance Costs

Fort Collins provided average day and peak day truck and labor traffic data for the construction and operational activities included in each alternative. They also provided information on projected traffic volumes on specific road segments they anticipate to be used by trucks and commuting workers. The Corps evaluated effects of construction traffic from each alternative based on a number of factors, including:

• Percentage increase in traffic on affected roadways for the average day and the peak day (including state highways, and county and local roads)
• Length of the roadway affected by construction traffic
• Background traffic volume and knowledge of the general nature of the road (i.e., major highway, local road, rural area)
• Types of construction vehicles required (percent of cars versus heavy trucks)
• Length of the construction period

The percent increase in traffic volumes on specific roads under each alternative was calculated to evaluate the potential for localized traffic-related nuisances to other drivers on the road and for increased road maintenance costs to Fort Collins or Larimer County. The Corps placed the potential for increased costs in the context of current spending on streets, roads and bridges to evaluate effects to those jurisdictions.

4.15.1.5 Water Rates and Tap Fees

Fort Collins plans to finance the capital costs of each alternative through a combination of cash reserves and debt issuance, which would be recovered in part through increased water supply requirement fees collected on new development; the plant investment fee would not change as a result of any alternative. Total capital costs include pre-construction costs (planning, engineering, and other design work), land and other acquisition costs, and all construction costs (labor, equipment costs, materials, and supplies). The cost of the No-Action Alternative includes acquisition of additional water supplies.

Fort Collins’ finance staff provided data on changes in water rates and tap fees under each alternative, along with the financial models that generated those estimates. The Corps evaluated the models and found them to be generally sound for this purpose. The Corps used the average single-family water consumption for the month of July (typically the highest-use month) to calculate the maximum effect of the change in the monthly bill. For the purposes of this analysis, the degree of effect is defined, specifically related to water rates and Water Supply Requirement fees, as follows:

• **Negligible**: Water rate and Water Supply Requirement increases of less than one percent.
• **Minor**: Water rate and Water Supply Requirement increases of more than one percent and up to five percent.
• **Moderate**: Water rate and Water Supply Requirement increases of more than five percent and up to 10 percent.
• **Major**: Water rate and Water Supply Requirement increases of more than 10 percent.

No specific numerical thresholds for determining the effects of changes in water rates or tap fees exist in the literature; these distinctions were developed based on professional experience and judgment.

4.15.1.6 Property Tax Losses

Fort Collins provided information on the number of acres of land purchased under each alternative, as well as the current owners of those properties. As a municipality, Fort Collins is not subject to paying property taxes on property it owns. Therefore, the land purchased by Fort Collins under each alternative would come off Larimer County’s tax rolls. The Corps researched the mill levies applicable to each parcel that Fort Collins would purchase, calculated the mill levy per acre of land and estimated the annual losses to each taxing entity from removal of that land from the Larimer County tax base. Those calculations used 2014 mill levy rates and 2014 assessed property values. Under Fort Collins’ Proposed Action, Fort Collins would purchase a number of acres of land from state or federal agencies. Those entities do not
currently pay property taxes on those parcels and therefore no loss of annual tax revenues would result from those purchases.

4.15.1.7 Agricultural Effects

To evaluate effects under the No-Action Alternative, the Corps obtained information on the number of NPIC shares that would be acquired and the number of C-BT units associated with those shares. The Corps then calculated the number of irrigated acres represented by the acquired C-BT shares based on Fort Collins’ most likely lease-back scenarios. The Corps assumed that those acres would continue as dryland operations. However, much of the agricultural water that would be acquired by Fort Collins under the No-Action Alternative is currently used as supplemental water, and therefore it may be unlikely that many acres would completely dry up. As a result, the analysis of agricultural effects represents the maximum effect to agriculture.

The Corps then applied data on agricultural land values and the value of agricultural products sold on a county basis to the calculation of acres removed from irrigation in Larimer and Weld Counties to determine the value of agricultural losses in each county. The Corps identified effects to Larimer and Weld Counties separately, since the scale of effects were unequal between the two counties. The Corps applied economic multipliers for the crop and animal production industry to the calculated losses to agricultural production to determine the associated direct losses to agricultural employment and income. The Corps estimated the total effects of changes in agricultural operations to economic output, employment, and income again using that same set of multipliers. The Corps placed those losses in context of overall economic conditions in those counties to assess effect levels.

For the purposes of this analysis, the degree of effect is defined, specifically related to changes in irrigated acreage, agricultural production and production values, as follows:

- **Negligible**: Changes of less than one percent.
- **Minor**: Changes of more than one percent and up to five percent.
- **Moderate**: Changes of more than five percent and up to 10 percent.
- **Major**: Changes of more than 10 percent.

No specific numerical thresholds for determining the effects of changes in agricultural operations exist in the literature; these distinctions were developed based on professional experience and judgment. The Corps evaluated effects to agricultural within the context of current countywide agricultural operations and economic conditions; effects to individual farms and farmers would vary and may be more intensive.

4.15.1.8 Quality of Life

The Corps evaluated effects to the quality of life of Larimer County citizens using information about each alternative in combination with results of the recreation and land use effect analyses. The Corps largely based this assessment on big-picture, long-term changes brought about by each alternative. However, short-term construction related effects to local residents or businesses were also assessed.
4.15.1.9 Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, was issued by President Clinton in 1994 for the purpose of focusing federal attention on the environmental and human health effects of federal actions on minority and low-income populations. Executive Order 12898 states that “To the greatest extent practicable and permitted by law…each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionally high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations….”

The Corps addressed the potential effects to minority and low-income populations within the Primary Impact Areas and secondary impact areas under each alternative. As part of that evaluation, the Corps considered the following: (1) locations of construction activity, (2) truck and other vehicle traffic routes, (3) changes in water rates and development fees, (4) potential changes in the availability or quality of public services and, (5) potential changes in the agricultural sector due to reduced irrigated acreage or reductions in water deliveries to agricultural producers. The Corps relied on census data regarding race, income levels and poverty levels with each Primary Impact Area and secondary impact area in combination with information about alternative-specific construction activities and other effects to evaluate potential environmental justice effects.

4.15.1.10 Data Adequacy

Section 3.15.4 describes the best available data for socioeconomic resources in the study areas. The Corps determined the data available and methods used were adequate to evaluate and describe reasonably foreseeable significant adverse effects on social and economic conditions in the study areas and to enable the decision maker to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable socioeconomic information as described in Section 4.2.1.5.

4.15.2 Effects Common to All Alternatives

4.15.2.1 Population and Demographic Characteristics

The relationship between water availability and population growth is complex and, as suggested by some studies, is “often misunderstood” (Nichols et al. 2001). According to the 2001 report Water and Growth in Colorado, “historically, it has been assumed that water development was a necessary precursor to growth and, similarly, that a lack of water development could act as a deterrent to growth. While these premises may have been true at one time, recent experience in Colorado and other western states shows both ideas are now unsupportable” (Nichols et al. 2001). The report provides evidence that limited water supplies do not act to limit growth in the modern west and that an abundance of water or water development does not act as a stimulus to growth on its own. It goes on to state that “the inherent limits of natural water resources are rarely viewed as providing an absolute limit to growth” and that the constraints of time, money, and technology needed to address that limited resource “are not typically viewed as real limits to continued expansion.” These statements are supported by research included in other studies as well. For example, a Western Land Use Trends and Policy document states that
historically “water has rarely been a major factor in municipal and industrial land use decisions and current land use trends and policy continue this tradition” (Riebsame et al. 1997).

In fact, the underlying assumption of a number of documents that examine the relationship between growth and water management is that future population increases are going to occur in Colorado and other areas regardless of the existing availability of water supplies (Colorado Water Conservation Board 2015, Colorado State University 2015, Nichols et al. 2001, Riebsame et al. 1997, Western Water Policy Review Advisory Commission 1998). With this understanding, planners focus on the myriad approaches to preparing for and accommodating that growth.

Larimer County and Fort Collins are expected to experience population growth in the future. A great number of factors, including economic growth and development, job opportunities, housing availability and prices, school quality, recreational opportunities, climate, culture, and other quality of life factors support that anticipated growth. The State Demography Office projects Larimer County’s population to grow by more than 200,000 people between 2015 and 2050 (Colorado Department of Local Affairs. 2015). That growth rate amounts to about a 65 percent increase in Larimer County’s population over that period. The North Front Range Metropolitan Planning Organization has prepared the 2040 Regional Transportation Plan, which includes population projections for parts of northern Colorado, including Fort Collins (North Front Range Metropolitan Planning Organization 2015). The Metropolitan Planning Organization’s population projections are largely based on projected economic and employment conditions for northern Colorado. That document projects more than 50 percent growth in the Fort Collins population between 2010 and 2040.

The Purpose and Need Report (WEST 2016) includes population projections for Fort Collins Utilities. Those projections indicate that approximately 44,000 additional people will be served by Fort Collins Utilities by 2065. Fort Collins Utilities itself does not play a role in defining or implementing Fort Collins’ land use, growth management or other development policies, all of which play a part in determining commercial and residential growth. However, it is Fort Collins Utilities’ responsibility to prepare for and meet the demands of current and future customers located within the Fort Collins Utilities service area.

Population growth for Fort Collins and Larimer County would be the same under all alternatives, including the No-Action Alternative. Although additional water storage facilities or additional water acquisitions would support local population growth, neither the action alternatives nor the No-Action Alternative would cause that growth to occur. Additionally, none of the alternatives would affect the demographic characteristics of the population. Age, ethnicity, education, and other current demographic patterns may change over time due to local or regional economic conditions or other factors, but the availability of additional water storage or water supplies on the part of Fort Collins Utilities would not affect those demographic characteristics. None of the activities included in the action or No-Action alternatives or the overall result of those alternatives would affect demographic conditions.
4.15.2.2 Housing Conditions

4.15.2.2.1 Housing Units and Vacancy Rates

Future population growth will necessarily result in increased demand for homes in Fort Collins and Larimer County. In addition, changing economic, cultural, and demographic trends, and a continued awareness of water issues in Colorado, will likely affect the demand for certain styles of housing. However, none of the alternatives themselves would affect local or regional housing availability or housing characteristics.

During the construction period, communities in northern Colorado would provide the majority of the construction workforce; those workers would commute to and from work sites on a daily basis, eliminating the need for any temporary worker housing. A small number of people included in the workforce may temporarily relocate to the area for purposes of specialty or other construction work, but that number of workers would place only negligible pressure on the available housing stock (seen in the vacancy rate) or rental prices in the area. No homes would be inundated or otherwise removed by the development of any alternative activities; therefore, the alternatives would not reduce the available housing stock anywhere in Larimer County. The very small number of additional permanent employees required for operations under any alternative would have no effect on housing availability.\(^1\) None of the alternatives would affect large-scale land uses in the region, which could affect the types of housing constructed in the future.

4.15.2.2.2 Property Values

In general, the purchase of property is a long-term investment; therefore, the property values of the majority of homes in Fort Collins and Larimer County would not likely be affected by the temporary, and localized, construction activities of any alternative. The exception may be the relatively small number of homes in close proximity to any construction site. Residents of those homes would have to contend with increased traffic, including a small number of heavy trucks, possibly noise from machinery, and certain temporary visual effects during the construction period. In the short-term, those inconveniences could potentially reduce the number of home sales or result in lower sales prices; however, home values are based on a number of factors, and any change in home values due to temporary construction activities would be minor. Once constructed, none of the facilities or the operational activities included in the alternatives would affect property values, with the possible exception of the Gravel Pits Alternative. Under that alternative, conversion of the gravel pits into water storage facilities may result in negligible to minor increases in the value of nearby homes due to the reduction in commercial traffic and visual benefits of the ponds.

4.15.2.3 Construction Activity and Workforce

Construction would occur year round, with activity anticipated to occur only during the day on weekdays. During the construction periods for each alternative, construction activities could result in short-term

\(^1\) Fort Collins’ Proposed Action and the No-Action Alternative would not require any additional employees for operational purposes.
nuisances to local residents and area visitors. Short-term, temporary effects could result from generation of dust, vehicle emissions, noise, construction traffic, and visual changes related to the existence of machinery, facilities, and construction activity. As stated in the *Alternative Descriptions Report*, “a Construction Management Plan would be prepared to address how to minimize effects to the project area from construction activities.” Fort Collins and its chosen contractors would implement best management practices during construction to reduce construction-related effects.

Each action alternative would require a certain number of workers, given the specific activities to take place. However, the mix of skills required for construction work under all alternatives would be similar. Construction workers and other types of workers required under each alternative would generally come from within northern Colorado and would commute to and from the work sites each day. As of 2015, there were over 19,000 people working in the construction industry in Larimer and Weld Counties alone, including over 1,570 specifically employed in non-residential construction. The average number of workers required under each alternative would range from about 30 people for the Expanded Glade Alternative to about 400 people for the Gravel Pits Alternative. Overall, the construction workforce required for each alternative would amount to a small portion of the existing construction workforce in the region, ranging from less than 0.5 percent to as much as two percent of the northern Colorado construction industry. As of early 2016, construction contractors in Colorado were reporting shortages of skilled labor; however, it is uncertain if that will continue to be the case at the time that any of these alternatives would be developed. In some areas, workers leaving the oil and gas industry are moving into construction, but that may change in the future if oil and gas prices begin to increase. A tight construction market could mean competition for workers, potentially resulting in schedule delays or cost increases for Fort Collins or other construction projects in northern Colorado. Hourly rates for construction workers would range from about $25 to $55 per hour, including benefits.

Construction would generally ramp up, reach a peak, and then ramp down over the estimated construction period for each alternative. The duration of peak period construction activity is estimated to be about four weeks. Peak numbers of construction workers and peak construction traffic volume are assumed to be 2.2 times the average number under each alternative (MWH Global 2015c). The peak number of workers would range from about 60 people to about 875 people, depending on the specific alternative.

### 4.15.2.4 Commuter Vehicles and Truck Traffic

Construction workers would commute to construction sites by way of local highways and improved construction access roads. Parking for workers’ vehicles would be located within construction disturbance areas. Haul trucks would transport materials and supplies to construction sites by local highways and project site access roads. Construction workers could carpool to work sites using their personal vehicles, reducing the number of commuter vehicles on the road. However, the increase in traffic due to commuting construction workers and truck transportation could result in drive time delays or detours for private and commercial vehicles traveling on those same roads. The lengths of those delays are unknown, but delays could be an issue for local residents and commercial vehicles on certain roads, especially two-lane roads, curvy roads, or rural roads, where reduced speeds may be required. In addition to delays, increased traffic could result in increased noise, air pollution, and safety issues, including vehicle collisions or other accidents.
As presented in the discussions for individual alternatives, the majority of traffic volume for each alternative would be due to commuter vehicles. Labor trips make up between 89 and 99 percent of total vehicle traffic, depending on the alternative. Truck traffic would be a very small component of total traffic volume for any alternative. Commuter vehicle trips would occur in the morning and in the afternoon, as workers travel to and from the site. The concentration of that traffic would reduce the duration or degree of traffic delays over the course of the day, but may exacerbate those effects at certain times of the morning or afternoon. Truck trips may be distributed throughout the day, reducing effects to other drivers from those slow-moving vehicles.

Construction activities would be temporary and any traffic-related inconveniences would be short-term (one to four years) and limited to weekdays. Only a small portion of Larimer County residents would likely notice or be affected by any construction activities and, at a county level, the effects to residents would be negligible due to the limited miles of roadway used to support construction traffic. However, local residents who may come into contact with vehicle or truck traffic may feel the effects are considerable. The average daily and peak daily volumes of construction traffic associated with each alternative are discussed in individual alternative sections.

4.15.2.5 Operations and Maintenance Activities

Fort Collins would conduct routine operations and maintenance activities for treatment plants, pipelines, pump stations, and dam operations, as applicable under each action alternative. These activities would include inspections of facilities, maintenance of mechanical and electrical equipment, routine replacement of parts and chemicals, and general housekeeping. Increased vehicle traffic during the operational phase of any alternative would be negligible.

4.15.2.6 Fort Collins Utilities Water Rates and Tap Fees

Fort Collins’ Water Supply Requirement fee would increase under all action alternatives, as well as the No-Action Alternative. The increase in Water Supply Requirement fees would be unique to each alternative; the discussion of effects for each alternative outlines specific Water Supply Requirement fee increases.

Monthly volume-based water rates would increase under all action alternatives to cover the costs of annual operations and maintenance activities under each alternative. Water rates would not increase under the No-Action Alternative, which does not include any specific operations and maintenance activities. The increase in water rates would be unique to each alternative; the discussion of effects for each alternative outlines specific rate increases.

Increases in Water Supply Requirement fees and in water rates under the action and No-Action alternatives would be in addition to any other rate or fee changes for other purposes. For example, Fort Collins may implement annual or periodic rate increases to cover the generally increasing costs of personnel or other administrative or operations costs. Fort Collins may also adjust water rates or tap fees in response to other projects.

Increases in the Water Supply Requirement fee would constitute major changes (greater than 10 percent) under all alternatives; specific percent changes under each alternative are discussed in subsequent
individual alternative sections. Fort Collins’ specific strategy for implementing large Water Supply Requirement fee increases has yet to be determined.

Increases in any type of development fees, including the Water Supply Requirement fee, can have effects on local development, housing costs, and regional development patterns:

- **Local and regional housing costs**: Developers would likely pass on part, if not all of the Water Supply Requirement fee to homebuyers. That would result in an increase in the total cost of new homes served by Fort Collins, as reflected in the sales price. Physical room for growth within Fort Collins’ service area boundaries is limited, so increases in the cost of relatively few homes may not be enough to affect overall housing costs. Effects on homebuyers will typically be spread over many years through mortgages, reducing any out-of-pocket financial effects to those affected buyers.

- **Developer decisions and development patterns**: Increases in the Water Supply Requirement fee may also affect developers’ decisions about what types of homes or other buildings to develop, perhaps leaning towards higher-end structures that would dilute effects of the Water Supply Requirement increase on the overall house cost. That type of decision could reduce the number of affordable housing developments. Alternatively, developers might decide to focus their efforts outside of Fort Collins’ service area, instead building commercial or residential structures within other municipalities or in unincorporated areas of northern Colorado - areas served by other water providers.

- **Desirability of Fort Collins**: Housing costs are only one factor affecting the desirability of a place in terms of a decision on where to live. However, the on-going annual increases in the Water Supply Requirement fee required under several of the alternatives and the potential resulting effects to housing costs could have a negative effect on the overall desirability of the area, in terms of affordability.

However, Fort Collins is not the only area in northern Colorado that has or will experience increases in housing costs. Housing costs have been on the rise across Larimer and Weld Counties (and in many other areas of Colorado) for a number of years, without much regard to specific location. Additionally, other water providers in northern Colorado are also undertaking infrastructure or other water planning projects, which may affect the cost of water in those areas as well. Those factors may limit the relative differences in the costs of water and of housing across the region.

### 4.15.2.7 Public Facilities and Services

In general, and other than for the Fort Collins Utilities, the alternatives would have a limited effect on the majority of public facilities and services. Overall, the action alternatives would allow the Fort Collins Utilities to meet projected future water demands with their existing water rights. Discussions for individual alternatives address the effects to Fort Collins Utilities customers in terms of increases in water rates and tap fees. None of the alternatives would affect water services provided by other public water providers or the availability of water to individuals using private wells.

Law enforcement agencies, fire protection agencies, and medical facilities may temporarily experience slight increases in calls and incidences during the construction phase of each action alternative. That
increased responsibility would be limited to the construction period, since the operational phases would not require commuting workers or trucking of materials to facility sites. For those agencies, increased traffic and construction activity may require additional response to accidents or other incidents at the construction sites or along commuting routes. Given the limited construction periods (one to four years), the size of the workforce under each alternative (averages of between 30 and 400 people), and the estimated volume of construction traffic (between about 40 to 540 vehicles per day), effects to those agencies would be temporary and negligible to minor compared to current workloads.

Solid waste and hazardous waste materials generated during construction would be disposed of at the Larimer County Landfill. Fort Collins’ Proposed Action would generate about 1,230 cubic yards of solid waste and a small amount of hazardous waste material; other action alternatives would generate much smaller amounts of solid and hazardous wastes. Fort Collins and its contractors would be responsible for any applicable disposal fees. The operational phases of the action alternatives would not produce any waste materials. The landfill currently receives more than 180,000 cubic yards of material per year and is expected to have space available through about 2024. After that time, the current facility will be closed and operations will be moved to a new location north of Fort Collins (Personal communication between Susan Walker and the Larimer County Landfill Staff, July 2016). The 1,230 cubic yards of waste generated by Fort Collins’ Proposed Action would amount to about 0.5 percent of total annual waste received by the landfill; that effect would be even less if the waste generated is distributed over the two-year construction period. The life of the landfill would not be noticeably affected by any of the alternatives. Therefore, effects to the landfill would be negligible.

As a municipal entity, Fort Collins is exempt from paying property taxes on land it owns. Fort Collins would purchase between two acres and 275 acres of land, depending on the individual alternative; the No-Action Alternative would not require purchase of any property. Purchased acreages would be exempt from property taxes, although some acreage currently owned by federal or state agencies is already exempt from property taxes. Property taxes fully or partially fund certain public services, including law enforcement agencies, fire protection districts, school districts, and libraries. As such, those services would experience small reductions in annual funding because of the action alternatives. Given the amount of acreage purchased under each alternative and the distribution of funds among various entities, effects to individual agencies would be negligible. The effect discussions for individual alternatives address the amount of property purchased and financial losses to specific agencies or districts.

4.15.2.8  Fort Collins and Larimer County Fiscal Conditions

4.15.2.8.1  Sales Tax Revenue

As a municipal entity, Fort Collins is exempt from paying sales taxes on the purchase of any materials, supplies, or other items. That exemption extends to contractors hired by Fort Collins to construct any facilities related to any alternatives. As such, Fort Collins, Larimer County, or other jurisdictions would not realize any increase in sales tax revenue because of the purchase of materials for construction or operation of any of the alternatives.
4.15.2.8.2 Property Tax Losses

Property purchased as part of the alternatives would be located outside Fort Collins boundaries and, therefore, Fort Collins’ property tax revenues would be unaffected. However, Larimer County exacts a mill levy of 22.459 mills (as of 2014) on properties within Larimer County. Therefore, Larimer County would lose a small amount of funding generated by property taxes under each of the alternatives, with the exception of the No-Action Alternative. The effect discussions for individual alternatives include the amount of reductions in funding to Larimer County; however, under all alternatives, the loss of property tax funding to Larimer County would be negligible.

4.15.2.8.3 Increased Road Maintenance Costs

In addition to the revenue losses described above, Fort Collins and Larimer County would also be responsible for any increased costs related to the maintenance of local roads used by trucks and workers commuting to various work sites. Road maintenance costs depend on a number of factors, including traffic volume, type of vehicles, weather, driver behavior, and existing road and pavement conditions. Heavy truck traffic has the potential to damage roads, resulting in expensive repairs. High volumes of overall traffic may also require repairs or other maintenance on county roads. Road construction and maintenance costs vary annually, but in recent years, Larimer County has spent as much as $50.9 million and Fort Collins has spent as much as $32.9 million per year on street expenditures.

Increases in Fort Collins and Larimer County road maintenance costs are likely to be negligible to minor under all alternatives for several reasons. Average daily truck traffic would be low under all action alternatives, ranging from about one to about four round-trips per day. Peak daily truck traffic would range from about two to nine round-trips. However, the number of commuting construction workers would be higher than truck trips on a daily basis. Additionally, trucks and construction worker traffic would be somewhat distributed among a number of different roads under each action alternative. The increase in traffic on any particular road would generally amount to a relatively small percent increase (MWH Global 2015c). The specific county roads traveled are discussed for individual alternatives in those sections. Overall, the relatively small increases in traffic volumes, especially heavy truck traffic, and the relatively short duration of construction activity would minimize road maintenance costs associated with the action alternatives. Individual effect discussions describe specific traffic data for each alternative. The No-Action Alternative would not result in any additional traffic of any type.

4.15.2.9 Fiscal Conditions of Other Entities

4.15.2.9.1 Colorado Department of Transportation

The Colorado Department of Transportation is responsible for maintenance of state highways and portions of other roads affected by the alternatives, including U.S. Highway 287 and Colorado Highway 14. Various portions of U.S. Highway 287 would see increased traffic volumes under each action alternative. Colorado Highway 14 would experience a very small amount of increased traffic. The Colorado Department of Transportation’s fiscal year 2014 budget included about $1.25 billion in total expenditures, including about $590 million in road maintenance projects throughout the state. The traffic generated by any of the action alternatives on either U.S. Highway 287 or Colorado Highway 14 would
not be enough to result in any increase in the Colorado Department of Transportation’s road maintenance costs.

4.15.2.9.2 North Poudre Irrigation Company

In 1993, Fort Collins and NPIC entered into an option agreement, whereby Fort Collins had the option of acquiring Halligan Reservoir for potential future expansion. Since that time, Fort Collins has made annual acquisition payments to NPIC, ranging from about $40,000 to about $190,000 per year. Fort Collins eventually acquired the reservoir in 2004. Under Fort Collins’ Proposed Action, Fort Collins would continue to make annual acquisition payments to NPIC through the year 2030. Under all alternatives other than Fort Collins’ Proposed Action, ownership of Halligan Reservoir would revert to NPIC. NPIC would not be obligated to buy back the existing reservoir and would not be financially liable to Fort Collins upon retaking ownership. However, NPIC would miss a total of about $1.14 million in acquisition payments scheduled to occur between 2020 and 2030.

4.15.2.10 Agricultural Effects

None of the action alternatives would involve either the inundation or purchase of any land currently used for agricultural purposes. According to information provided by Fort Collins and its consultants, the ditch company shares associated with each of the action alternatives are already either controlled by Fort Collins or will be acquired as part of a reasonably foreseeable future action; additional NPIC shares would be acquired under the No-Action Alternative. The effects associated with the RFFAs are addressed separately from project effects and are included in the cumulative effects section, Chapter 5 of this Draft EIS. As a result, there would be no effects to agricultural water supplies, irrigated acreage, or agricultural operations due to the action alternatives.

4.15.2.11 Quality of Life and Social Effects

The overall quality of life of Fort Collins and Larimer County residents currently have would be largely unaffected by the action alternatives, which would not change the general nature or character of the region, or the economic sustainability or livelihood of businesses or residents. Both Fort Collins and Larimer County encourage preservation of agricultural land and agricultural operations and agricultural operations would continue to be an integral part of Larimer County’s identity.

Short-term, construction-related nuisances would exist under all alternatives, with the exception of the No-Action Alternative, but those effects would be focused in specific small areas (i.e., immediately around reservoirs, gravel pits, or other facility sites or along pipeline routes). In the long-term, after Fort Collins completed construction on any of the action alternatives, there would be very limited changes in the daily lives or the livelihood of Larimer County residents. The very small amount of revenue decreases to certain public service entities would not affect the quality of services provided by those agencies.

The most noticeable and longest lasting effect of these alternatives may be the water supply requirement fee and water rate increases for Fort Collins customers, including local developers. However, the annual increases in water rates are quite small for any alternative.
4.15.3 Halligan Dam Rehabilitation

Due to the age and current condition of Halligan Dam, it would likely undergo rehabilitation under all alternatives, other than Fort Collins’ Proposed Action, within the next 10 years (Harvey Economics 2018a). Under Fort Collins’ Proposed Action, the work completed to enlarge Halligan Dam would negate the need for any repairs or rehabilitation of the existing dam, unless dam conditions change noticeably in the near future. Under all other alternatives, including the No-Action Alternative, ownership of the dam would revert to NPIC.

4.15.3.1 Dam Rehabilitation Costs

An initial estimate of the cost of dam rehabilitation activities was included in the Alternative Descriptions Report (MWH Global 2015c). At that time, the estimated cost of rehabilitation activities was $7.6 million. Fort Collins updated that estimate to $8.7 million in mid-2018, based on increases in the costs of materials and supplies for other projects occurring over that period. With about 6,400 acre-feet of existing storage capacity, the cost to rehabilitate Halligan Dam and maintain its storage is an estimated $1,360 per acre-foot.

4.15.3.2 Construction Traffic

Traffic created by construction activity, including haul trucks and commuting workers, has the potential to affect residents near Halligan Reservoir and other drivers on affected roadways. Traffic would increase by an average of about 31 round trips per day over the two-year construction period, including both truck trips and labor trips. During peak periods, traffic would increase by about 70 round trips per day.

The majority of truck and other vehicle traffic would travel on U.S. Highway 287, from Fort Collins north to the Halligan Reservoir access. On an average day, traffic volume would increase by a maximum of about two percent on a small section of U.S. Highway 287 due to project-related traffic; peak day increases would amount to a maximum of about four percent on that section of the road. Increases in traffic volume would be limited to weekdays and would largely occur in the mornings and afternoons as the result of commuting construction workers. The construction contractor would be encouraged to carpool or shuttle workers to and from the site to reduce the volume of vehicle trips; however increased traffic may be noticeable at certain times of the day.

From U.S. Highway 287, truck and vehicle traffic would use the Halligan Reservoir access road to get to the dam site. The access road is gated and would be manned during working hours to alleviate any backups onto U.S. Highway 287. The gate would be locked at other times of the day. Fort Collins would conduct a traffic study to determine the need for adding a left-hand turn lane to U.S. Highway 287 to accommodate truck traffic entering the access road and to evaluate the need for an acceleration lane for truck traffic entering U.S. Highway 287 from the access road. Fort Collins would work with Larimer County and the Colorado Department of Transportation to address safety concerns and develop appropriate safety measures. Current traffic volume on the Halligan Reservoir access road is unknown; however, no residences and few buildings of any type are located along that road, suggesting minimal daily traffic. Therefore, it is unlikely that construction-related truck and commuter vehicle traffic on the access road would cause any effects to other drivers or local residents.
Overall, transportation related effects would be negligible to minor during the two-year construction period. Any increases in vehicle traffic during the operational phase would be negligible.

4.15.3.3 Employment, Income, and Economic Stimulus

The socioeconomic effects of construction activities required for dam rehabilitation would be similar in type to the effects of construction activity under Fort Collins’ Proposed Action and alternatives, including the following:

- Generation of short-term employment and income
- Additional truck and commuter vehicle traffic on certain roads between Fort Collins and Halligan Dam
- Short-term increase in business activity due to purchases of materials and supplies from local and regional vendors
- Potential increases in Fort Collins water rates and NPIC assessments, as described below

4.15.3.4 North Poudre Irrigation Company Assessments

The Corps has assumed that the costs of Halligan Dam rehabilitation would be recouped via a pro-rata, one-time additional assessment on each NPIC share. However, depending on the schedule of rehabilitation activities, the costs might be spread out over a multi-year period, which would reduce the economic effects to shareholders. Increases in NPIC assessments would affect all NPIC shareholders.

Fort Collins would be responsible for about $3.25 million in dam rehabilitation costs under the action alternatives and about $3.83 million under the No-Action Alternative. Fort Collins’ assessments paid to irrigation companies are considered operational funds, which are largely paid through water rates. Therefore, an increase in NPIC assessments would likely result in an increase in Fort Collins water rates. The amount of the increase and the potential implementation of water rate increases under each alternative are discussed in subsequent individual alternative sections. The increase in water rates specific to the dam rehabilitation costs would be in addition to the rate increases necessary to cover the project costs of each alternative.

Costs to other municipal, water district, or agency shareholders could be recouped through increases in water rates or other special charges or fees.

Altogether, NPIC’s agricultural shareholders would be responsible for about $2.0 million of rehabilitation costs under the action alternatives and about $1.4 million under the No-Action Alternative. On average, each agricultural shareholder owns about 4.5 shares and would be responsible for about $3,900 in dam rehabilitation costs. This amount would represent an additional expense and reduction in net income for those shareholders. The significance of this expense would depend in the individual shareholder’s economic circumstances.
4.15.4  Fort Collins’ Proposed Action

4.15.4.1  Project Costs
Fort Collins’ Proposed Action would cost an estimated $38.2 million dollars (2018 dollars). That amount includes pre-construction costs (e.g., field exploration and design), construction costs (labor, equipment, materials and supplies), land and other acquisition costs, and operations and maintenance costs (labor, materials, energy). The project cost estimate does not include costs of permitting or mitigation, or any costs related to risk or uncertainty given the limited conceptual design that exists for this alternative.

4.15.4.2  Construction Phase Employment, Income, and Economic Stimulus

4.15.4.2.1  Direct Economic Stimulus
Direct construction costs of Fort Collins’ Proposed Action would be $30.2 million, which includes labor, equipment and materials costs and excludes pre-construction costs, land acquisition and operations and maintenance costs. The physical construction activities required to enlarge Halligan Reservoir would occur over a period of about 24 months. Total labor hours required to complete the work were estimated to be 170,800; the equivalent of an average annual workforce of about 42 full-time people. During the course of the 24-month construction period, construction employment would peak at about 92 workers. Estimated earnings for all labor required under Fort Collins’ Proposed Action would amount to almost $10.2 million. Equipment costs and the purchase of materials and supplies would comprise about $19.9 million of the $30.2 million construction cost.

4.15.4.2.2  Total Economic Stimulus
Overall, Fort Collins’ Proposed Action would generate approximately $59.6 million in total economic activity in the region over the two-year construction period, including $19.1 million in total income earnings (for an annual average of about 89 full-time people) and a total of $39.3 million of purchased goods. The $39.3 million of purchased goods is equivalent to about 0.4 percent of annual retail sales in Fort Collins and about 0.2 percent as compared to retail sales in Larimer County. Therefore, the construction work completed for Fort Collins’ Proposed Action would provide a negligible stimulus to the regional economy.

4.15.4.3  Operational Employment, Income, and Economic Stimulus
Enlargement of Halligan Reservoir would not require any additional employees; existing Fort Collins staff would conduct the operations and maintenance activities. Annual operations and maintenance costs would amount to about $89,800 under Fort Collins’ Proposed Action, mainly related to the purchase of materials and supplies. On an annual basis, the total economic stimulus related to operations and maintenance activities would be about $141,900, a negligible amount when compared to annual retail sales for Fort Collins or Larimer County (less than 0.004 percent). Over the entire 50-year operational period, the total economic output related to the operation of the enlarged Halligan Reservoir would be about $3.7 million.
4.15.4.4 Fort Collins Utilities Water Rates and Tap Fees
Given the costs presented herein, Fort Collins’ Proposed Action would increase the monthly volume charge (cost per thousand gallons of usage) by 0.3 percent for all Fort Collins Utilities customers to cover annual operations and maintenance costs. The fixed monthly base charge would be unaffected. The increase in the volumetric component of customer rates would amount to an increase of about $0.12 on the water bill of an average single-family customer in the month of July. Given the combination of the fixed and volumetric components of water rates, the overall increase in monthly bills would amount to about 0.2 percent. Increases in water rates under Fort Collins’ Proposed Action would be negligible for all customer types.

Given the costs presented herein, Fort Collins’ Proposed Action would increase the Water Supply Requirement fee by 23 percent for all customer types; that increase would constitute a major effect to that fee. Section 4.15.2.6 discusses the effects of increases in the Water Supply Requirement fee on developers, housing costs, and regional development patterns.

4.15.4.5 Fiscal Effects

4.15.4.5.1 Property Tax Losses
Fort Collins would purchase about 27 acres of privately owned property in the 132.5-acre inundation area for the enlarged Halligan Reservoir. Larimer County would remove the 27 acres of land purchased by Fort Collins from tax rolls because of Fort Collins’ municipal identity. Those acres are rural in nature, generally used for livestock grazing; assessed values for those properties are low compared to other land uses. The loss of a small amount of annual property tax revenue under Fort Collins’ Proposed Action would affect several specific entities within Larimer County, including Larimer County itself. The effects would be negligible for each of those groups, with losses of property taxes ranging from 23 cents per year for the Health District of Northern Larimer County to $5.65 per year for the Poudre R-1 School District.

The remainder of the inundation area is either land currently owned by Fort Collins or Colorado Parks and Wildlife, or is Bureau of Land Management land on which Fort Collins would acquire a right-of-way. Colorado Parks and Wildlife owns property that Fort Collins would purchase; that agency does not pay property taxes and there would be no property tax losses from Fort Collins’ purchase of Colorado Parks and Wildlife land.

4.15.4.5.2 Increased Road Maintenance Costs
Potential increases in road maintenance costs for Fort Collins, Larimer County, or Colorado would be associated with increased truck and worker traffic. The level of increased traffic volume under Fort Collins’ Proposed Action is unlikely to result in any noticeable increase in road maintenance costs.

4.15.4.5.3 North Poudre Irrigation Company Finances
Fort Collins makes annual acquisition payments to NPIC for Halligan Reservoir. The total amount of all payments made between 1993 and 2030 would amount to about $5.4 million. NPIC has used, and would
continue to use, that money for a number of purposes, including general maintenance throughout their system.

4.15.4.6 Environmental Justice

Under Fort Collins’ Proposed Action, construction activities would be concentrated in the vicinity of Halligan Dam (within the Halligan Reservoir Primary Impact Area). As described in Section 3.15.5, the Halligan Reservoir Primary Impact Area includes a very small percent of minority residents (about four percent of total Primary Impact Area residents); however, income levels of Primary Impact Area residents are relatively low, and poverty rates are relatively high, as compared to the state. It is unknown how many, if any, minority or low-income Primary Impact Area residents live in close proximity to the dam; however, construction-related effects, including noise, dust, traffic, or other effects, would potentially affect all Primary Impact Area residents living near the dam, regardless of race or income. Therefore, minority and low-income populations would not be disproportionally affected by construction activities occurring within the Primary Impact Area.

Truck and commuter vehicle traffic would be dispersed among a number of local roads, as well as U.S. Highway 287, depending on where workers live and where materials are produced. Traffic routes would not be specifically concentrated through areas of minority or low-income populations; therefore, no disproportionate effects would be felt by those groups as a result of increases in vehicle traffic during the construction phase or for long-term operations.

Increases in water rates for Fort Collins Utilities customers would be considered negligible under Fort Collins’ Proposed Action; however, those increases would have a larger effect on low-income customers in terms of the percent of income required to pay for water service. For low-income customers, even a small increase in water costs may be a noticeable effect. Increases in water rates would be applied to all customers, regardless of race or income; therefore, low-income and minority groups would not be disproportionately affected by rate increases. The increase in the water supply requirement fee may also have a more noticeable effect on low-income populations, potentially affecting the ability to purchase a home in Fort Collins. However, the increase in that fee and the resulting effects on housing stock would apply to all potential homebuyers, regardless of race or income; low-income and minority groups would not be disproportionally affected by the Water Supply Requirement fee increase.

Fort Collins’ Proposed Action would result in negligible reductions in annual property tax revenue received by Larimer County and specific public entities within the Halligan Reservoir Primary Impact Area. Those entities (i.e., school district, fire district, library district) serve all county and Primary Impact Area residents, regardless of race or income. Therefore, any changes in public services would not result in disproportionate effects to minority or low-income populations. Overall, Fort Collins’ Proposed Action would not result in any disproportionate effects to minority or low-income populations as the result of construction activities or long-term operations.

4.15.4.7 Effects of Other Mitigation Measures

Fort Collins could undertake certain actions as mitigation for the loss of recreational opportunities along about a one-mile reach of the North Fork upstream of Halligan Reservoir, and as mitigation for the
inundation of portions of the Cherokee State Wildlife Area Middle Unit. Some of those actions, including the following, would result in socioeconomic effects to residents and businesses in northern Colorado:

- Fort Collins is considering the possibility of opening a portion of Halligan Reservoir and the adjacent shoreline to public recreation, which could include fishing from shore, fishing from a human propelled watercraft such a kayak or belly boat, and wildlife viewing. The recreation area would be managed by Fort Collins or a third party.

- Construction of a small parking area and a vault toilet near the area where the access road would meet the enlarged Halligan Reservoir.

Recreational visitors would access the new parking area at Halligan Reservoir from County Road 80C (Cherokee Park Road) and existing Colorado Parks and Wildlife access roads (vehicle access allowed between May 2nd and August 31st). Annual and daily traffic volumes associated with public recreation on Halligan Reservoir have not been quantified; however, due to the limited nature of recreation being considered, combined with vehicle restrictions through the Cherokee State Wildlife Area Middle Unit, increases in traffic due to recreation are anticipated to be small.

If Fort Collins would allow public recreation at Halligan Reservoir and along the shoreline, the Corps estimated that about 1,000 visitors per year might recreate at the enlarged Halligan Reservoir. The opportunity to recreate at Halligan Reservoir would provide a social benefit to Larimer County residents and visitors, in terms of the existence of an additional location available for recreation. However, the economic effects of this mitigation measure may be limited for several reasons:

- Access to Halligan Reservoir would be limited (four-wheel drive only in the summer months; hike-in only during other months), motorized boating would be prohibited, and no overnight camping would be allowed. Those factors would limit the number of overall visitors each year.

- Fort Collins does not envision implementing any permit fees to access the area.

- It is unknown how much of the estimated visitation to Halligan Reservoir would constitute new recreational activity in Larimer County and how much might reflect use of Halligan Reservoir as a substitute for other existing locations. New recreational activity may generate sales of certain types of gear, fishing permits or other items, while the movement of activity from one location to another would not likely generate a measurable amount of additional economic activity.

- Increased recreational activity on the part of existing anglers may not generate additional spending at businesses that cater to fishing. Those visitors likely already own the necessary gear for recreation and may not purchase additional items solely on the opportunities provided at Halligan Reservoir.

- Construction of a parking area would generate a small amount of short-term employment and income for construction workers. Those construction activities may also result in a small amount of additional spending by Fort Collins for materials and supplies from local businesses; those purchases would not be subject to local or state sales tax.
4.15.5 Expanded Glade Alternative

4.15.5.1 Project Costs

The expansion of NISP’s proposed Glade Reservoir to accommodate additional water storage space for Fort Collins would cost an estimated $60.9 million dollars (2018 dollars). That amount includes pre-construction costs (e.g., field exploration and design), construction costs (labor, equipment, materials, and supplies), land and other acquisition costs, and operations and maintenance costs (labor, materials, energy). The project cost estimate does not include costs of permitting or mitigation, or any costs related to risk or uncertainty, given the limited conceptual design that exists for this alternative.

4.15.5.2 Construction Phase Employment, Income, and Economic Stimulus

4.15.5.2.1 Direct Economic Stimulus

Direct construction costs of the Expanded Glade Alternative would be $43.0 million, which includes labor, equipment and materials costs and excludes pre-construction costs, land acquisition and operations and maintenance costs. Construction activity to expand the proposed Glade Reservoir would occur over a period of about 48 months. Total labor hours required to complete the work were estimated to be 221,900, the equivalent of an average annual workforce of about 27 full-time people. During the course of the 48-month construction period, construction employment for the Fort Collins expansion only would peak at about 60 workers. Total earnings for all labor required under this alternative would amount to about $11.6 million. Equipment costs and the purchase of materials and supplies would comprise about $31.4 million of the $43.0 million construction cost.

4.15.5.2.2 Total Economic Stimulus

Overall, the Expanded Glade Alternative would generate approximately $84.8 million in total economic activity in the region over the four-year construction period, including $21.6 million in total income earnings (for an annual average of about 58 full-time people) and a total of $62.0 million of purchased goods. That $62.0 million of purchased goods is equivalent to about 0.3 percent of annual retail sales in Fort Collins and about 0.15 percent as compared to Larimer County’s retail sales. Therefore, the construction work completed for the Expanded Glade Alternative would provide a negligible stimulus to the regional economy.

4.15.5.3 Operational Employment, Income, and Economic Stimulus

The Expanded Glade Alternative would require one additional employee to complete operations and maintenance activities, particularly pumping and pretreatment facility operations. Fort Collins assumes annual wages for that employee would be approximately $56,000 and, including benefits, would amount to approximately $70,000. Annual operations and maintenance costs would amount to about $369,300 under the Expanded Glade Alternative, which includes wages and benefits for one additional employee, plus materials, supplies, and pump station energy costs.
On an annual basis, the total economic stimulus related to operations and maintenance activities would be about $584,000, a negligible amount when compared to annual income and retail sales data at Fort Collins and County levels (approximately 0.02 percent). Total annual employment generated by operational activities would be about three full-time people. Over the entire 50-year operational period, the total economic output related to the operation of the Expanded Glade Alternative would be about $15.0 million.

4.15.5.4 Construction Traffic

For the Expanded Glade Alternative, traffic would increase by an average of about 20 round trips per day over the four-year construction period, including both truck trips and labor trips. During peak periods, traffic would increase by about 43 round trips per day.

The majority of truck and other vehicle traffic would travel on U.S. Highway 287, between Fort Collins and Colorado Highway 14 at the mouth of the Poudre Canyon, and then on Colorado Highway 14 to the access road leading to the construction site. On an average day, traffic volume would increase by a maximum of about 0.5 percent on small portions of U.S. Highway 287 and a maximum of about 1.6 percent on a small section of Colorado Highway 14, due to project related traffic. A very small number of trucks and commuter vehicles would use local roads within Fort Collins. The relatively small amount of additional traffic on these roads would result in negligible transportation effects over the four-year construction period. Increased vehicle traffic during the operational phase would be negligible.

4.15.5.5 Fort Collins Utilities Water Rates and Tap Fees

Given the costs presented herein, under the Expanded Glade Alternative, Fort Collins’ monthly volume charge for water would increase by 1.3 percent for all Fort Collins Utilities customers to cover additional annual operations and maintenance costs. The fixed monthly base charge would be unaffected. The increase in the volumetric component of customer rates would amount to an increase of about $0.49 on the water bill of an average single-family customer in the month of July. Given the combination of the fixed and volumetric components of water rates, the overall increase in monthly bills would amount to about 0.9 percent. Increases in water rates under the Expanded Glade Alternative would be negligible for all customer types.

Section 4.15.2.5 discussed the likelihood of Fort Collins increasing water rates to pay for their portion of Halligan Dam rehabilitation costs. Under the Expanded Glade Alternative, that increase could be as much as 11.75 percent in the year in which the additional NPIC assessments are charged. However, it is more likely that Fort Collins would spread that increase out over a period of several years, reducing the effects to water rates in any given year.

Given the costs presented herein for the Expanded Glade Alternative, Fort Collins’ water supply requirement fee would increase by 43 percent for all customer types; that increase would constitute a major effect to that fee. Section 4.15.2.6 discussed the effects of increases in the Water Supply Requirement fee on developers, housing costs, and regional development patterns.
4.15.5.6 Fiscal Effects

4.15.5.6.1 Property Tax Losses
As part of this alternative, Fort Collins would purchase from Northern Water 57 acres of land in the inundation area of the expanded reservoir. Northern Water does not pay property taxes on that acreage presently. Therefore, Fort Collins’ purchase of that land would not result in any property tax losses. No entities that receive funding from property taxes would be affected.

4.15.5.6.2 Increased Road Maintenance Costs
The low level of increased traffic volume due to construction of the proposed Glade Reservoir is unlikely to result in any noticeable increase in Larimer County’s road maintenance costs. No additional recreational activity would be expected to occur at the proposed Glade Reservoir because of Fort Collins’ proposed Glade Reservoir expansion. Therefore, no additional recreational traffic would be generated by the expansion and Larimer County would not be responsible for any additional road costs or other operating expenses.

4.15.5.7 Environmental Justice
Under the Expanded Glade Alternative, construction activities would be concentrated in the area of the proposed Glade Reservoir (located within the Expanded Glade Primary Impact Area). As described in Section 3.15.6, the Expanded Glade Primary Impact Area includes a small percent of minority residents (about six percent of total Primary Impact Area residents). Income levels of Primary Impact Area residents are relatively high and poverty rates are relatively low compared to the rest of the state. Construction-related effects, including noise, dust, traffic, or other effects, would potentially affect all Primary Impact Area residents living near the proposed Glade Reservoir, regardless of race or income. Therefore, minority and low-income populations would not be disproportionately affected by construction activities occurring within the Primary Impact Area.

Truck and commuter vehicle traffic would be dispersed among a number of local roads, as well as U.S. Highway 287, depending on where workers live and where materials are produced. Traffic routes would not be specifically concentrated through areas of minority or low-income populations; therefore, no disproportionate effects would be felt by those groups as a result of increases in vehicle traffic during the construction phase or for long-term operations.

Increases in water rates for Fort Collins Utilities customers would be considered negligible under the Expanded Glade Alternative; however, those increases would have a larger effect on low-income customers in terms of the percent of income required to pay for water service. For low-income customers, even a small increase in water costs may be a noticeable effect. Increases in water rates would be applied to all customers, regardless of race or income; therefore, low-income and minority groups would not be disproportionately affected by rate increases. The increase in the Water Supply Requirement fee may also have a more noticeable effect on low-income populations, potentially affecting the ability to purchase a home in Fort Collins. However, the increase in that fee and the resulting effects on housing stock would apply to all potential homebuyers, regardless of race or income; low-income and minority groups would
not be disproportionally affected by the Water Supply Requirement fee increase. Overall, the Expanded Glade Alternative would not result in any disproportionate effects to minority or low-income populations as the result of construction activities or long-term operations.

4.15.6 Gravel Pits Alternative

4.15.6.1 Project Costs
The Gravel Pits Alternative would cost an estimated $133.4 million dollars (2018 dollars). That amount includes pre-construction costs (e.g., field exploration and design), construction costs (labor, equipment, materials, and supplies), land and other acquisition costs, and operations and maintenance costs (labor, materials, and energy). The project cost estimate does not include costs of permitting or mitigation, or any costs related to risk or uncertainty given the limited conceptual design that exists for this alternative.

4.15.6.2 Construction Phase Employment, Income, and Economic Stimulus

4.15.6.2.1 Direct Economic Stimulus
Direct construction costs of the Gravel Pits Alternative would be $99.3 million, which includes labor, equipment and materials costs and excludes pre-construction costs, land acquisition and operations and maintenance costs. Construction activities related to the gravel pits, pipelines, and other facilities included in the Gravel Pits Alternative would occur over a period of about 12 months. Total labor hours required to complete the work were estimated to be 810,900, the equivalent of an average annual workforce of about 398 full-time people, although during the course of the 12-month construction period, construction employment would peak at about 875 workers. Total earnings for all labor required under this alternative would amount to over $35.4 million. Equipment costs and the purchase of materials and supplies would comprise about $63.9 million of the $99.3 million construction cost.

4.15.6.2.2 Total Economic Stimulus
Overall, the Gravel Pits Alternative would generate approximately $196.0 million in total economic activity in the region over the one-year construction period, including $66.0 in total income earnings (for an annual average of about 847 full-time people) and a total of $126.1 of purchased goods. That $126.1 million of purchased goods is equivalent to about 2.6 percent of annual retail sales in Fort Collins and about 1.3 percent of retail sales in Larimer County. Therefore, the construction work completed for the Gravel Pits Alternative would provide a minor stimulus to the regional economy.

4.15.6.3 Operational Employment, Income, and Economic Stimulus
The Gravel Pits Alternative would require one additional employee to complete operation and maintenance activities, particularly pumping and pre-treatment facility operations. Fort Collins assumes annual wages for that employee would be approximately $56,000 and, including benefits, would amount to approximately $70,000. Annual operations and maintenance costs would amount to about $431,700 for
the Gravel Pits Alternative, which includes wages and benefits for one additional employee, plus materials, supplies, and pump station energy costs.

On an annual basis, the total economic stimulus related to operations and maintenance activities would be about $682,000, a negligible amount when compared to retail sales data for Fort Collins or Larimer County (less than 0.02 percent). Total annual employment generated by operational activities would be about three full-time people. Over the entire 50-year operational period, the total economic output related to the operation of the gravel pits and associated facilities would be about $17.5 million.

4.15.6.4 Construction Traffic

For the Gravel Pits Alternative, traffic would increase by an average of about 268 round trips per day over the one-year construction period, including both truck trips and labor trips. During peak periods, traffic would increase by about 590 round trips per day. The majority of that traffic would be workers commuting to various work sites; very few truck trips would occur on a daily basis.

Under the Gravel Pits Alternative, trucks and commuting workers would travel to work sites at the gravel pits and along the pipeline route using a number of roads, including a segment of U.S. Highway 287; Larimer County Roads 54G, 19, and 48; and Overland Trail Road. On a peak day, traffic volume would increase by a maximum of about 4.4 percent on one segment of U.S. Highway 287, a maximum of about 17 percent on a short segment of Larimer County Road 19 (less than four miles) and a maximum of about seven percent on a very short segment of Overland Trail Road, due to project-related traffic. Average day traffic volumes would be about half of peak day volumes. Overall, traffic effects would be minor to moderate during the one-year construction period.

4.15.6.5 Fort Collins Utilities Water Rates and Tap Fees

Given the costs presented herein, under the Gravel Pits Alternative, Fort Collins’ monthly volume charge would increase by 1.6 percent for all Fort Collins Utilities customers to cover increases in annual operations and maintenance costs. The fixed monthly base charge would be unaffected. The increase in the volumetric component of customer rates would amount to an increase of about $0.57 on the water bill of an average single-family customer in the month of July. Given the combination of the fixed and volumetric components of water rates, the overall increase in monthly bills would amount to about 1.0 percent. Increases in water rates under the Gravel Pits Alternative would be minor for all customer types.

Section 4.15.2.6 discussed the likelihood of Fort Collins increasing water rates to pay for their portion of Halligan Dam rehabilitation costs. Under the Gravel Pits Alternative, that increase could be as much as 11.75 percent in the year in which the additional NPIC assessments are charged. However, it is more likely that Fort Collins would spread that increase out over a period of several years, reducing the effects to water rates in any given year.

Given the costs presented herein for the Gravel Pits Alternative, Fort Collins’ Water Supply Requirement fee would increase by 123 percent for all customer types; that increase would constitute a major effect to that fee. Section 4.15.2.6 discussed the implementation of this fee increase and the effects of Water Supply Requirement fee increases on developers, housing costs, and regional development patterns.
4.15.6.6 Fiscal Effects

4.15.6.6.1 Property Tax Losses
Under the Gravel Pits Alternative, Fort Collins would purchase about 275 acres of land near the existing gravel pit complex. About 270 of those acres are the gravel pits and surrounding properties; the remaining five acres would house the pump station, pre-treatment facility, and associated infrastructure. Private individuals or entities currently own that acreage. Therefore, Fort Collins’ land purchases would remove all 275 acres from the Larimer County tax rolls. The loss of a relatively small amount of annual property tax revenue under the Gravel Pits Alternative would affect several specific entities within Larimer County, including Larimer County itself. However, the effects to any individual entity affected by this loss would be negligible. For example, in 2012, Larimer County property tax revenue was about $89.0 million; the estimated loss of about $2,800 per year to Larimer County would be inconsequential. Loss of $6,577 of property tax revenue to the school district would be very small, given the school district’s revenues from property taxes of over $66 million per year. All other entities would each lose less than $1,500 per year in property tax revenue, which also should be unnoticeable.

4.15.6.6.2 Increased Road Maintenance Costs
The level of increased traffic volume under the Gravel Pits Alternative, especially as somewhat dispersed over a number of roads and continuing only over a one-year period, is unlikely to result in any measurable increase in road maintenance costs.

4.15.6.7 Environmental Justice
Under the Gravel Pits Alternative, construction activities would be concentrated in close proximity to the existing or future gravel pits (within the Gravel Pits Primary Impact Area). As described in Section 3.15.7, about eight percent of residents of the Gravel Pits Primary Impact Area are minorities. Income levels of Primary Impact Area residents are relatively high compared to the rest of the state, while poverty rates are similar to the rest of the state. Construction related effects, including noise, dust, traffic or other effects, would potentially affect all Primary Impact Area residents, regardless of race or income. Therefore, minority and low-income populations would not be disproportionally affected by construction activities occurring within the Primary Impact Area.

Truck and commuter vehicle traffic would be dispersed among a number of local roads, as well as a segment of U.S. Highway 287, depending on where workers live and where materials are produced. Traffic routes would not be specifically concentrated through areas of minority or low-income populations; therefore, no disproportionate effects would be felt by those groups as a result of increases in vehicle traffic during the construction phase or for long-term operations.

Increases in water rates for Fort Collins Utilities customers would be considered minor under the Gravel Pits Alternative. Those increases would have a larger effect on low-income customers in terms of the percent of income required to pay for water service. For low-income customers, even a small increase in water costs may be a noticeable effect. Increases in water rates would be applied to all customers, regardless of race or income; therefore, low-income and minority groups would not be disproportionally
affected by rate increases. The increase in the Water Supply Requirement fee may also have a more noticeable effect on low-income populations, potentially affecting the ability to purchase a home in Fort Collins. However, the increase in that fee and the resulting effects on housing stock would apply to all potential homebuyers, regardless of race or income; low-income and minority groups would not be disproportionately affected by the Water Supply Requirement fee increase.

The Gravel Pits Alternative would result in negligible reductions in the annual property tax revenue received by Larimer County and specific public entities within the Gravel Pits Primary Impact Area. Those entities (i.e., school district, fire district, library district) serve all county and Primary Impact Area residents, regardless of race or income. Therefore, any changes in public services would not result in disproportionate effects to minority or low-income populations.

In terms of agricultural activity, the loss of a small amount of water per irrigated acre in the later part of the growing season could have an effect on per acre yields for NPIC’s agricultural shareholders. A reduction in yields may result in fewer seasonal workers hired within the agricultural sector in Larimer County. Farm workers may be disproportionately comprised of minority and low-income individuals; therefore, minority and low-income farm workers may be disproportionately affected by the operation of the Gravel Pits Alternative. However, the number of hired farm workers affected would depend on the amount of any reduction in per-acre yields and whether those reductions were large enough to result in less hiring of seasonal labor. Additionally, only NPIC shareholders would experience the potential reduction in yields, limiting the number of potentially affected farm workers.

The Gravel Pits Alternative could result in disproportionate effects to minority or low-income populations as the result of changes in the operation of Joe Wright Reservoir. However, those effects would be limited to seasonal farm workers hired by NPIC’s agricultural shareholders, a potentially small number of people. Neither construction activities nor operation of the gravel pits would result in any disproportionate effects to minority or low-income populations.

4.15.6.8 Agricultural Effects

Reoperation of Joe Wright Reservoir would reduce late summer and early fall water releases from the reservoir. Historically, Fort Collins has exchanged about 1,600 acre-feet of released Joe Wright water with NPIC annually, to the mutual benefit of both parties. The exchange allows NPIC to take delivery of its C-BT water at the Munroe Canal at a time of year when NPIC shareholders need that water to finish crops and in a location where NPIC can deliver the water to shareholders on the northern end of the NPIC system. However, the reduction in Joe Wright Reservoir releases means that NPIC would likely lose the possibility of exchanging that 1,600 acre-feet of water, reducing total annual NPIC diversions by that amount (less than three percent of total NPIC diversions). The reduction in diversions and allocations would be distributed among all NPIC shareholders, including agricultural operators.

As of 2018, NPIC included about 550 agricultural shareholders; together, those shareholders hold about 2,500 NPIC shares (about 25 percent of total shares). Reoperation of Joe Wright Reservoir would result in a loss of about 0.16 acre-feet per share (a loss of between 2.7 percent and four percent per share). Agricultural shareholders within NPIC irrigate about 23,000 acres of agricultural land (NPIC 2015 website). Altogether, NPIC’s agricultural shareholders would experience a loss of about 400 acre-feet of water each year, or about 0.02 acre-feet per irrigated acre, as the result of changes in the water yield of...
agricultural shares. Municipal shareholders often rent water back to agricultural shareholders. If the Joe Wright Reservoir reoperation resulted in a decrease in rented water to agricultural operators such that the entire 1,600 acre-feet of water lost to NPIC annually affected only agricultural operations, the effect would amount to a loss of 0.07 acre-feet per irrigated acre.

Although the relatively small reduction in water deliveries would not be large enough to measurably change either the number of acres irrigated or the types of crops grown in the area, a reduction at that time of the year would have the potential to reduce per-acre yields. The degree of any effect to crop yields would also depend on weather and other factors, as well as individual irrigator circumstances. Effects would be negligible to minor for individual operators.

4.15.7 Agricultural Reservoirs Alternative

4.15.7.1 Project Costs

The Agricultural Reservoirs Alternative would cost an estimated $170.8 million dollars (2018 dollars). That amount includes pre-construction costs (e.g., field exploration and design), construction costs (labor, equipment, materials, and supplies), land and other acquisition costs, and operations and maintenance costs (labor, materials, and energy). The project cost estimate does not include costs of permitting or mitigation, or any costs related to risk or uncertainty given the limited conceptual design that exists for this alternative.

4.15.7.2 Construction Phase Employment, Income, and Economic Stimulus

4.15.7.2.1 Direct Economic Stimulus

Direct construction costs of the Agricultural Reservoirs Alternative would be $82.6 million, which includes labor, equipment and materials costs and excludes pre-construction costs, land acquisition and operations and maintenance costs. Construction activities required to support Fort Collins use of NPIC Reservoirs Number 5 and 6 would occur over a period of about 12 months. Total labor hours required to complete the work were estimated to be 509,100, the equivalent of an average annual workforce of about 250 full-time people, although during the course of the 12-month construction period, construction employment would peak at about 549 workers. Total earnings for all labor required under the Agricultural Reservoirs Alternative would amount to about $22.8 million. Equipment costs and the purchase of materials and supplies would comprise about $59.7 million of the $82.6 million construction cost.

4.15.7.2.2 Total Economic Stimulus

Overall, the Agricultural Reservoirs Alternative would generate approximately $163.0 million in total economic activity in the region over the one-year construction period, including $42.5 million in total income earnings (for an annual average of about 532 full-time people) and a total of $117.9 million of purchased goods. That $117.9 million of purchased goods is equivalent to less than 2.5 percent of annual retail sales in Fort Collins and less than 1.2 percent for Larimer County. Therefore, the construction work
completed for the Agricultural Reservoirs Alternative would provide a minor stimulus to the regional economy.

### 4.15.7.3 Operational Employment, Income, and Economic Stimulus

The Agricultural Reservoirs Alternative would require one additional employee to complete operation and maintenance activities, particularly pumping and pre-treatment facility operations. Fort Collins assumes annual wages for that employee would be approximately $56,000 and, including benefits, would amount to approximately $70,000. Annual operations and maintenance costs would amount to about $447,600 per year under the Agricultural Reservoirs Alternative, which includes wages and benefits for one additional employee, plus materials, supplies, and pump station energy costs.

On an annual basis, the total economic stimulus related to operations and maintenance activities would be about $707,200, a negligible amount when compared to annual retail sales volume for Fort Collins or Larimer County (less than 0.02 percent). Total annual employment generated by operational activities would be about three full-time people. Over the entire 50-year operational period, the total economic output related to operation of the Agricultural Reservoirs Alternative would be about $18.2 million.

In addition to the economic effects described above, NPIC would receive a relatively large sum of money as payment for both the storage space in the reservoirs and the reduction in water rights yields (described in Section 4.15.7.6). NPIC may choose to use that money in a number of ways, including system maintenance projects, which could generate future employment opportunities.

### 4.15.7.4 Construction Traffic

For the Agricultural Reservoirs Alternative, traffic would increase by an average of about 170 round trips per day over the one-year construction period, including both truck trips and labor trips. During peak periods, traffic would increase by about 375 round trips per day. Almost 98 percent of total vehicle traffic would be due to commuting workers.

The Agricultural Reservoirs Alternative would require trucks and commuting workers to travel to work sites at the reservoirs and along the pipeline route using a number of roads, including a segment of U.S. Highway 287, Larimer County Roads 54G and 58, Overland Trail Road, and Terry Lake Road. On a peak day, traffic volume would increase by a maximum of about three percent on one segment of U.S. Highway 287, a maximum of about three percent on Larimer County Road 54G and a maximum of about five percent on Overland Trail Road, due to project-related traffic. A very small number of vehicles would travel on other county and city roads throughout the construction period. Overall, traffic effects would be minor to moderate during the one-year construction period.

### 4.15.7.5 Fort Collins Utilities Water Rates and Tap Fees

Given the costs presented herein, under the Agricultural Reservoirs Alternative, Fort Collins’ monthly volume charge would increase by 1.6 percent for all Fort Collins Utilities customers to cover increases in annual operations and maintenance costs associated with this alternative. The fixed monthly base charge would be unaffected. The increase in the volumetric component of customer rates would amount to an increase of about $0.60 on the water bill of an average single-family customer in the month of July. Given
the combination of the fixed and volumetric components of water rates, the overall increase in monthly 
bills would amount to about 1.1 percent. Increases in water rates under the Agricultural Reservoirs 
Alternative would be minor for all customer types.

Section 4.15.2.6 discussed the likelihood of Fort Collins increasing water rates to pay for their portion of 
Halligan Dam rehabilitation costs. Under the Agricultural Reservoirs Alternative, that increase could be 
as much as 11.75 percent in the year in which the additional NPIC assessments are charged. However, it 
is more likely that Fort Collins would spread that increase out over a period of several years, reducing the 
effects to water rates in any given year.

Given the costs presented herein for the Agricultural Reservoirs Alternative, Fort Collins’ Water Supply 
Requirement fee would increase by 166 percent for all customer types; that increase would constitute a 
major effect to that fee. Section 4.15.2.6 discussed the implementation of this fee increase and the effects 
of Water Supply Requirement fee increases on developers, housing costs and regional development 
patterns.

4.15.7.6 Fiscal Effects

4.15.7.6.1 Property Tax Losses

As part of the Agricultural Reservoirs Alternative, Fort Collins would purchase about two acres of land 
for the pre-treatment facility, pump station, and other infrastructure. Private entities currently own that 
property and Fort Collins’ purchase of that land would remove it from the Larimer County tax rolls. The 
result would be the loss of a very small amount of annual property tax revenue for several specific entities 
within Larimer County, including Larimer County itself. The effects are negligible for each of those 
groups, ranging from two cents to $6.59 per year.

4.15.7.6.2 Increased Road Maintenance Costs

The level of increased traffic volume associated with the Agricultural Reservoirs Alternative, especially 
as somewhat dispersed over a number of roads, is unlikely to result in any noticeable increase in road 
maintenance costs.

4.15.7.6.3 North Poudre Irrigation Company Finances and Operations

Under the Agricultural Reservoirs Alternative, NPIC would be financially affected in two ways. First, 
Fort Collins would purchase storage space in NPIC Reservoirs Number 5 and 6 for approximately 
$25.3 million. Second, Fort Collins would pay NPIC approximately $41.1 million for reduction in water 
rights yields due to reduced storage volume in those reservoirs. Fort Collins would only purchase a 
portion of the total capacity of each reservoir. Ownership of the reservoirs and operation of the remaining 
storage space in each reservoir would continue to be the responsibility of NPIC. NPIC would likely use 
the funds generated by this alternative for several purposes including general system maintenance and as 
part of a “rainy day” fund for emergencies or other issues. NPIC could also decide to purchase additional 
water supplies, for example additional C-BT units, to replace any loss in yield associated with Fort 
Collins’ use of Reservoirs Number 5 and 6.
These transactions would benefit NPIC financially, but would not measurably affect the irrigation company’s ability to provide water to shareholders for several reasons, including the location and current use of the reservoirs and the amount of the yield reduction compared to total NPIC supplies. Reservoirs Number 5 and 6 are located on the southern end of NPIC’s system and, as such, are only used to serve a very small number of shareholders and a small number of irrigated acres (between 600 and 1,000 acres total; personal communication between Susan Walker, Scott Hummer, General Manager of the North Poudre Irrigation Company, and Ed Harvey, September 2015). Delivery of water to those shareholders would continue via Reservoirs Number 5 and 6. Historically, the reservoirs have been useful in making exchanges with other entities in northern Colorado, but in recent years, the potential for continuing those exchanges has dwindled.

The second component of this transaction, the reduction in water right yields associated with Reservoirs Number 5 and 6, would result in an annual yield reduction of an average of about 1,500 acre-feet for NPIC. As compared to average annual diversions of about 65,000 acre-feet, that reduction in yield would amount to a very small portion of total NPIC supplies, about 2.5 percent. NPIC would distribute that reduction among all shareholders, since each share of NPIC stock is allocated the same (pro rata) amount of water. That small reduction to each shareholder would likely be a minor effect to individual water users.

Currently, one benefit of Agricultural Reservoirs Number 5 and 6 to NPIC is the revenue from recreational leases. Those recreational leases, and the associated revenue, would continue under the Agricultural Reservoirs Alternative.

4.15.7.7 Agricultural Effects

The approximately 1,500 acre-feet reduction in water rights yields associated with Reservoirs Number 5 and 6 would result in a small reduction in the annual allocation to each NPIC shareholder, including agricultural operators. That small reduction, about 2.5 percent of the annual allocation, would not be large enough to change either the number of acres irrigated or the types of crops grown in the area. The small reduction in water supplies for each agricultural shareholder would have the potential to marginally reduce per-acre yields; however, the specific effects of that reduction on agricultural yields would also depend on weather and other factors. Alternatively, if NPIC decided to purchase additional water supplies using the payments made by Fort Collins, those supplies would be made available to shareholders and the agricultural effects associated with Fort Collins’ purchase of storage space in these reservoirs would be minimized or possibly even eliminated.

4.15.7.8 Environmental Justice

Under the Agricultural Reservoirs Alternative, construction activities would be concentrated around NPIC Reservoirs Number 5 and 6 (within the Agricultural Reservoirs Primary Impact Area). As described in Section 3.15.8, about eight percent of residents of the Agricultural Reservoirs Primary Impact Area are minorities. Income levels of Primary Impact Area residents are relatively high and poverty rates are relatively low compared to the rest of the state. Construction related effects, including noise, dust, traffic, or other effects, would potentially affect all Primary Impact Area residents, regardless of race or income.
Therefore, minority and low-income populations would not be disproportionately affected by construction activities occurring within the Primary Impact Area.

Truck and commuter vehicle traffic would be dispersed among a number of local roads, as well as a segment of U.S. Highway 287, depending on where workers live and where materials are produced. Traffic routes would not be specifically concentrated through areas of minority or low-income populations; therefore, no disproportionate effects would be felt by those groups as a result of increases in vehicle traffic during the construction phase or for long-term operations.

Increases in water rates for Fort Collins Utilities customers would be considered minor under the Agricultural Reservoirs Alternative. Those increases would have a larger effect on low-income customers in terms of the percent of income required to pay for water service. For low-income customers, even a small increase in water costs may be a noticeable effect. Increases in water rates would be applied to all customers, regardless of race or income; therefore, low-income and minority groups would not be disproportionately affected by rate increases. The increase in the Water Supply Requirement fee may also have a more noticeable effect on low-income populations, potentially affecting the ability to purchase a home in Fort Collins. However, the increase in that fee and the resulting effects on housing stock would apply to all potential homebuyers, regardless of race or income; low-income and minority groups would not be disproportionately affected by the Water Supply Requirement fee increase.

The Agricultural Reservoirs Alternative would result in negligible reductions in the annual property tax revenue received by Larimer County and specific public entities within Larimer County. Those entities (i.e., school district, fire district, library district) serve all county and Primary Impact Area residents, regardless of race or income. Therefore, any changes in public services would not result in disproportionate effects to minority or low-income populations.

In terms of agricultural activity, the loss of a small amount of water per NPIC share could have an effect on per-acre yields for agricultural shareholders. A reduction in yields may result in fewer seasonal workers hired within the agricultural sector in Larimer County. Farm workers may be disproportionately comprised of minority and low-income individuals; therefore, minority and low-income farm workers may be disproportionately affected by the Agricultural Reservoirs Alternative. However, the number of seasonal farm workers affected would depend on the amount of any reduction in per acre yields and whether those reductions were large enough to result in less hiring of seasonal labor. Additionally, only NPIC shareholders would experience the potential reduction in yields, limiting the number of potentially affected farm workers.

The Agricultural Reservoirs Alternative could result in disproportionate effects to minority or low-income populations as the result of reduction in water rights yields associated with Reservoirs Number 5 and 6. However, those effects would be limited to seasonal farm workers hired by NPIC’s agricultural shareholders, a potentially small number of people. Neither construction activities nor any other aspects of the operation of Reservoirs Number 5 and 6 would result in any disproportionate effects to minority or low-income populations.
4.15.8 No-Action Alternative

As described in Section 1.1.5, the No-Action Alternative would include reoperation of Joe Wright Reservoir, acquisition of additional NPIC shares, and implementation of more frequent and severe water use restrictions. Reoperation of Joe Wright Reservoir under the No-Action Alternative would be the same as described for the Gravel Pits Alternative. The acquisition of NPIC shares would include Fort Collins’ acquisition of 655 additional shares in that company. Additionally, Fort Collins would implement mandatory water use restrictions about six percent of the time (five years out of the 86-year modeling period). Of those five years, four would require Level 1 restrictions and one would require Level 3 restrictions. The 2014 Updated Water Supply Shortage Response Plan (Fort Collins 2014) includes a description of the full scope Level 1 and Level 3 restrictions. Figure 4-70 presents a brief summary of the major restrictions.

<table>
<thead>
<tr>
<th>Water Use Activity</th>
<th>Level 1</th>
<th>Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lawn Watering on City Parks/ School Grounds/ Athletic Fields/ Golf Courses</td>
<td>Max 1.25” per week on any day before 10 am or after 6 pm</td>
<td>Only for selected fields. Max 0.75” per week on any day before 10 am or after 6 pm</td>
</tr>
<tr>
<td>Watering Dirt for City Park Ball Fields</td>
<td>Unrestricted</td>
<td>Unrestricted</td>
</tr>
<tr>
<td>Splash Parks</td>
<td>Unrestricted</td>
<td>No use allowed</td>
</tr>
<tr>
<td>Outdoor Swimming Pools</td>
<td>Unrestricted</td>
<td>Unrestricted</td>
</tr>
<tr>
<td>Water Rates</td>
<td>No adjustment</td>
<td>25% increase in all current water rates</td>
</tr>
<tr>
<td>Excess Water Use Surcharge</td>
<td>No adjustment</td>
<td>15% increase in surcharge</td>
</tr>
</tbody>
</table>


Figure 4-70. Selected water use restrictions included in the Fort Collins Updated Water Supply Shortage Response Plan.

4.15.8.1 Project Costs

Fort Collins would invest about the same amount of money budgeted for Fort Collins’ Proposed Action into water acquisitions, specifically shares of NPIC (MWH Global 2015c). Therefore, the No-Action Alternative would cost an estimated $38.2 million dollars, all for water acquisitions.

4.15.8.2 Employment, Income, and Economic Stimulus

The No-Action Alternative would not directly generate any additional jobs, associated income, or economic stimulus. Fort Collins would not hire any additional people or purchase any specific materials or supplies for operations.
4.15.8.3 **Fort Collins Utility Water Rates and Tap Fees**

Because the No-Action Alternative would not entail any operation and maintenance activities, Fort Collins would not implement a permanent increase in volumetric water rates as a direct result of this alternative. Water rates would only increase in years in which Fort Collins would implement Level 3 mandatory watering restrictions; in those years, water rates would increase by 25 percent for all customers. Additionally, the excess water surcharge would increase by 15 percent for all customers in applicable situations. These increases in water rates would result in major effects to customers; however, Level 3 restrictions would occur only rarely, in one year of the 86-year modeling period. Due to the rarity of Level 3 restrictions, the net effect would be minor.

Section 4.15.2.6 discussed the likelihood of Fort Collins increasing water rates to pay for their portion of Halligan Dam rehabilitation costs. Under the No-Action Alternative, that increase could be as much as 13.82 percent in the year in which the additional NPIC assessments are charged. However, it is more likely that Fort Collins would spread that increase out over a period of several years, reducing the effects to water rates in any given year.

Given the costs presented herein, the No-Action Alternative would require a 23 percent increase in Fort Collins’ Water Supply Requirement fee for all customer types; that increase would constitute a major effect to that fee. This increase is the same as that estimated for Fort Collins’ Proposed Action due to the assumption that the total costs of the No-Action Alternative would be similar to those of Fort Collins’ Proposed Action.

4.15.8.4 **Fiscal Effects**

As noted above, Level 3 watering restrictions include a 25 percent increase in water rates and a 15 percent increase in the excess water use surcharge. Instead of increasing revenues, it is more likely that total revenues from water sales and water use would decrease in those years due to the restrictions on watering and the reduced use by customers. Level 3 restrictions would occur very rarely based on past hydrologic history, limiting the effects to Fort Collins’ finances.

4.15.8.5 **Agricultural Effects**

Under the No-Action Alternative, agricultural operations and the agricultural economy of Larimer and Weld Counties would be affected by both the reoperation of Joe Wright Reservoir and acquisition of additional NPIC shares. The economic effects of reoperation of Joe Wright Reservoir would be the same as those described under the Gravel Pits Alternative in Section 4.15.6.8 (negligible to minor effects to the agricultural operations of NPIC shareholders). The acquisition of an additional 655 NPIC shares would remove about 1,300 acre-feet of water from about 800 acres of irrigated agricultural land in Larimer and Weld Counties (about 3.5 percent of the 23,000 total acres irrigated with NPIC water in northern Colorado). Those acres would remain in agriculture as dryland operations. The conversion of 740 acres in Larimer County would be equivalent to less than two percent of total irrigated acreage in that county. In Weld County, the conversion of about 40 acres would amount to less than 0.1 percent of total irrigated acreage in Weld County.
The loss of agricultural production and the revenues associated with that production would be focused on a small number of producers receiving NPIC water. For those specific individuals, the combination of the loss of small amounts of water due to reoperation of Joe Wright Reservoir and conversion of acreage to dryland operations would have an overall minor to moderate effect. Dry-up of agricultural land is also viewed as a negative effect on the quality of life in the region, where residents place value on the agricultural heritage and open space in the area. NPIC’s agricultural shareholders would also be responsible for a portion of the costs of Halligan Dam rehabilitation. On average, each of those shareholders would be responsible for about $3,900, occurring in one year or spread out over several years.

The direct loss of agricultural production value would amount to about $1.0 million for Larimer and Weld Counties combined. The $0.9 million loss of production in Larimer County would amount to about 0.7 percent of total production value in that county, while the approximately $0.1 million loss in Weld County would amount to less than 0.1 percent of total value in that location. Those agricultural losses would result in a total economic loss of about $2.4 million. For Larimer County, a $2.1 million loss of output represents a reduction of less than 0.1 percent of the total value of all output in the county. The total economic loss to Weld County would be about $240,000. Those losses would be considered negligible at the county level given the extent of the agricultural sector in northern Colorado.

About seven people employed in the agricultural industry in Larimer County would lose their jobs, as would about one agricultural worker in Weld County. Employment effects would amount to less than 0.1 percent in Larimer County and in Weld County. Total employment and income effects to Larimer County would all be less than 0.1 percent compared to total county employment and income data. Again, effects to Weld County are much smaller than those to Larimer County; the magnitude of the effects to Weld County is less than 0.1 percent for both employment and income.

As mentioned previously, this analysis represents the maximum possible effect to agriculture and assumes Fort Collins uses the water from all of acquired shares every year. This assumption will not be valid for some time and, even then, in many years a portion of the shares would be available for lease to agriculture.

4.15.8.6 Quality of Life and Social Effects

Similar to effects under the action alternatives, the overall quality of life of Fort Collins and Larimer County residents would be largely unaffected by the No-Action Alternative. The general nature and character of the region, as well as the economic sustainability or livelihood of businesses or residents would remain largely unchanged. Agricultural operations would continue to be a part of Larimer County’s identity; however, County residents are likely to see the dry-up of about 740 acres of agricultural land as an undesirable effect. Although those acres would remain in agriculture, this would constitute a loss of about one percent of total irrigated acres in Larimer County.

Under the No-Action Alternative, "mandatory water use restrictions during periods of drought and system failures would be implemented in an attempt to reduce water demands to minimize the effect of shortages during such periods" (MWH Global 2015c). Total water demands would have to be reduced by about 25 percent as a result of the restrictions for Fort Collins to be able to meet customer demands during times of drought or system failure. Mandatory water use restrictions would be implemented more frequently
compared to the action alternatives, and would also be more severe and in effect for a longer period of time. Although the restrictions would be limited in duration (implemented in approximately five years of the 86-year modeling period), reductions in allowable water use levels could result in occasional water shut-offs and greater risk that water for critical services and fire protection may be unavailable during supply interruptions. Additionally, Level 3 water restrictions could have long-lasting effects on vegetation and landscaping, affecting the overall aesthetic of Fort Collins. However, trees and landscaping may be watered by hand at any time. During times when Fort Collins would need to enforce mandatory water use restrictions, the potential exists for a moderate level of effects to residents, with the exception of major, temporary effects from water rate increases under Level 3 restrictions. Those effects would be focused specifically on activities related to water use.

4.15.8.7 Environmental Justice

Water rates for Fort Collins Utilities customers would increase only in years in which Fort Collins would implement Level 3 mandatory watering restrictions. Those increases would have a larger effect on low-income customers in terms of the percent of income required to pay for water service; however, rate increases would occur rarely. The rare increase in water rates due to drought conditions would be applied to all customers, regardless of race or income; therefore, low-income and minority groups would not be disproportionately affected by the increase. The increase in the Water Supply Requirement fee may have a more noticeable effect on low-income populations, potentially affecting the ability to purchase a home in Fort Collins. However, the increase in that fee and the resulting effects on housing stock would apply to all potential homebuyers, regardless of race or income; low-income and minority groups would not be disproportionately affected by the Water Supply Requirement fee increase.

In terms of agricultural activity, the reduction of water per NPIC share due to re-operation of Joe Wright Reservoir combined with the loss of irrigated acreage in Larimer and Weld Counties could result in fewer seasonal workers hired within the agricultural sector of northern Colorado. Farm workers may be disproportionately comprised of minority and low-income individuals; therefore, minority and low-income farm workers may be disproportionately affected under the No-Action Alternative. However, only NPIC shareholders and NPIC irrigated acreage would be affected, potentially limiting the number of affected farm workers.
### 4.15.9 Effects Summary

Table 4-69. Summary of socioeconomic effects by alternative.

<table>
<thead>
<tr>
<th>Socioeconomic Resource</th>
<th>Halligan Dam Rehabilitation</th>
<th>Fort Collins' Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
<th>No-Action Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total project costs</td>
<td>$8,700,000</td>
<td>$38,245,000</td>
<td>$60,940,000</td>
<td>$133,370,000</td>
<td>$170,760,000</td>
<td>$38,245,000</td>
</tr>
<tr>
<td>Construction duration</td>
<td>24 months</td>
<td>24 months</td>
<td>48 months</td>
<td>12 months</td>
<td>12 months</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Direct construction stimulus</td>
<td>Generation of short-term employment, income equal to or less than Proposed Action.</td>
<td>42 full time employees; $10.2 million in earnings; $30.2 million in economic activity.</td>
<td>27 full time employees; $11.6 million in earnings; $43.0 million in economic activity.</td>
<td>398 full time employees; $35.4 million in earnings; $99.3 million in economic activity.</td>
<td>250 full time employees; $22.8 million in earnings; $82.6 million in economic activity.</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Total construction stimulus</td>
<td>Generation of short-term employment, income equal to or less than Proposed Action.</td>
<td>89 full time employees; $19.1 million in earnings; $59.6 million in economic activity.</td>
<td>58 full time employees; $21.6 million in earnings; $84.8 million in economic activity.</td>
<td>847 full time employees; $66.0 million in earnings; $196.0 million in economic activity.</td>
<td>532 full time employees; $42.5 million in earnings; $163.0 million in economic activity.</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Direct operational stimulus, annual</td>
<td>Not Applicable.</td>
<td>No full time employees; $0 in earnings; $89,800 in annual output.</td>
<td>One full time employee; $369,300 in wages, materials and supplies.</td>
<td>One full time employee; $431,700 in wages, materials and supplies.</td>
<td>One full time employee; $447,600 in wages, materials and supplies.</td>
<td>No full time employees; $0 in earnings; $0 in output.</td>
</tr>
<tr>
<td>Total operational stimulus, annual</td>
<td>Not Applicable.</td>
<td>No full time employees; $0 in earnings; $141,900 in annual economic stimulus.</td>
<td>Three full time employees; $584,000 in economic stimulus.</td>
<td>Three full time employees; $682,000 in economic stimulus.</td>
<td>Three full time employees; $707,200 in economic stimulus.</td>
<td>No full time employees; $0 in earnings; $0 in output.</td>
</tr>
</tbody>
</table>
## Socioeconomic Resource

<table>
<thead>
<tr>
<th>Resource</th>
<th>Halligan Dam Rehabilitation</th>
<th>Fort Collins' Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
<th>No-Action Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction traffic volume</td>
<td>Traffic volumes equal to or less than those of the Proposed Action.</td>
<td>Average daily increase in round trips: 31; Peak daily increase of round trips: 70.</td>
<td>Average daily increase in round trips: 20; Peak daily increase of round trips: 43.</td>
<td>Average daily increase in round trips: 268; Peak daily increase of round trips: 590.</td>
<td>Average daily increase in round trips: 170; Peak daily increase of round trips: 375.</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Population growth/demographics</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Project would support, but not cause population growth; no effects to demographic characteristics.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
</tr>
<tr>
<td>Housing conditions</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Negligible effects to housing availability, conditions or property values.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Negligible to minor increases to the value of nearby homes.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
</tr>
<tr>
<td>Public facilities and services</td>
<td>Negligible amount of increased demand from construction; negligible amount of revenue loss.</td>
<td>Negligible amount of increased demand from construction and operations; negligible amount of revenue loss.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>No effects.</td>
</tr>
<tr>
<td>Agricultural activity/economy</td>
<td>No effects to agricultural water supplies, irrigated acreage or agricultural operations.</td>
<td>No effects to agricultural water supplies, irrigated acreage or agricultural operations.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Similar to Fort Collins' Proposed Action, but includes the potential loss of about 1,600 acre-feet of water to NPIC shareholders.</td>
<td>Similar to Fort Collins' Proposed Action, but includes the potential loss of about 1,500 acre-feet of water to NPIC shareholders.</td>
<td>800 acres converted from irrigated to dryland agriculture; $1.0M loss of annual agricultural production; loss of eight agricultural jobs.</td>
</tr>
<tr>
<td>Socioeconomic Resource</td>
<td>Halligan Dam Rehabilitation</td>
<td>Fort Collins' Proposed Action</td>
<td>Expanded Glade Alternative</td>
<td>Gravel Pits Alternative</td>
<td>Agricultural Reservoirs Alternative</td>
<td>No-Action Alternative</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-----------------------------</td>
<td>------------------------------</td>
<td>---------------------------</td>
<td>------------------------</td>
<td>-------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Water Rates/Water Supply Requirement (WSR) fee</td>
<td>Potential additional increases in water rates.</td>
<td>0.3 percent increase in water rates; 23 percent increase in WSR fee.</td>
<td>1.3 percent increase in water rates; 43 percent increase in WSR fee; possible additional rate increase to cover costs of Halligan Dam rehabilitation.</td>
<td>1.6 percent increase in water rates; 123 percent increase in WSR fee; possible additional rate increase to cover costs of Halligan Dam rehabilitation.</td>
<td>1.6 percent increase in water rates; 166 percent increase in WSR fee; possible additional rate increase to cover costs of Halligan Dam rehabilitation.</td>
<td>23 percent increase in WSR fee; 25 percent water rate increase under Level 3 restrictions; possible additional rate increase to cover costs of Halligan Dam rehabilitation.</td>
</tr>
<tr>
<td>Fiscal effects</td>
<td>Either no property tax loses or same as Fort Collins' Proposed Action depending on which alternative is selected.</td>
<td>Annual loss of property tax would be negligible and spread out among various entities in Larimer County.</td>
<td>No property tax losses.</td>
<td>Annual loss of property tax would be negligible and spread out among various entities in Larimer County.</td>
<td>Annual loss of property tax would be negligible and spread out among various entities in Larimer County.</td>
<td>No property tax losses.</td>
</tr>
<tr>
<td>Quality of life</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Short-term nuisance to local residents during construction; None to negligible long-term effects.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Potential moderate to major effects only in years with mandatory watering restrictions.</td>
</tr>
<tr>
<td>Overall level of effect</td>
<td>Negligible to minor; beneficial and adverse; short-term and long-term.</td>
<td>Negligible to minor; beneficial and adverse; short-term and long-term.</td>
<td>Negligible to minor; beneficial and adverse; short-term and long-term.</td>
<td>Generally minor; beneficial and adverse; short-term and long-term; major WSR fee effects.</td>
<td>Generally minor; beneficial and adverse; short-term and long-term; major WSR fee effects.</td>
<td>Negligible to minor; long-term.</td>
</tr>
</tbody>
</table>
### Chapter 4: Environmental Effects

#### Socioeconomic Resource

<table>
<thead>
<tr>
<th>Resource</th>
<th>Halligan Dam Rehabilitation</th>
<th>Fort Collins' Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
<th>No-Action Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental justice</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>No disproportionate effects to minority or low-income populations as the result of construction activities or long-term operations.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Possible disproportionate effects due to changes in the operation of Joe Wright Reservoir to minority or low-income populations, affecting a potentially small number of seasonal farm workers. No disproportionate effects to minority or low-income populations as a result of construction or operation of the Agricultural Reservoirs.</td>
<td>Possible disproportionate effects due to reduction in water rights yields to minority or low-income populations, affecting a potentially small number of seasonal farm workers. No disproportionate effects to minority or low-income populations as a result of construction or operation of the Agricultural Reservoirs.</td>
<td>Possible disproportionate effects due to changes in the operation of Joe Wright Reservoir to minority or low-income populations, affecting a potentially small number of seasonal farm workers.</td>
</tr>
</tbody>
</table>
4.15.10 Unavoidable Adverse Effects

Fort Collins’ Proposed Action and alternatives would result in unavoidable adverse socioeconomic effects related to increases in the cost of water service or the cost of connection charges for new customers (and corresponding cost of new homes), or both.

The Gravel Pits and Agricultural Reservoirs Alternatives also include the potential loss of water to NPIC’s agricultural shareholders, which could reduce agricultural production, as well as employment and income in the agricultural sector. The No-Action Alternative would include the conversion of about 800 acres of irrigated land to dryland farming, resulting in lost agricultural revenue and reduced agricultural employment and income in Larimer and Weld Counties.

4.15.11 Mitigation Measures

No specific mitigation measures have been determined necessary at this time by Fort Collins for socioeconomic resources.

4.16 RECREATION

Potential effects to recreational resources are based on applicable thresholds for specific river segments or other recreational facilities covered by this Draft EIS. There are no formal federal, state, or local agency regulations or standards pertaining to recreational resources, which may include recreational opportunities, facilities, activities, or experiences. However, there are location- or activity-specific thresholds which can determine the potential uses of an area. For example, stream flows in a specific stretch of a river may have to be at or above a certain level to support aquatic life and to support a fishery; the required water flows for recreational boating purposes are likely to be different from those required for fishing. Land-based recreation will also have thresholds, for example, a limit to the number of people in an area before it becomes overcrowded. These thresholds are unique to different locations and the physical characteristics of those locations.

4.16.1 Methods

Potential effects to recreational resources were evaluated for the following categories: (1) effects to land-based activities and facilities; and (2) effects to water-based activities, including activities occurring on various stretches of the North Fork and the Main Stem, as well as recreational activity on affected reservoirs. The Corps considered several factors in the evaluation of effects to recreation due to Fort Collins’ Proposed Action and each of the alternatives, including:

- Changes in stream flows at different locations and at different times of the year
- Effects to aquatic habitat and fish
- Changes in the number of available boating days on the Poudre River at different locations
- Changes in the physical characteristics of affected reservoirs
The location and duration of construction activities

Effects to wildlife

The intensity of effects to recreation was evaluated for each alternative using the following criteria:

- **Negligible**: Effects to the physical amenity (i.e., reservoirs, stream flows, aquatic habitat, public lands open to recreation, roads) would not result in any changes in recreational access, activity levels, or the quality of the experience.

- **Minor**: Effects to the conditions of physical amenities have the potential to increase or decrease recreational activity levels or the quality of the experience by noticeable, but small amounts.

- **Moderate**: Effects to the conditions of physical amenities have the potential to increase or decrease recreational activity levels or the quality of the experience by larger and more noticeable amounts.

- **Major**: Effects to the conditions of physical amenities have the potential to increase or decrease recreational activity levels, or the quality of the experience in a clear and fundamental way. For example, the development of a new recreational amenity or the elimination of an existing recreational opportunity.

Given the location and use of the recreational amenities affected by Fort Collins’ Proposed Action or other alternatives, anticipated minor, moderate, or major effects changes in activity levels or quality could not be quantified in most instances due to lack of data.

### 4.16.1.1 Land–Based Recreation

Land-based recreation (hiking, hunting, camping, biking, etc.) occurs on public and private properties in the areas surrounding individual alternative components (reservoirs, gravel pits, pipelines, etc.) or along the Main Stem. The Corps evaluated the following potential effects to land-based recreation from implementation of the action and No-Action alternatives:

- Changes in the existence of recreational structures or facilities (i.e., inundation of existing facilities, plans for the creation of new facilities)

- Changes in the types of recreational activities available (i.e., would any current activities be prohibited in the future or would the alternative allow any additional activities?)

- Changes in access to recreational locations (i.e., road closures or detours, changes in entrance or exit points)

- Changes in the quality of the recreational experience

- Changes in visitor use days

The effects described above may occur as the result of construction activities, operational activities, or both. Construction activity can result in temporary effects, such as traffic, noise, dust, and other localized nuisances that could affect the quality of a recreational experience. Construction may also temporarily alter access routes, temporarily close recreational areas, or permanently eliminate some facilities. Operational activities could result in increased traffic volume, which might affect the quality of a recreational experience or the desire to visit an area. Operations could also affect land-based recreation.
because of the visual or physical effects related to changing water levels in the included storage facilities (i.e., reservoirs and gravel pits).

The Corps gathered detailed information about alternative specific construction and operation activities, including location of machinery and facilities, type and duration of activity, traffic volume, details about Fort Collins watering restrictions as applicable to recreation, and other relevant alternative activities or information. The sources of this information included the *Alternative Descriptions Report* (MWH Global 2015c), interviews with Fort Collins staff, and communications with Fort Collins’ engineering consultants.

### 4.16.1.2 Water–Based Recreation

Changes in stream flows, reservoir surface areas, or access under Fort Collins’ Proposed Action or any of the alternatives could result in changes to the quality of water-based recreation or changes in the number of recreational visitor days. The Corps evaluated the following potential effects to water-based recreation in segments of the North Fork and Main Stem as defined in Chapter 3 of this Draft EIS:

- Changes in stream flows on the North Fork or Main Stem in various locations throughout the recreation season (May through September)
- Changes in surface area of affected reservoirs, including Halligan Reservoir, the proposed Glade Reservoir and NPIC Reservoirs Number 5 and 6
- Changes in visitor use days
- Changes in the quality of a recreational amenity, setting, or experience
- Changes in access to rivers, reservoirs or other areas for fishing or boating

#### 4.16.1.2.1 Stream Flow Modeling

The Corps obtained stream flow data from the Common Technical Platform hydrology model for each gage by month and hydrological condition (wet, dry, average, or all years) for each alternative (CDM Smith 2016, CDM Smith 2018). The data included current and future flow conditions at each location without projects, as well as current and future flow conditions with each Project Alternative. The Corps compared flows with and without each alternative under current and future flow conditions. The Corps also obtained data on the change in number of days per month at certain flow levels for specific locations where boating activity requires a minimum flow.

#### 4.16.1.2.2 Reservoir Modeling

The *Alternative Descriptions Report* (MWH Global 2015c), the *Operations Report* (Fort Collins 2019), and additional information from Fort Collins provided data on the changes in reservoir surface area, depth, and other related characteristics for Halligan Reservoir, the proposed Glade Reservoir, and NPIC Reservoirs Number 5 and 6. In general, increases in reservoir surface area and depth would have beneficial effects on recreation, and perhaps on boating in particular, since a larger reservoir may accommodate a larger number of visitors, reduce crowding, or allow for the existence of additional types of activities (i.e., motor boating). The Corps evaluated the potential for increased recreational visitation or
activity on all affected reservoirs; however, the conditions of use for Halligan Reservoir and the NPIC reservoirs generally precluded that possibility. For the Expanded Glade, the NISP calculations for estimating visitation were considered, along with knowledge of the characteristics of the Fort Collins expansion in the assessment.

4.16.1.2.3 Effects to Fishing

Results of the *North Fork Aquatic Resources Baseline Technical Report* (GEI 2019a) were used to evaluate effects to fish populations and overall fishing conditions. The *North Fork Aquatic Resources Baseline Technical Report* details the complex relationship between stream flow changes and effects on fish and other aquatic resources. In a general sense, effects to fishing conditions and fishing opportunities were estimated based on changes in flows at each gage location, as well as changes in fish habitat availability and the effect determinations made in the report. Changes to public access for fishing in specific locations were also considered. Additionally, the level of fishing activity at specific locations was also a determinant of effects. For example, if a change in stream flows in a given area has an adverse effect on fish, but no fishing activity occurs in that area, there would be no effects to recreation at that location.

4.16.1.2.4 Effects to Boating

The Corps evaluated effects to boating on reservoirs and segments of the Main Stem where boating is legally permitted to the public. Changes in stream flows could affect boating in a number of ways. Increases or decreases in flows change the shape and depth of the river, as well as the speed of the journey, all of which would affect the boating experience. At a certain point, boating can become dangerous, or even impossible, if flows are either too high or too low. Flow changes may diminish or enhance certain features of the river, again affecting the experience or opportunity for boating. River-based boating effects are based on the average percent change in monthly flows at each gage location, as well as changes in the number of days at optimal and minimum flow levels for different types of boating, by month. Changes in the number of days above 900 cubic feet per second (optimal flows for boating), above 250 cubic feet per second (minimum acceptable flows for kayaking) and above 325 cubic feet per second (minimum acceptable flows for rafting) were evaluated downstream of the Munroe Canal Diversion. At the Lincoln Street Gage, changes in the number of days above 150 cubic feet per second were evaluated. For the purposes of evaluating effects to boating opportunities, changes in the number of days at various flow levels were presented, by location and by month, in full day increments. Changes in a part of a day were rounded up or down to the nearest full day.

4.16.1.3 Recreational Economy

Changes in land-based or water-based recreational activity levels (i.e., number of visitor or user days) would be considered effects to local recreation businesses. The Corps calculated the direct economic benefits or losses resulting from potential changes in activity days using per person per day expenditures for specific activities. To calculate total effects, economic multipliers for the recreation industry were applied to those direct effects.
4.16.1.4 Data Adequacy

Section 3.16.3 describes the best available data for recreation in the study areas. The Corps determined the data available and methods used were adequate to evaluate and describe reasonably foreseeable significant adverse effects on recreation in the study areas and to enable the decision maker to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable recreation information as described in Section 4.2.1.5.

4.16.2 Effects Common to All Alternatives

4.16.2.1 Wildlife-Dependent Activities

Each of the alternatives would result in short- and long-term effects to wildlife (see Section 4.12), which would potentially affect the quality of wildlife-dependent recreational activity. Wildlife-dependent activities include wildlife watching, hunting, or the enjoyment of wildlife as part of other activities (hiking, biking, camping, fishing). In general, the Corps determined that alternatives would have either no effect to a negligible effect on wildlife, with the exception of aquatic species on the North Fork upstream of Halligan Reservoir and each alternative would have a minor to moderate beneficial effect on the associated reservoirs. Subsequently, there would be only no effect to a negligible effect on wildlife-dependent activities.

4.16.2.2 Recreation on the North Fork: Future Conditions Baseline Comparison

Fort Collins’ Proposed Action would result in major adverse effects to river characteristics and aquatic habitat upstream of Halligan Reservoir and moderate to major adverse effects on the fishing experience and fishing activity levels in that area. Fort Collins’ Proposed Action would result in moderate beneficial effects to aquatic habitat immediately below Halligan Dam, resulting in a minor to moderately improved fishing experience for the limited number of anglers with legal access to that area. In other stretches of the North Fork downstream of Halligan Reservoir, Fort Collins’ Proposed Action would result in negligible to major beneficial effects to aquatic habitat and negligible to moderate beneficial effects to fishing activity, depending on location.

Under all other alternatives, effects to aquatic habitat, fisheries, and fishing activity would be negligible. Boating effects would be negligible under all alternatives.

4.16.2.3 Recreation on the Main Stem - Above Fort Collins: Future Conditions Baseline Comparison

Small changes in flows would result in negligible effects on aquatic habitat and fish, resulting in negligible effects to fishing in this section of the Main Stem. There would be no reductions in the average number of boating days with flows above 900 cubic feet per second in this section of the Main Stem due to any of the alternatives, as compared to future condition flows without a project. None of the alternatives would change the number of days at or above 325 cubic feet per second. The Agricultural Reservoirs Alternative would reduce the number of days at or above 250 cubic feet per second by about one; the other alternatives would not change the number of days at that flow level during the recreation
season. Overall, effects to boating opportunities and experience on the Main Stem above Fort Collins would be negligible under all action alternatives.

4.16.2.4 Recreation on the Main Stem - Through Fort Collins: Future Conditions Baseline Comparison

Small changes in flows would have negligible effects on aquatic habitat and fish resulting in negligible effects to fishing in this section of the Main Stem. Future conditions with the action alternatives would result in very few reductions in the average number of days with flows above 150 cubic feet per second in this section of the Main Stem. Acceptable boating days would be reduced by one or two days over the entire boating season under each action alternative. The No-Action Alternative would not result in any reduction of boating days. Effects to boating would be negligible to minor under each of the alternatives.

4.16.2.5 Recreational Activity and Associated Economic Activity

Changes in stream flows and reservoir levels would have negligible effects on fishing and boating and would not result in measurable changes in the number of user days for those activities at any location. Because the number of recreational activity days would not noticeably change as the direct result of any of the alternatives, changes to recreational spending and the local recreational economy would be negligible as the result of any alternative.

4.16.3 Rehabilitation of Halligan Dam

Due to the age and current condition of Halligan Dam, it would likely undergo rehabilitation under all alternatives within the next 10 years (Harvey Economics 2018c). Construction work on the dam would require at least partial draining of Halligan Reservoir during the 24-month construction period. Some specific construction activities would also likely occur during the draining period. Fort Collins (and NPIC) would refill the reservoir upon completion of construction activities. Fort Collins and NPIC have drained Halligan Reservoir occasionally in the past to make repairs or conduct other work on the dam or other structures; recreation on the reservoir ceases at those times. Depending on water conditions, Fort Collins and NPIC could drain and refill the reservoir relatively quickly. It was assumed that no recreation (fishing, boating, swimming, other) would take place on the reservoir for as many as 24 months.

Wildlife watching, hiking, horseback riding, and other land-based activities occur on properties surrounding Halligan Reservoir. Construction activity, including noise levels, dust generation, and increased traffic volumes (construction workers and trucks) may affect the quality of these experiences. However, construction contractors would confine activity to the area close to the existing dam site; noise, dust, and other potential construction related nuisances would likely not be noticeable away from that area. Fort Collins’ Proposed Action would not alter or restrict access to surrounding properties.

Rehabilitation activities would have a major short-term adverse effect on the members of the Landowners Association for Phantom Canyon Ranches that use Halligan Reservoir for water-based recreation or that simply enjoy the reservoir for the scenic beauty and ambiance it provides. However, that effect would be

2 Under Fort Collins’ Proposed Action, the work completed to enlarge Halligan Dam would negate the need for any repairs or rehabilitation of the existing dam.
temporary, limited to the 24-month construction period for this alternative, and would affect a very limited number of people.

4.16.4 Fort Collins’ Proposed Action

4.16.4.1 Halligan Reservoir and the Surrounding Area

Landowners Association for Phantom Canyon Ranches currently has exclusive access for recreational use of Halligan Reservoir under an existing lease agreement with Fort Collins. However, input from other agencies involved in the EIS process (i.e., Colorado Parks and Wildlife, Larimer County) has the potential to affect the long-term recreational use of Halligan Reservoir and surrounding property owned by Fort Collins. For example, Fort Collins could allow public access to Halligan Reservoir as part of its Fish and Wildlife Mitigation Planning Process, or Larimer County could seek to impose recreational conditions through the County 1041 permitting/intergovernmental agreement process.

The only recreational facility in the area is a gravel road located on the southwest side of the reservoir that acts as a boat launch. Landowners Association for Phantom Canyon Ranches members also park a small number of boats on the side of this road. Reservoir enlargement would inundate a small portion of the gravel road. The inundation would shorten the length of the road, but would not affect use of the road as a boat launch or the availability of boat parking in the area. However, smaller boats, of the type generally owned by members of the Landowners Association for Phantom Canyon Ranches, may also be launched into Halligan Reservoir from other a few other areas along the shoreline.

In the long term, after the completion of construction activities and after the reservoir is re-filled, recreation on the enlarged Halligan Reservoir would occur as it does now. The same types of water-based activities that currently take place on Halligan Reservoir would occur on the enlarged reservoir. The shoreline of the expanded reservoir would provide similar boat access. Additionally, the volume of recreational activity on the reservoir is not anticipated to change. Although the enlarged reservoir would result in an additional 133 surface acres of recreational space, the number of Landowners Association for Phantom Canyon Ranches members and their use of the reservoir limits recreational activity. For example, the Landowners Association for Phantom Canyon Ranches does not allow waterskiing, jet skiing, and other large-motor boating activities on Halligan Reservoir; those activities might benefit from additional surface space, if they were allowed.

The reservoir enlargement would inundate about 19.5 acres of the Cherokee State Wildlife Area Middle Unit. That inundation would reduce the total acreage available for hunting and other recreational activity by a small amount (less than one percent of total Cherokee State Wildlife Area Middle Unit land). Additionally, about 0.75 mile of the North Fork upstream of Halligan Reservoir would be inundated, effectively replacing river habitat (free-flowing riffle and pool complexes) with reservoir habitat. Changes in aquatic habitat would limit or eliminate certain biological functions, such as spawning, for fish species and may result in a reduced number of different types of fish species in the inundated area. Inundation would change the physical and biological characteristics of the affected 0.75 mile stretch of river, resulting in a diminished fishing experience and reduced fishing activity in the Cherokee State Wildlife Area Middle Unit. Inundation would also reduce the length of the North Fork publicly accessible for fishing. Reservoir enlargement would also inundate an existing dirt parking area located within the
Cherokee State Wildlife Area Middle Unit adjacent to the North Fork. A replacement parking area would be developed outside of the inundation area.

Fort Collins’ Proposed Action would result in moderate to major beneficial effects to aquatic habitat immediately below Halligan Dam, resulting in an improved fishing experience for the limited number of anglers with legal access to that area. In other stretches of the North Fork downstream of Halligan Reservoir, Fort Collins’ Proposed Action would result in minor to moderate beneficial effects to aquatic habitat and negligible to minor beneficial effects to fishing activity.

### 4.16.4.2 Assessment of Effects

A small portion of the Cherokee State Wildlife Area Middle Unit would be inundated, reducing public access to about 19.5 acres of land for hunting or other recreational activities; a small parking area would be relocated;

About 0.75 mile of the North Fork upstream of Halligan Reservoir would be inundated, adversely affecting aquatic habitat and reducing fishing activity in that area;

Flow changes in the North Fork below Halligan Reservoir and in the Main Stem would result in negligible to major beneficial changes in aquatic habitat and fisheries, which could improve fishing conditions in some locations;

Flow changes would have negligible to minor adverse effects to boating activity due to loss of boating days in some locations;

Given the effects described above, the recreational economy and businesses that cater to recreational activities and users would be largely unaffected by construction, operational activity, or changes in stream flows as related to Fort Collins’ Proposed Action;

Overall, Fort Collins’ Proposed Action would have a mostly negligible effect on long-term land and water based recreational activity and related economic activity, although site-specific beneficial and adverse effects would occur.

### 4.16.5 Expanded Glade Alternative

This alternative includes an expansion of NISP’s proposed Glade Reservoir to include additional water storage capacity for Fort Collins. On its own, NISP’s proposed Glade Reservoir would include a maximum of about 1,635 surface acres. As discussed in various NISP Supplemental Draft EIS documents, if an agency or entity such as Larimer County agreed to manage the area, the proposed Glade Reservoir and the surrounding area would likely attract visitors for recreational purposes. Water- and land-based recreational opportunities available on or around the proposed Glade Reservoir could include non-motorized or “wakeless” boating, fishing, swimming, hiking, biking, camping, picnicking, and other opportunities. NISP Supplemental Draft EIS documents detail the estimated effects of those recreational activities at the proposed Glade Reservoir. The discussion of recreational effects included below addresses only the incremental effects associated with the Fort Collins expansion.
4.16.5.1 Expanded Glade Reservoir

Given the relatively small increase in additional surface acres, it is unlikely that the Expanded Glade Alternative would result in any noticeable additional recreational activity in the area in excess of estimates from the NISP Supplemental Draft EIS for Glade Reservoir. NISP Supplemental Draft EIS documents estimate 338,600 annual recreational visits to NISP’s proposed Glade Reservoir, given the physical characteristics of that proposal (BBC Research and Consulting 2015, USACE 2015). At full capacity, NISP’s proposed Glade Reservoir would have a maximum surface area of about 1,635 acres; average recreation season surface area would be about 1,240 acres. The Expanded Glade Alternative would increase the surface area of the proposed Glade Reservoir by 63 acres, or about a 3.5 percent increase in surface area on the northwestern edge of the reservoir, extending the reservoir about an additional 700 feet at its narrowest point. The expansion would not provide enough additional surface acreage or create any unique physical characteristics or conditions to attract additional visitors. Additionally, Fort Collins would not construct or develop any additional amenities or features that would attract or support additional visitation. Therefore, the NISP estimate of 338,600 visitor days at the proposed Glade Reservoir is likely inclusive of the Fort Collins expansion.

The Expanded Glade Alternative would not result in any recreational effects outside of the proposed Glade Reservoir. The expansion would not alter access points, change recreational interest or activity levels, or restrict or expand opportunities on surrounding public or private lands.

4.16.5.2 Assessment of Effects

The small amount of additional surface area on the proposed Glade Reservoir would not attract additional recreational visitors to that amenity.

The expansion of the proposed Glade Reservoir would not affect other public lands or the recreational activities that occur on surrounding properties.

Flow changes in the North Fork and in the Main Stem would result in negligible to minor beneficial changes in aquatic habitat and fisheries, which could improve fishing conditions in some locations.

Flow changes would have negligible to minor adverse effects to boating activity due to loss of boating days in some locations.

Given the effects described above, the recreational economy and businesses that cater to recreational activities and users would be largely unaffected by construction, operational activity, or changes in stream flows as related to the expansion of the proposed Glade Reservoir.

The Expanded Glade Alternative would have a largely negligible effect on short- and long-term land- and water-based recreational activity and economy.

4.16.6 Gravel Pits Alternative

4.16.6.1 Gravel Pit Complex and Pipeline Route

Fort Collins would purchase and develop eight gravel pits as part of the Gravel Pits Alternative. No recreational activity currently occurs on any of those gravel pits. Fort Collins would drain the pits
periodically when customer demand requires the additional water. For that reason, as well as others, Fort Collins does not plan to allow any recreational activity on or around those pits in the future.

Fort Collins would route the bi-directional pipeline along the western edge of the Butterfly Woods Natural Area. Construction of that pipeline may cause temporary closure of a portion of the Poudre River Trail running through the natural area. Trail closure may occur over a period of a few weeks.

Construction activity would not limit or restrict access to either the natural area or the nearby Lion’s Open Space or limit any specific types of activities at those locations, other than those related to the trail closure. However, the side effects of construction activities, including noise, increased traffic, and dust, may temporarily affect the quality of recreational activity at both the natural area and the open space.

Construction activity at the gravel pits and along the pipeline route would occur over a period of about 12 months.

Fort Collins would route a portion of the bi-directional pipeline through the Reservoir Ridge Natural Area, close to a public parking lot and the trailhead for the Michaud Spur Trail. Construction activity may require the temporary closure of the existing parking lot, as well as a portion of the Michaud Spur Trail; however, a temporary parking area may be constructed, and Fort Collins would ensure access to the natural area was not hindered. Trail closure may occur over a period of a few weeks. As with the Butterfly Woods Natural Area and the Lion’s Open Space, construction activities may affect the quality of some recreational experiences; however, Reservoir Ridge is a larger area, and visitors would likely be able to distance themselves from those activities. Construction activity may also temporarily affect the quality of recreation on the privately owned Claymore Lake. Although construction activity would occur over a 12-month period, pipeline construction at specific locations would be much more limited in duration. There would be no anticipated permanent effects to recreation at any of these locations upon completion of construction activities.

4.16.6.2 Joe Wright Reservoir

Reoperation of Joe Wright Reservoir would include higher winter carryover levels in the reservoir. There would be no changes to water levels in the summertime, when the reservoir is already at maximum capacity. No structural changes would occur at the reservoir under this alternative. Therefore, the reoperation of this reservoir would not affect recreational activity at that location.

4.16.6.3 Assessment of Effects

Construction-related nuisances would be temporary and the Gravel Pits Alternative would not result in any permanent changes to recreational facilities or activities.

Flow changes in the North Fork and in the Main Stem would result in negligible changes in aquatic habitat and fisheries, which would result in negligible changes in fishing conditions.

Flow changes would have negligible to minor adverse effects to boating activity due to loss of boating days in some locations.

Given the effects described above, the recreational economy and businesses that cater to recreational activities and users would be largely unaffected by construction, operational activity, or changes in stream flows as related to the development of the gravel pit storage or re-operation of Joe Wright Reservoir.
The Gravel Pits Alternative would have a largely negligible effect on short and long-term land and water based recreational activity and economy, although site-specific beneficial and adverse effects would occur.

### 4.16.7 Agricultural Reservoirs Alternative

#### 4.16.7.1 Agricultural Reservoirs and Pipeline Route

NPIC currently leases the recreational rights to Reservoirs Number 5 and 6 to two private clubs. The Agricultural Reservoirs Alternative would leave recreation on those reservoirs largely unaffected for several reasons. First, NPIC would continue ownership of the reservoirs and those recreational leases would continue to be in effect. NPIC would not change the contractual obligations of either party because of this alternative. No changes in currently allowed or prohibited activities would take place. Secondly, Fort Collins’ use of those reservoirs for additional water storage would not require the expansion or enlargement of either reservoir, which might result in major construction effects, reservoir drainage, or other recreational closures, temporary or otherwise. Lastly, Fort Collins would operate their portion of storage space in such a way that the surface areas and depths of the reservoirs would experience only minimal changes during the recreation season compared to current conditions. On average, operation of the Agricultural Reservoirs Alternative would result in small decreases in volume (three to four percent), surface area (two percent) and depth (three percent) at each reservoir during the summer recreation season. On a month-to-month basis during the season, the surface area of each reservoir would decrease by between one and four percent. Those relatively small changes would not result in any additional recreational activity on either reservoir due to the way recreational club members currently use the reservoir.

Due to the location of recreational sites on Reservoir Number 5, an increase of even a few feet could inundate some of those sites, as well as the access road leading to those sites. However, analysis of reservoir flows indicates that reservoir depths would decrease by small amounts throughout the recreation season, making flooding of those sites unlikely.

Construction activities would take place over a period of about 12 months. In the vicinity of the NPIC reservoirs, construction activities would include a modification of the outlet structure on Reservoir Number 6, as well as development of about 2.5 miles of pipeline on the east side of the NPIC reservoirs, and construction of a portion of the new bi-directional pipeline to the south. Construction activity and associated noise, traffic, dust, or other nuisances has the potential to temporarily affect the quality of recreational activity at the reservoirs; however, the majority of recreation occurs on weekends, while most, if not all, construction activity would occur during the week. Construction activity would not close off any access to the reservoirs.

Fort Collins would route portions of the bi-directional pipeline between the Butterfly Woods Natural Area and the Lions Open Space and through the Reservoir Ridge Natural Area, as described for the Gravel Pits Alternative. Effects to recreation in those areas would be the same for the Agricultural Reservoirs Alternative as described for the Gravel Pits Alternative.
4.16.7.2 Assessment of Effects

Construction-related nuisances would be temporary and this alternative would not result in any permanent changes to recreational facilities or activities.

Flow changes in the North Fork and in the Main Stem would result in negligible changes in aquatic habitat and fisheries, which would result in negligible changes in fishing conditions.

Flow changes would have negligible to minor adverse effects to boating activity due to loss of boating days in some locations.

The Agricultural Reservoirs Alternative would have a largely negligible effect on land and water based recreation.

4.16.8 No-Action Alternative

The No-Action Alternative would include the following components: (1) reoperation of Joe Wright Reservoir; (2) acquisition of additional NPIC shares and; (3) implementation of more frequent and severe water use restrictions.

4.16.8.1 Reoperation of Joe Wright Reservoir

Fort Collins’ reoperation of Joe Wright Reservoir under the No-Action Alternative would be the same as that described for the Gravel Pits Alternative. As discussed in Section 4.16.6.2, the reoperation would not result in any recreational effects.

4.16.8.2 Acquisition of North Poudre Irrigation Company Shares

In and of itself, the acquisition of additional NPIC shares would not directly affect recreation. Section 4.16.2 discussed changes in stream flows resulting from use of those shares and recreational effects that would stem from those changes.

4.16.8.3 Watering Restrictions

Under the No-Action Alternative, Fort Collins would implement mandatory watering restrictions for its water customers on a limited basis; watering restrictions would occur in five years out of the 86-year modeling period, or about six percent of the time. Because those restrictions would apply only to Fort Collins Utilities customers, recreational effects would be limited to those activities that require water delivered by Fort Collins (i.e., public and private swimming pools, public parks, or other public recreational facilities).

In years in which restrictions would occur, Fort Collins would enforce Level 1 restrictions (four out of every five years of restrictions); other years would require Level 3 restrictions. The full scope of restrictions included at each level is described in the 2014 Updated Water Supply Shortage Response Plan.

Level 1 restrictions would not likely result in noticeable effects to recreational opportunities or activity levels within the boundaries of Fort Collins. Some city parks, athletic fields, and golf courses may be drier or have slightly less visual appeal due to limitations on lawn watering, but those areas would
continue to be usable for recreational purposes. Level 1 restrictions would not limit or prohibit any specific activities or levels of use at any facility.

Level 3 restrictions would be more severe and would have a larger effect on local recreation. The City would not water certain parks, playing fields, and golf courses, and others would experience limited watering to the extent that they may look much drier and browner than in other years. Although all parks and other facilities would continue to be available for recreational use, people may choose not to visit those areas excluded from watering or they may experience reduced benefits from recreating at those locations due to changes in visual characteristics. No watering would occur at splash parks, eliminating that recreational activity. Although water use for outdoor swimming pools would be unrestricted, the increase in water rates may deter people from filling their private pools or may result in increases in entrance fees to public pools.

Overall, because of the limited number of years in which mandatory restrictions would occur in combination with the fact that in most years, restrictions would fall under the category of Level 1 restrictions, the recreational effects associated with mandatory watering restrictions would be negligible to minor.

4.16.8.4 Assessment of Effects

The No-Action Alternative would have a negligible effect on land- and water-based recreation. No construction activities would occur under this alternative and there would be no physical effects to any recreational facilities or existing amenities. Flow changes in the North Fork and the Main Stem would result in negligible changes in aquatic habitat and fisheries, which would result in negligible changes in fishing conditions. Flow changes in the Main Stem would be small and would not result in changes to boating activity.

4.16.9 Unavoidable Adverse Effects

Fort Collins’ Proposed Action would result in certain unavoidable adverse effects to recreation, including the temporary draining of Halligan Reservoir during construction; that action would eliminate all fishing and boating activity on the reservoir for a period of 24 months. Additionally, inundation of a portion of the Cherokee State Wildlife Area Middle Unit may eliminate or change the volume or type of recreational activity that currently occurs on that specific piece of land.

Under the Expanded Glade, Gravel Pits and Agricultural Reservoirs Alternatives, the rehabilitation activities required at Halligan Dam may result in a temporary draining of the reservoir, resulting in elimination of fishing or boating activity for a short-term period of time. Those alternatives would also result in adverse effects to fishing activity below Halligan Dam due to adverse effects to aquatic habitat and fish populations.

Fort Collins’ Proposed Action and all action alternatives would result in reductions in the number of days at either minimum or optimal stream flow levels for certain types of boating activity in specific locations. The No-Action Alternative would not result in any unavoidable adverse effects to recreational resources.
### 4.16.10 Recreation Effects Summary

Table 4-70. Summary of recreation effects by alternative.

<table>
<thead>
<tr>
<th>Recreational Activity</th>
<th>Halligan Dam Rehabilitation*</th>
<th>Fort Collins' Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
<th>No-Action Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishing on the North Fork</td>
<td>Potential temporary reduction or elimination of recreational fishing activity on the North Fork (and Halligan Reservoir) due to rehabilitation activities.</td>
<td>Moderate to major adverse effect above Halligan Reservoir; negligible to moderate beneficial effects for other areas downstream of Halligan Reservoir.</td>
<td>Negligible effects in all segments of the North Fork.</td>
<td>Negligible effects in all segments of the North Fork.</td>
<td>Negligible effects in all segments of the North Fork.</td>
<td>Negligible effects in all segments of the North Fork.</td>
</tr>
<tr>
<td>Boating on the North Fork</td>
<td>Potential temporary reduction or elimination of recreational boating activity on the North Fork (and Halligan Reservoir) due to rehabilitation activities.</td>
<td>Negligible effects due to small changes in flows.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
</tr>
<tr>
<td>Fishing on the Main Stem above Fort Collins</td>
<td>Negligible effects due to small changes in flows.</td>
<td>Negligible effects due to small changes in flows.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
</tr>
<tr>
<td>Boating on the Main Stem above Fort Collins</td>
<td>Negligible effects due to small changes in flows.</td>
<td>Negligible effects due to small changes in flows.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>No changes in boating days or activity.</td>
</tr>
</tbody>
</table>
### Table: Environmental Effects of Recreational Activities

<table>
<thead>
<tr>
<th>Recreational Activity</th>
<th>Halligan Dam Rehabilitation*</th>
<th>Fort Collins' Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
<th>No-Action Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishing on the Main Stem</td>
<td>No effect.</td>
<td>Negligible effects due to small changes in flows.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
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<tr>
<td>through Fort Collins</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Boating on the Main Stem</td>
<td>No effect.</td>
<td>Negligible to minor effects from loss of boating days.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>Same as for Fort Collins' Proposed Action.</td>
<td>No changes in boating days or activity.</td>
</tr>
<tr>
<td>through Fort Collins</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recreation at facility site</td>
<td>No recreation would be possible on the reservoir for as long as 24 months during the construction period; long-term recreational activity would be unchanged.</td>
<td>No recreation would be possible on the reservoir for as long as 24 months during the construction period; long-term recreational activity would be unchanged.</td>
<td>No additional recreational use on top of that estimated for NISP's proposed Glade Reservoir.</td>
<td>The gravel pits would continue to be closed to the public for recreational purposes and would not result in any change to recreation.</td>
<td>Recreational use of the reservoirs would continue as under current conditions; no changes in facilities, access, or activities would occur.</td>
<td>Not applicable.</td>
</tr>
</tbody>
</table>

*These effects would occur under all alternatives.
4.16.11 Mitigation Measures

Fort Collins’ Proposed Action would inundate 19.5 acres of the Cherokee State Wildlife Area Middle Unit and require an easement from Colorado Parks and Wildlife. Fort Collins is considering the possibility of the following actions as mitigation for the loss of recreation (primarily fishing) along about a one-mile reach of the North Fork upstream of Halligan Reservoir (about 0.41 mile of that reach is currently accessible to the public) and as mitigation for inundation of portions of the Cherokee State Wildlife Area Middle Unit:

- **Public Access**: Fort Collins is considering opening a portion of Halligan Reservoir and the adjacent shoreline to public recreation, which could include fishing from shore, fishing from a human propelled watercraft such as a kayak or belly boat, and wildlife viewing.
- **Parking Area**: Fort Collins is evaluating the potential of constructing a small parking area and a vault toilet near the area where the Access Road meets the enlarged reservoir.
- **Recreation Monitoring**: Fort Collins plans to conduct periodic habitat, wildlife, and noxious weed surveys along the enlarged Halligan Reservoir shoreline to monitor effects of public recreation. Frequency, location, and scope of surveys would be determined annually in consultation with an Adaptive Management Committee. However, Fort Collins would commit to conduct surveys annually for the first five years and every two years for the first 15 years following construction.
- **Fish and Wildlife Mitigation Plan**: Fort Collins would develop a fish and wildlife mitigation plan and seek approval from Colorado Parks and Wildlife pursuant to Colorado Revised Statutes Section 37-60-122.2.

4.16.11.1 Effects of the Mitigation Measures:

If Fort Collins provides public access to Fort Collins-owned property along the Halligan Reservoir shoreline, additional public recreation opportunities would include fishing and wildlife watching at Halligan Reservoir and along the shoreline. A small parking lot and vault toilet could be developed to accommodate visitors. Minimal upgrades to the existing access road would be made. This mitigation measure would provide a recreational benefit to the region. However, the remote location of Halligan Reservoir, the envisioned four-wheel drive-only access during summer months and the limited types of recreational activities that would be available would likely result in somewhat limited visitation. The Corps estimated that as many as one thousand visitors per year might recreate at the enlarged Halligan Reservoir. Members of the Landowners Association for Phantom Canyon Ranches would continue to have access to the reservoir for recreation, but would share reservoir space with other visitors. Fort Collins would work with those landowners to minimize any potential conflicts (e.g., trespassing) with future visitors. Fort Collins would also work to prevent visitors to Halligan Reservoir from intruding into the Cherokee State Wildlife Area Middle Unit for purposes other than hunting and fishing. That effort might include signage or other indications of State Wildlife Area boundaries. Fort Collins might prohibit hunting at Halligan Reservoir.
4.17 LAND USE

Potential effects to existing land use practices are based on regulations and codes applicable to the geographic locations relevant to the alternatives addressed in this Draft EIS. More formal guidelines and regulations exist for specific land use practices allowed on individual properties in certain areas. Both the Larimer County and City of Fort Collins’ Land Use Codes and zoning regulations proscribe the potential uses of properties under their jurisdictions.

4.17.1 Methods

The Corps evaluated the following potential effects to current land ownership patterns and to existing and planned land uses from implementation of Fort Collins’ Proposed Action, the action alternatives, and the No-Action alternative:

- Changes in land ownership, on an individual parcel basis or at a regional level
- Changes in specific activities or allowable uses of individual parcels of land, potentially including public access to certain areas
- Conflict with current land use codes or comprehensive plans
- Effects to agricultural land uses, activity and production
- Effects related to specific construction activities

The scoping process identified several specific land use concerns, including interruption of local educational and stewardship programs; increased trespassing on private property due to the presence of construction crews; power line locations; effects to ranching operations; effects to the Cherokee State Wildlife Area; and effects on existing and future conservation easements, including potential compensation.

Detailed information was gathered about alternative-specific construction and operational activities, including the agreement between Fort Collins and NPIC regarding ownership of Halligan Reservoir; inundation areas, Fort Collins’ land purchases and acquired easements, construction activity and disturbance areas, changes in ownership of agricultural ditch company shares, and the details of Fort Collins’ watering restrictions program. The information came from a variety of sources, including the Alternative Descriptions Report (MWH Global 2015c), conversations with Fort Collins staff, and communications with Fort Collins’ engineering consultants. Alternative-specific details, together with the baseline data gathered previously, provided a basis for evaluating land use effects due to the action and No-Action alternatives.

4.17.1.1 Data Adequacy

Section 3.17.3 describes the best-available data for land use in the study areas. The Corps determined the data available and methods used were adequate to evaluate and describe reasonably foreseeable significant adverse effects on land use in the study areas and to enable the decision maker to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable land use information as described in Section 4.2.1.5.
4.17.2 Effects Common to All Alternatives

4.17.2.1 Ownership of Halligan Reservoir

Under all alternatives other than Fort Collins’ Proposed Action, ownership of Halligan Reservoir and all related facilities would revert from Fort Collins back to NPIC. NPIC would take over all responsibility for dam maintenance and reservoir operations on the part of its shareholders.

4.17.2.2 Land Purchases and Easements

Fort Collins would purchase all acreage required to support permanent facilities, such as gravel pit sites, pump stations, and pre-treatment plants, or to expand existing reservoirs (with the exception of the right-of-way obtained on Bureau of Land Management property on the northeast side of Halligan Reservoir). Fort Collins would obtain easements for project components, such as pipelines, access roads, staging areas, and borrow areas where ownership would not be required. In the case of easements, use of the property may be permanent or temporary in nature. For example, pipelines may require permanent easements, since periodic access may be required for maintenance or other purposes. Staging areas may only require temporary easement during the construction period. Section 4.15 discusses the financial costs of those purchases and easements.

4.17.2.3 Other Construction Disturbance Areas

Physical disturbances from inundation or the construction of access roads or other facilities (i.e., pump stations, pre-treatment plants) would remain as permanent changes to the landscape and land uses. Other construction disturbances, including borrow areas, staging areas, pipeline routes, or other features, would be temporary. Fort Collins would return these areas to their original conditions after construction (MWH Global 2015a). That work may require re-vegetation or other remediation measures.

Pipeline construction would require enough right-of-way to accommodate the pipeline trench, excavation pile, and a haul route along the side of the work area. This area could be from 75 feet to 150 feet wide, depending on trench width and depth of the pipe. Construction contractors would need to create a haul road along the alignment to move equipment in and out and to haul aggregates and pipe to the alignment, as well as to load and haul waste material away from excavations.

Parking for commuting workers would be located within the identified construction disturbance areas for each alternative. Construction workers would commute to specific sites in the morning and drive away from those sites at the end of the workday. Fort Collins prohibits trespassing by workers onto private property.

Public access to staging and borrow areas and to other construction disturbance areas would be restricted for safety and other reasons. However, construction activities would not restrict access to other surrounding properties.

4.17.2.4 Power Supplies and Line Locations

Each alternative would require power supplies to operate specific facilities or equipment, including water treatment plants, pump stations, reservoir valves, or other items. Fort Collins construction contractors
may need to create new transmission lines or connections to existing lines to obtain additional power supplies. Fort Collins and its contractors would erect new power poles or towers as needed and conductors would be installed to connect to the power source (MWH Global 2015c). To minimize visual disturbances, Fort Collins would install underground powerlines, where feasible.

**4.17.2.5 Agricultural Operations**

Ditch company shares associated with each of the action alternatives are already either controlled by Fort Collins or will be acquired as part of a reasonably foreseeable future action. The use of shares acquired through RFFAs are not alternative-related effects, but instead are addressed in the cumulative effects component of the Draft EIS (Chapter 5). Therefore, the Corps considered only the additional alternative-specific potential effects to agricultural acreage and operations in the land use analysis. For example, there may be additional agricultural effects under the Gravel Pit Alternative and the Agricultural Reservoirs Alternative related to the unique operations included in each of those alternatives. Additionally, Fort Collins would acquire additional NPIC shares under the No-Action Alternative. Effects to agricultural land use operations are discussed for each alternative in the following sections.

**4.17.2.6 Land Uses along the North Fork and Main Stem**

Over the course of a year, flows on the North Fork and Main Stem would increase and decrease at different times of the year under each of the action alternatives, as well as the No-Action Alternative (CDM Smith 2016h). Changes in flow amounts are unique to each alternative. The anticipated changes in Poudre River flows would not affect current land ownership of individual properties, regional land ownership patterns, property access or the uses of individual properties under any alternative.

**4.17.2.7 Consistency with Local Land Use Planning Documents**

Activities included as part of each of the action alternatives are consistent with the Larimer County Master Plan, Larimer County Comprehensive Plan, and Larimer County zoning regulations.

**4.17.3 Halligan Dam Rehabilitation**

Due to the age and current condition of Halligan Dam, it would likely undergo rehabilitation under all alternatives within the next 10 years (Harvey Economics, 2018c). Together, staging and borrow areas would affect up to 47 acres. Those 47 acres represent the total area in which staging and borrow activities could occur and should therefore be considered the maximum extent of disturbance from those activities; the actual construction disturbance area may be less than 47 acres. An additional 11.5 acres would be disturbed during construction of access roads and road buffers.

Construction workers, trucks, and equipment would generally use existing roads to access the dam site and associated construction facilities. Those access roads may require improvement by the chosen contractor based on the size and types of equipment anticipated for construction. Additional access roads may be required during construction, depending on the final location of staging and borrow areas; these

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3 Under Fort Collins’ Proposed Action, the work completed to enlarge Halligan Dam would negate the need for any repairs or rehabilitation of the existing dam.
additional roads would be permanent features. Construction access across the North Fork downstream of the dam may require installation of a temporary bridge.

Additionally, a river diversion would be required to facilitate foundation preparation and develop work platforms during rehabilitation of the dam. That diversion would require construction of a cofferdam upstream of the current dam site and placement of temporary pipes to divert water around the dam site during construction. These temporary facilities would be located within the identified construction disturbance area. Rehabilitation of the dam would not require the construction of any new power lines.

4.17.4 Fort Collins’ Proposed Action

Under Fort Collins’ Proposed Action, Fort Collins would acquire permanent ownership of Halligan Reservoir and would take responsibility for operation and maintenance of the new dam and administration of Fort Collins water in the reservoir’s additional storage space. NPIC would continue to operate its current storage volume in the reservoir for agricultural purposes as it has in the past.

4.17.4.1 Halligan Reservoir Inundation Area

Expansion of Halligan Reservoir would inundate 133 acres of land immediately surrounding the existing reservoir, including about 19.5 acres of Cherokee State Wildlife Area, nine acres of Bureau of Land Management land and 12 acres of private property. Although inundation would occur on all sides of the existing reservoir, due to differences in topography most of the inundated area would be on the south and west sides of the reservoir.

Fort Collins currently owns most of the property that would potentially be inundated by expansion of Halligan Reservoir, but would purchase about 60 additional acres of land as part of the inundated area or for use as a reservoir buffer. Fort Collins would purchase up to 33 acres of the Cherokee State Wildlife Area and up to 27 acres of private property. In additions, Fort Collins would acquire easements on other proprieties. In December 2016, Fort Collins submitted an application to the Bureau of Land Management for a perpetual Federal Land Policy and Management Act right-of-way to inundate a maximum of nine acres of Bureau of Land Management land; that application is currently pending. Inundation of any properties would remove the land from any type of land-based use. Fort Collins’ land purchases or easement acquisitions would not alter or restrict access to or the uses of the remaining portions of those properties.

The reservoir expansion would not inundate any land owned by the Phantom Canyon Ranches Landowners’ Association. Fort Collins’ Proposed Action would inundate a small portion of the gravel access road leading to the reservoir and a boat launch. Essentially, expansion of the reservoir would slightly shorten the length of the gravel road, and require that a new boat launch area be constructed at the end of the shortened road. Access to the reservoir would not be restricted under Fort Collins’ Proposed Action. In addition to the gravel road and boat launch, three power poles are also located within the proposed inundation area; all three power poles would need to be relocated under Fort Collins’ Proposed Action.
4.17.4.2 Assessment of Effects

Fort Collins’ Proposed Action would include both long- and short-term changes in land ownership and land use, mainly near Halligan Reservoir. Those land use impacts would be negligible to minor in nature. There would be no land use effects along either the North Fork or the Main Stem because of Fort Collins’ Proposed Action.

4.17.5 Expanded Glade Alternative

On its own, NISP’s proposed Glade Reservoir would inundate 1,626 acres of land and require related infrastructure and facilities for construction and operation. The discussion of land use effects included below addresses only the incremental inundation area, infrastructure, and facilities associated with the additional storage development for Fort Collins.

4.17.5.1 Expanded Glade Inundation Area

The inundated area associated with the proposed Glade Reservoir expansion (about 63 acres) includes a small portion of the proposed U.S. Highway 287 realignment for NISP’s proposed Glade Reservoir, requiring the realigned highway to be moved another approximately 700 feet to the north (Fort Collins 2019). The Expanded Glade Alternative would not result in inundation of any other structures, facilities, or specific features. Fort Collins would purchase the 63 acres of land to be inundated from Northern Water.

4.17.5.2 Construction Disturbance Areas

Fort Collins would need to enlarge existing infrastructure and build new facilities for the proposed Glade Reservoir to accommodate the additional storage space required for water operations. These include the existing river diversion structure and conveyance canal, and the proposed Glade Reservoir dam, forebay, pump station, inlet structure, and outlet structure. Land use effects would be associated with the initial construction and operation of these facilities as part of the NISP project, including the borrow area, one large staging area, and temporary or permanent road construction. Any incremental effects related to the enlargement of these facilities to accommodate Fort Collins would be negligible.

The Expanded Glade Alternative would require a pre-treatment facility, pump station, additional pipelines, and a new river turnout. These facilities would be solely associated with Fort Collins operations at the proposed Glade Reservoir. All facilities would be close to the reservoir on land owned by Northern Water. Construction of the proposed infrastructure for Fort Collins would require additional staging areas and access roads, also located on land owned by Northern Water. Up to 70 acres of temporary disturbance and about three acres of permanent disturbance would occur on these lands. There would be up to 38 acres dedicated to staging activities, but the actual staging disturbance area may be less than 38 acres. Construction activities for the Expanded Glade Alternative would occur concurrently over a period of 48 months.
4.17.5.3 Assessment of Effects

The Expanded Glade Alternative would include both long- and short-term changes in land ownership and land use, mainly near the proposed Glade Reservoir. Inundation (long-term) and construction disturbance (largely short-term) would occur on land owned by Northern Water as part of the NISP project; that would reduce the intensity of effects since Fort Collins would use those areas for similar purposes. Altogether, land use effects would be negligible to minor in nature. There would be no land use effects along either the North Fork or the Main Stem because of the Expanded Glade Alternative.

4.17.6 Gravel Pits Alternative

4.17.6.1 Purchase of Gravel Pits and Other Properties

As part of the Gravel Pit Alternative, Fort Collins would purchase and develop eight gravel pit sites for water storage purposes. Five of the eight pits have already been excavated; the remaining three are either partially excavated or have not yet been excavated. Current gravel pit owners would fully mine the pits of commercial materials before the pits become available to Fort Collins. Fort Collins would design the proposed gravel pit storage reservoirs to operate as a single unit; however, Fort Collins could alter the long-term operation strategy to use the currently excavated pits in the interim. The gravel pits would take on an entirely different use once purchased and used for water storage; however, water storage is a use consistent with other surrounding pits in the area.

In addition to the gravel pits, Fort Collins would also purchase a small piece (about two acres) of property for a pump station and the pre-treatment plant. Altogether, Fort Collins would purchase about 275 acres under this alternative.

4.17.6.2 Construction Disturbance Area

Construction activity near the gravel pits would include development of several miles of new pipeline, as well as pump stations and a pre-treatment facility. Construction activities would occur over a period of 12 months; Fort Collins would construct various facilities concurrently to minimize the construction period. Several staging areas would be located at the gravel pits and along the pipeline routes, ranging in size from one to three acres. A materials processing area of approximately five acres would be required to support stockpiling, screening, and crushing operations. A borrow area would be located within one of the gravel pits. Temporary access roads would also be located near the pits and the surrounding area.

This alternative would include up to 112 acres of temporary land disturbance and about 23 acres of permanent disturbance. The approximately 23 acres affected by staging activities represents the total area in which staging could occur and should therefore be considered the maximum extent of related disturbance; the actual staging disturbance area may be less than 23 acres.

4.17.6.3 Application to Local Ordinances and State Regulations

According to the *Alternative Descriptions Report*,

“All gravel pit sites selected for this alternative, except portions of the Home Office Mine-B, Home Office Mine-A released, and Home Office Mine-B released sites, are outside the Poudre River 100-year
floodplain based on floodplain maps prepared by the Federal Emergency Management Agency. Gravel pit sites in the 100-year floodplain would only have below-grade storage, avoiding effects on flood levels at the Overland Gravel Pits complex and adjacent properties. In this way gravel pit storage should be consistent with the Larimer County floodplain development ordinances. All the proposed gravel pit storage sites are outside the Poudre River regulatory floodway” (MWH Global 2015c). A floodplain development permit would be required for construction of any gravel pit storage within the 100-year floodplain.

Fort Collins would design two of the gravel pits located outside the floodplain to accommodate above-groundwater storage; Fort Collins would achieve the additional storage capacity by constructing 20-foot high berms around those pits. The berms would be classified as Small Dams by the Colorado Division of Water Resources and would be subject to jurisdiction by the State Engineers Office, requiring that Fort Collins obtain approval for construction of the berms from the State Engineer’s Office.

4.17.6.4 Reoperation of Joe Wright Reservoir

This alternative also includes reoperation of the existing water storage capacity in Joe Wright Reservoir. The reoperation plan includes increasing the winter carryover pool in the reservoir to the maximum level at which no new infrastructure would be required. No construction activity would occur near the reservoir and no additional land purchases would be required.

The reservoir reoperation would result in as much as a three percent reduction in water supplies to individual NPIC shareholders. That level of reduction would not be large enough to change either the number of acres irrigated or the types of crops grown in the area. Overall, reoperation of Joe Wright Reservoir would have negligible effects on local or regional land uses.

4.17.6.5 Assessment of Effects

The Gravel Pit Alternative would include both long- and short-term changes in land ownership and land use, which would be largely concentrated on the gravel pit complex. Fort Collins’ purchase of the pits would permanently change both ownership and land use of those properties. Construction disturbance would be largely temporary and would be generally consistent with the types of industrial activities that currently occur in the area (truck traffic, operation of large machinery). Altogether, land use effects would be negligible to minor. No land use effects would occur along either the North Fork or Main Stem because of the Gravel Pit Alternative.

4.17.7 Agricultural Reservoirs Alternative

4.17.7.1 NPIC Reservoirs Number 5 and 6

The Agricultural Reservoirs Alternative would not result in any long- or short-term changes to the size, shape, or other physical characteristics of the reservoirs. No additional inundation would occur on any properties surrounding the reservoirs. Access routes to the reservoirs would remain unchanged for NPIC staff or members of the private boating associations that lease recreational rights to the reservoirs.
4.17.7.2 Construction Disturbance Areas

Construction activities would occur over a period of 12 months. Those activities would include modification of the existing outlet works at Reservoir Number 6, installation of several miles of new pipelines, and construction of a new pump station, new pre-treatment plant, and other smaller facilities. Several staging areas would be located near the reservoirs and along the pipeline route. Temporary access roads would also be located on the east side of the reservoirs. This alternative would include up to 373 acres of temporary land disturbance, mainly related to the pipeline, and about 11 acres of permanent disturbance. The approximately 120 acres affected by staging activities represent the total area in which staging could occur and should therefore be considered the maximum extent of related disturbance; the actual staging disturbance area may be less than 120 acres. As part of this alternative, Fort Collins would purchase about two acres to accommodate the pump station and pre-treatment plant.

4.17.7.3 Agricultural Effects

Operation of the Agricultural Reservoirs Alternative would result in about a 1,500 acre-feet reduction in total water supplies for NPIC shareholders due to loss of water rights associated with Reservoirs Number 5 and 6. That total reduction would translate into a small reduction in the annual water allocations of each NPIC shareholder, including agricultural operators. That small reduction, about 2.5 percent of the annual allocation, would not be large enough to change either the number of acres irrigated or the types of crops grown in the area. However, NPIC could decide to purchase additional water supplies (i.e., C-BT units) with the payments made by Fort Collins to replace the lost yield. If that were to occur, effects to agricultural operations and activity would be minimized, or even eliminated.

4.17.7.4 Assessment of Effects

The Agricultural Reservoirs Alternative would include both long- and short-term changes in land ownership and land use. Construction disturbance would be largely short-term, but disturbance would cover a large area due to the length of the pipeline route. Fort Collins would only purchase about two acres of land for specific purposes. Additionally, small changes in agricultural operations would occur throughout Larimer County. Overall, land use effects would be negligible to minor under this alternative. No land use effects would occur along either the North Fork or Main Stem because of the Agricultural Reservoirs Alternative.

4.17.8 No-Action Alternative

The No-Action Alternative would not include construction or development of any physical structures for purposes of water storage or delivery. As described in Section 2.3.5, the No-Action Alternative would include reoperation of Joe Wright Reservoir, acquisition of additional NPIC shares, and implementation of more frequent and severe water use restrictions.

4.17.8.1 Reoperation of Joe Wright Reservoir

Land use effects related to reoperation of Joe Wright Reservoir under the No-Action Alternative would be the same as those described for the Gravel Pits Alternative in Section 4.17.6.4. Overall, reoperation of Joe Wright Reservoir would have negligible effects to land use.
4.17.8.2 Acquisition of Additional NPIC Shares

Acquisition of additional NPIC shares would result in the conversion of 800 acres of irrigated farmland to dryland farming in Larimer and Weld Counties.

4.17.8.3 Mandatory Water Use Restrictions

Lawn watering and other types of outdoor water use would be limited under the No-Action Alternative. Effects to the urban landscape within Fort Collins would be limited to those few years in which mandatory water use restrictions would be implemented (five out of 86 years, or about six percent of the years).

During the years in which Level 1 restrictions would occur (four out of the five years of restrictions, or about one in 20 years), visual effects to trees, vegetation, and landscaping could occur; however, those features would continue to be present in Fort Collins. Use of parks and athletic fields would generally continue as it does without restrictions. Physical effects to area landscaping may be noticeable, but would not result in any changes in land ownership or specific land uses.

Level 3 restrictions would more severely affect the visual aspects of residential, commercial, and public outdoor spaces; the potential exists for long-lasting effects to trees and landscaping, depending on duration of the restrictions. However, Level 3 restrictions would not alter either land ownership or specific uses of individual properties located within Fort Collins. One exception may be reduced visitation or use of some parks or other public spaces due to the drier conditions and reduced visual appeal. However, Fort Collins would continue to maintain and operate those spaces for recreation and any reduced visitation would be of relatively short duration.

4.17.8.4 Assessment of Effects

The No-Action Alternative would include long-term changes in land use on the 800 acres of Larimer County and Weld County farmland converted from irrigation to dryland farming. No construction disturbance would occur and no land would be purchased or inundated under the No-Action Alternative. No land use effects would occur along either the North Fork or Main Stem because of the No-Action Alternative. Overall, land use effects would be negligible to minor under this alternative.
### 4.17.9 Effects Summary

**Table 4-71. Summary of land use effects by alternative.**

<table>
<thead>
<tr>
<th>Land Use Component</th>
<th>Halligan Dam Rehabilitation*</th>
<th>Fort Collins’ Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
<th>No-Action Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ownership of Halligan Reservoir</td>
<td>Ownership of Halligan Reservoir would depend on which alternative is selected.</td>
<td>Fort Collins would acquire permanent ownership of the reservoir, as well as maintenance responsibilities for the new dam. NPIC would continue to manage its current storage volume.</td>
<td>Ownership of the reservoir and all facilities would revert back to NPIC, as would responsibility for dam maintenance and reservoir operations.</td>
<td>Same as for the Expanded Glade Alternative.</td>
<td>Same as for the Expanded Glade Alternative.</td>
<td>Same as for the Expanded Glade Alternative.</td>
</tr>
<tr>
<td>Purchased property</td>
<td>None.</td>
<td>About 61 acres, including up to 34 acres of State Wildlife Area and up to 30 acres of private property; right-of-way acquired on Bureau of Land Management land.</td>
<td>A total of 63 acres owned by Northern Water.</td>
<td>A total of 275 acres, including eight gravel pits and about two acres for the pump station and pre-treatment plant.</td>
<td>About two acres for the pump station and pre-treatment plant.</td>
<td>None.</td>
</tr>
<tr>
<td>Inundation area</td>
<td>None.</td>
<td>A total of 133 acres, including 19.5 acres of State Wildlife Area, nine acres of Bureau of Land Management land, and 12 acres of private property.</td>
<td>A total of 63 acres of land at the northern end of the proposed Glade Reservoir.</td>
<td>All eight gravel pits would be inundated.</td>
<td>No additional land would be inundated.</td>
<td>None.</td>
</tr>
<tr>
<td>Agricultural operations</td>
<td>No loss of irrigated acreage or changes in agricultural operations.</td>
<td>No loss of irrigated acreage or changes in agricultural operations.</td>
<td>Same as for Fort Collins’ Proposed Action.</td>
<td>Same as for Fort Collins’ Proposed Action.</td>
<td>Same as for Fort Collins’ Proposed Action.</td>
<td>A total of about 800 irrigated acres in Larimer and Weld Counties would be converted to dryland farming.</td>
</tr>
<tr>
<td>Land Use Component</td>
<td>Halligan Dam Rehabilitation*</td>
<td>Fort Collins' Proposed Action</td>
<td>Expanded Glade Alternative</td>
<td>Gravel Pits Alternative</td>
<td>Agricultural Reservoirs Alternative</td>
<td>No-Action Alternative</td>
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</tr>
<tr>
<td>Construction disturbance area</td>
<td>A maximum of 59 acres; about 54 acres of temporary disturbance and five acres of permanent features.</td>
<td>Same as Halligan Dam Rehabilitation</td>
<td>A maximum of 73 acres; about 70 acres of temporary disturbance and three acres of permanent features.</td>
<td>A maximum of 135 acres; about 112 acres of temporary disturbance and 23 acres of permanent features.</td>
<td>A maximum of 384 acres; about 373 acres of temporary disturbance and 11 acres of permanent features.</td>
<td>None.</td>
</tr>
<tr>
<td>Property access</td>
<td>Access to individual private or public properties would not be restricted during construction or operations.</td>
<td>Access to individual private or public properties would not be restricted during construction or operations.</td>
<td>Same as for Fort Collins’ Proposed Action.</td>
<td>Same as for Fort Collins’ Proposed Action.</td>
<td>Same as for Fort Collins’ Proposed Action.</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Property located along the North Fork and Main Stem</td>
<td>No effects to current land ownership, property access, or potential uses of parcels located along the rivers.</td>
<td>No effects to current land ownership, property access, or potential uses of parcels located along the rivers.</td>
<td>Same as for Fort Collins’ Proposed Action.</td>
<td>Same as for Fort Collins’ Proposed Action.</td>
<td>Same as for Fort Collins’ Proposed Action.</td>
<td>Same as for Fort Collins’ Proposed Action.</td>
</tr>
</tbody>
</table>

*These effects would occur under all alternatives.
4.17.10 **Unavoidable Adverse Effects**

Fort Collins’ Proposed Action and alternatives would each result in certain types of unavoidable adverse effects to land uses, including inundation, changes in property ownership, temporary and permanent construction disturbance areas, or changes in agricultural operations.

Under Fort Collins’ Proposed Action, 133 acres of land would be inundated, including portions of a State Wildlife Area, Bureau of Land Management land, and private property. The Expanded Glade Alternative would inundate about 63 acres of land, including a portion of U.S. Highway 287. The Gravel Pits Alternative inundate about 275 acres of land currently used as part of gravel mining operations. No residences or other structures would be inundated under any alternative. Fort Collins’ Proposed Action and all action alternatives would require Fort Collins to purchase small amounts of acreage from private individuals or public entities, resulting in permanent changes in land ownership and land use for those acres. Fort Collins’ Proposed Action and all action alternatives would also require development of temporary and permanent disturbance areas to support construction activities and access for construction vehicles. The No-Action Alternative would affect agricultural land use due to the conversion of about 800 irrigated acres in Larimer and Weld Counties to dryland farming.

4.17.11 **Mitigation Measures**

No specific mitigation measures related to land use have been determined necessary at this time by Fort Collins.

4.18 **Visual and Aesthetic Resources**

Potential effects to visual and aesthetic resources were assessed based on the infrastructure that would be constructed under each alternative. Temporary effects due to construction were not considered.

4.18.1 **Methods**

Infrastructure associated with each alternative may include pipelines, pump stations, treatment plants, water tanks, and dams or berms. To assess the visual effects of each piece of infrastructure, the footprint and height of each item was estimated. Fort Collins provided dam elevations and reservoir footprints in the *Alternative Descriptions Report* (MWH Global 2015c). These are the largest elements most critical to analysis of visual effects. Pipelines were assumed to be below ground and not visible. The *Alternative Descriptions Report* also included information on sizing, hydraulic parameters, and potential treatment processes for the pump stations, tanks, and treatment plants. This information was used, along with a review of similar-sized existing facilities, to estimate the dimensions of pump stations, treatment plants, and tanks for each alternative. The *Alternative Descriptions Report* also included location information for all facilities.

Using a GIS, a viewshed analysis was conducted on all infrastructure associated with each alternative, including existing infrastructure that Fort Collins would use. The viewshed analysis tools in GIS use digital elevation data to show areas where each infrastructure element would be visible. The resulting area
is conservative because it only accounts for terrain and excludes aboveground objects like trees and buildings; these objects reduce the actual viewshed of any infrastructure associated with the alternatives. The viewshed analysis study area was defined as a 10-mile radius around each infrastructure element. Key observation points used in the analysis are described and shown in Chapter 3, Section 3.18.

To measure with-project visual quality and any effects on visual quality due to the alternatives, the visual quality metric was used. This was also used to assess the affected environment, and is described in Section 3.18.2. In addition, a separate visibility metric was used to measure the degree of effects any infrastructure would have on a given view by rating three elements of each view: distance, view angle, and view amount. Qualities associated with each visibility element rating are shown in Table 4-72. Total visibility score was calculated for each key observation point by summing the element ratings.

Table 4-72. Visibility metric – description of element ratings.

<table>
<thead>
<tr>
<th>Element</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>Evident</td>
<td>Identifiable</td>
<td>Perceptible</td>
</tr>
<tr>
<td>View angle</td>
<td>Not applicable</td>
<td>Above</td>
<td>Below</td>
</tr>
<tr>
<td>View amount</td>
<td>Large</td>
<td>Moderate</td>
<td>Small</td>
</tr>
</tbody>
</table>

1 Definitions for each of the visibility metric terms are provided in the Visual Resources Technical Report (CDM Smith 2016a).

The visual quality score measures the overall view quality before and after construction of each alternative, including all elements of the landscape not associated with any alternative. The visibility score measures how visible various elements of the alternative would be. For example, a dam constructed in an area that already contained significant elements of artificial form might have a high visibility score, but little to no impact on the visual quality score. The same dam constructed in a pristine area could have the same visibility score but cause a greater reduction in the visual quality score due to the introduction of artificial form to an undeveloped area. More detailed descriptions of visibility scores are available in the Visual Resources Technical Report (CDM Smith 2016a).

The with-projects visual quality at each key observation point was estimated after construction of the associated alternative using a combination of the GIS viewshed analysis and three-dimensional visualization in Google Earth. The ratings for visual quality and visibility elements were collected in the field and the data were then brought into GIS for analysis. The element ratings for each key observation point were summed to determine the total visual quality and visibility scores. Within each alternative, the total scores of all key observation points were averaged to give average visual quality and visibility scores for that alternative.

Under these metrics, construction of these alternatives primarily affects two elements of the visual quality metric - water form and artificial form. Introducing artificial structures, such as dams or buildings, into a largely natural landscape degrades visual quality. However, introducing a water form, through views of a reservoir, can improve visual quality. The alternatives may affect the remaining elements if new infrastructure blocks views of natural forms.

Smaller visual effects not captured by these metrics can occur due to flow changes in streams and canals or due to changes in reservoir operations. A greater (or lesser) fluctuation in stored water levels in
existing reservoirs can result in a wider (or narrower) strip of shoreline where vegetation does not grow. These secondary effects would not change the overall visual effects of each alternative.

4.18.1.1 Data Adequacy

Section 3.18.3 describes the best available data for visual resources in the study areas. The Corps determined the data available and methods used were adequate to evaluate and describe reasonably foreseeable significant adverse effects on visual and aesthetic conditions in the study areas and to enable the decision maker to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable visual resource information as described in Section 4.2.1.5.

4.18.2 Halligan Dam Rehabilitation

Due to the age and condition of the existing Halligan Dam, it would be rehabilitated under all Project Alternatives, regardless of which one is chosen. Therefore, the following effects are common to all alternatives.

None of the visual quality scores for any key observation points changed from baseline conditions for rehabilitation of Halligan Dam. Due to the remote location of the dam, it is not visible from any public areas where key observation points are located, and does not negatively affect the visual quality ratings of any key observation points. The average visual rating would remain at 12, and the average key observation point visibility score would be 2.

4.18.3 Fort Collins’ Proposed Action

None of the visual quality scores for any key observation points changed from baseline conditions for Fort Collins' Proposed Action. Although Fort Collins' Proposed Action would increase the area of water visible at all key observation points, this change was not significant enough to increase the visual quality ratings. The average visual rating would remain at 12, and the average key observation point visibility score for Fort Collins' Proposed Action would be 2.

4.18.4 Expanded Glade Alternative

The Expanded Glade Alternative would increase the amount of visible water and infrastructure at all key observation points, but this change was not significant enough to affect the visual quality ratings because the Expanded Glade Alternative would be a very small-scale expansion of the reservoir proposed for NISP. Therefore, none of the visual quality scores for any key observation points would change from baseline conditions for the Expanded Glade Alternative. The average visual rating would remain at 10, and the average visibility score would be 2.

4.18.5 Gravel Pits Alternative

Changes from baseline conditions would be as follows:
Key observation point 1 would have a decrease in the artificial landform score due to visibility of the treatment plant. However, trees would partially or totally obscure the treatment plant during summer, and this negative visual effect would occur only during winter.

The berm constructed along the road would obscure the view from key observation point 2. Containment, water form, and color and texture scores would all drop. The artificial landform would not drop because Fort Collins would construct the berm of dirt rather than artificial materials.

The artificial landform score for key observation point 3 would drop due to visibility of the treatment plant.

Key observation point 4 would have no change from existing conditions.

Key observation point 5 would have an increase in water form score due to the addition of a pit that does not currently exist in this location.

Key observation points 6, 7, and 8 would have no change from existing conditions. The infrastructure associated with this alternative would be distant and trees and buildings would obscure the view.

The resulting average visual quality score would be 7, and the average visibility score would be 3. The average visual quality score of 7 is one point less than the existing condition average visual quality score of 8. As noted above, three of the eight key observation points would have some decrease in visual quality, one would have an increase in visual quality, and four would have no change in visual quality compared to existing conditions.

### 4.18.6 Agricultural Reservoirs Alternative

Changes from baseline conditions would be as follows:

- Key observation points 1 and 2 had views only of the existing reservoirs. Building this alternative would have little to no effect on these two key observation points since no new infrastructure would be visible. Any resulting change in operations of these two reservoirs could result in minor changes along the shoreline.

- Key observation point 3 would have a decrease in the artificial landform score due to visibility of the treatment plant. However, trees would partially or totally obscure the treatment plant during summer and this negative visual effect would occur only during winter.

- Key observation point 4 would not change from existing conditions. Although GIS analysis indicated the treatment plant would be visible from this location, based on a field visit there would be significant tree cover between this point and the treatment plant, which would obscure the plant for some or all of the year. In addition, because some artificial landforms are already visible, the treatment plant building would not negatively affect the artificial landforms score.

- The artificial landform score for key observation point 5 would drop due to visibility of the treatment plant.
The resulting average visual quality score would be 6, and the average visibility score would be 5. The average visual quality score of 6 is one point less than the existing condition average visual quality score of 7. As noted above, two of the five key observation points would have some decrease in visual quality and three would have no change compared to existing conditions.

4.18.7 No-Action Alternative

The visual quality score would not change from existing conditions because Fort Collins would construct no new infrastructure for the No-Action Alternative other than that described under Section 4.18.2.

4.18.8 Effects Summary

Although infrastructure would be visible from public areas for all alternatives, overall effects on visual quality would be small for all alternatives (Table 4-73). Fort Collins' Proposed Action and the Expanded Glade Alternative would have no change in visual quality scores. For Fort Collins' Proposed Action, Halligan Reservoir is in a remote area, and most affected areas already have a view of the existing reservoir. Similarly, although some areas with views of the Expanded Glade Alternative infrastructure would be publically accessible, these areas would generally also have views of NISP infrastructure, resulting in no change from baseline conditions (Table 4-73). The Gravel Pits Alternative and Agricultural Reservoirs Alternative have some shared infrastructure, which would be generally visible from public areas. However, many baseline views in this area already include artificial landforms, resulting in a reduction in the overall visual quality score by one point (Table 4-73). Finally all alternatives include Halligan Dam rehabilitation which would be similar to construction of the new Halligan Dam and would not result in any change to the visual quality score (Table 4-73).

Table 4-73. Summary of visual resource effects by alternative.

<table>
<thead>
<tr>
<th>Visual Quality Score</th>
<th>Halligan Dam Rehabilitation*</th>
<th>Fort Collins’ Proposed Action</th>
<th>Expanded Glade Alternative</th>
<th>Gravel Pits Alternative</th>
<th>Agricultural Reservoirs Alternative</th>
<th>No-Action Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>12</td>
<td>12</td>
<td>10</td>
<td>8</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>With project</td>
<td>12</td>
<td>12</td>
<td>10</td>
<td>7</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Change</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>Key observation point visibility score</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

*These effects would occur under all alternatives.

4.18.9 Unavoidable Adverse Effects

All alternatives would result in unavoidable adverse effects to visual resources; however, overall effects would be small.
4.18.10 Mitigation Measures

No mitigation measures related to aesthetics or visual resources have been determined necessary at this time by Fort Collins.

4.19 AIR QUALITY

Potential effects to local and regional air quality include emissions for both criteria pollutants and greenhouse gas emissions. Short-term direct air quality effects are related primarily to construction activities. Construction emissions include exhaust emissions from heavy-duty construction equipment, exhaust emissions from construction workers’ vehicles and delivery vehicles, and fugitive dust emissions. Long-term direct air quality effects include continued emissions from operation and maintenance of the alternatives, such as increased electricity use to operate any pumps. No indirect air quality effects, which typically occur from growth-inducing effects from changes in land use, population density, or growth rates, would occur.

4.19.1 Methods

Standard emission estimation models approved by the Environmental Protection Agency were used to estimate emissions from construction activities associated with the action alternatives, including on-road and off-road vehicles and equipment, dust, various construction activities, and operations. The majority of emissions would be from non-road equipment used during construction activities. Factors for engine exhaust and fugitive dust were used along with estimated activity levels, such as number of pieces of equipment, number of days of active operation, and vehicle miles traveled to determine total emissions of criteria air pollutants. Emission factors and models used to estimate emissions for the alternatives are described in the Air Quality Technical Report (CDM Smith 2019).

4.19.1.1 Data Adequacy

Section 3.19 describes the best-available data for air quality in the study areas. The Corps determined the data available and methods used were adequate to evaluate and describe reasonably foreseeable significant adverse effects on air quality in the study areas and to enable the decision maker to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable air quality information as described in Section 4.2.1.5.

4.19.2 Halligan Dam Rehabilitation

Due to the age and condition of the existing Halligan Dam, it would be rehabilitated under all Project Alternatives, regardless of which one is chosen. Therefore, the following effects are common to all alternatives.

4.19.2.1 Construction Emissions

Construction-related emissions for rehabilitation of Halligan Dam were estimated for off-road construction equipment, on-road haul trucks and delivery vehicles, and construction worker commuting
for criteria pollutants (Table 4-74) and greenhouse gases (Table 4-75). Basic control measures would be implemented at all construction sites. Control measures or operational procedures to be employed may include, but are not necessarily limited to, planting vegetation cover, providing synthetic cover, watering, chemical stabilization, furrows, compacting, minimizing size of areas disturbed in winter, and wind breaks (Colorado Air Quality Control Commission Regulation 1, Section III.D.2.b.(iv)).

**Table 4-74. Halligan Dam Rehabilitation - Unmitigated maximum annual criteria pollutant construction emissions.**

<table>
<thead>
<tr>
<th>Source</th>
<th>VOC (tpy)</th>
<th>NOx (tpy)</th>
<th>CO (tpy)</th>
<th>SO2 (tpy)</th>
<th>PM10 (tpy)</th>
<th>PM2.5 (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-road haul trucks and delivery vehicle exhaust</td>
<td>0.02</td>
<td>0.14</td>
<td>0.07</td>
<td>&lt;0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Construction worker commuting exhaust</td>
<td>0.17</td>
<td>0.17</td>
<td>2.06</td>
<td>&lt;0.01</td>
<td>0.03</td>
<td>0.01</td>
</tr>
<tr>
<td>Non-road construction equipment exhaust</td>
<td>3.93</td>
<td>37.76</td>
<td>25.25</td>
<td>0.05</td>
<td>2.42</td>
<td>2.32</td>
</tr>
<tr>
<td>Fugitive dust emissions</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>40.54</td>
<td>3.23</td>
</tr>
<tr>
<td>Total annual emissions</td>
<td>4.12</td>
<td>38.07</td>
<td>27.38</td>
<td>0.05</td>
<td>43.01</td>
<td>5.57</td>
</tr>
</tbody>
</table>

VOC and NOx are precursor pollutants for ozone formation and are used to represent ozone. Additionally, there are no sources of lead emissions and so lead is not shown on the table.

CO = carbon monoxide; NOx = nitrogen oxides; PM10 = inhalable particulate matter; PM2.5 = fine particulate matter; SO2 = sulfur dioxide; VOC = volatile organic compound; tpy = tons per year; n/a = not applicable

**Table 4-75. Halligan Dam Rehabilitation - Unmitigated maximum annual greenhouse gas construction emissions.**

<table>
<thead>
<tr>
<th>Source</th>
<th>CO2 (tpy)</th>
<th>CH4 (tpy)</th>
<th>N2O (tpy)</th>
<th>CO2e (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-road haul trucks and delivery vehicle exhaust</td>
<td>67</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>67</td>
</tr>
<tr>
<td>Construction worker commuting exhaust</td>
<td>205</td>
<td>0.01</td>
<td>&lt;0.01</td>
<td>207</td>
</tr>
<tr>
<td>Nonroad construction equipment exhaust</td>
<td>8,538</td>
<td>0.01</td>
<td>&lt;0.01</td>
<td>8,539</td>
</tr>
<tr>
<td>Total annual emissions</td>
<td>8,810</td>
<td>0.02</td>
<td>0.01</td>
<td>8,813</td>
</tr>
<tr>
<td>Total annual emissions (metric tons per year)</td>
<td>7,992</td>
<td>0.02</td>
<td>0.01</td>
<td>7,995</td>
</tr>
</tbody>
</table>

CO2 = carbon dioxide; CO2e = carbon dioxide equivalent; CH4 = methane; N2O = nitrous oxide; tpy = tons per year

The Environmental Protection Agency's general conformity rule contains requirements designed to meet provisions of Section 176(c) of the Clean Air Act. The de minimis thresholds contained in 40 Code of Federal Regulations 93.153 establish levels at which emission increase would not interfere with a nonattainment area’s progress towards attainment, nor would they jeopardize a maintenance area’s ability to continue to demonstrate attainment. As such, a threshold of 100 tons per year, consistent with the general conformity regulations, was selected to determine if an action alternative could cause an adverse effect on air quality. Because emissions of all pollutants would be less than this threshold, no adverse air quality effects from criteria pollutant emissions would be expected from rehabilitation of Halligan Dam (Table 4-74).
Construction activities could result in emissions of hazardous air pollutants from non-road construction equipment and vehicle trips. Because of the temporary nature of construction and negligible emissions of hazardous air pollutants expected to occur, there would be no short- or long-term adverse effects from hazardous air pollutants.

A threshold of 25,000 metric tons of carbon dioxide equivalent was used to evaluate whether, under the Council on Environmental Quality draft guidance, it is necessary to complete a quantitative and qualitative assessment in the Draft EIS. Because carbon dioxide equivalent emissions would be less than 25,000 metric tons of carbon dioxide equivalent (Table 4-75), it is not necessary to complete a quantitative and qualitative assessment in the Draft EIS.

Emissions from construction activities could affect regional haze and visibility. Regulations adopted by the Colorado Air Quality Control Commission address point and area sources of emissions that contribute to regional haze in Colorado, including common construction activities such as storing and handling materials, mining, haul roads and trucks, tailings piles and ponds, demolition and blasting activities, sandblasting, and animal-confinement operations. Particulate matter emission controls specified in Regulation 1 most directly address the sources of fine and course particles known to have a minor, but measured, effect on visibility in Class I areas of the state. According to the Visibility and Regional Haze State Implementation Plan, the greatest effect from coarse mass-related construction in the state is expected in Rocky Mountain National Park, in which slightly over six percent of the total effect on visibility on the 20 percent worst days is attributed to coarse mass particulate matter from construction activities (CDPHE 2016). All other Class I areas have effects from construction in the two to three percent range (CDPHE 2016). Regulation 1 requires applicable new and existing sources to limit emissions and implement a fugitive emission control plan. This would reduce the effect to regional haze and visibility from rehabilitation of Halligan Dam.

4.19.2.2 General Conformity Applicability Evaluation

Fort Collins’ Proposed Action is subject to general conformity because it involves a federal agency. The Denver/North Front Range area is designated as a marginal nonattainment area for ozone; therefore, this area is subject to a general conformity de minimis threshold of 100 tons per year for volatile organic compounds and nitrogen oxides (as ozone precursors). Additionally, the Fort Collins area is designated as a maintenance area for carbon monoxide, thereby making it subject to a de minimis threshold of 100 tons per year.

Only emissions that occur within the Denver/North Front Range ozone nonattainment area and the Fort Collins carbon monoxide maintenance area would be subject to the general conformity de minimis thresholds. Because the area immediately surrounding Halligan Reservoir is designated attainment for all pollutants, only off-site vehicular traffic could occur within the nonattainment areas. Table 4-76 evaluates the applicability of general conformity to Fort Collins’ Proposed Action. As shown in the table, volatile organic compound, nitrogen oxides, and carbon monoxide emissions would each be less than 100 tons per year (see 40 Code of Federal Regulations 93.153); therefore, general conformity would not apply to Fort Collins’ Proposed Action and no further analysis is required.
Table 4-76. Fort Collins' Proposed Action - General conformity applicability evaluation.

<table>
<thead>
<tr>
<th></th>
<th>VOC (tpy)</th>
<th>NOx (tpy)</th>
<th>CO (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum annual emissions</td>
<td>0.19</td>
<td>0.31</td>
<td>2.13</td>
</tr>
<tr>
<td>General conformity de minimis threshold¹</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Exceeds threshold?</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

¹The general conformity de minimis thresholds are provided in 40 Code of Federal Regulations 93.153(a)(1) for nonattainment areas and 40 Code of Federal Regulations 93.153(a)(2) for maintenance areas.

CO = carbon monoxide; NOx = nitrogen oxides; VOC = volatile organic compound; tpy = tons per year

4.19.3 Fort Collins’ Proposed Action

4.19.3.1 Operational Emissions

No long-term operational emissions would be expected to occur under Fort Collins’ Proposed Action.

4.19.4 Expanded Glade Alternative

4.19.4.1 Construction Emissions

Construction for Fort Collins' facilities for the Expanded Glade Alternative would include only dedicated delivery pipelines, a pump station, and a pretreatment facility. The Corps assumed construction of facilities common to NISP (Poudre Valley Canal expansion, dam, forebay, main pump station, inlet and outlet works) were covered in the NISP Draft EIS per the Alternative Descriptions Report. Construction-related emissions for the Expanded Glade Alternative were estimated for off-road construction equipment, on-road haul trucks and delivery vehicles, and construction worker commuting. Basic control measures would be implemented at all construction sites. Control measures or operational procedures to be employed may include, but are not necessarily limited to, planting vegetation cover, providing synthetic cover, watering, chemical stabilization, furrows, compacting, minimizing disturbed area in the winter, and wind breaks (Colorado Air Quality Control Commission Regulation 1, Section III.D.2.b.(iv)).

Emissions of all pollutants would be less than the general conformity de minimis threshold of 100 tons per year; therefore, no adverse air quality effects would be expected (Table 4-77). Based on draft Council on Environmental Quality guidance, because carbon dioxide equivalent emissions would be less than 25,000 metric tons of carbon dioxide equivalent per year (Table 4-78), it is not necessary to complete a quantitative and qualitative assessment in the Draft EIS.
### Table 4-77. Expanded Glade Alternative - Unmitigated average annual construction emissions.

<table>
<thead>
<tr>
<th>Source</th>
<th>VOC (tpy)</th>
<th>NOx (tpy)</th>
<th>CO (tpy)</th>
<th>SO2 (tpy)</th>
<th>PM10 (tpy)</th>
<th>PM2.5 (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-road haul trucks and delivery vehicle exhaust</td>
<td>&lt;0.01</td>
<td>0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Construction worker commuting exhaust</td>
<td>0.04</td>
<td>0.04</td>
<td>0.53</td>
<td>&lt;0.01</td>
<td>0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Nonroad construction equipment exhaust</td>
<td>2.60</td>
<td>18.45</td>
<td>13.52</td>
<td>0.03</td>
<td>1.44</td>
<td>1.34</td>
</tr>
<tr>
<td>Fugitive dust emissions</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>23.48</td>
<td>3.17</td>
</tr>
<tr>
<td><strong>Total annual emissions</strong></td>
<td>2.64</td>
<td>18.50</td>
<td>14.06</td>
<td>0.03</td>
<td>24.94</td>
<td>4.51</td>
</tr>
</tbody>
</table>

CO = carbon monoxide; NOx = nitrogen oxides; PM10 = inhalable particulate matter; PM2.5 = fine particulate matter; SO2 = sulfur dioxide; VOC = volatile organic compound; tpy = tons per year; N/A = not applicable

### Table 4-78. Expanded Glade Alternative - Unmitigated maximum annual greenhouse gas construction emissions.

<table>
<thead>
<tr>
<th>Source</th>
<th>CO2 (tpy)</th>
<th>CH4 (tpy)</th>
<th>N2O (tpy)</th>
<th>CO2e (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-road haul trucks and delivery vehicle exhaust</td>
<td>4</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>4</td>
</tr>
<tr>
<td>Construction worker commuting exhaust</td>
<td>55</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>55</td>
</tr>
<tr>
<td>Nonroad construction equipment exhaust</td>
<td>5,903</td>
<td>0.03</td>
<td>0.01</td>
<td>5,907</td>
</tr>
<tr>
<td><strong>Total annual emissions</strong></td>
<td>5,963</td>
<td>0.03</td>
<td>0.01</td>
<td>5,967</td>
</tr>
<tr>
<td><strong>Total annual emissions (metric tpy)</strong></td>
<td>5,409</td>
<td>0.03</td>
<td>0.01</td>
<td>5,413</td>
</tr>
<tr>
<td><strong>Total project emissions (2020-2024, metric tons)</strong></td>
<td>27,066</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CO2 = carbon dioxide; CO2e = carbon dioxide equivalent; CH4 = methane; N2O = nitrous oxide; tpy = tons per year

Construction activities could result in emissions of hazardous air pollutants from non-road construction equipment and vehicle trips. Because of the temporary nature of construction and negligible emissions of hazardous air pollutants expected to occur, there would be no short- or long-term adverse effects from hazardous air pollutants.

Emissions from construction activities could affect regional haze and visibility. Colorado Air Quality Control Commission regulations require applicable new and existing sources to limit emissions and implement a fugitive emission control plan; Fort Collins has proposed such a plan as a mitigation measure (see Section 4.19.10). This would reduce the effect to regional haze and visibility of construction of the Expanded Glade Alternative.

#### 4.19.4.2 Operational Emissions

As previously discussed, operational emissions would occur from operation of the pump stations and water treatment plants. Criteria pollutant emissions were not estimated because no localized emissions would occur; however, indirect effects from greenhouse gas emissions from electricity use were estimated (Table 4-79).
Table 4-79. Expanded Glade Alternative - Unmitigated maximum annual greenhouse gas operational emissions.

<table>
<thead>
<tr>
<th>Source</th>
<th>Energy (kWh/yr)</th>
<th>CO₂ (tpy)</th>
<th>CH₄ (tpy)</th>
<th>N₂O (tpy)</th>
<th>CO₂e (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge at Pump Station B – inflow</td>
<td>676,545</td>
<td>616.55</td>
<td>0.007</td>
<td>0.010</td>
<td>619.57</td>
</tr>
<tr>
<td>Discharge at Pump Station B – outflow</td>
<td>35,841</td>
<td>32.66</td>
<td>&lt;0.001</td>
<td>0.001</td>
<td>32.82</td>
</tr>
<tr>
<td>Water treatment</td>
<td>129,000</td>
<td>117.56</td>
<td>0.001</td>
<td>0.002</td>
<td>118.14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>841,386</strong></td>
<td><strong>766.78</strong></td>
<td><strong>0.009</strong></td>
<td><strong>0.012</strong></td>
<td><strong>770.53</strong></td>
</tr>
<tr>
<td><strong>Total (metric tpy)</strong></td>
<td><strong>n/a</strong></td>
<td><strong>695.62</strong></td>
<td><strong>0.008</strong></td>
<td><strong>0.011</strong></td>
<td><strong>699.03</strong></td>
</tr>
</tbody>
</table>

kWh/yr = kilowatt hours per year; CO₂ = carbon dioxide; CH₄ = methane; N₂O = nitrous oxide; CO₂e = carbon dioxide equivalent; tpy = tons per year

Lifetime operational greenhouse gas emissions were calculated assuming a 100-year lifespan. These emissions were then added to total construction emissions to estimate total project-related greenhouse gas emissions. Lifetime emissions were estimated to be 96,969 metric tons of carbon dioxide equivalent.

### 4.19.4.3 General Conformity Applicability Evaluation

As described in Section 4.19.2.2, volatile organic compounds, nitrogen oxides, and carbon monoxide emissions were compared to the general conformity de minimis thresholds to evaluate applicability. All construction activities would occur within the Denver/North Front Range ozone nonattainment area and the Fort Collins carbon monoxide maintenance area (construction worker commuting and haul truck trips). All construction activities associated with non-road equipment would occur outside of the Fort Collins carbon monoxide maintenance area; however, trips associated with construction worker commuting and truck trips could occur within the maintenance area. Without knowing the exact percent of trips that would occur within the region, it was conservatively assumed that all on-road vehicle travel would occur within the Fort Collins carbon monoxide maintenance area. A comparison of these emissions to the general conformity de minimis thresholds identified in 40 Code of Federal Regulations 93.153 is provided in Table 4-80. As shown in that table, volatile organic compound, nitrogen oxides, and carbon monoxide emissions would each be less than 100 tons per year (see 40 Code of Federal Regulations 93.153); therefore, general conformity would not apply to the Expanded Glade Alternative and no further analysis is required.

Table 4-80. Expanded Glade Alternative - General conformity applicability evaluation.

<table>
<thead>
<tr>
<th></th>
<th>VOC (tpy)</th>
<th>NOx (tpy)</th>
<th>CO (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum annual emissions</strong></td>
<td>0.04</td>
<td>0.05</td>
<td>0.54</td>
</tr>
<tr>
<td><strong>General conformity de minimis threshold</strong></td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td><strong>Exceeds threshold?</strong></td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

¹The general conformity de minimis thresholds are provided in 40 Code of Federal Regulations 93.153(a)(1) for nonattainment areas and 40 Code of Federal Regulations 93.153(a)(2) for maintenance areas.

CO = carbon monoxide; NOx = nitrogen oxides; VOC = volatile organic compound; tpy = tons per year
4.19.5 Gravel Pits Alternative

4.19.5.1 Construction Emissions

This alternative would require construction of pipelines, pump stations, a river turnout, and a pretreatment facility. Construction-related emissions for the Gravel Pits Alternative were estimated for off-road construction equipment, on-road haul trucks and delivery vehicles, and construction worker commuting (Table 4-81 and Table 4-82). Basic control measures would be implemented at all construction sites. Control measures or operational procedures to be employed may include, but are not necessarily limited to, planting vegetation cover, providing synthetic cover, watering, chemical stabilization, furrows, compacting, minimizing disturbed area in the winter, and wind breaks (Colorado Air Quality Control Commission Regulation 1, Section III.D.2.b.(iv)).

Table 4-81. Gravel Pits Alternative - Unmitigated maximum annual criteria pollutant construction emissions.

<table>
<thead>
<tr>
<th>Source</th>
<th>VOC (tpy)</th>
<th>NOx (tpy)</th>
<th>CO (tpy)</th>
<th>SO2 (tpy)</th>
<th>PM10 (tpy)</th>
<th>PM2.5 (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-road haul trucks and delivery vehicle exhaust</td>
<td>0.63</td>
<td>4.38</td>
<td>2.24</td>
<td>0.02</td>
<td>0.43</td>
<td>0.22</td>
</tr>
<tr>
<td>Construction worker commuting exhaust</td>
<td>0.27</td>
<td>0.27</td>
<td>3.27</td>
<td>0.00</td>
<td>0.04</td>
<td>0.01</td>
</tr>
<tr>
<td>Nonroad construction equipment exhaust</td>
<td>6.06</td>
<td>34.83</td>
<td>104.47</td>
<td>0.07</td>
<td>2.23</td>
<td>2.09</td>
</tr>
<tr>
<td>Fugitive dust emissions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total annual emissions</strong></td>
<td><strong>6.96</strong></td>
<td><strong>39.49</strong></td>
<td><strong>109.98</strong></td>
<td><strong>0.09</strong></td>
<td><strong>80.73</strong></td>
<td><strong>12.35</strong></td>
</tr>
</tbody>
</table>

CO = carbon monoxide; NOx = nitrogen oxides; PM10 = inhalable particulate matter; PM2.5 = fine particulate matter; SO2 = sulfur dioxide; VOC = volatile organic compound; tpy = tons per year; N/A = not applicable

Table 4-82. Gravel Pits Alternative - Unmitigated maximum annual greenhouse gas construction emissions.

<table>
<thead>
<tr>
<th>Source</th>
<th>CO2 (tpy)</th>
<th>CH4 (tpy)</th>
<th>N2O (tpy)</th>
<th>CO2e (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-road haul trucks and delivery vehicle exhaust</td>
<td>2,134</td>
<td>0.15</td>
<td>0.01</td>
<td>2,140</td>
</tr>
<tr>
<td>Construction worker commuting exhaust</td>
<td>325</td>
<td>0.01</td>
<td>0.01</td>
<td>328</td>
</tr>
<tr>
<td>Nonroad construction equipment exhaust</td>
<td>12,650</td>
<td>0.04</td>
<td>0.01</td>
<td>12,655</td>
</tr>
<tr>
<td><strong>Total annual emissions</strong></td>
<td><strong>15,110</strong></td>
<td><strong>0.20</strong></td>
<td><strong>0.03</strong></td>
<td><strong>15,122</strong></td>
</tr>
<tr>
<td><strong>Total annual emissions (metric tons per year)</strong></td>
<td><strong>13,707</strong></td>
<td><strong>0.18</strong></td>
<td><strong>0.02</strong></td>
<td><strong>13,719</strong></td>
</tr>
<tr>
<td><strong>Total construction emissions (2020-2021, metric tons)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>27,438</strong></td>
</tr>
</tbody>
</table>

CO2 = carbon dioxide; CO2e = carbon dioxide equivalent; CH4 = methane; N2O = nitrous oxide; tpy = tons per year

Emissions of all criteria pollutants, except carbon monoxide, would be less than the general conformity de minimis threshold of 100 tons per year; therefore, adverse air quality effects could occur (Table 4-82). In addition to interfering with Colorado’s ability to attain or maintain the ambient air quality standards, high carbon monoxide concentrations can cause harmful effects by reducing oxygen delivery in the body (see Chapter 3 for more information). Based on the draft Council on Environmental Quality guidance, because carbon dioxide equivalent emissions would be less than 25,000 metric tons of carbon dioxide equivalent...
per year (Table 4-82), it is not necessary to complete a quantitative and qualitative assessment in the Draft EIS.

Construction activities could result in emissions of hazardous air pollutants from non-road construction equipment and vehicle trips. Because of the temporary nature of construction and negligible hazardous air pollutants emissions expected to occur, there would be no short- or long-term adverse effects from hazardous air pollutants.

Emissions from construction activities could affect regional haze and visibility. Colorado Air Quality Control Commission regulations require applicable new and existing sources to limit emissions and implement a fugitive emission control plan; Fort Collins has proposed such a plan as a mitigation measure (see Section 4.19.10). This would reduce the effect to regional haze and visibility of construction of the Gravel Pits Alternative.

### 4.19.5.2 Operational Emissions

As previously discussed, operational emissions would occur from operation of the pump stations and water treatment plants. Criteria pollutant emissions were not estimated because no localized emissions would occur; however, indirect effects from greenhouse gas emissions due to electricity use were estimated (Table 4-83).

**Table 4-83. Gravel Pits Alternative - Unmitigated maximum annual greenhouse gas operational emissions.**

<table>
<thead>
<tr>
<th>Source</th>
<th>Energy (kWh/yr)</th>
<th>CO₂ (tpy)</th>
<th>CH₄ (tpy)</th>
<th>N₂O (tpy)</th>
<th>CO₂e (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge at Pump Station C – inflow</td>
<td>20,000</td>
<td>18.23</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>18.32</td>
</tr>
<tr>
<td>Discharge at Pump Station C – outflow</td>
<td>263,000</td>
<td>239.68</td>
<td>0.003</td>
<td>0.004</td>
<td>240.85</td>
</tr>
<tr>
<td>Discharge at Pump Station A</td>
<td>149,000</td>
<td>135.79</td>
<td>0.002</td>
<td>0.002</td>
<td>136.45</td>
</tr>
<tr>
<td>Discharge at Pump Station G</td>
<td>54,000</td>
<td>49.21</td>
<td>0.001</td>
<td>0.001</td>
<td>49.45</td>
</tr>
<tr>
<td>Water treatment</td>
<td>270,000</td>
<td>246.06</td>
<td>0.003</td>
<td>0.004</td>
<td>247.26</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>756,000</strong></td>
<td><strong>688.96</strong></td>
<td><strong>0.008</strong></td>
<td><strong>0.011</strong></td>
<td><strong>692.34</strong></td>
</tr>
<tr>
<td><strong>Total (metric tons per year)</strong></td>
<td>N/A</td>
<td><strong>625.03</strong></td>
<td><strong>0.01</strong></td>
<td><strong>0.01</strong></td>
<td><strong>628.09</strong></td>
</tr>
</tbody>
</table>

kWh/yr = kilowatt hours per year; CO₂ = carbon dioxide; CH₄ = methane; N₂O = nitrous oxide; CO₂e = carbon dioxide equivalent; tpy = tons per year; N/A = not applicable

Lifetime operational greenhouse gas emissions were calculated assuming a 100-year lifespan. These emissions were then added to total construction emissions to estimate total project-related greenhouse gas emissions. Lifetime emissions were estimated to be 90,246 metric tons of carbon dioxide equivalent.

### 4.19.5.3 General Conformity Applicability Evaluation

As described in Section 4.19.2.2, volatile organic compound, nitrogen oxides, and carbon monoxide emissions were compared to the general conformity de minimis thresholds to evaluate applicability. All construction activities would occur within the Denver/North Front Range ozone nonattainment area and the Fort Collins carbon monoxide maintenance area (construction worker commuting and haul truck trips). All construction activities associated with non-road equipment would occur outside of the Fort...
Collins carbon monoxide maintenance area; however, trips associated with construction worker commuting and truck trips could occur within the region. Without knowing the exact percent of trips that would occur within the region, it was conservatively assumed that all on-road vehicle travel would occur within the Fort Collins carbon monoxide maintenance area. Table 4-84 compares these emissions to the general conformity de minimis thresholds identified in 40 Code of Federal Regulations 93.153. As shown in the table, volatile organic compound, nitrogen oxides, and carbon monoxide emissions would each be less than 100 tons per year (see 40 Code of Federal Regulations 93.153); therefore, general conformity would not apply to the Gravel Pits Alternative and no further analysis is required.

Table 4-84. Gravel Pits Alternative - General conformity applicability evaluation.

<table>
<thead>
<tr>
<th>Source</th>
<th>VOC (tpy)</th>
<th>NOx (tpy)</th>
<th>CO (tpy)</th>
<th>SO2 (tpy)</th>
<th>PM10 (tpy)</th>
<th>PM2.5 (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum annual emissions</td>
<td>0.90</td>
<td>4.66</td>
<td>5.51</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General conformity de minimis threshold1</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exceeds threshold?</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1The general conformity de minimis thresholds are provided in 40 Code of Federal Regulations 93.153(a)(1) for nonattainment areas and 40 Code of Federal Regulations 93.153(a)(2) for maintenance areas.

CO = carbon monoxide; NOx = nitrogen oxides; VOC = volatile organic compound; tpy = tons per year

4.19.6 Agricultural Reservoirs Alternative

4.19.6.1 Construction Emissions

Under the Agricultural Reservoirs Alternative, Fort Collins would acquire additional water storage capacity in existing agricultural reservoirs. The alternative would require construction of a pipeline, pump stations, and a pre-treatment facility. Construction-related emissions for the Agricultural Reservoirs Alternative were estimated for off-road construction equipment, on-road haul trucks and delivery vehicles, and construction worker commuting (Table 4-85). Basic control measures would be implemented at all construction sites.

Table 4-85. Agricultural Reservoirs Alternative - Unmitigated maximum annual criteria pollutant construction emissions.

<table>
<thead>
<tr>
<th>Source</th>
<th>VOC (tpy)</th>
<th>NOx (tpy)</th>
<th>CO (tpy)</th>
<th>SO2 (tpy)</th>
<th>PM10 (tpy)</th>
<th>PM2.5 (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-road haul trucks and delivery vehicle exhaust</td>
<td>0.01</td>
<td>0.04</td>
<td>0.02</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Construction worker commuting exhaust</td>
<td>0.17</td>
<td>0.17</td>
<td>2.05</td>
<td>&lt;0.01</td>
<td>0.03</td>
<td>0.01</td>
</tr>
<tr>
<td>Nonroad construction equipment exhaust</td>
<td>4.15</td>
<td>17.95</td>
<td>97.96</td>
<td>0.04</td>
<td>1.42</td>
<td>1.31</td>
</tr>
<tr>
<td>Fugitive dust emissions</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>46.86</td>
<td>5.73</td>
</tr>
<tr>
<td>Total annual emissions</td>
<td>4.32</td>
<td>18.15</td>
<td>100.03</td>
<td>0.04</td>
<td>48.30</td>
<td>7.05</td>
</tr>
</tbody>
</table>

CO = carbon monoxide; NOx = nitrogen oxides; PM10 = inhalable particulate matter; PM2.5 = fine particulate matter; SO2 = sulfur dioxide; VOC = volatile organic compound; tpy = tons per year; N/A = not applicable

Emissions of all criteria pollutants, except carbon monoxide, would be less than the general conformity de minimis threshold of 100 tons per year; therefore, adverse air quality effects from construction activities could occur (Table 4-86). In addition to interfering with the State’s ability to attain or maintain the
ambient air quality standards, high carbon monoxide concentrations can cause harmful effects by reducing oxygen delivery in the body (see Chapter 3 for more information). Based on the draft Council on Environmental Quality guidance, because carbon dioxide equivalent emissions would be less than 25,000 metric tons of carbon dioxide equivalent per year (Table 4-86), it is not necessary to complete a quantitative and qualitative assessment in the Draft EIS.

**Table 4-86. Agricultural Reservoirs Alternative - Unmitigated maximum annual greenhouse gas construction emissions.**

<table>
<thead>
<tr>
<th>Source</th>
<th>CO₂ (tpy)</th>
<th>CH₄ (tpy)</th>
<th>N₂O (tpy)</th>
<th>CO₂e (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-road haul trucks and delivery vehicle exhaust</td>
<td>17</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>17</td>
</tr>
<tr>
<td>Construction worker commuting exhaust</td>
<td>204</td>
<td>0.01</td>
<td>&lt;0.01</td>
<td>206</td>
</tr>
<tr>
<td>Nonroad construction equipment exhaust</td>
<td>6,038</td>
<td>0.03</td>
<td>0.01</td>
<td>6,042</td>
</tr>
<tr>
<td><strong>Total annual emissions</strong></td>
<td><strong>6,259</strong></td>
<td><strong>0.04</strong></td>
<td><strong>0.02</strong></td>
<td><strong>6,265</strong></td>
</tr>
<tr>
<td><strong>Total annual emissions (metric tons per year)</strong></td>
<td><strong>5,678</strong></td>
<td><strong>0.03</strong></td>
<td><strong>0.01</strong></td>
<td><strong>5,683</strong></td>
</tr>
<tr>
<td><strong>Total construction emissions (2020-2021, metric tons)</strong></td>
<td><strong>11,366</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CO₂ = carbon dioxide; CO₂e = carbon dioxide equivalent; CH₄ = methane; N₂O = nitrous oxide; tpy = tons per year

Construction activities could result in emissions of hazardous air pollutants from non-road construction equipment and vehicle trips. Because of the temporary nature of construction and negligible hazardous air pollutants emissions expected to occur, there would be no short- or long-term adverse effects from hazardous air pollutants.

Emissions from construction activities could affect regional haze and visibility. Colorado Air Quality Control Commission regulations require applicable new and existing sources to limit emissions and implement a fugitive emission control plan; Fort Collins has proposed such as plan as a mitigation measure (see Section 4.19.10). This would reduce the effect to regional haze and visibility of construction of the Agricultural Reservoirs Alternative.

### 4.19.6.2 Operational Emissions

As previously discussed, operational emissions would occur from operation of the pump stations and water treatment plants. Criteria pollutant emissions were not estimated because no localized emissions would occur; however, indirect effects from greenhouse gas emissions from electricity use were estimated (Table 4-87). Lifetime operational greenhouse gas emissions were calculated assuming a 100-year lifespan. These emissions were then added to total construction emissions to estimate total project-related greenhouse gas emissions. Lifetime emissions were estimated to be 55,298 metric tons of carbon dioxide equivalent.
Table 4-87. Agricultural Reservoirs Alternative - Unmitigated maximum annual greenhouse gas operational emissions.

<table>
<thead>
<tr>
<th>Source</th>
<th>Energy (kWh/yr)</th>
<th>CO₂ (tpy)</th>
<th>CH₄ (tpy)</th>
<th>N₂O (tpy)</th>
<th>CO₂e (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge at Pump Station D</td>
<td>224,789</td>
<td>204.86</td>
<td>0.002</td>
<td>0.003</td>
<td>205.86</td>
</tr>
<tr>
<td>Water treatment</td>
<td>304,000</td>
<td>277.04</td>
<td>0.003</td>
<td>0.004</td>
<td>278.40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>528,789</strong></td>
<td><strong>481.90</strong></td>
<td><strong>0.006</strong></td>
<td><strong>0.007</strong></td>
<td><strong>484.26</strong></td>
</tr>
<tr>
<td><strong>Total (metric tpy)</strong></td>
<td><strong>N/A</strong></td>
<td><strong>437.18</strong></td>
<td><strong>0.005</strong></td>
<td><strong>0.007</strong></td>
<td><strong>439.32</strong></td>
</tr>
</tbody>
</table>

kWh/yr = kilowatt hours per year; CO₂ = carbon dioxide; CH₄ = methane; N₂O = nitrous oxide; CO₂e = carbon dioxide equivalent; tpy = tons per year; N/A = not applicable

4.19.6.3 General Conformity Applicability Evaluation

As described for Fort Collins’ Proposed Action, volatile organic compound, nitrogen oxides, and carbon monoxide emissions were compared to the general conformity de minimis thresholds to evaluate applicability. Construction activities would occur within the Denver/North Front Range ozone nonattainment area and the Fort Collins carbon monoxide maintenance area (construction worker commuting and haul truck trips). All construction activities associated with non-road equipment would occur outside of the Fort Collins carbon monoxide maintenance area; however, trips associated with construction worker commuting and truck trips could occur within the region. Without knowing the exact percent of trips that would occur within the region, it was conservatively assumed that all on-road vehicle travel would occur within the Fort Collins carbon monoxide maintenance area. Table 4-88 compares these emissions to the general conformity de minimis thresholds identified in 40 Code of Federal Regulations 93.153. As shown in the table, volatile organic compound, nitrogen oxides, and carbon monoxide emissions would each be less than 100 tons per year (see 40 Code of Federal Regulations 93.153); therefore, general conformity would not apply to the Agricultural Reservoirs Alternative and no further analysis is required.

Table 4-88. Agricultural Reservoirs Alternative - General conformity applicability evaluation.

<table>
<thead>
<tr>
<th></th>
<th>VOC (tpy)</th>
<th>NOx (tpy)</th>
<th>CO (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum annual emissions</td>
<td>0.18</td>
<td>0.21</td>
<td>2.07</td>
</tr>
<tr>
<td>General conformity de minimis threshold¹</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Exceeds threshold?</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

¹The general conformity de minimis thresholds are provided in 40 Code of Federal Regulations 93.153(a)(1) for nonattainment areas and 40 Code of Federal Regulations 93.153(a)(2) for maintenance areas. CO = carbon monoxide; NOx = nitrogen oxides; VOC = volatile organic compound; tpy = tons per year

4.19.7 No-Action Alternative

Under the No-Action Alternative, the city would implement nonstructural measures to improve water supplies. Therefore, no air quality effects would occur under the No-Action Alternative other than those due to rehabilitation of Halligan Dam described under Section 4.19.2.

4.19.8 Effects Summary

Estimates for emissions of criteria pollutants associated with each alternative are based on construction-related emissions, as well as 100 years of operations emissions (Table 4-89). The Gravel Pits Alternative
would have the highest emissions levels for all criteria pollutants as a result of the extensive excavation required during construction. Although total project carbon monoxide emissions would exceed the general conformity de minimis thresholds for the Gravel Pit and Agricultural Reservoirs alternatives, largely due to a gasoline-fueled generator operating during construction, most emissions would not occur in the carbon monoxide maintenance areas. A full general conformity determination would not be required if one of these alternatives was selected as the preferred alternative because emissions would not exceed the general conformity de minimis threshold in the designated maintenance areas. Rehabilitation of Halligan Dam would have higher emissions than the Expanded Glade Reservoir Alternative due to more extensive construction requirements.

Table 4-89. Summary of air quality effects by alternative.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Halligan Dam Rehabilitation</th>
<th>Fort Collins’ Proposed Action</th>
<th>Expanded Glade</th>
<th>Gravel Pits</th>
<th>Agricultural Reservoirs</th>
<th>No Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOC (tpy)</td>
<td>4.12</td>
<td>0</td>
<td>2.64</td>
<td>6.96</td>
<td>4.32</td>
<td>0</td>
</tr>
<tr>
<td>NOx (tpy)</td>
<td>38.07</td>
<td>0</td>
<td>18.50</td>
<td>39.49</td>
<td>18.15</td>
<td>0</td>
</tr>
<tr>
<td>CO (tpy)</td>
<td>27.38</td>
<td>0</td>
<td>14.06</td>
<td>109.98</td>
<td>100.03</td>
<td>0</td>
</tr>
<tr>
<td>SO(_2) (tpy)</td>
<td>0.05</td>
<td>0</td>
<td>0.03</td>
<td>0.09</td>
<td>0.04</td>
<td>0</td>
</tr>
<tr>
<td>PM(_{10}) (tpy)</td>
<td>43.01</td>
<td>0</td>
<td>24.94</td>
<td>80.73</td>
<td>48.30</td>
<td>0</td>
</tr>
<tr>
<td>PM(_{2.5}) (tpy)</td>
<td>5.57</td>
<td>0</td>
<td>4.51</td>
<td>12.35</td>
<td>7.05</td>
<td>0</td>
</tr>
<tr>
<td>CO(_2) (metric tons)(^2)</td>
<td>15,990</td>
<td>0</td>
<td>96,969</td>
<td>90,246</td>
<td>55,298</td>
<td>0</td>
</tr>
</tbody>
</table>

\(^1\)These effects would occur under all alternatives.
\(^2\)Emissions represent lifetime project emissions (total construction plus 100-year operational emissions).

4.19.9 Unavoidable Adverse Effects

All alternatives would unavoidably increase emission of volatile organic compounds, nitrogen oxides, carbon monoxide, sulfur dioxide, inhalable particulate matter, fine particulate matter, and carbon dioxide equivalent during construction. Carbon monoxide emissions would exceed the general conformity de minimis thresholds for the Gravel Pit and Agricultural Reservoirs alternatives, largely due to a gasoline-fueled generator operating during construction.

4.19.10 Mitigation Measures

To minimize effects from fugitive dust and other emissions from all construction operations, Fort Collins would develop an Emissions Control Plan that would be implemented during construction under all alternatives. For their Proposed Action, Fort Collins may evaluate the feasibility of designing the new dam to allow for future small hydropower installation, which could eventually be installed to produce renewable power with no greenhouse emissions. Adding future hydropower capability to the dam would make it easier for Fort Collins to install hydropower to the structure, thereby reducing impacts on water quality, waters of the U.S., and the aquatic ecosystem from retrofitting the dam at a later date. This measure would help Fort Collins meet its future renewable energy goals with minimal structure
modification and impacts. The proposed Glade Reservoir Enlargement and Agricultural Reservoir Alternatives could potentially include the option for hydropower generation, but this is not likely to be an option for the Gravel Pit Reservoirs Alternative.

4.20 NOISE

Noise level increases over ambient levels may have adverse effects on humans and the natural environment. Noise effects can be short-term, such as temporary noise generated from construction activities, or long-term, such as noise from on-going operation of new facilities.

4.20.1 Methods

Noise level effects were analyzed for activities associated with construction, traffic along haul and commute roads, and operation of facilities for the alternatives. Larimer County's daytime maximum permissible levels for construction were used to assess whether the noise effects from construction of the proposed alternatives would cause an adverse effect to sensitive receptors. Operational noise levels were compared against the Larimer County and Fort Collins maximum permissible levels for residential land uses.

Construction and operational equipment noise levels were predicted using the equations and guiding principles from the Federal Highway Administration Roadway Construction Noise Model (RCNM) User's Guide (2006). The Roadway Construction Noise Model database provides maximum noise levels for various pieces of equipment at a reference distance of 50 feet. Noise levels for rock screening and crushing were based on Bureau of Reclamation (2006). Major construction activities and the construction schedule were used to calculate noise produced by each of the alternatives.

Transportation noise impacts would be due to increased local commuter traffic and trucks hauling waste and construction materials. Basic logarithmic addition and subtraction for noise levels were used to estimate the increase in roadway noise (CDM Smith 2016f). The analysis applied to all potential receptors along a roadway and was based on equivalent passenger vehicle volumes calculated from traffic volumes, haul and commute routes, projected traffic volume in 2010, and posted speeds.

4.20.1.1 Data Adequacy

Section 3.20.3 describes the best-available data for noise in the study areas. The Corps determined the data available and methods used were adequate to evaluate and describe reasonably foreseeable significant adverse effects on noise in the study areas and to enable the decision maker to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable noise information as described in Section 4.2.1.5.

4.20.2 Halligan Dam Rehabilitation

Rehabilitation of Halligan Dam would occur under all alternatives, regardless of which one is chosen. Major construction activities for Halligan Dam rehabilitation would include mobilization, site preparation (including right-of-way clearing, access road improvement, and preparing working space), river
diversion, rehabilitation of existing dam, excavation, foundation preparation, grout curtain construction, outlet works construction, concrete placement for dam, and demobilization. It was assumed that for each major construction activity, all anticipated construction equipment would operate simultaneously during the day between 7:00 a.m. and 7:00 p.m. for a conservative analysis. The closest receptor (referred to as Receptor H-1) to Halligan Reservoir is a residence situated approximately 3,800 feet from the proposed construction staging area. Crushing and blasting operations would result in the highest noise levels. Estimated noise levels at the nearest receptor as a result of construction activities at Halligan Dam (41 to 58 A-weighted decibels) would not exceed Larimer County's maximum permissible noise level for construction. Therefore, no adverse noise effects would be expected from rehabilitation of Halligan Dam. Violation of the local noise ordinance would be a significant effect within the area. However, noise effects from construction equipment would not be significant because estimated noise levels at the nearest receptor as a result of rehabilitation of Halligan Dam would not exceed Larimer County's maximum permissible noise level for construction, and no additional noise-producing activities were anticipated to occur concurrently in the vicinity of Halligan Dam.

The estimated increase in peak 1-hour and daily equivalent noise level due to vehicular traffic associated with construction worker commute and off-site hauling for rehabilitation of Halligan Dam is less than two A-weighted decibels for all haul and commute routes; therefore, a substantial increase in noise levels (10 A-weighted decibels) is not expected (Table 4-90). A substantial increase in roadway noise would be a significant effect within the area, but noise effects from hauling and construction worker commute associated with Halligan Dam rehabilitation would not be significant because estimated noise increase would be less than 10 A-weighted decibels.

**Table 4-90. Summary of construction-related traffic noise from off-site hauling and construction worker commute for rehabilitation of Halligan Dam.**

<table>
<thead>
<tr>
<th>Haul Route/Commute Segment</th>
<th>Increase in Average Daily $L_{eq}$ (dBA)</th>
<th>Increase in Peak 1-hour $L_{eq}$ (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Highway 287</td>
<td>&lt;1</td>
<td>&lt;2</td>
</tr>
<tr>
<td>County Road 54G</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>County Road 19 (Taft Hill Road)</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Colorado Highway 14</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Interstate Highway 25</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

dBA = A-weighted decibels; $L_{eq}$ = equivalent noise level

### 4.20.3 Fort Collins’ Proposed Action

Noise levels due to operation of the enlarged Halligan Reservoir would be similar to existing conditions. Because there would be no change in noise levels resulting from operation activities, no effects would occur.

### 4.20.4 Expanded Glade Alternative

For the Expanded Glade Alternative, Fort Collins would construct a pump station, a pretreatment plant, and associated delivery pipelines.
Major construction activities for the Expanded Glade Alternative would include:

- Mobilization, site preparation trenching, pipe installation, slope protection, backfilling, and demobilization for the pipeline construction
- Mobilization, site preparation, excavation, concrete placement, construction above and below grade, mechanical and electrical equipment installation, control system installation, and demobilization for the water treatment facility and pump station.

It was assumed that during each major construction activity, all anticipated construction equipment would operate simultaneously during the day between 7:00 a.m. and 7:00 p.m. at the pump station/pretreatment facility and pipeline construction sites for a conservative analysis. The predicted 8-hour equivalent noise levels at the construction sites are 70 to 89 A-weighted decibels. The ranges refer to different noise levels that may result from the different major construction activities. Construction noise levels are similar to those predicted for the construction of NISP facilities (70 to 90 A-weighted decibels at 50 feet) (Corps 2008, 2015). Construction noise from the pump station/pretreatment facility would be 41 to 54 A-weighted decibels at the nearest sensitive receptor, approximately 2,200 feet away (referred to as Receptor G-1). Resulting noise levels at the receptor closest to the proposed pipeline location (also Receptor G-1) at approximately 350 feet would be 53 to 72 A-weighted decibels. Estimated noise levels at the nearest receptor as a result of construction activities for the Expanded Glade Alternative would not exceed Larimer County's maximum permissible noise level for construction; therefore, no adverse noise effects would be expected from construction of the Expanded Glade Alternative. Noise effects from construction of the Expanded Glade Alternative would not be significant because estimated noise levels at the nearest receptor would not exceed Larimer County's maximum permissible noise level for construction.

The estimated increase in peak one-hour and daily equivalent noise levels due to vehicular traffic associated with construction worker commute and off-site hauling under the Expanded Glade Alternative is less than one A-weighted decibel for all identified haul and commute routes (Table 4-91). Therefore, a substantial increase in noise levels is not anticipated. Noise effects from construction-related traffic for the Expanded Glade Alternative would not be significant because the estimated noise increase would be less than 10 A-weighted decibels.

**Table 4-91. Summary of construction-related traffic noise from off-site hauling and construction worker commute for the Expanded Glade Alternative.**

<table>
<thead>
<tr>
<th>Haul Route/Commute Segment</th>
<th>Increase in Average Daily $L_{eq}$ (dBA)</th>
<th>Increase in Peak 1-hour $L_{eq}$ (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Highway 287</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Drake Road</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Timberline Road</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Colorado Highway 14</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Interstate Highway 25</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

$dBA = A$-weighted decibels; $L_{eq} = $ equivalent noise level

Operational noise would include pumps and other equipment at the pretreatment facility and additional vehicle trips associated with operation of the pretreatment facility. Operation of one pump and one
generator would result in an operational noise level of approximately 84 A-weighted decibels at the facility. At the nearest receptor, 2,200 feet from the facility, the noise level would be decreased by 34 A-weighted decibels due to distance attenuation. The pretreatment facility would be designed with building materials that would reduce equipment noise levels so as to not violate the local noise ordinance. Construction materials and acoustical treatments may be specified to provide additional noise reduction. Trucks hauling solids and delivery trucks would travel to and from the pretreatment facility. Approximately 25 truck trips would occur each year with up to three trips occurring every three to 135 days (MWH Global 2015b). These truck trips would be infrequent and are not anticipated to contribute substantially to the noise environment.

Estimated noise levels at the nearest receptor as a result of operation of the proposed pump station/pretreatment facility for the Expanded Glade Alternative would not exceed Larimer County's maximum permissible noise level for residential areas. Therefore, no adverse noise effects would result from operation of the Expanded Glade Alternative. According to the NISP Supplemental Draft EIS, operational noise from NISP pump stations would be maintained below noise standards (Corps 2008, 2015). Noise effects would not be significant because operational noise levels from the Expanded Glade Alternative and NISP would not exceed Larimer County's maximum permissible noise level for residential areas.

4.20.5 Gravel Pits Alternative

Construction-related noise levels for the Gravel Pits Alternative were estimated for construction activities at the storage sites, pump stations, the pretreatment facility, new pipelines, and along haul and commute roads. Major construction activities for the Gravel Pits Alternative would include:

- Site preparation, excavation, material screening, inlet/outlet structures, slurry wall, and placing and compacting core and shell material for the gravel pits
- Mobilization, site preparation, trenching, pipe installation, slope protection, backfilling, and demobilization for the pipeline construction
- Mobilization, site preparation, excavation, concrete placement, construction above and below grade, mechanical and electrical equipment installation, control system installation, and demobilization for the water treatment facility and pump station.

During each major construction activity at the pump station/pretreatment facility, all anticipated construction equipment was assumed to operate simultaneously during the day between 7:00 a.m. and 7:00 p.m. for a conservative analysis, resulting in noise levels of 70 to 88 A-weighted decibels at the construction site. The ranges refer to the noise levels that could result from different construction activities. Construction noise from the pump station/pretreatment facility would be 56 to 72 A-weighted decibels at the nearest sensitive receptor, approximately 300 feet away (referred to as Receptor GP-2).

Pipeline construction would occur as close as 25 feet to residential neighborhoods. At this distance, it would be unreasonable to operate more than one piece of equipment at a time due to physical limitations. For the loudest piece of equipment during each major construction activity, the resulting noise level at the receptor closest to the proposed pipeline locations (Receptor GP-3), at approximately 25 feet, would be
76 to 87 A-weighted decibels for the various major construction activities associated with pipeline construction. All other receptors along the proposed pipeline would experience noise levels at or less than those estimated for Receptor GP-3. A similar approach was taken for construction activities at the gravel pits, which may be as close as 25 feet from the nearest residence (Receptor GP-1). Modifications of the gravel pits would result in 87 A-weighted decibels from one piece of equipment at the closest receptor (25 feet).

Estimated noise levels at the nearest receptor as a result of construction of pipelines and modifications of the gravel pits for the Gravel Pits Alternative would exceed Larimer County's maximum permissible noise level for construction. Therefore, sensitive receptors near these construction sites would be adversely affected. These effects, however, would be short-term, lasting the duration of construction. Noise effects from construction of the Gravel Pits Alternative components would be significant. Construction noise from the pump station/pretreatment facility would not exceed the county ordinance level.

The estimated increase in peak one-hour and daily equivalent noise level (A-weighted decibels) due to vehicular traffic associated with construction worker commute and off-site hauling under the Gravel Pits Alternative is less than three A-weighted decibels for all haul and commute routes (Table 4-92). Therefore, a substantial increase in noise levels (10 A-weighted decibels) would not occur. Noise effects from the haul and commute routes used in the Gravel Pits Alternative would not be significant because the estimated noise increase would be less than 10 A-weighted decibels.

Table 4-92. Summary of construction-related traffic noise from off-site hauling and construction worker commute for the Gravel Pit Alternative.

<table>
<thead>
<tr>
<th>Haul Route/Commute Segment</th>
<th>Increase in Average Daily $L_{eq}$ (dBA)</th>
<th>Increase in Peak 1-hour $L_{eq}$ (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Highway 287</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>County Road 54G</td>
<td>&lt;1</td>
<td>&lt;2</td>
</tr>
<tr>
<td>County Road 19 (Taft Hill Road)</td>
<td>&lt;1</td>
<td>&lt;3</td>
</tr>
<tr>
<td>Drake Road</td>
<td>&lt;1</td>
<td>1</td>
</tr>
<tr>
<td>County Road 48 (Vine Drive)</td>
<td>&lt;1</td>
<td>2</td>
</tr>
<tr>
<td>County Road 21/21C (Overland Trail Road)</td>
<td>&lt;1</td>
<td>2</td>
</tr>
<tr>
<td>Colorado Highway 14</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Interstate Highway 25</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

dBA = A-weighted decibels; $L_{eq}$ = 1-hour equivalent noise level

Operational noise would include pumps and other equipment at the pretreatment facility, and additional vehicle trips associated with operation of the pretreatment facility. Operation of one pump and one generator would result in an operational noise of approximately 84 A-weighted decibels at the facility. At 300 feet, the estimated distance to the nearest receptor, the noise level would decrease to approximately 68 A-weighted decibels. The pretreatment facility would be designed with building materials that would reduce equipment noise levels so as to not violate the local noise ordinance. Construction materials and acoustical treatments could be specified to provide additional noise reduction. Trucks hauling solids and delivery trucks would travel to and from the pretreatment facility. Approximately 50 truck trips would occur each year with up to three trips occurring every three to 135 days (MWH Global 2015b).
truck trips would be infrequent and would not be anticipated to contribute substantially to the noise environment.

Estimated noise levels at the nearest receptor as a result of operation of the proposed pump station/pretreatment facility for the Gravel Pits Alternative would not exceed Larimer County's maximum permissible noise level for residential areas. Therefore, no adverse noise effects would result from operation of the Gravel Pits Alternative, and noise effects would not be significant.

### 4.20.6 Agricultural Reservoirs Alternative

Construction-related noise levels for the Agricultural Reservoirs Alternative were estimated for construction activities at the pretreatment facility, new pipelines, and along haul and commute roads. Major construction activities for the Agricultural Reservoirs Alternative would include:

- Mobilization, site preparation, trenching, pipe installation, slope protection, backfilling, and demobilization for the pipeline construction
- Mobilization, site preparation, excavation, concrete placement, construction above and below grade, mechanical and electrical equipment installation, control system installation, and demobilization for the water treatment facility and pump station.

During each major construction activity, all anticipated construction equipment was assumed to operate simultaneously during the day between 7:00 a.m. and 7:00 p.m. at the pump station or pretreatment facility construction for a conservative analysis, resulting in noise levels of 70 to 88 A-weighted decibels. The ranges refer to different noise levels that may result from the different major construction activities. Construction noise from the pump station/pretreatment facility would be 56 to 73 A-weighted decibels at the nearest sensitive receptor, approximately 300 feet away (referred to as Receptor AR-1). Construction noise at the pump station/pretreatment facility would not exceed Larimer County's maximum permissible noise level.

Pipeline construction would occur as close as 25 feet to residential neighborhoods. At this distance, it would be unreasonable to operate more than one piece of equipment at a time due to physical limitations. The loudest piece of equipment in each major construction activity was selected to represent the noise level at the construction site. The resulting noise level at the receptor closest to the proposed pipeline locations (Receptor AR-2), at approximately 25 feet, would be 76 to 87 A-weighted decibels. All other receptors along the proposed pipeline, including those near Agricultural Reservoirs Number 5 and 6, would experience noise levels at or less than those estimated for Receptor AR-2. Estimated noise levels at the nearest receptor as a result of construction of pipelines for the Agricultural Reservoirs Alternative would exceed Larimer County's maximum permissible noise level for construction; therefore, sensitive receptors near these construction sites may be adversely affected. These effects, however, would be short-term, lasting the duration of construction. Noise effects from construction sites also would be significant.

The estimated increase in peak 1-hour and daily equivalent noise level (A-weighted decibels) due to vehicular traffic associated with construction worker commute and off-site hauling under the Agricultural Reservoirs Alternative is less than two A-weighted decibels for all haul and commute routes (Table 4-93).
Therefore, a substantial increase in noise levels (10 A-weighted decibels) is not anticipated. Noise effects from construction-related traffic for this alternative also would not be significant.

**Table 4-93. Summary of construction-related traffic noise from off-site hauling and construction worker commute for the Agricultural Reservoirs Alternative.**

<table>
<thead>
<tr>
<th>Haul Route/Commute Segment</th>
<th>Increase in Average Daily $L_{eq}$ (dBA)</th>
<th>Increase in Peak 1-hour $L_{eq}$ (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Highway 287</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>County Road 54G</td>
<td>&lt;1</td>
<td>1</td>
</tr>
<tr>
<td>County Road 19 (Taft Hill Road)</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Drake Road</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>County Road 48 (Vine Drive)</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Timberline Road</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>County Road 21/21C (Overland Trail Road)</td>
<td>&lt;1</td>
<td>2</td>
</tr>
<tr>
<td>Terry Lake Road</td>
<td>&lt;1</td>
<td>2</td>
</tr>
<tr>
<td>County Road 58</td>
<td>&lt;1</td>
<td>2</td>
</tr>
<tr>
<td>Colorado Highway 14</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Interstate Highway 25</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

dBA = A-weighted decibels; $L_{eq}$ = 1-hour equivalent noise level

Operational noise would include pumps and other equipment at the pretreatment facility, and additional vehicle trips associated with the operation of the pretreatment facility. One pump and one generator would result in an operational noise level of approximately 84 A-weighted decibels at the facility. The nearest receptor would be approximately 300 feet from the facility. The equipment noise level would decrease to approximately 68 A-weighted decibels at 300 feet from the facility. Noise-generating equipment at the pretreatment facility would be housed in a building, which would provide additional noise reduction so as to not violate the local noise ordinance. Construction materials and acoustical treatments may be specified to provide additional noise reduction. Trucks hauling solids and delivery trucks would travel to and from the pretreatment facility. Approximately 56 truck trips would occur each year with up to three trips occurring every three to 135 days (MWH Global 2015b). These truck trips would be infrequent and would not be anticipated to contribute substantially to the noise environment. Estimated noise levels at the nearest receptor as a result of operation of the proposed pump station/pretreatment facility for the Agricultural Reservoirs Alternative would not exceed Larimer County's maximum permissible noise level for residential areas. Therefore, no adverse noise effects would result from operation of the Agricultural Reservoirs Alternative, and noise effects would not be significant.

**4.20.7 No-Action Alternative**

The non-structural measures under the No-Action Alternative would not require construction, increased traffic, or long-term operations of any facilities; therefore, there would be no noise effects related to the No-Action Alternative other than those associated with rehabilitating Halligan Dam (Section 4.20.2).
4.20.8 Effects Summary

A comparison of the anticipated noise effects for each of the alternatives is summarized in Table 4-94. The Gravel Pits Alternative would have the highest construction equipment noise levels. Construction equipment noise levels for the Gravel Pits and Agricultural Reservoirs alternatives would exceed the county noise thresholds due to the proximity of proposed project component areas to residential neighborhoods. Fort Collins' Proposed Action and the Expanded Glade Alternative would not exceed the county noise thresholds from associated construction or operational activities. Construction-related traffic for Fort Collins' Proposed Action and all alternatives would not result in a substantial increase of roadway noise. Operation of the pump station or pretreatment facility for the Expanded Glade Alternative, Gravel Pits Alternative, and Agricultural Reservoirs Alternative would not exceed Larimer County's maximum permissible noise level for residential areas. Therefore, no adverse noise effects would result from construction or operation of Fort Collins' Proposed Action and the Expanded Glade Alternative and operation of the Gravel Pits Alternative and Agricultural Reservoirs Alternative.

Noise effects would not be significant for construction and operation of Fort Collins' Proposed Action and the Expanded Glade Alternative, and operation of the Gravel Pits Alternative and the Agricultural Reservoirs Alternative because county noise thresholds would not be exceeded. However, construction of the Gravel Pits Alternative and the Agricultural Reservoirs Alternative would be significant because noise levels would exceed county noise thresholds (Table 4-94).

### Table 4-94. Summary of effects related to noise by alternative.

<table>
<thead>
<tr>
<th>Noise from construction at the nearest receptor (dBA)</th>
<th>Halligan Dam Rehabilitation</th>
<th>Fort Collins' Proposed Action</th>
<th>Expanded Glade</th>
<th>Gravel Pits</th>
<th>Agricultural Reservoirs</th>
<th>No Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>41 - 58</td>
<td>N/A</td>
<td>41 - 54 (GP-1)</td>
<td>87 (GP-1)</td>
<td>56 - 73 (AR-1)</td>
<td>No change from existing</td>
<td></td>
</tr>
<tr>
<td>53 - 72 (GP-1)</td>
<td></td>
<td>56 - 72 (GP-2)</td>
<td>76 - 87 (GP-3)</td>
<td>67 - 87 (AR-2)</td>
<td>No change from existing</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Construction-related traffic noise increase (dBA)</th>
<th>Varies by road and ranges from &lt;1 to &lt;2</th>
<th>N/A</th>
<th>For all roads &lt;1</th>
<th>Varies by road and ranges from &lt;1 to &lt;3</th>
<th>Varies by road and ranges from &lt;1 to 2</th>
<th>No change from existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No change from existing</td>
<td>&lt;50</td>
<td></td>
<td>&lt;68</td>
<td>&lt;68</td>
<td>No change from existing</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Any exceedance of Larimer County's permissible noise level (construction)?</th>
<th>No</th>
<th>No</th>
<th>No</th>
<th>Yes, for pipeline construction and modifications of the gravel pits.</th>
<th>Yes, for pipeline construction</th>
<th>No</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Any exceedance of</th>
<th>No</th>
<th>No</th>
<th>No</th>
<th>No</th>
<th>No</th>
<th>No</th>
</tr>
</thead>
</table>

4-111
4.20.9 Unavoidable Adverse Effects

All alternatives would have short-term unavoidable adverse effects from construction noise. None of the alternatives would have long-term unavoidable adverse effects from increased noise levels.

4.20.10 Mitigation Measures

To minimize the potential for construction activities to effect local residents, Fort Collins has proposed to constrain loud construction activities, such as blasting, to daytime working hours for all Project Alternatives.

4.21 Hazardous Sites and Materials

A hazardous site may cause environmental contamination through three primary pathways. First, construction activities may disturb contaminated soils or groundwater through activities such as excavation, dewatering of trenches or other construction areas, and development of wells to supply water for use during construction. Second, new reservoir areas may cause local groundwater table levels to rise, creating a risk of groundwater contamination from nearby hazardous sites where contamination was previously limited to the vadose zone (i.e., the area from the ground surface to the top of the water table). Lastly, local stormwater runoff from contaminated sites could drain into planned reservoirs, creating a potential for contamination of drinking water supplies.

4.21.1 Methods

Potential effects are discussed for those sites determined to pose a risk for hazardous materials release by a given Project Alternative. The 16 hazardous sites identified include sites listed under the Resource Conservation and Recovery Act and the Comprehensive Environmental Response, Compensation, and Liability Information System, leaking underground storage tank sites, and sites from the NISP Supplemental Draft EIS. However, a number of the sites listed appear in various databases for compliance reasons such as mandated reporting, inspections, and tracking of hazardous materials, and have no record of violation of environmental regulations and no known release into the environment. The following sites have experienced a known release or violation:
• U.S. Highway 287 Right-of-way (five releases at three locations)
  o Only the Expanded Glade Alternative is potentially affected
• The F.E. Warren Number 13 trichloroethylene plume site
  o Only the Expanded Glade Alternative is potentially affected

In addition, the hazardous sites evaluation from the NISP Draft EIS included mitigation recommendations for the Larimer County Sheriff's Pistol Range and the former Forks Lumber Company. Although there are no records of previous releases or violations, contamination at these two sites is possible. These two sites are located within the search area of the Expanded Glade Alternative.

4.21.1.1 Data Adequacy
Section 3.21.3 describes the best-available data for hazardous sites and materials in the study areas. The Corps determined the data available and methods used were adequate to evaluate and describe reasonably foreseeable significant adverse effects of hazardous sites and materials in the study areas and to enable the decision maker to make a reasoned choice between alternatives. The Corps did not identify any incomplete or unavailable hazardous site or material information as described in Section 4.2.1.5.

4.21.2 Halligan Dam Rehabilitation
Due to the age and condition of the existing Halligan Dam, it would be rehabilitated under all of the alternatives, regardless of which one is chosen. However, no hazardous sites or materials were found in the area of the dam rehabilitation site, including access roads and borrow areas or the 0.5-mile buffer around these features; therefore, no effects related to hazardous sites or materials would occur.

4.21.3 Fort Collins’ Proposed Action
No hazardous sites were found within the search area for the Fort Collins’ Proposed Action in any of the regulatory environmental databases; therefore, no effects related to hazardous sites or materials would occur.

4.21.4 Expanded Glade Alternative
The four leaking underground storage tank sites identified in the Expanded Glade Alternative search area were all classified as “No Further Action Required”. This status indicates conditions at the sites do not currently constitute any violation of regulatory environmental standards. However, the underground storage tanks should still be avoided to the greatest extent practicable during construction and operation of the Expanded Glade Alternative to avoid any potential risk of release. Four other potentially hazardous sites were located within the Expanded Glade Alternative search area: the F.E. Warren Number 13 Formerly Used Defense Site, the Forks Lumber Company site, the U.S. Highway 287 right-of-way, and the Larimer County Sheriff's Pistol Range.
4.21.4.1 F.E. Warren Number 13 Formerly Used Defense Site – Trichloroethylene Plume

Trichloroethylene is an industrial solvent used at this site to clean fuel tanks following missile readiness tests. It poses a number of known and potential risks to human health, and the Environmental Protection Agency has formally classified it as a known human carcinogen and a non-carcinogenic health hazard since 2004 (Environmental Protection Agency 2011). Samples from monitoring wells in the planned forebay footprint for the NISP proposed Glade Reservoir had two wells with trichloroethylene below detection limits and one with trichloroethylene below the quantification limit. Of two additional wells within the construction disturbance area, one was below the detection limit and another had detected trichloroethylene levels of 5.2 micrograms per liter, above the CDPHE standard of five micrograms per liter (CDPHE 2013), at a location about 420 feet northwest of the northwestern edge of the planned forebay. The plume does not appear to extend to the Expanded Glade footprint. Therefore, the Expanded Glade Alternative would not cause any additional effect related to the trichloroethylene plume.

4.21.4.2 Forks Lumber Company

Although there are no recorded violations on this site, presence of pentachlorophenol or other hazardous wood preservatives is possible at the current Forks Lumber Company location, and mitigation or best management practices may be necessary at this site. According to the NISP Final EIS, if the proposed Glade Reservoir is constructed, the Forks Lumber Company site would require site-specific investigations and remediation, if necessary, during final design so that any potential effects to the proposed Glade Reservoir can be avoided or minimized. This information would be used if the Expanded Glade Alternative is selected to determine if any additional investigation and/or remediation would be required to avoid or minimize effects.

4.21.4.3 U.S. Highway 287 Right-of-Way

Known releases within the U.S. Highway 287 right-of-way include asphalt and petroleum fuel products, which pose potential environmental and human health risk and may contaminate soils, groundwater, or surface water. According to the Larimer County Department of Health and Environment, no contamination remains within the Expanded Glade Alternative search area related to the U.S. Highway 287 right-of-way. Therefore, conditions at these sites do not constitute recognized hazardous conditions. No effects related to the U.S. Highway 287 right-of-way would occur under the Expanded Glade Alternative.

4.21.4.4 Larimer County Sheriff’s Pistol Range

Although there are no recorded violations on this site, the presence of lead as an environmental contaminant is likely; therefore, this location meets the definition of a hazardous site, and may require additional investigation, management, or mitigation. However, this site is not within the footprint of the Expanded Glade Alternative. According to the NISP Final EIS, if the proposed Glade Reservoir is constructed and the Larimer County Sheriff’s Pistol Range site continues to be used, best management practices would be implemented and berms would be constructed to limit direct stormwater runoff from the range into the proposed Glade Reservoir. If the Expanded Glade Alternative is chosen, best
management practices implemented for the proposed Glade Reservoir would avoid and minimize effects under the Expanded Glade Alternative.

### 4.21.5 Gravel Pits Alternative

No active hazardous sites occur within the search area for the Gravel Pits Alternative, therefore no effects related to hazardous sites or materials would occur.

### 4.21.6 Agricultural Reservoirs Alternative

No active hazardous sites occur within the search area for the Agricultural Reservoirs Alternative, therefore no effects related to hazardous sites or materials would occur.

### 4.21.7 No-Action Alternative

The No-Action Alternative would not require any construction and would not affect or be affected by any hazardous sites.

### 4.21.8 Effects Summary

There are no potential hazardous waste site effects on any alternative except for the Expanded Glade Alternative. Three hazardous sites exist within the Expanded Glade Alternative search area, requiring appropriate mitigation and management practices:

- Tricholoethylene plume at the F.E. Warren Number 13 Formerly Used Defense Site
- Larimer County Sheriff's Pistol Range
- Forks Lumber Company

All three of these sites affect the NISP Proposed Action regardless of Fort Collins' participation in the proposed Glade Reservoir. Fort Collins’ additional capacity in the proposed Glade Reservoir under the Expanded Glade Alternative would have no additional effects related to these three sites.

### 4.21.9 Unavoidable Adverse Effects

No known unavoidable adverse effects would result from any alternative due to hazardous sites or materials.

### 4.21.10 Mitigation Measures

Because rehabilitation of Halligan Dam would not result in effects related to hazardous sites or materials, no mitigation measures are proposed. Fort Collins has not proposed mitigation measures related to hazardous sites and materials. However, if the Expanded Glade Alternative is chosen, additional investigation or remediation may be required at the Forks Lumber Company Site, depending on what is
found during development of the proposed Glade Reservoir. No mitigation measures would be required for the other sites.

4.22 REFERENCES


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