Soils Technical Report

for the

Halligan Water Supply Project Environmental Impact Statement

Prepared for

U.S. Army Corps of Engineers

Omaha District

Prepared by:

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May 2016
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## Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
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<tbody>
<tr>
<td>3PC</td>
<td>Third party contractor</td>
</tr>
<tr>
<td>AF</td>
<td>Acre-feet</td>
</tr>
<tr>
<td>C-BT</td>
<td>Colorado-Big Thompson</td>
</tr>
<tr>
<td>CEQ</td>
<td>Council on Environmental Quality</td>
</tr>
<tr>
<td>CORPS</td>
<td>The U.S. Army Corps of Engineers</td>
</tr>
<tr>
<td>EIS</td>
<td>Environmental Impact Statement</td>
</tr>
<tr>
<td>Enlarged Halligan Reservoir</td>
<td>Fort Collins Proposed Action</td>
</tr>
<tr>
<td>Fort Collins</td>
<td>City of Fort Collins</td>
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<tr>
<td>FPPA</td>
<td>Farmland Protection Policy Act</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information System</td>
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<td>Gravel Pits Alternative</td>
<td>Gravel Pits and Joe Wright Reservoir Reoperation Alternative</td>
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<td>Halligan Water Supply Project</td>
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<tr>
<td>NEPA</td>
<td>The National Environmental Policy Act</td>
</tr>
<tr>
<td>North Fork</td>
<td>North Fork Cache La Poudre River</td>
</tr>
<tr>
<td>Northern Water</td>
<td>Northern Colorado Water Conservancy District’s</td>
</tr>
<tr>
<td>NPIC</td>
<td>North Poudre Irrigation Company</td>
</tr>
<tr>
<td>NRCS</td>
<td>Natural Resource Conservation Service</td>
</tr>
<tr>
<td>NSIP SDEIS 2015</td>
<td>Northern Integrated Supply Project Supplemental Draft EIS</td>
</tr>
<tr>
<td>NSIS</td>
<td>National Soil Information System</td>
</tr>
<tr>
<td>Poudre River</td>
<td>Cache La Poudre River</td>
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<tr>
<td>RGLS</td>
<td>Regulatory Guidance Letter</td>
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<tr>
<td>SSURGO</td>
<td>Soil Survey Geographic</td>
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CDM Smith, Inc.
1 Introduction

A technical consulting team prepared this Soils technical report for the Halligan Water Supply Project (Halligan Project). The Halligan Project Environmental Impact Statement (EIS) will summarize the information in this report. This report presents descriptions of potential environmental effects to Soils associated with the City of Fort Collins' (Fort Collins) Proposed Action, three alternatives to Fort Collins' Proposed Action, and the No-Action Alternative.

1.1 Description of Alternatives

The U.S. Army Corps of Engineers (Corps) conducted a screening process to identify alternatives to Fort Collins’ Proposed Action that met the future water demands for Fort Collins as stated in the Purpose and Need Report (WEST et al. 2015). The Alternatives Screening Report (DiNatale Water Consultants and CDM Smith 2015) presents the screening process and the three alternatives identified along with the No-Action Alternative. As part of the screening process, Fort Collins provided details regarding the construction, water conveyance, technical aspects and assumptions for the Fort Collins' Proposed Action, three alternatives, and the No-Action Alternative that are discussed in the "Final Alternatives Description Report" (MWH 2015). The hydrologic models utilized and the associated outputs are described in the "Hydrologic Modeling Technical Report" (CDM Smith and DiNatale Water Consultants 2015). For this report, we present a brief overview of the Fort Collins' Proposed Action, three alternatives, and the No-Action Alternative for a general understanding.

All of the alternatives include water storage with the exception of the No-Action Alternative. Under Fort Collins' Proposed Action and each alternative, Fort Collins proposed to store the same existing water rights including converted Southside Ditch rights, reusable Water Supply and Storage Company rights, the conditional Grey Mountain right, and the conditional water right associated with the enlarged Halligan Reservoir with a priority date of December 10, 2013, if approved.

1.1.1 Fort Collins' Proposed Action

Fort Collins' Proposed Action is to enlarge the Halligan Reservoir, which is located on the North Fork Cache La Poudre River (North Fork) about 25 miles northwest of Fort Collins. Currently, the North Poudre Irrigation Company (NPIC) owns the entire water storage capacity of 6,400 acre-feet (AF) at the Halligan Reservoir. Fort Collins would increase the capacity by 8,125 AF for a total water storage capacity of 14,525 AF. The current maximum surface area of the Halligan Reservoir is 253 acres, while the maximum surface area of the enlarged reservoir would be approximately 386 acres. Fort Collins has applied for a conditional water right for the storage of water in the enlarged Halligan Reservoir with a priority date of December 10, 2013. To enlarge the existing reservoir, Fort Collins would raise the existing dam an estimated 25 feet. In general, Fort Collins would enlarge the reservoir by expanding the foundation on the
downstream face of the dam approximately 8 to 12 feet and make the dam thicker and taller while maintaining a geometry similar to the existing dam. Preparation for the foundation would require rock excavation along the abutments and valley bottom outside of the existing footprint. During construction, the North Fork would bypass the construction via a temporary cofferdam and outlet pipes.

Fort Collins cannot directly divert water released from Halligan Reservoir into its existing intake facilities that convey water to the Fort Collins water treatment facility. Under its Proposed Action, Fort Collins would release water from Halligan Reservoir into the North Fork and allow that water to flow down the North Fork into and through the Seaman Reservoir until it reaches the Cache La Poudre River (Poudre River). Fort Collins would divert a similar amount of water at its intakes located on the Poudre River above the confluence with the North Fork. This process is referred to as an exchange and must be authorized by a court issued exchange decree. Fort Collins has two separate intakes on the main stem of the Poudre River: 1) the existing City of Fort Collins Pipeline via its diversion structure located at Gateway Park, and 2) the Pleasant Valley Pipeline via the existing Munroe Canal (a.k.a. North Poudre Supply Canal or Munroe Gravity Ditch) diversion structure.

Fort Collins would develop the following infrastructure and construction areas in association with this alternative (Figure 1-1): the raised Halligan dam, new outlet works, a cofferdam and temporary outlet pipes, a temporary bridge below the existing dam to access both sides of the North Fork during construction, staging areas, a batch plant, burrow pits, and access roads.
Figure 1-1. Fort Collins' Proposed Action.
1.1.2 Expanded Glade Alternative

The Expanded Glade Alternative would provide Fort Collins with 6,075 AF of water storage through the expansion of the proposed Glade Reservoir. The Expanded Glade Alternative is contingent on the Corps permitting the Glade Reservoir. Glade Reservoir is a 170,000 AF reservoir that is part of Northern Colorado Water Conservancy District’s (Northern Water) proposed action analyzed in the Northern Integrated Supply Project Supplemental Draft EIS (NISP SDEIS 2015). Under this alternative Fort Collins would operate its storage in the enlarged Glade Reservoir independently, enlarging and using several components of the proposed Glade Reservoir infrastructure to store and release water from the reservoir. Fort Collins would require some additional infrastructure. The expansion would require raising the dam approximately 4 feet higher than the NISP design. The maximum surface area of the expanded Glade Reservoir is expected to be approximately 1,693 acres, which is 57 acres more than the maximum surface area of the Glade Reservoir proposed by NISP.

Fort Collins would deliver water through the Poudre Valley Canal to the NISP proposed diversion point into Glade Reservoir. This diversion point and the Poudre Valley Canal would need to be enlarged to accommodate both NISP and Fort Collins water inflows simultaneously. Fort Collins would temporarily retain the diverted water in the Glade Forebay and then pump it into the reservoir. Fort Collins would release water through the Glade Dam infrastructure and either route the water to the Poudre River for use in an exchange or send it directly into Fort Collins existing raw water supply lines. Fort Collins would construct a new pipeline that would connect the Glade Reservoir outlet pipeline to Fort Collins’ existing pipelines and the Pleasant Valley Pipeline. Fort Collins could release water into Fort Collins’ new pipeline and then into the Poudre River at a river turnout in exchange for water diverted by Fort Collins upstream of the confluence with the North Fork. Alternatively, Fort Collins could direct water to a new pretreatment facility co-located with the Glade Pump Station at the foot of the dam and then convey the water through its new pipeline to its existing raw water supply lines.

Fort Collins would develop the following infrastructure in association with this alternative (Figure 1-2): the raised Glade dam, increased depth to the NISP proposed forebay, larger or additional pumps located at the NISP pump station, a pretreatment facility, a pipeline from the pretreatment facility to the raw water supply lines, and a river turnout on the new pipeline.
Figure 1-2. Expanded Glade Alternative.
1.1.3 Gravel Pits Alternative

The Gravel Pits and Joe Wright Reservoir Reoperation Alternative (hereafter Gravel Pits Alternative) would involve using a complex of gravel pits on the north side of the Poudre River near Taft Hill Road for water storage. The eight interconnected cells at the gravel pit complex would provide approximately 3,875 AF of combined water storage. After the gravel pits are completed, Fort Collins would excavate additional storage within the area of the permitted gravel pit, if needed, to achieve the desired water storage. Two of the existing pits outside the floodplain would likely require above-grade storage achieved by the construction of 20-foot tall berms around the perimeter of the pit. Twenty-foot-high berms are classified as jurisdictional dams under the Colorado Division of Safety of Dam criteria (Colorado Division of Water Resources 2016) and would require specific design standards provided by the Colorado State Engineer. The final design would require the approval of the Colorado State Engineer prior to construction.

Generally, Fort Collins would convey water from the Poudre River to the gravel pits and then release the water from the gravel pits back to the Poudre River for exchange or into the existing Fort Collins raw water pipelines. To move water to the gravel pits, Fort Collins would divert water from the Larimer County No. 2 Canal diversion structure south of the Poudre River. Fort Collins would install a 42-inch pipeline beneath the riverbed to carry water north to the gravel pits. Water would enter the gravel pit complex at the Stenger pit or Home Office pit, and would flow to other pits by gravity, or in some cases, by pumping into the North Shores No. 1 pit, depending on the difference in water levels between the Stenger and North Shore pits.

For an exchange, Fort Collins would release water from the gravel pits into new pipelines and then into the Poudre River at a turnout located on the north bank in exchange for water diverted into its intakes higher up on the Poudre River. The other option would be for Fort Collins to pump water to a pretreatment facility. The pretreatment facility would improve the water quality to levels similar to the water diverted at Fort Collins' intakes, and would deliver this pretreated water directly into the Fort Collins raw water supply lines.

As part of this alternative, Fort Collins would store more water over the winter at Joe Wright Reservoir by authorizing fewer single use water trades with the NPIC. No physical changes are required for this operational change.

Fort Collins would develop the following infrastructure in association with this alternative (Figure 1-3): new pipelines, three pump stations, a pretreatment facility, diversion structure, staging areas, and access roads.
Figure 1-3. Gravel Pits Alternative.
1.1.4 Agricultural Reservoirs Alternative

For the Agricultural Reservoirs Alternative, Fort Collins would achieve additional water storage by procuring dedicated space in two existing reservoirs: NPIC Reservoir No. 5 and Reservoir No. 6. These reservoirs are interconnected and can be operated as a single element. The reservoirs are located approximately 9 miles northeast of the Fort Collins water treatment facility. The feasibility of this alternative depends on Fort Collins and NPIC being able to manage its storage capacity independently. The combined reservoirs have a capacity of 17,830 AF, so Fort Collins would need to acquire 6,475 AF of storage that would constitute approximately 36 percent of the available combined capacity of the two reservoirs. Fort Collins would acquire the storage in the reservoirs through a purchase and operating agreement with NPIC. Fort Collins would need to independently own, operate, and otherwise control the water storage for it to count towards its safety factor. For an acquisition to be possible, Fort Collins would need to compensate NPIC for loss of water capacity, loss of water rights, and any detrimental consequences inflicted to NPIC's system or shareholders.

Fort Collins would divert water from the Poudre River at the Munroe Canal diversion structure and convey the water by gravity into the Pleasant Valley Pipeline and through a new bi-directional 48-inch diameter pipe ending at the control valve by the Reservoir No. 6 outlet. From Reservoir No. 6, a new dedicated pipeline would convey the water to Reservoir No. 5 using a pressurized conveyance system eliminating the need for a pump.

Similar to the Gravel Pits alternative, Fort Collins would have two options for water released from Reservoirs Nos. 5 and 6: either to use the water in an exchange or direct the water into Fort Collins existing raw water supply lines. For an exchange, Fort Collins would release water from the reservoirs into the bi-directional pipeline and then into the Poudre River at a turnout located on the north bank in exchange for water diverted into its intakes on the Poudre River above the confluence with the North Fork. The other option would be for Fort Collins to pump water to a pretreatment facility and then into the Fort Collins' raw water supply lines. The pretreatment facility would improve the water quality to levels similar to the water diverted at Fort Collins' raw water intakes. Fort Collins would release water for exchanges when possible to reduce the amount of pumping required.

Fort Collins would develop the following infrastructure in association with this alternative (Figure 1-4): new pipelines, a valve house, a pump station, a pretreatment facility, diversion structure, staging areas, and access roads.
Figure 1-4. Agricultural Reservoir Alternative.
1.1.5 No-Action Alternative

The No-Action Alternative, unlike the action 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.

- Fort Collins would change its operational procedures at its existing Joe Wright Reservoir to store more water over the winter.
- Fort Collins would acquire additional NPIC shares either through direct purchase of shares or by requiring residential and commercial development to provide dedicated shares.
- Fort Collins would implement mandatory water use restrictions during drought periods and system failures.

All components of the No-Action Alternative are non-structural and require no ground disturbance of any type.

Under the first measure of its No-Action Alternative, Fort Collins would conduct fewer single-use water transactions with NPIC to maintain a higher water level at the Joe Wright Reservoir over the winter, similar to the Gravel Pits Alternative. Fort Collins would set the winter carryover capacity for Joe Wright Reservoir at 3,200 AF. To sustain this level, Fort Collins would need to cut the amount of late summer and fall distribution of single-use water for subsequent exchange with NPIC. NPIC has previously accepted these single use exchanges of Joe Wright Reservoir water for NPIC's water from the Colorado-Big Thompson Project (C-BT) stored in Horsetooth Reservoir, which has been mutually beneficial for Fort Collins and NPIC. Fort Collins benefitted from the water exchanges by reducing the amount of single use water stored in Joe Wright Reservoir allowing storage space for more reusable use water collected in the spring from Michigan Ditch. For NPIC, the exchanges allowed water diversion at Munroe Canal during times when the exchange potential for moving C-BT water upstream to the Munroe Canal was low. This reoperation option would require no new infrastructure and would provide no new storage capacity for Fort Collins.

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. NPIC shares would specifically need to have a C-BT storage component. Acquiring NPIC shares provides Fort Collins additional C-BT water and its associated storage. Northern Water has imposed limitations on the amount of additional C-BT shares Fort Collins can directly purchase. However, it would be permissible for Fort Collins to acquire C-BT units by purchasing NPIC shares or through dedication from developers. Fort Collins has deliberately focused on developing its Poudre River sources to diversify its system, as it already owns a large amount of C-BT shares.
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 2013) to address drought and emergency water supply situations. The plan provides four response levels to address various levels of supply shortage severity. Since its inception in 2003, Fort Collins has imposed mandatory water restrictions (Response Level 1) twice—in 2003 to respond to the early 2000s drought, and in 2013 in response to drought and water quality impacts of the High Park Fire. Under the No-Action Alternative, water supply shortages would likely be more frequent and severe and water restrictions would be implemented more frequently, would be more severe, and would last longer. Mandatory water use restrictions would not create additional firm water yield or storage capacity, but the approach would extend available supplies during a drought or interruption in water supply. However, modeling suggests that during the design drought, even with restrictions, Fort Collins would not be able to maintain a reserve of water equal to 15 percent of Fort Collins' average annual demand as a buffer in case of storage or delivery system failure, forest fire, adverse unexpected water court rulings, or other unanticipated stressors on its water delivery system. This would make Fort Collins vulnerable to water shortages and the possibility of water shutoffs if an unforeseen event disrupted the water supply system.

For further details on this alternative or the other proposed alternatives, please see the Final Alternatives Description Report (MWH 2015).

### 1.2 Regulatory and Management Framework

Soil resources in general are not specifically regulated by state or federal agencies; however, certain actions overlying the soil resources may be regulated by several specific regulatory agencies. These are described in the specific associated technical reports.

The conversion of designated farmland to nonagricultural use may be regulated and subject to Farmland Protection Policy Act (FPPA) requirements. In 1994, the FPPA was enacted to address the conversion of farmland to nonagricultural uses for federally funded projects. The FPPA was passed to “minimize the extent to which federal programs contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses, and to assure that Federal programs are administered in a manner that, to the extent practicable, will be compatible with State, unit of local government, and private programs and policies to protect farmland.”

The program is administered by the Natural Resource Conservation Service (NRCS) through U.S. Department of Agriculture regulations. Typically, farmland designation is identified based on soil types that meet specific criteria and typically evaluations are conducted as part of the NEPA process. Proposed federal actions that affect designated prime farmland, unique farmland, or farmland of statewide importance could be subject to FPPA
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2 Methods

2.1 Search Areas

CDM Smith collected soil resource information in the vicinity of the Fort Collins’ Proposed Action and the Alternatives from the Soil Survey of Larimer County Area, Colorado (Moreland 1980) and the NRCS Soil Survey Geographic (SSURGO) database for Larimer County Area, Colorado (Survey Area CO644). CDM Smith evaluated these published data to determine soil characteristics and potential impacts on the soil resources within the footprints of the Proposed Action and Alternatives for the Halligan Project.

2.2 Methodology Overview

The SSURGO data includes Geographic Information System (GIS) soil map units that are linked to attributes in the National Soil Information System (NSIS) relational database. We summarized the distribution of soil mapping units in the study area through the use of ESRI ArcMap software and generated reports for the corresponding map units from the NSIS database with Microsoft Access. For this analysis we used the following reports: "Map Unit Description (Brief, Generated)," "Map Unit Description (Brief, Tabular)," "Engineering Properties," "Physical Properties," and "Hazard of Erosion and Suitability for Roads on Forestland." These reports provided relevant information regarding soil characteristics that we evaluated to determine the potential for impacts to the soil resources described in this technical report.

We reviewed the "Physical Properties" report to evaluate the potential for erosion for each of the soils within the 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 percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity.
The soil definitions of slope classes defined by the NRCS are detailed in (Table 2-1) below.

### Table 2-1. Definitions of slope classes.

<table>
<thead>
<tr>
<th>Classes</th>
<th>Classes</th>
<th>Slope Gradient Limits</th>
<th>Slope Gradient Limits</th>
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<tbody>
<tr>
<td>Simple Slopes</td>
<td>Complex Slopes</td>
<td>Lower Percent</td>
<td>Upper Percent</td>
</tr>
<tr>
<td>Nearly level</td>
<td>Nearly level</td>
<td>0</td>
<td>3</td>
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<tr>
<td>Gently sloping</td>
<td>Undulating</td>
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<tr>
<td>Strongly sloping</td>
<td>Rolling</td>
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<td>Moderately steep</td>
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<tr>
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<tr>
<td>Very steep</td>
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3 Affected Environment

3.1 Fort Collins’ Proposed Action

Below we describe the principal or dominant soils in order of relative abundance within the Proposed Action footprint. The principal soils are presented in (Table 3-1). The distribution of the soil map units within the vicinity of and within the study area associated with the Proposed Action are displayed on (Figure 3-1).

Table 3-1. Soil map units in the Fort Collins’ Proposed Action footprint.

<table>
<thead>
<tr>
<th>Soil Map Unit Number</th>
<th>Map Unit Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Breece coarse sandy loam, 9 to 30 percent slopes</td>
</tr>
<tr>
<td>32</td>
<td>Farnuf-Boyle-Rock outcrop complex, 10 to 25 percent slopes</td>
</tr>
<tr>
<td>43</td>
<td>Haploborolls-Rock outcrop complex, steep</td>
</tr>
<tr>
<td>93</td>
<td>Rock outcrop</td>
</tr>
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</table>

Characteristics of each soil map unit within the Fort Collins’ Proposed Action are as follows:

3.1.1 Haploborolls-Rock Outcrop Complex, Steep (Map Unit 43)

The Haploborolls-Rock outcrop complex is located along the eastern, northern, and southern edges of the Proposed Action inundation footprint and a portion of the potential borrow and staging areas located along the southeastern corner of the inundation footprint. This outcrop complex is typically found on mountainsides and fans. The complex is suited for a limited amount of grazing and it also may provide wildlife habitat and watershed protection. This complex consists of steep and strongly steep soils and rock outcrop. The Haploborolls soils are extremely variable and range from sandy loam to loam with varying amounts of boulders of granite, gneiss, and schist. The surface runoff within the alternative area is classified as rapid, with a severe potential for erosion. The potential for wind erosion is not classified. The Haploborolls-Rock outcrop complex within the study area is not considered prime or unique farmland.
Figure 3-1. Fort Collins’ Proposed Action: Soil Resource Distribution.
3.1.2 **Farnuf-Boyle-Rock Outcrop Complex, 10 to 25 Percent Slopes (Map Unit 32)**

The Farnuf-Boyle-Rock outcrop complex is located along the southwest edge of the Proposed Action inundation footprint and a portion of the potential borrow and staging areas located along the southeastern corner of the inundation footprint. This outcrop complex is typically found on ridges and valley sides. The complex is suited for native grass growth and may provide wildlife habitat. This complex consists of moderately steep slopes, consisting of about 40 percent Farnuf loam, 30 percent Boyle gravelly sandy loam, and about 20 percent rock outcrop. The surface runoff from Farnuf-Boyle-Rock Outcrop is classified as rapid, with a severe potential for erosion and the potential for wind erosion is moderate to low. The Farnuf-Boyle-Rock outcrop complex within the study area is not considered prime or unique farmland.

3.1.3 **Rock Outcrop (Map Unit 93)**

The Rock outcrop mapping unit is located along the northern edge of the Proposed Action inundation footprint. This mapping unit is bare or nearly bare rock with very shallow soils, located mainly around the edges of the mapped areas. The mapping unit typically supports native wildlife habitat and is used for esthetic purposes. The surface runoff off the rock outcrop mapping unit is classified as rapid, with a severe potential for erosion on the included soils and in adjacent areas that receive the runoff. The potential for wind erosion is not classified. The mapping unit within the study area is not considered to be prime or unique farmland.

3.1.4 **Breece Coarse Sandy Loam, 9 to 30 Percent Slopes (Map Unit 20)**

The Breece soils are located along the southern edge of the Proposed Action inundation footprint. These soils typically support native pastureland, native hay meadows, and cultivated crops in certain locations. Breece soils consist of very deep, well-drained soils that formed in thick non-calcareous alluvium and slope alluvium derived mainly from granite. Breeze soils are generally found on concave alluvial fans, toe slopes, and small upland drainageways. The surface runoff from Breece soils is classified as medium to rapid, with a severe potential for erosion. The potential for wind erosion is moderate. The Breeze soils within the study area are not considered to be prime or unique farmland.

3.2 **Expanded Glade Alternative**

Below we describe the principal soils within the Expanded Glade Alternative inundation footprint (Table 3-2) and within the footprints of the conveyance system, potential construction disturbance, borrow, and staging areas associated with the Expanded Glade Alternative (Table 3-3). The principal soils are considered the dominant soils present within the Expanded Glade Alternative footprint and are described in order of relative abundance below. (Figure 3-2) shows the location of the soil map units within the Expanded Glade Alternative footprint.
Table 3-2. Soil map units located within the inundation footprint for the Expanded Glade Alternative.

<table>
<thead>
<tr>
<th>Soil Map Unit Number</th>
<th>Map Unit Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Baller-Rock outcrop complex, 15 to 45 percent slopes</td>
</tr>
<tr>
<td>25</td>
<td>Connerton-Barnum complex, 3 to 9 percent slopes</td>
</tr>
<tr>
<td>43</td>
<td>Haploborolls-Rock outcrop complex, steep</td>
</tr>
<tr>
<td>44</td>
<td>Haplustolls, hilly</td>
</tr>
<tr>
<td>45</td>
<td>Haplustolls-Rock outcrop complex, steep</td>
</tr>
<tr>
<td>46</td>
<td>Harlan fine sandy loam, 1 to 3 percent slopes</td>
</tr>
<tr>
<td>47</td>
<td>Harlan fine sandy loam, 3 to 9 percent slopes</td>
</tr>
<tr>
<td>57</td>
<td>Kirtley loam, 3 to 9 percent slopes</td>
</tr>
<tr>
<td>58</td>
<td>Kirtley-Purner complex, 5 to 20 percent slopes</td>
</tr>
<tr>
<td>74</td>
<td>Nunn clay loam, 1 to 3 percent slopes</td>
</tr>
<tr>
<td>84</td>
<td>Poudre fine sandy loam, 0 to 1 percent slope</td>
</tr>
<tr>
<td>85</td>
<td>Purner fine sandy loam, 1 to 9 percent slopes</td>
</tr>
<tr>
<td>86</td>
<td>Purner-Rock outcrop complex, 10 to 50 percent slopes</td>
</tr>
<tr>
<td>87</td>
<td>Ratake-Rock outcrop complex, 25 to 55 percent slopes</td>
</tr>
<tr>
<td>93</td>
<td>Rock outcrop</td>
</tr>
<tr>
<td>95</td>
<td>Satanta loam, 1 to 3 percent slopes</td>
</tr>
<tr>
<td>96</td>
<td>Satanta loam, 3 to 5 percent slopes</td>
</tr>
</tbody>
</table>
Table 3-3. Soil map units located in the construction disturbance and staging areas associated with the Expanded Glade Alternative.

<table>
<thead>
<tr>
<th>Soil Map Unit Number</th>
<th>Map Unit Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Altvan loam, 3 to 9 percent slopes</td>
</tr>
<tr>
<td>12</td>
<td>Baller-Rock outcrop complex, 15 to 45 percent slopes</td>
</tr>
<tr>
<td>24</td>
<td>Connerton-Barnum complex, 0 to 3 percent slopes</td>
</tr>
<tr>
<td>25</td>
<td>Connerton-Barnum complex, 3 to 9 percent slopes</td>
</tr>
<tr>
<td>43</td>
<td>Haploborolls-Rock outcrop complex, steep</td>
</tr>
<tr>
<td>44</td>
<td>Haplustolls, hilly</td>
</tr>
<tr>
<td>45</td>
<td>Haplustolls-Rock outcrop complex, steep</td>
</tr>
<tr>
<td>49</td>
<td>Heldt clay loam, 3 to 6 percent slopes</td>
</tr>
<tr>
<td>64</td>
<td>Loveland clay loam, 0 to 1 percent slopes</td>
</tr>
<tr>
<td>77</td>
<td>Otero sandy loam, 0 to 3 percent slopes</td>
</tr>
<tr>
<td>81</td>
<td>Paoli fine sandy loam, 0 to 1 percent slopes</td>
</tr>
<tr>
<td>84</td>
<td>Poudre fine sandy loam, 0 to 1 percent slope</td>
</tr>
<tr>
<td>85</td>
<td>Purner fine sandy loam, 1 to 9 percent slopes</td>
</tr>
<tr>
<td>86</td>
<td>Purner-Rock outcrop complex, 10 to 50 percent slopes</td>
</tr>
<tr>
<td>93</td>
<td>Rock outcrop</td>
</tr>
<tr>
<td>105</td>
<td>Table Mountain loam, 0 to 1 percent slopes</td>
</tr>
</tbody>
</table>
Figure 3-2. Expanded Glade Alternative: Soil Resource Distribution.
Characteristics of each soil map unit within the Expanded Glade Alternative are as follows:

### 3.2.1 Haplustolls-Rock Outcrop, Complex Steep (Map Unit 45)

The Haplustolls-Rock outcrop complex is located along the eastern edge of the Expanded Glade Alternative inundation footprint and over a portion of the conveyance system, potential disturbance areas, and staging and borrow area as displayed in (Figure 3-2). This outcrop complex is typically found on colluvial slopes and hillsides and is suited to support native grass growth. This complex consists of strongly sloping to steep slopes and rock outcrop. The Haplustolls soils are extremely variable and range from sandy loam to clay loam with varying amounts of cobbles and stone sized rocks 10 to 60 inches in diameter. The surface runoff potential of Haplustolls soils is classified as medium to rapid, with a severe potential for erosion. The potential for wind erosion is not classified. The Haplustolls-Rock outcrop complex within the study area is not considered to be prime or unique farmland.

### 3.2.2 Haplustolls, Hilly (Map Unit 44)

The Haplustolls soils are located along the northern and northwestern edge of the Expanded Glade Alternative inundation footprint and over a portion of the conveyance system, potential disturbance areas, and staging and borrow area as displayed in (Figure 3-2). Haplustolls soils typically support native grass vegetation. The Haplustolls soil series is generally found on fans and lower side slopes of ridges in the foothills. The Haplustolls soils are mainly loam and clay loam, but the content of cobbles is variable within short distances. The surface runoff from Haplustolls soils is classified as rapid, with a moderate to severe potential for water erosion. The potential for wind erosion is not classified. The Haplustolls, hilly soils within the study area are not considered prime or unique farmland.

### 3.2.3 Satanta Loam, 1 to 5 Percent Slopes (Map Unit 95 and Map Unit 96)

The Satanta loam soils are mostly located underlying portions of the proposed pipeline system and staging areas as displayed in (Table 3-2). The Satanta loam soils typically support vegetation used for pastureland and dry and irrigated cropland. The Satanta loam soils are generally found on terraces and uplands and consists of very deep, well-drained soils that formed in eolian deposits. The surface runoff of Satanta loam with 1 to 3 percent slopes (Map Unit 95) is classified as slight with a slight to moderate potential for erosion. The surface runoff of Satanta loam with 3 to 5 percent slopes (Map Unit 36), is classified as medium with a moderate potential for erosion. The potential for wind erosion for Satanta loam soil is moderate. The Satanta loam soils within the study area are considered prime farmland if irrigated.

### 3.2.4 Poudre Fine Sandy Loam, 0 to 1 Percent Slope (Map Unit 84)

The Poudre soils are mostly located underlying portions of the proposed pipeline system and staging areas as displayed in (Figure 3-2). Poudre soils typically support vegetation used for
grazing. Poudre soil is generally found on terraces, floodplains, and drainageways and consist of somewhat poorly or poorly drained soils that formed in thick calcareous micaceous moderately-coarse textured alluvium derived principally from micaceous schist and gneiss. The surface runoff from Poudre soil is classified as slow with a slight potential for erosion. The potential for wind erosion is moderate. The Poudre soils within the study area are not considered prime or unique farmland.

3.2.5 Kirtley Loam, 3 to 9 Percent Slopes (Map Unit 57)

The Kirtley soils are mostly located along the northern edge of the Expanded Glade Alternative inundation footprint as displayed in (Figure 3-2). Kirtley soils typically support rangeland vegetation and some small areas of either dry or irrigated cropland. Kirtley soils are generally found on upland parts of hills and ridges and consist of well-drained soils that are moderately deep to soft bedrock. The Kirtley soil formed from calcareous sediments weathered from redbed shales and sandstone. The surface runoff of the Kirtley soil is classified as medium to rapid, with a severe potential for erosion. The potential for wind erosion is moderate. The Kirtley soils within the study area are not considered prime or unique farmland.

3.2.6 Connerton-Barnum Complex, 0 to 9 Percent Slopes (Map Unit 24 and Map Unit 25)

The Connerton-Barnum complex soils are generally located underlying portions of the conveyance system, potential disturbance areas, and staging and borrow area as displayed in (Figure 3-2). The Connerton-Barnum soil is typically found on terraces and fans and is suited for native grass growth, pasture land, or irrigated crops. This complex consists of level to strongly sloping soils, consisting of about 50 percent Connerton fine sandy loam and 40 percent Barnum loam. The surface runoff of Connerton-Barnum complex with 0 to 3 percent slopes (Map Unit 24) is classified as slow to medium and the hazard of water erosion and wind erosion can range from slight to moderate. The surface runoff of the Connerton-Barnum complex with 3 to 9 percent slopes (Map Unit 25) is classified as medium, with a moderate to severe potential for erosion. The potential for wind erosion is moderate. The Connerton-Barnum complex with 0 to 3 percent slopes is considered prime farmland if irrigated and the Connerton-Barnum complex with 3 to 9 percent slopes is considered farmland of statewide importance.

3.2.7 Other Soils

In addition to the principal soils described within this section, the Haploborolls-Rock outcrop complex, steep (Map Unit 45), as described in Section 3.1.1, is a principal soil type located along the northern and northeastern edge of the Expanded Glade Alternative inundation footprint and underlying a portion of conveyance system, potential disturbance areas, and staging and borrow area as displayed in (Figure 3-2). Other soil map units have been identified in lesser amounts compared to the principal soils within the alternative footprint and are included in (Table 3-2). The other soil map units identified within the study area that are not considered to be principal soils within the study area are presented in (Table 3-3). These map units also may be potentially
disturbed by the alternative implementation and consist of similar soil characteristics, geographic settings, parent material, and slopes as described for the principal soil map units.

3.3 Gravel Pits Alternative

Below we describe the principal soils within the Gravel Pits Alternative footprint in order of relative abundance. The principal soils are considered the dominant soils present within the Gravel Pits Alternative footprint and are presented in (Table 3-4). The distribution of the soil map units within the vicinity of and within the study area associated with the Gravel Pits Alternative is displayed on (Figure 3-3).

Table 3-4. Soil Map Units located in the Gravel Pits Alternative Footprint.

<table>
<thead>
<tr>
<th>Soil Map Unit Number</th>
<th>Map Unit Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Aquepts, loamy</td>
</tr>
<tr>
<td>9</td>
<td>Bainville-Epping silt loams, 5 to 20 percent slopes</td>
</tr>
<tr>
<td>22</td>
<td>Caruso clay loam, 0 to 1 percent slope</td>
</tr>
<tr>
<td>42</td>
<td>Gravel pits</td>
</tr>
<tr>
<td>54</td>
<td>Kim loam, 3 to 5 percent slopes</td>
</tr>
<tr>
<td>59</td>
<td>Laporte-Rock outcrop complex, 3 to 30 percent slopes</td>
</tr>
<tr>
<td>60</td>
<td>Larim gravelly sandy loam, 5 to 40 percent slopes</td>
</tr>
<tr>
<td>63</td>
<td>Longmont clay, 0 to 3 percent slopes</td>
</tr>
<tr>
<td>64</td>
<td>Loveland clay loam, 0 to 1 percent slopes</td>
</tr>
<tr>
<td>66</td>
<td>Minnequa silt loam, 3 to 9 percent slopes</td>
</tr>
<tr>
<td>81</td>
<td>Paoli fine sandy loam, 0 to 1 percent slopes</td>
</tr>
<tr>
<td>84</td>
<td>Poudre fine sandy loam, 0 to 1 percent slope</td>
</tr>
<tr>
<td>89</td>
<td>Renohill clay loam, 0 to 3 percent slopes</td>
</tr>
<tr>
<td>90</td>
<td>Renohill clay loam, 3 to 9 percent slopes</td>
</tr>
<tr>
<td>92</td>
<td>Riverwash</td>
</tr>
<tr>
<td>95</td>
<td>Satanta loam, 1 to 3 percent slopes</td>
</tr>
<tr>
<td>105</td>
<td>Table Mountain loam, 0 to 1 percent slopes</td>
</tr>
</tbody>
</table>
Figure 3-3. Gravel Pits Alternative: Soil Resource Distribution.
3.3.1 Loveland Clay Loam, 0 to 1 Percent Slopes (Map Unit 64)

The Loveland soils are generally located underlying portions of the conveyance system, potential disturbance areas, and staging and borrow area as displayed in (Figure 3-3). The Loveland soils typically support native pastureland and irrigated crops. The Loveland soil series is generally found in floodplains and low terraces along the smaller streams draining the Rocky Mountain areas and consist of poorly-drained, moderately-permeable soils formed in alluvial sediments derived from a variety of rock sources. The surface runoff of Loveland soil is classified as slow, with a slight potential for erosion. The potential for wind erosion is moderate. The Loveland soils are considered prime farmland if irrigated.

3.3.2 Table Mountain Loam, 0 to 1 Percent Slopes (Map Unit 105)

The Table Mountain soils are located along the northern and northwestern portion of the Gravel Pits Alternative footprint and over a portion of conveyance system, potential disturbance areas, and staging and borrow area as displayed in (Figure 3-3). The Table Mountain soils typically support vegetation within grazing land and dry or irrigated cropland. The Table Mountain soil series is generally found on alluvial fans, terraces, and concave drains or old floodplains and consist of deep, well-drained soils that formed in thick, calcareous, medium-textured alluvium derived from sedimentary and metamorphic rocks. The surface runoff of Table Mountain soil is classified as slow, with a slight potential for erosion. The potential for wind erosion is moderate. The Table Mountain soils are considered prime farmland if irrigated.

3.3.3 Paoli Fine Sandy Loam, 0 to 1 Percent Slopes (Map Unit 81)

The Paoli soils are mostly located underlying portions of the conveyance system, potential disturbance areas, and staging and borrow area as displayed in (Figure 3-3). The Paoli soils typically support native grassland and irrigated crops. The Paoli soil series is generally found on low terraces and bottom lands and consist of very deep, well-drained soils that formed in thick, calcareous medium-textured alluvium derived from sedimentary and metamorphic rocks. The surface runoff of Paoli soil is slow. The potential of water erosion is classified as slight and the potential of wind erosion hazard is classified as moderate. The Paoli soils are considered prime farmland if irrigated.

3.3.4 Caruso Clay Loam, 0 to 1 Percent Slope (Map Unit 22)

The Caruso soils are typically located along the northern and northwestern portion of the Gravel Pits Alternative footprint as displayed in (Figure 3-3). The Caruso soils typically support native grassland and irrigated crops. The Caruso soil series is generally found on nearly level floodplains and consist of deep, somewhat poorly-drained soils that formed in loamy alluvium on flood plains. The surface runoff of Caruso soil is classified as slow, with a slight potential for erosion. The potential for wind erosion is moderate. The Caruso soils within the study area are considered prime farmland if irrigated.
3.3.5 Other Soils

In addition to the principal soils map units present within the Gravel Pits Alternative footprint, the designated storage units for the Gravel Pits Alternative will utilize existing gravel pit map units (Map Unit 42). These are areas where the soil and underlying gravel deposits have been removed or are currently being mined, and therefore the areas are not considered prime or unique farmland. Other soil map units have been identified in lesser amounts compared to the principal soils within the alternative footprint and are included in (Table 3-4). These map units also may be potentially disturbed by the alternative implementation and consist of similar soil characteristics, geographic settings, parent material, and slopes as described for the principal soil map units.

3.4 Agricultural Reservoirs Alternative

Below we describe the principal soils within the Agricultural Reservoirs Alternative footprint in order of relative abundance. The principal soils are considered the dominant soils present within the Agricultural Reservoirs Alternative footprint and are presented in (Table 3-5). The distribution of the soil map units within the vicinity of and within the study area associated with the Agricultural Reservoirs Alternative footprint is displayed in (Figure 3-4), (Figure 3-5), and (Figure 3-6).

Table 3-5. Soil Map Units in Agricultural Reservoir Alternative Footprint.

<table>
<thead>
<tr>
<th>Soil Map Unit Number</th>
<th>Map Unit Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Altvan-Satanta loams, 3 to 9 percent slopes</td>
</tr>
<tr>
<td>5</td>
<td>Aquepts, loamy</td>
</tr>
<tr>
<td>6</td>
<td>Aquepts, ponded</td>
</tr>
<tr>
<td>9</td>
<td>Bainville-Epping silt loams, 5 to 20 percent slopes</td>
</tr>
<tr>
<td>12</td>
<td>Baller-Rock outcrop complex, 15 to 45 percent slopes</td>
</tr>
<tr>
<td>22</td>
<td>Caruso clay loam, 0 to 1 percent slope</td>
</tr>
<tr>
<td>27</td>
<td>Cushman fine sandy loam, 3 to 9 percent slopes</td>
</tr>
<tr>
<td>34</td>
<td>Fort Collins loam, 0 to 1 percent slopes</td>
</tr>
<tr>
<td>35</td>
<td>Fort Collins loam, 1 to 3 percent slopes</td>
</tr>
<tr>
<td>36</td>
<td>Fort Collins loam, 3 to 5 percent slopes</td>
</tr>
<tr>
<td>37</td>
<td>Fort Collins loam, 5 to 9 percent slopes</td>
</tr>
<tr>
<td>42</td>
<td>Gravel pits</td>
</tr>
<tr>
<td>45</td>
<td>Haplustolls-Rock outcrop complex, steep</td>
</tr>
<tr>
<td>48</td>
<td>Heldt clay loam, 0 to 3 percent slopes</td>
</tr>
<tr>
<td>49</td>
<td>Heldt clay loam, 3 to 6 percent slopes</td>
</tr>
<tr>
<td>53</td>
<td>Kim loam, 1 to 3 percent slopes</td>
</tr>
<tr>
<td>54</td>
<td>Kim loam, 3 to 5 percent slopes</td>
</tr>
<tr>
<td>Soil Map Unit Number</td>
<td>Map Unit Name</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------------------------------------------------------</td>
</tr>
<tr>
<td>55</td>
<td>Kim loam, 5 to 9 percent slopes</td>
</tr>
<tr>
<td>56</td>
<td>Kim-Thedalund loams, 3 to 15 percent slopes</td>
</tr>
<tr>
<td>59</td>
<td>Laporte-Rock outcrop complex, 3 to 30 percent slopes</td>
</tr>
<tr>
<td>60</td>
<td>Larim gravelly sandy loam, 5 to 40 percent slopes</td>
</tr>
<tr>
<td>63</td>
<td>Longmont clay, 0 to 3 percent slopes</td>
</tr>
<tr>
<td>64</td>
<td>Loveland clay loam, 0 to 1 percent slopes</td>
</tr>
<tr>
<td>65</td>
<td>Midway clay loam, 5 to 25 percent slopes</td>
</tr>
<tr>
<td>66</td>
<td>Minnequa silt loam, 3 to 9 percent slopes</td>
</tr>
<tr>
<td>71</td>
<td>Nelson fine sandy loam, 3 to 9 percent slopes</td>
</tr>
<tr>
<td>73</td>
<td>Nunn clay loam, 0 to 1 percent slope</td>
</tr>
<tr>
<td>74</td>
<td>Nunn clay loam, 1 to 3 percent slopes</td>
</tr>
<tr>
<td>76</td>
<td>Nunn clay loam, wet, 1 to 3 percent slopes</td>
</tr>
<tr>
<td>79</td>
<td>Otero sandy loam, 5 to 9 percent slopes</td>
</tr>
<tr>
<td>80</td>
<td>Otero-Nelson sandy loams, 3 to 25 percent slopes</td>
</tr>
<tr>
<td>81</td>
<td>Paoli fine sandy loam, 0 to 1 percent slopes</td>
</tr>
<tr>
<td>84</td>
<td>Poudre fine sandy loam, 0 to 1 percent slope</td>
</tr>
<tr>
<td>89</td>
<td>Renohill clay loam, 0 to 3 percent slopes</td>
</tr>
<tr>
<td>90</td>
<td>Renohill clay loam, 3 to 9 percent slopes</td>
</tr>
<tr>
<td>92</td>
<td>Riverwash</td>
</tr>
<tr>
<td>95</td>
<td>Satanta loam, 1 to 3 percent slopes</td>
</tr>
<tr>
<td>101</td>
<td>Stoneham loam, 1 to 3 percent slopes</td>
</tr>
<tr>
<td>102</td>
<td>Stoneham loam, 3 to 5 percent slopes</td>
</tr>
<tr>
<td>103</td>
<td>Stoneham loam, 5 to 9 percent slopes</td>
</tr>
<tr>
<td>105</td>
<td>Table Mountain loam, 0 to 1 percent slopes</td>
</tr>
<tr>
<td>106</td>
<td>Tassel sandy loam, 3 to 25 percent slopes</td>
</tr>
<tr>
<td>107</td>
<td>Thedalund loam, 0 to 3 percent slopes</td>
</tr>
<tr>
<td>108</td>
<td>Thedalund loam, 3 to 9 percent slopes</td>
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<tr>
<td>113</td>
<td>Ulm clay loam, 0 to 3 percent slopes</td>
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<tr>
<td>114</td>
<td>Ulm clay loam, 3 to 5 percent slopes</td>
</tr>
<tr>
<td>118</td>
<td>Wiley silt loam, 1 to 3 percent slopes</td>
</tr>
</tbody>
</table>
Figure 3-4. Agricultural Reservoirs Alternative: Soil Resource Distribution.
Figure 3-5. Agricultural Reservoirs Alternative: Soil Resource Distribution.
Figure 3-6. Agricultural Reservoirs Alternative: Soil Resource Distribution.
3.4.1 Kim Loam, 1 to 9 Percent Slopes (Map Unit 53, 54 and 55)

The Kim loam soils are generally located underlying portions of the conveyance system, potential disturbance, and staging areas as displayed in (Figure 3-4), (Figure 3-5), and (Figure 3-6). The Kim soils typically support vegetation within native pastureland and dry or irrigated cropland. The Kim loam soil series is generally found in the uplands landscape and consist of very deep, moderately permeable, well-drained soils that formed in alluvium and mixed eolian and alluvial material derived from sandstone and shale. Kim soils are generally found on alluvial fans below escarpments of sedimentary rock and uplands. The Kim loam with 1 to 3 percent slopes (Map Unit 53) is found in a lesser extent within the Agricultural Reservoirs Alternative footprint. The surface runoff of the Kim loam with 1 to 3 percent slopes is classified as low and the potential of water and wind erosion are slight and moderate, respectively. The surface runoff of Kim loam with 3 to 5 percent slopes (Map Unit 54) is classified as medium, with a moderate potential for erosion. The potential for wind erosion is moderate. The Kim loam with 5 to 9 percent slopes (Map Unit 55) is found in a lesser extent within the Agricultural Reservoir Alternative footprint, and surface runoff of the soil is classified as rapid, with a severe potential for erosion. The potential for wind erosion is moderate. The Kim soils are considered farmland of statewide importance.

3.4.2 Nunn Clay Loam, 0 to 3 Percent Slopes (Map Unit 73, 74, and 76)

The Nunn Clay loam soils are located underlying portions of the conveyance system, potential disturbance, and staging areas as displayed in (Figure 3-4), (Figure 3-5), and (Figure 3-6). The soils typically support vegetation found on irrigated land. The Nunn clay loam soil series is generally found on high terraces or alluvial fans, or in drainageways, and consists of very deep, well-drained soils that formed in loess and mixed alluvium. The surface runoff of Nunn clay loam with 0 to 1 percent slopes (Map Unit 73) is classified as slow with a potential of slight erosion. The potential for wind erosion is moderate. The surface runoff of Nunn clay loam with 1 to 3 percent slopes (Map Unit 74) is classified as slow to medium and the potential of wind and water erosion are slight and moderate, respectively. The wet Nunn clay loam with 1 to 3 percent slopes (Map Unit 76) is found in a lesser extent within the Agricultural Reservoir Alternative footprint. The surface runoff of the soil is classified as slow with a potential of slight erosion. The potential for wind erosion is moderate. The Nunn Clay loam soils are all considered prime farmland if irrigated.

3.4.3 Fort Collins Loam, 1 to 9 Percent Slopes (Map Unit 35, 36, and 37)

The Fort Collins soils are located underlying portions of the conveyance system, potential disturbance, and staging areas as displayed in (Figure 3-4), (Figure 3-5), and (Figure 3-6). The Fort Collins soil series is generally found on terraces, hills, plains, and alluvial fans and consist of very deep, well-drained soils that formed in mixed eolian sediments and alluvium. The surface

CDM Smith, Inc. 3-17
runoff of Fort Collins loam with 1 to 3 percent slopes (Map Unit 35) is classified as slow with a slight to moderate potential of wind and water erosion. The Fort Collins loam soils with 1 to 3 percent slopes are considered prime farmland if irrigated. The surface runoff of Fort Collins loam with 3 to 5 percent slopes (Map Unit 36) is classified as moderate, with a moderate potential of wind and water erosion. The Fort Collins loam soils with 3 to 5 percent slope are considered prime farmland if irrigated. The Fort Collins loam with 5 to 9 percent slopes (Map Unit 37) is found in a lesser extent within the Agricultural Reservoir Alternative footprint. The surface runoff is classified as rapid, with a severe potential of wind and water erosion. The Fort Collins loam soils with 5 to 9 percent slopes are considered farmland of statewide importance.

3.4.4 Other Soils

Other soil map units not described above have been identified in lesser amounts compared to the principal soils within the Agricultural Reservoirs Alternative footprint and are presented in (Table 3-5). These map units also may be potentially disturbed by the alternative implementation and consist of similar soil characteristics, geographic settings, parent material, and slopes as described for the principal soil map units.

The designated storage units for the Agricultural Reservoirs Alternative will utilize existing agricultural reservoirs, prime or unique farmland would not be permanently inundated by this alternative implementation.

3.5 No-Action Alternative

The No-Action Alternative is described in "No Action Alternative Revised Definition, Revised Draft," prepared by the City of Fort Collins on May 10, 2015. The No-Action Alternative options described in the document do not require any structural concepts and would not require any construction activities or disturbance of any soil resources to be conducted by the city.
4 Environmental Consequences

We evaluated the potential effects the Fort Collins’ Proposed Action and each alternative could have on soil resources or soil map units including the permanent loss of soil resources within inundation areas, erosion during construction, shoreline erosion at new or enlarged reservoirs, reservoir or stream sedimentation, and soil suitability for revegetation of disturbed areas. The disturbance areas identified in this technical report for each alternative are considered potential maximums. 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. We also evaluated potential maximum impacts on prime and unique farmland soils if present within the footprints of the alternatives.

4.1 Fort Collins’ Proposed Action

4.1.1 Soil Loss and Disturbance

The Fort Collins’ Proposed Action would result in a permanent loss of approximately 132.5 acres of soil resources from inundation and less than 0.5 acres from the enlarged footprint of the dam. The proposed borrow areas are currently outside of the reservoir footprint; therefore, there is additional potential loss of 22.4 acres of soil resources from extraction of material for dam construction. Permanent and temporary access roads would result in a loss of soil resources of 5.0 and 6.5 acres, respectively. Additional temporary soil disturbance of 29.4 acres is likely at reservoir construction and staging area locations. The potential footprint of permanent and temporary disturbance is shown on (Figure 3-1).

The soils within the areas potentially affected by the Proposed Action do not consist of prime or unique farmland soils. Therefore, the Proposed Action will not impact prime and unique farmland soils.

4.1.2 Soil Erosion

4.1.2.1 Temporary Erosion

We have estimated that approximately 29.4 acres of soil resources underlying temporary access roads and staging areas will be temporarily disturbed during construction of the alternative. The majority of soil types subject to temporary wind erosion within potential construction disturbance areas are classified as having a moderate to severe susceptibility to erosion. The disturbed areas for this alternative have medium to rapid runoff potential and the potential for water erosion is generally severe due to the steeper slopes.
4.1.2.2 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 the 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.

4.1.2.3 Sedimentation

The Fort Collins' Proposed Action will continue to be filled with direct flows from the North Fork. The primary source of streamflow in the North Fork 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. In general, there is a small amount of sediment accumulation in the Halligan Reservoir 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 the Halligan Reservoir and is documented in, Halligan Reservoir Sediment Budget 2002 and 2003, prepared for North Poudre Irrigation Company, Prepared by Telesto Solutions, Inc., dated November 2003. Shoreline water erosion and areas of soil disturbance from construction also would also potentially contribute sediment to the reservoir.

4.1.3 Revegetation Potential

In general, the soils present in the potential temporarily disturbed areas have limited revegetation potential. The soils are composed primarily of outcrop complexes that are limited because of steep slope, shallow soils, and the amount of rock in the soil. During construction, recovery of topsoil from areas of temporary disturbance could increase revegetation potential following construction, but generally recovered soils have lower productivity after reapplication. Once construction of the alternative is complete, a new soil survey will 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.

A wetland re-survey will be completed along the Fort Collins' Proposed Action expanded inundation area footprint. The re-survey will be conducted to investigate the presence of soils along this area which may allow for new wetland establishment.
4.2 Expanded Glade Alternative

4.2.1 Soil Loss and Disturbance

The Expanded Glade Alternative would result in a permanent loss of approximately 63 acres of soil resources from inundation reservoir expansion. Additionally, construction of permanent access roads and the river turnout would result in the permanent loss of approximately 3 acres of soil resources. There are no additional borrow areas associated with the construction of this alternative; therefore, there is no significant additional potential loss or disturbance of soil resources from extraction of material for dam construction or other infrastructure.

Additional temporary soil disturbance of approximately 70 acres is likely at temporary access roads, pipeline disturbance areas, and staging area locations. The potential footprint of permanent and temporary disturbance is shown on Figure 3-2.

Most of the areas to be permanently impacted by the Expanded Glade Alternative are not considered prime and unique farmland. However, a small portion totaling approximately 10 acres of Nunn, Harlan and Satanta soils in the northern and southwestern portions of the Expanded Glade Alternative footprint, respectively, are considered prime farmland if irrigated.

Approximately 47 acres of the soils within the proposed footprint of the temporarily disturbed areas of the Expanded Glade Alternative, including the pipeline disturbance area, are considered prime and unique farmland. Table 4-1 displays the soil resource farmland designations within these footprints.

Table 4-1. Soil map units farmland designation within the temporarily disturbed areas of the Expanded Glade Alternative footprint.

<table>
<thead>
<tr>
<th>Soil Map Unit Number</th>
<th>Map Unit Name</th>
<th>Farmland Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Altvan loam, 3 to 9 percent slopes</td>
<td>Farmland of Statewide Importance</td>
</tr>
<tr>
<td>24</td>
<td>Connerton-Barnum complex, 0 to 3 percent slopes</td>
<td>Farmland of Statewide Importance</td>
</tr>
<tr>
<td>25</td>
<td>Connerton-Barnum complex, 3 to 9 percent slopes</td>
<td>Farmland of Statewide Importance</td>
</tr>
<tr>
<td>49</td>
<td>Heldt clay loam, 3 to 6 percent slopes</td>
<td>Farmland of Statewide Importance</td>
</tr>
<tr>
<td>64</td>
<td>Loveland clay loam, 0 to 1 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>77</td>
<td>Otero sandy loam, 0 to 3 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>81</td>
<td>Paoli fine sandy loam, 0 to 1 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>95</td>
<td>Satanta loam, 1 to 3 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>96</td>
<td>Satanta loam, 3 to 5 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>105</td>
<td>Table Mountain loam, 0 to 1 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
</tbody>
</table>
4.2.2 Soil Erosion

4.2.2.1 Temporary Erosion

We have estimated that approximately 70 acres of soil resources underlying temporary access roads, pipeline disturbance areas, and staging areas will be temporarily disturbed during construction of the Expanded Glade Alternative. The potential for wind erosion in the majority of the soils within the temporarily disturbed areas identified within the Expanded Glade Alternative footprint ranges from slight to moderate. Over half of the soil resources within the temporarily disturbed areas located at the southwestern portion of the Expanded Glade Alternative is comprised of Satanta and Poudre soils and other gentle sloping soil series. The surface runoff potential on these soils is slight to moderate and the potential for water erosion is generally low to moderate.

The remaining soils have a generally severe potential for temporary wind erosion within disturbed areas. The surface runoff potential of the soils within these areas is medium to rapid and the potential for water erosion is generally severe due to the steeper slopes.

4.2.2.2 Shoreline/Bank Erosion

The Expanded Glade Alternative would inundate additional areas and would increase the potential for shoreline erosion. The water erosion potential of the soils located along the eastern, southern, and western shorelines and banks is generally severe. Although the K factors are generally moderate, the presence of steeper slopes determines greater susceptibility to erosion. The water erosion potential of the soils located along the northern shoreline and bank is moderate as a result of the medium textured soils present because they are moderately susceptible to detachment and they produce moderate runoff.

4.2.2.3 Sedimentation

The slopes surrounding the Glade Reservoir footprint are generally moderate and the drainage is ephemeral, which indicates surface runoff and sediment transport from the surrounding areas would be low. The water source for storage for the proposed enlarged reservoir would be the North Fork through the Poudre Valley Canal. The primary source of streamflow 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 temporary disturbances could reduce the potential for erosion from these sites.
4.2.3 Revegetation Potential

The soils in the temporarily disturbed areas have limitations but are designated as prime farmland if irrigated and farmland of statewide importance, which indicates they may be suitable for revegetation at the completion of the alternative construction. As a result of the potential disturbance in the designated areas, once construction of the alternative is complete, a new soil assessment will 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.

4.3 Gravel Pits Alternative

4.3.1 Soil Loss and Disturbance

The development of this alternative would not result in a permanent loss or disturbance of soil resources at the gravel pit storage units identified for use under this alternative, as they are located at the Overland Gravel Pits complex. This alternative is based on the assumption that these gravel pits will be excavated prior to the implementation of this alternative.

Berm construction may be necessary on some of the gravel pits to accommodate the needed water storage capacity and may result in the permanent loss and disturbance of 6 acres of soil resources. Similarly, the proposed conveyance system structures such as the pump stations could result in the potential loss and disturbance of 5 acres of soil resources. The proposed alignment and location of the pipeline corridor was selected to follow existing roads and easements with the intention of limiting potential permanent and temporary disturbance large grade changes and to avoid areas that could be problematic for obtaining easements. Permanent and temporary access roads would result in loss and disturbance of soil resources of 12.5 and 17.5 acres, respectively. Additionally, temporary soil disturbance of 94 acres is likely at conveyance system construction and staging area locations. The potential footprint of permanent and temporary loss and disturbance of soil resources is shown on (Figure 3-3).

Approximately 74 acres of the soil resources within the pipeline disturbance area and the staging area footprints have prime farmland designation. As such, there would be a loss and permanent disturbance of approximately 18 acres of soil resources with prime and unique farmland designation and a temporary disturbance of 56 acres of soil resources with prime and unique farmland designation as a result of the development of this alternative. (Table 4-2) displays soil resource farmland designations that are present within these areas.
Table 4-2. Soil map unit farmland designation within the Gravel Pits Alternative disturbance and conveyance system footprint.

<table>
<thead>
<tr>
<th>Soil Map Unit Number</th>
<th>Map Unit Name</th>
<th>Farmland Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Caruso clay loam, 0 to 1 percent slope</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>54</td>
<td>Kim loam, 3 to 5 percent slopes</td>
<td>Farmland of Statewide Importance</td>
</tr>
<tr>
<td>55</td>
<td>Kim loam, 5 to 9 percent slopes</td>
<td>Farmland of Local Importance</td>
</tr>
<tr>
<td>63</td>
<td>Longmont clay, 0 to 3 percent slopes</td>
<td>Prime Farmland if irrigated and reclaimed of excess salts and sodium</td>
</tr>
<tr>
<td>64</td>
<td>Loveland clay loam, 0 to 1 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>66</td>
<td>Minnequa silt loam, 3 to 9 percent slopes</td>
<td>Farmland of Local Importance</td>
</tr>
<tr>
<td>81</td>
<td>Paoli fine sandy loam, 0 to 1 percent slopes</td>
<td>Prime farmland if irrigated</td>
</tr>
<tr>
<td>95</td>
<td>Satanta loam, 1 to 3 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>105</td>
<td>Table Mountain loam, 0 to 1 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
</tbody>
</table>

4.3.2 Soil Erosion

4.3.2.1 Temporary Erosion

The proposed alignment and location of the pipeline corridor was selected to follow existing roads and easements with the intention of limiting potential permanent and temporary disturbance of soil resources. As such, we have estimated that approximately 111.5 acres of soil resources will be temporarily disturbed during construction of the alternative due to temporary access roads, pipeline disturbance areas, and staging areas. The potential for temporary wind erosion in the majority of soils within the construction disturbance areas range from slight to moderate (Moreland, 1980). The principal soils within the potential disturbance and construction areas are generally gently sloping soil series. The surface runoff of these soils is slow to moderate and the potential for water erosion is generally slight to moderate.

4.3.2.2 Shoreline/Bank Erosion

Shoreline and Bank erosion will be limited due to use of constructed berms that will be designed to minimize this issue.

4.3.2.3 Sedimentation

Sediment yield from surrounding areas to the gravel pit reservoirs will be minimal, since limited or no runoff will enter from surrounding areas. The slopes surrounding the proposed gravel pit are gentle, which indicates surface runoff and sediment transport from the surrounding areas will be low. Water for this alternative would be diverted from the Poudre River through the existing Larimer County No. 2 Canal diversion structure and conveyed using excess capacity in the canal. The primary source of streamflow 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 will have minimal potential for shoreline erosion. Revegetation of temporary disturbances could reduce the potential for erosion at these sites.

4.3.3 Revegetation Potential

In general, the existing soils in the remaining areas have limitations but are designated as prime farmland if irrigated and farmland of statewide importance, which indicates they may be suitable for revegetation at the completion of the alternative construction. As a result of the potential disturbance in the designated areas, once construction of the alternative is complete, a new soil assessment will need to be conducted to design the reclamation program. Fort Collins intends to fully revegetate any disturbed soils associated with the alternative once construction is complete.

4.4 Agricultural Reservoirs Alternative

4.4.1 Soil Loss and Disturbance

The development of the Agricultural Reservoirs Alternative would not result in a permanent loss and disturbance of soil resources at the agricultural reservoir footprints identified for use under this alternative. This alternative is based on the assumption that these agricultural reservoirs are existing prior to the implementation of this alternative.

The development of this alternative would result in the potential permanent loss of 2 acres of soil resources from the construction of the proposed conveyance system structures such as the pump station. The proposed alignment and location of the pipeline corridor was selected to follow existing roads and easements with the intention of limiting potential permanent and temporary disturbance of soil resources. Permanent and temporary access roads would result in a loss of soil resources of 9.0 and 12.5 acres, respectively. Additional temporary soil disturbance of 360 acres is likely at the conveyance system construction and staging area locations. The potential footprint of permanent and temporary disturbance is shown on (Figure 3-4), (Figure 3-5), and (Figure 3-6).

The majority of the soils within the footprint of the temporarily disturbed areas and conveyance system have prime farmland designation. As such, there would be a loss and permanent disturbance of approximately 8 acres of soil resources with prime or unique farmland designation and a temporary disturbance of 236 acres of soil resources with prime or unique farmland designation as a result of the development of this alternative. (Table 4-3) displays soil resource farmland designations that are present within these areas.
Table 4-3. Soil map units farmland designation within the Agriculture Reservoir Alternative disturbance and conveyance system footprint.

<table>
<thead>
<tr>
<th>Soil Map Unit Number</th>
<th>Map Unit Name</th>
<th>Farmland Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Altvan-Satanta loams, 3 to 9 percent slopes</td>
<td>Farmland of Statewide Importance</td>
</tr>
<tr>
<td>22</td>
<td>Caruso clay loam, 0 to 1 percent slope</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>34</td>
<td>Fort Collins loam, 0 to 1 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>35</td>
<td>Fort Collins loam, 1 to 3 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>36</td>
<td>Fort Collins loam, 3 to 5 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>37</td>
<td>Fort Collins loam, 5 to 9 percent slopes</td>
<td>Farmland of Statewide Importance</td>
</tr>
<tr>
<td>48</td>
<td>Heldt clay loam, 0 to 3 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>49</td>
<td>Heldt clay loam, 3 to 6 percent slopes</td>
<td>Farmland of Statewide Importance</td>
</tr>
<tr>
<td>53</td>
<td>Kim loam, 1 to 3 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>54</td>
<td>Kim loam, 3 to 5 percent slopes</td>
<td>Farmland of Statewide Importance</td>
</tr>
<tr>
<td>55</td>
<td>Kim loam, 5 to 9 percent slopes</td>
<td>Farmland of Local Importance</td>
</tr>
<tr>
<td>63</td>
<td>Longmont clay, 0 to 3 percent slopes</td>
<td>Prime Farmland if irrigated and reclaimed of excess salts and sodium</td>
</tr>
<tr>
<td>64</td>
<td>Loveland clay loam, 0 to 1 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>66</td>
<td>Minnequa silt loam, 3 to 9 percent slopes</td>
<td>Farmland of Local Importance</td>
</tr>
<tr>
<td>73</td>
<td>Nunn clay loam, 0 to 1 percent slope</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>74</td>
<td>Nunn clay loam, 1 to 3 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>76</td>
<td>Nunn clay loam, wet, 1 to 3 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>81</td>
<td>Paoli fine sandy loam, 0 to 1 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>89</td>
<td>Renohill clay loam, 0 to 3 percent slopes</td>
<td>Farmland of Statewide Importance</td>
</tr>
<tr>
<td>95</td>
<td>Satanta loam, 1 to 3 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>101</td>
<td>Stoneham loam, 1 to 3 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>102</td>
<td>Stoneham loam, 3 to 5 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>103</td>
<td>Stoneham loam, 5 to 9 percent slopes</td>
<td>Farmland of Local Importance</td>
</tr>
<tr>
<td>105</td>
<td>Table Mountain loam, 0 to 1 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>107</td>
<td>Thedalund loam, 0 to 3 percent slopes</td>
<td>Farmland of Statewide Importance</td>
</tr>
<tr>
<td>113</td>
<td>Ulm clay loam, 0 to 3 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>114</td>
<td>Ulm clay loam, 3 to 5 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
<tr>
<td>118</td>
<td>Wiley silt loam, 1 to 3 percent slopes</td>
<td>Prime Farmland if irrigated</td>
</tr>
</tbody>
</table>
4.4.2 **Soil Erosion**

4.4.2.1 **Temporary Erosion**

The proposed alignment and location of the pipeline corridor was selected to follow existing roads and easements with the intention of limiting potential permanent and temporary disturbance of soil resources. As such, we have estimated that approximately 372.5 acres of soil resources will be temporarily disturbed during construction of the alternative due to temporary access roads, pipeline disturbance areas, and staging areas. The potential for temporary wind erosion in the majority of the 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 on these soils within the alternative construction disturbances area is slow to medium and the potential for water erosion is generally low to moderate (Moreland, 1980).

4.4.2.2 **Shoreline/Bank Erosion**

The proposed water storage units for the alternative are existing agricultural reservoirs and will not be altered with implementation of the alternative, so the shoreline and bank erosion rates are generally stable and will not change with implementation of the alternative. The alternative only requires construction of a conveyance system, since the reservoirs already exist.

The water erosion potential of the soils located along the existing northern, eastern, and southern shorelines and banks of Reservoir Number 5 is generally slight. The water erosion potential of the soils located along the shorelines and banks of the existing Reservoir Number 6 are generally moderate to severe. The water erosion potential of these soils is moderate as a result of the medium textured soils present. However, as the water storage units are existing, the shoreline and bank erosion rates are presumed to be stable and should not change from current conditions.

4.4.2.3 **Sedimentation**

The majority of the slopes surrounding the proposed Agricultural Reservoirs Numbers 5 and 6 are gentle to moderate, ranging from 1 to 5 percent slope, which indicates surface runoff and sediment transport from the surrounding areas will be low to moderate. Water to fill Reservoirs Numbers 5 and 6 would be diverted from the Poudre River at the Munroe Canal diversion structure and conveyed by gravity to the Reservoir Number 6 outlet structure. The primary source of streamflow 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 the alternative utilizes existing storage reservoir units. Surrounding areas of temporary soil disturbance from construction of the conveyance system would also contribute sediment to the
reservoir. However, revegetation of temporary disturbances could reduce erosion from these sites to natural erosion rates.

4.4.3 Revegetation Potential

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

4.4.4 No-Action Alternatives

The No Action Alternative does not require any structural concepts and would not require any construction activities or disturbance of any soil resources to be conducted by Fort Collins. However, implementation of the No Action Alternative could potentially reduce the loss of soil resources within prime farmland designated soils by the acquisition of shares in irrigation for use of the shares' C-BT storage component to fulfill the purpose and need of Fort Collins. If the vegetation present on these soil resources returned to native prairie vegetation, the potential of soil resource loss would potentially decrease with the increase of vegetative cover. The soil resources potentially affected by implementation of this alternative will be confirmed in the final design.

Additionally, the potential reoperation of Joe Wright Reservoir to obtain additional winter storage volumes would not result in alterations to the reservoir. The shoreline and bank erosion rates are generally stable at the existing reservoir and will not likely change with implementation of the alternative.
5 Summary of Effects

We evaluated the potential for maximum permanent loss and disturbance of soil resources for the Fort Collins’ Proposed Action and the Alternatives described in Section 1-1. The disturbance areas identified in this technical report for each alternative are considered potential maximums. 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. Most of the impacts on soil resources associated with the alternatives, which would result in the maximum permanent acreage loss and disturbance are within reservoir enlargement areas and underlying access roads, permanent infrastructure or borrow areas. (Table 5-1) shows the total maximum permanent loss and disturbance acreages for all soil resources for each alternative.

A portion of the soil resources within the permanent loss and disturbance areas for each alternative have designations of prime or unique farmland. We evaluated the soil resources present within the total maximum permanent loss and disturbance acreages with these designations for each alternative and are described below.

We evaluated the permanent loss and disturbance of soil resources with prime or unique farmland designation for the Fort Collins’ Proposed Action and the Alternatives. As described in Section 4.1.1, no soils designated as prime farmland or other farmland designations are present within the Fort Collins' Proposed Action inundation footprint or other areas of disturbance associated with the Fort Collins' Proposed Action. Therefore, the Proposed Action would not cause the permanent loss and disturbance of prime farmland. Additionally, there are no soils designated as prime farmland or other farmland designations present within the Fort Collins' Proposed Action areas of temporary disturbance associated with the Fort Collins’ Proposed Action. Therefore, the Fort Collins' Proposed Action would not cause temporary disturbance of any prime farmland designated soil resources.

As described in Section 4.2.1, there are 10 acres of soil resources designated as prime farmland if irrigated present within the Enlarged Glade Reservoir Alternative inundation footprint and other designated areas of permanent loss and disturbance. Therefore, the Enlarged Glade Alternative would cause a small permanent loss and disturbance of prime farmland if irrigated. In addition, there are 47 acres of soil resources designated as prime farmland if irrigated within the areas of potential temporary disturbance associated with the alternative. Therefore, the Enlarged Glade Alternative would cause a minor amount of temporary disturbance of prime farmland if irrigated designated soil resources.
Table 5-1. Total maximum acreage of permanent loss and disturbance of soil resources.

<table>
<thead>
<tr>
<th>Alternative Name</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fort Collins’ Proposed Action</strong></td>
<td></td>
</tr>
<tr>
<td>Inundation Area</td>
<td>132.5</td>
</tr>
<tr>
<td>Access Roads</td>
<td>5.0</td>
</tr>
<tr>
<td>Dam Footprint</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Borrow Areas</td>
<td>22.4</td>
</tr>
<tr>
<td><strong>Expanded Glade Alternative (Fort Collins Impacts only)</strong></td>
<td></td>
</tr>
<tr>
<td>Inundation Area, from NISP level to Fort Collins Level</td>
<td>63</td>
</tr>
<tr>
<td>Access Roads</td>
<td>3.0</td>
</tr>
<tr>
<td>Borrow Area</td>
<td>N/A</td>
</tr>
<tr>
<td>River Turn Out</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Valves/Valve House</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td><strong>Gravel Pits Alternative</strong></td>
<td></td>
</tr>
<tr>
<td>Gravel Pits Storage</td>
<td>6.0</td>
</tr>
<tr>
<td>Access Roads</td>
<td>12.5</td>
</tr>
<tr>
<td>Pump Stations (3)</td>
<td>4.5</td>
</tr>
<tr>
<td>Pretreatment</td>
<td>0.5</td>
</tr>
<tr>
<td>River Turn Out</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Valve House</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Borrow Area</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Agricultural Reservoir Alternative</strong></td>
<td></td>
</tr>
<tr>
<td>Access Roads</td>
<td>9.0</td>
</tr>
<tr>
<td>Pump Station/Pretreatment</td>
<td>2.0</td>
</tr>
<tr>
<td>Valve House-3</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>River Turn Out</td>
<td>&lt;0.5</td>
</tr>
</tbody>
</table>

NOTE: Areas indicated have been rounded to the nearest half-acre due to limited accuracy of available data.
NA- Not Applicable

Approximately 18 acres of soil resources within the Gravel Pits Alternative footprint with the designation of either prime farmland if irrigated or prime farmland if irrigated and reclaimed of excess salts and sodium are within the footprint of designated areas of permanent loss and disturbance associated with the alternative. As described in Section 4.3.1, the development of this alternative would not result in a permanent loss or disturbance of soil resources at the gravel pit storage units. This alternative is based on the assumption that these gravel pits will be excavated prior to the implementation of this alternative, as a result, the Gravel Pits Alternative would cause a small permanent loss and disturbance of farmland designated soil resources. In addition, there are 56 acres of soils designated as prime farmland if irrigated or prime farmland if irrigated and reclaimed of excess salts and sodium within the designated areas of potential temporary disturbance associated with the alternative. As a result, the Gravel Pits Alternative would potentially cause a small amount of temporary disturbance of prime farmland designated...
soil resources. The potential soil loss and disturbance within the alternative footprint is described in Section 4.2.1.

There are 8 acres of soil resources designated as prime farmland if irrigated or prime farmland if irrigated and reclaimed of excess salts and sodium present within the Agricultural Reservoir Alternative designated areas of permanent loss and disturbance. Therefore, the Agricultural Reservoir Alternative would cause a small permanent loss and disturbance of prime farmland designated soil resources. In addition, there are 236 acres of soils designated as prime farmland if irrigated or prime farmland if irrigated and reclaimed of excess salts and sodium, within the areas of potential temporary disturbance associated with the alternative. Therefore, the Agricultural Reservoir Alternative would cause a moderate amount of temporary disturbance of prime farmland designated soil resources. The potential soil loss and disturbance within the alternative footprint is described in Section 4.2.1

The No Action Alternative does not require any structural concepts and would not require any construction activities or disturbance of any soil resources to be conducted by Fort Collins, as detailed in Section 4.2.1. However, implementation of the No Action Alternative could potentially impact soil resources designed as prime or unique farmland by the acquisition of shares in irrigation. The soil resources affected by implementation of this alternative will be confirmed in the final design.
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6 Literature Cited

Colorado Department of Natural Resources. 2016. Design Review and Construction Inspection. Colorado Division of Water Resources, Department of Natural Resources. Information Available at: http://water.state.co.us/SurfaceWater/DamSafety/DesignConstruction/Pages/default.aspx


