FINDING OF NO SIGNIFIGANT IMPACT:
Repairs and Improvements to Teller Dam
U.S. ARMY GARRISON FORT CARSON, CO

U.S. Army Garrison (USAG) Fort Carson has prepared an Environmental Assessment (EA) (July 2017) that evaluates the potential environmental impacts associated with repairing geotechnical and design deficiencies associated with Teller Dam.

Description of the Proposed Action
Fort Carson is proposing to address various deficiencies with Teller Dam by implementing a range of standard engineering techniques to reduce seepage and increase hydraulic capacity.

The design would include:

-Raising the embankment 13ft, from 5,498 to 5,511ft to increase the amount of available spillway head and associated outflow capacity.
- Increasing the height of the dam using soil and rock from the spillway or other surrounding locations, or offsite.
- Treating the abutment seepage using methods such as grouting, blanket and filter material on the upstream side, secant piles, excavating to abutment contacts and treating sandstone and then backfilling.
- Installing an improved subdrain system.
- Repairing downstream crossings.
- Placing rip rap, soil cement, grouting, and/or vegetation on the embankment to protect from erosion.

The Proposed Action is the Army's Preferred Alternative.

Purpose and Need
As the owner of Teller Dam, Fort Carson has a need to ensure the dam is safely maintained and operated in compliance with applicable standards and regulations. The purpose of the proposed action is to address and resolve dam safety concerns by making appropriate modifications, repairs and improvements necessary to ensure the safe operation of the dam.

Alternatives Considered
Fort Carson initially conducted risk and engineering analyses and screened various alternatives in concert with consulting experts and technical representatives from potentially affected communities, including the Office of the State Engineer. For the purpose of this action, USAG Fort Carson considered two alternatives and the No Action Alternative. The No Action Alternative served as a baseline against which impacts associated with the Proposed Action could be evaluated.

Alternative 1, which is the Army's preferred alternative, would address hydraulic capacity and seepage. By adding material to the dam, it would be raised by up to 13

feet in height, which would allow a calculated maximum rain event to safely pass through the spillway without overtopping the dam.

To address the seepage, standard engineering techniques would be employed including; secant piles, filter materials, grouting, excavation and armoring.

Alternative 2 would employ similar standard engineering techniques to address seepage, but rather than adding height to the dam, concrete would be used to armor and protect the embankment from erosion and failure.

Both of the alternatives include the use of materials to be sourced in the vicinity of the dam. This environmental assessment has identified and analyzed the areas from which those materials would be sourced. Once the precise locations of the borrow sites are identified, and before earth moving operations are commenced, borrow site operations will be reviewed to determine if conditions warrant supplemental NEPA documentation as required by 32 CFR 651.5(g) and 40 CFR 1502.9(c).

The Army evaluated the merits of several alternatives for construction and recurring costs, impact on the military mission, feasibility, proven prior use, public health and safety, prevention of injury to natural and cultural resources, capability to pass the inflow design flood, and mitigation of high risk potential failure modes. This approach allowed Fort Carson to assess the current and future benefits of each alternative, and determine how efficiently the alternative met the purpose and need of the project.

No Action Alternative
Under the No Action Alternative no large scale attempts would be made to protect the dam from failure, and no improvements made to address the insufficient hydraulic capacity would be made. Storage restrictions would likely remain in effect and monitoring of the dam would continue.

Public Participation and Review Process
Pursuant to Title 32 Code of Federal Regulations (CFR) Part 651.14(b), the Army must make an EA and Draft Finding of No Significant Impact (FNSI) available to the public for review and comment for a minimum of 30 days prior to a final decision.

The Draft EA will be available for a 30-day public comment period beginning August 2nd. The documents were posted on the World Wide Web, with links to the document provided at http://www.carson.army.mil/DPW/nepa.html. Interested parties are invited to review and comment on the documents within 30 days of the respective publication. Commenters were asked to send comments via email, regular mail, and/or telephone. Comments by the public, government agencies, other appropriate entities, and stakeholders will be fully considered in the drafting of the Final EA and FNSI.

Previously, in November, 2015 Fort Carson hosted a risk conference and invited and obtained input from the Planning, Public Works and Safety Engineers of the potentially affected City, County and State.

Agency and Tribal Consultation
Repairs to the dam, as an updated modern structure which was modified by the Army in 1989, are exempted activities under provisions of the Fort Carson Down Range PA. (Appendix 1, D1b). Therefore, consultation for the repair of the dam has already been conducted. Consultation for other earthwork in accordance with Section 106 of the National Historic Preservation Act (NHPA) and its implementing regulations 36 CFR Part 800 will be initiated with the Colorado State Historic Preservation Officer (SHPO), Native American Tribes, and other stakeholders and consulting parties during the design phase of the repairs and will be concluded before earth-moving work is initiated.

Environmental Consequences
Potential direct, indirect, and cumulative impacts of the Proposed Action and alternatives is identified in the analysis and public comments will be considered during the development and finalization of the EA. Potential impacts associated with implementing the Proposed Action for the valued environmental components (VECs) identified in the EA, were not significant.

Mitigation Required
There is potential for negative effects caused by the construction and repair activities. Disturbances associated with the repairs and improvements to the dam and use of borrow sites would potentially impact resources mostly as a result of ground disturbance, primarily construction vehicle traffic, erosion and stormwater pollution, and fugitive dust emissions.

To minimize this, Fort Carson would incorporate elements of design and BMPs to reduce this potential. Fort Carson would ensure that appropriate measures have been included to mitigate these potential impacts. These measures include, but are not limited to, the following:

- If the ground disturbing activity is going to be started during Migratory Bird Treaty Act (MBTA) nesting season 15 Apr to 15 Sept annually, then prior coordination with the Directorate of Public Works, Environmental Division, Wildlife Office is necessary to conduct clearing surveys for ground/shrub nesting birds to minimize potential MBTA violations;
- Wildlife surveys to identify, capture and relocate Colorado checkered whiptails;
- A stormwater Pollution Prevention Plan (SWPPP) must be developed in accordance with the Fort Carson Stormwater Management Plan (SWMP) and submitted to the Fort Carson Stormwater Program for review and approval prior to filing a Notice of Intent (NOI) with the U.S. Environmental Protection Agency (USEPA) for coverage under the Construction General Permit (CGP);
- Permit applications would include a fugitive dust control plan and would include all land disturbance associated with this project;
- Avoiding all activity, to the extent possible, within line of sight of the golden eagle nest during nesting season;
- Initiating Section 106 Consultation once borrow pit locations are chosen; and
- Coordinating construction vehicle traffic to avoid community events.

Conclusion

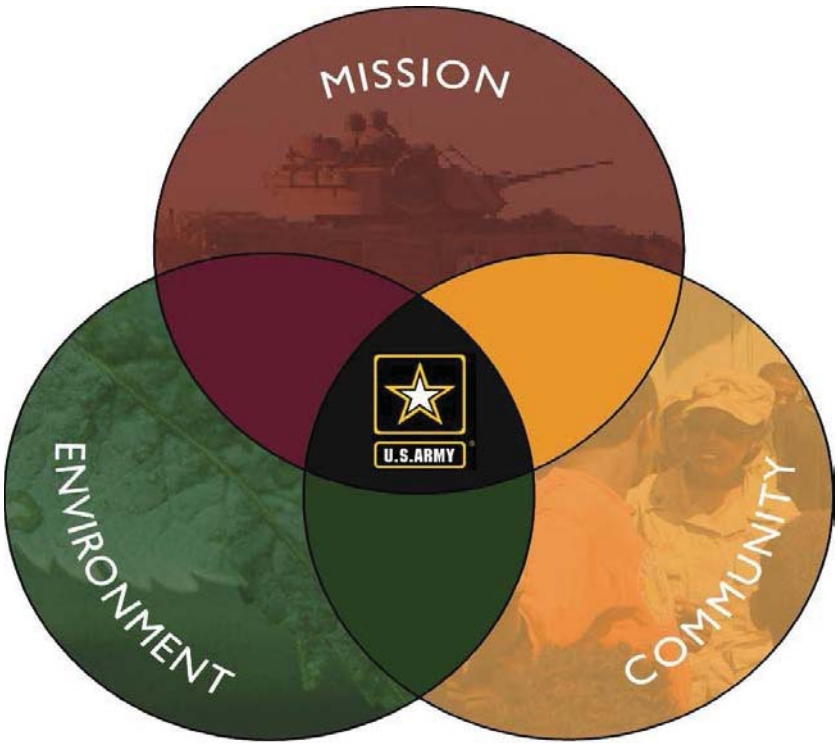
The EA on which this FNSI was prepared is pursuant to 32 CFR 651 and U.S. Council on Environmental Quality (CEQ) regulations (Title 40, U.S. Code, Parts 1500-1508) for implementing the procedural requirements of the National Environmental Policy Act (NEPA). Based on the analysis contained in the EA and the Army's intent to follow prescribed regulations and comply with applicable permits and agreements, the Army has determined that the Proposed Action would have no significant direct, indirect, or cumulative impact on the human or natural environment. Therefore, based on review of this EA, I conclude that the Proposed Action, the Army's Preferred Alternative, is not a major federal action that would significantly affect the quality of the environment within the meaning of Section 102(2)(c) of NEPA. Accordingly, no Environmental Impact Statement (EIS) is required. With this finding, I approve selection of the Proposed Action.

Date: 10 OCT 17

RONALD P. FITCH JR.
COL, SF
Garrison Commander
Fort Carson, Colorado

Environmental Assessment

Repairs and Improvements to Teller Dam
Fort Carson, CO. July 2017



Fort Carson
Directorate of Public Works, Environmental Division

ENVIRONMENTAL ASSESSMENT

Repairs and Improvements to Teller Dam
Fort Carson, CO.

July 2017

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25 September 2017
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COL, SF
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10 OCT 17
Date

ENVIRONMENTAL ASSESSMENT

Repairs and Improvements to Teller
Dam Fort Carson, CO

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ENVIRONMENTAL ASSESSMENT
Repairs and Improvements to Teller
Dam Fort Carson, CO

1.0 PURPOSE, NEED, AND SCOPE

This section presents the purpose and need for the Proposed Action, defines the scope of the environmental analysis and issues to be considered, identifies decisions to be made, and identifies other relevant documents and actions.

1.1 Introduction

This Environmental Assessment (EA) was prepared to evaluate the potential impacts of the Army's proposal to repair and improve Teller Dam at Fort Carson, CO. The Proposed Action would serve to bring the dam into compliance with applicable dam safety standards. Currently Teller Dam has the following deficiencies.

Hydraulic Capacity Deficiency
Teller Dam does not currently have capacity to pass the Inflow Design Flood (IDF) based on Colorado and Federal regulations,

Geotechnical Deficiencies
The State of Colorado Division of Water Resources observed the following structural deficiencies in August of 2013.

- Sinkhole on upstream slope that may be associated with the migration of embankment materials
- Seepage observed in Dakota formation joints

1.2 Purpose and Need for Proposed Action

In 1966, Fort Carson acquired Teller Dam as part of an expansion of the installation. The dam was constructed in 1909, and it does not currently meet modern dam safety criteria.

Maintenance and repair projects dating back to the 1980s have been carried out in efforts to correct or mitigate these deficiencies. In 2013, the State of Colorado Dam Safety Branch conducted an inspection together with United States Army Corps of Engineers (USACE). Observations of seepage and a sinkhole on the upstream left abutment resulted in the issuance of a Zero Storage Restriction Order by the Office of the State Engineer, Division of Water Resources, Colorado Department of Natural Resources.

In response, USACE evaluated and developed conceptual designs for repair alternatives to meet dam safety criteria. As the owner of Teller Dam, Fort Carson has a need to ensure the dam is properly and safely maintained and operated in compliance with applicable standards and regulations. The purpose of the proposed action is to address and resolve dam safety concerns by making appropriate

modifications, repairs, and improvements necessary to ensure the safe operation of the dam.

1.3 Scope of Analysis

This EA analyzes effects of repairing and improving Teller dam on Fort Carson. This EA has been developed in accordance with the National Environmental Policy Act (NEPA) of 1969 and implementing regulations issued by the President's Council on Environmental Quality (CEQ) published in 40 Code of Federal Regulations (CFR) Parts 1500-1508 and the Army's NEPA-implementing procedures published in 32 CFR Part 651, *Environmental Analysis of Army Actions (Army Regulation 200-2)*. This EA facilitates the Installation's planning and informed decision-making, helping the Garrison Commander and the public to understand the potential extent of environmental impacts of the Proposed Action and alternatives, and whether those impacts (direct, indirect, and cumulative) are significant.

This EA describes the potential environmental consequences resulting from the Proposed Action and the Alternatives on environmental resources.

1.4 Decision(s) to Be Made

The decision to be made is whether or not to implement the Proposed Action or an alternative, and if implementation would cause significant impacts to the human or natural environment. The final decision is the responsibility of the Garrison Commander at Fort Carson. If no significant environmental impacts are determined, based on the evaluation of impacts in the EA, a Finding of No Significant Impact (FNSI) will be signed by the Garrison Commander. If it is determined that the Proposed Action will have significant environmental impacts, either the action will not be undertaken, or a Notice of Intent (NOI) to prepare an Environmental Impact Statement (EIS) will be published in the *Federal Register*.

1.5 Agency and Public Participation

Public participation opportunities with respect to this EA and decision-making on the Proposed Action are guided by 32 Code of Federal Regulations (CFR) Part 651, *Environmental Analysis of Army Actions (Army Regulation* [AR] *200-2)*. Consideration of the views and information of all interested persons promotes open communication and enables better decision-making. All agencies, organizations, and members of the public having an interest in the Proposed Action, including minority, low-income, disadvantaged, and Native American groups, are given the opportunity to comment on this EA, as described below.

Upon completion, the Proposed Action and the entire record will be reviewed and the Agency will determine the foreseeable impacts and the need for mitigation. If the Proposed Action remains within the assessment parameters described in this draft, the EA along with a Draft FNSI, with mitigation measures if applicable, will be available to the public for 30 days, starting from the last day of publication of the Notice of Availability (NOA) in the local media. The documents will be available at: http://www.carson.army.mil/DPW/nepa.html

Anyone wishing to comment on the Proposed Action or request additional information should contact the Fort Carson NEPA Coordinator, Directorate of Public Works; Environmental Division at: usarmy.carson.imcom-central.list.dpw-ed-nepa@mail.mil.

At the end of the 30-day public review period, the Army will consider all comments submitted by individuals, agencies, or organizations on the Proposed Action, EA, or Draft FNSI. Copies of individual comment letters and the associated responses received during this period will be included in the final documentation in Appendix A.

Section 106 of the National Historic Preservation Act

Teller Dam, with its associated ditch and remnants of other water control features, was recorded and evaluated for eligibility on the National Register of Historic Places (NRHP) in November 2013 and was determined to be not eligible (Edward C. Nichols to Carlos Rivera-deAguilar, letter, 4 February 2014, CHS #65322, History Colorado, Colorado). Repairs to the dam, as an updated modern structure which was modified by the Army in 1989, are exempted activities under provisions of the Fort Carson Down Range PA. (Appendix 1, D1b). Therefore, consultation for the repair of the dam has already been conducted.

With regards to borrow pit selection and excavation; consultation in accordance with Section 106 of the National Historic Preservation Act (NHPA) and its implementing regulations 36 CFR Part 800 will be initiated with the Colorado State Historic Preservation Officer (SHPO), Native American Tribes, and other consulting parties during the design phase of the repairs and will be concluded before earth-moving work is initiated. Consultation will include thirteen federally recognized Native American Tribes, who are culturally affiliated with Fort Carson; the El Paso County Commissioners; Colorado Council of Professional Archaeologists; Colorado Preservation, Inc.; and the Tatanka Group, LLC.

1.6 Legal Framework

A decision on whether to proceed with the Proposed Action rests on numerous factors such as mission requirements, schedule, funding availability, safety, and environmental considerations. In addressing environmental considerations, Fort Carson is guided by relevant statutes (and their implementing regulations) and Executive Orders (EOs) that establish standards and provide guidance on environmental and natural resources management and planning. These include, but are not limited to, the following:

- Clean Air Act;
- Clean Water Act;
- Noise Control Act;
- Endangered Species Act;
- Migratory Bird Treaty Act;
- National Historic Preservation Act;
- Archaeological Resources Protection Act;

- Resource Conservation and Recovery Act;
- Toxic Substances Control Act;
- EO 11988, Floodplain Management, as amended;
- EO 11990, Protection of Wetlands;
- EO 12088, Federal Compliance with Pollution Control Standards;
- EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations;
- EO 13045, Protection of Children from Environmental Health Risks and Safety Risks;
- EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management;
- EO 13175, Consultation and Coordination with Indian Tribal Governments;
- EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds; and
- EO 13514, Federal Leadership in Environmental, Energy, and Economic Performance.

2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

This section describes the Proposed Action. 32 CFR 651 (AR 200-2) and Council on Environmental Quality regulations (40 CFR 1500) require the identification of reasonable alternatives to the Proposed Action, including the No Action Alternative. Courses of action to address the deficiencies of Teller Dam were evaluated and screened based on criteria detailed below.

Screening Criteria

Fort Carson assembled a multi-disciplinary team, which included dam construction and safety experts from outside the Army and USACE. The team identified and narrowed a list of potential alternatives via a semi-quantitative risk analysis that immediately eliminated alternatives that had the potential to increase flooding events for the community downstream. In November, 2015 Fort Carson hosted a risk conference and invited and obtained input from the Planning, Public Works and Safety Engineers of the potentially affected City, County and State. Afterwards, the Army further evaluated the merits of viable alternatives and screened them based on the following criteria:

- construction and recurring costs
- impact on the military mission
- feasibility
- proven prior use
- public health and safety
- prevention of injury to natural and cultural resources
- capability to pass the IDF
- mitigation of high risk potential failure modes.

This approach allowed Fort Carson to assess the current and future benefits of each alternative, and determine how efficiently the alternative met the purpose and need of the project.

The remaining alternatives considered were developed by the USACE to assess the ability to meet project needs and establish criteria defining the level of acceptable risk (AECOM 2016) with the purpose of meeting federal and state dam requirements and permanently reducing the risk of dam failure. Of the Valued Environmental Components (VECs), the potential for significant negative impacts to Environmental Health and Safety Risks for Children serves as an immediate disqualifier.

2.1 Proposed Action Alternative 1

The Proposed Action is to modify Teller Dam to mitigate high risk failure modes and to ensure compliance with both federal and state dam safety criteria by abutment treatment and embankment raise to elevation 5,511ft (Dam Raise). This is the Army's preferred alternative.

The Proposed Action alternative would reduce the risks for the Potential Failure Modes of Internal Erosion due to Seepage and Overtopping. By raising the dam, the amount of spillway head and associated outflow capacity is increased, therefore it would not overtop during an IDF event. Water would pass to the east in the spillway and re-enter the Turkey Creek drainage. See Appendix B for a conceptual drawing.

The design would include:
-Raising the embankment 13ft from 5,498 to 5,511ft to increase the amount of available spillway head and associated outflow capacity.
- Increasing the height of the dam using soil and rock from the spillway or other surrounding locations, or offsite.
- Treating the abutment seepage using methods such as grouting, blanket and filter material on the upstream side, secant piles, excavating to abutment contacts and treating sandstone and then backfilling.
- Installing an improved sub drain system.
- Repairing downstream crossings.
- Placing rip rap, soil cement, grouting, and/or vegetation on the embankment to protect from erosion.

2.2 Alternative 2. Abutment Treatment and Embankment Overtopping Protection

This alternative shares many components with the Proposed Action and would reduce the risk of failure from the high risk Potential Failure Modes of Internal Erosion due to Seepage and Overtopping. The main difference is that rather than raising the elevation, Articulated Concrete Block Mat (ACBM) or other armoring material would be used to protect the downstream slope of the dam when it overtops in an IDF event.

The design would include:
- Armoring the embankment for overtopping by using overtopping protection such as roller compacted concrete, ACBM, or comparable armoring material.
- Treating the abutment seepage using methods such as grouting, blanket and filter material on the upstream side, secant piles, excavating to abutment contacts and treating sandstone and then backfilling
- Installing an improved sub drain system.

- Repairing downstream crossings.

A concrete batch plant would be employed and this would potentially include the use of locally sourced materials as described in Section 2.3 below.

2.3 Potential Design and Borrow Sites

Proposed Action Alternative 1

The preferred alternative of raising the dam would require about 70,000 cubic yards of material to be added to the existing dam. Fill material would be obtained from non-sensitive areas near the dam itself. It is possible that some materials may need to be obtained from off the installation to supplement or fully supply the amount required for the embankment raise.

In order to identify the precise source of fill material for raising of the dam, USACE would sample the areas highlighted in green in figure 2.1. The locations were evaluated and identified in a process coordinating the requirements of construction engineers, environmental and cultural staff and the range operations staff. Some other nearby areas of initial interest were considered but were rejected due to the occurrence of sensitive species, cultural sites, and golden eagle nesting sites. Other areas were removed from further consideration because they could potentially increase the likelihood of fugitive dust emissions or negatively impact military training in the vicinity.

Alternative 2

As with the Proposed Action, material would be required to implement the repairs as described in Section 2.2. Areas that may have suitable materials for establishment of a borrow pit to support the concrete batch plant, preferably from a pre-existing quarry, are within the polygons identified in figure 2.1.

For both alternatives, collection of the appropriate materials would be obtained from one to four borrow sites within the identified polygons. The disturbance is expected to be less than 50 acres total. Once the precise locations of the borrow sites are identified, and before earth moving operations are commenced, borrow site operations will be reviewed to determine if conditions warrant supplemental NEPA documentation as required by 32 CFR 651.5(g) and 40 CFR 1502.9(c). If the review indicates no need for a supplemental analysis, that determination will be documented in a Record of Environmental Consideration (REC.) Otherwise, supplemental or independent NEPA analysis will be conducted and documented with the appropriate level of review.

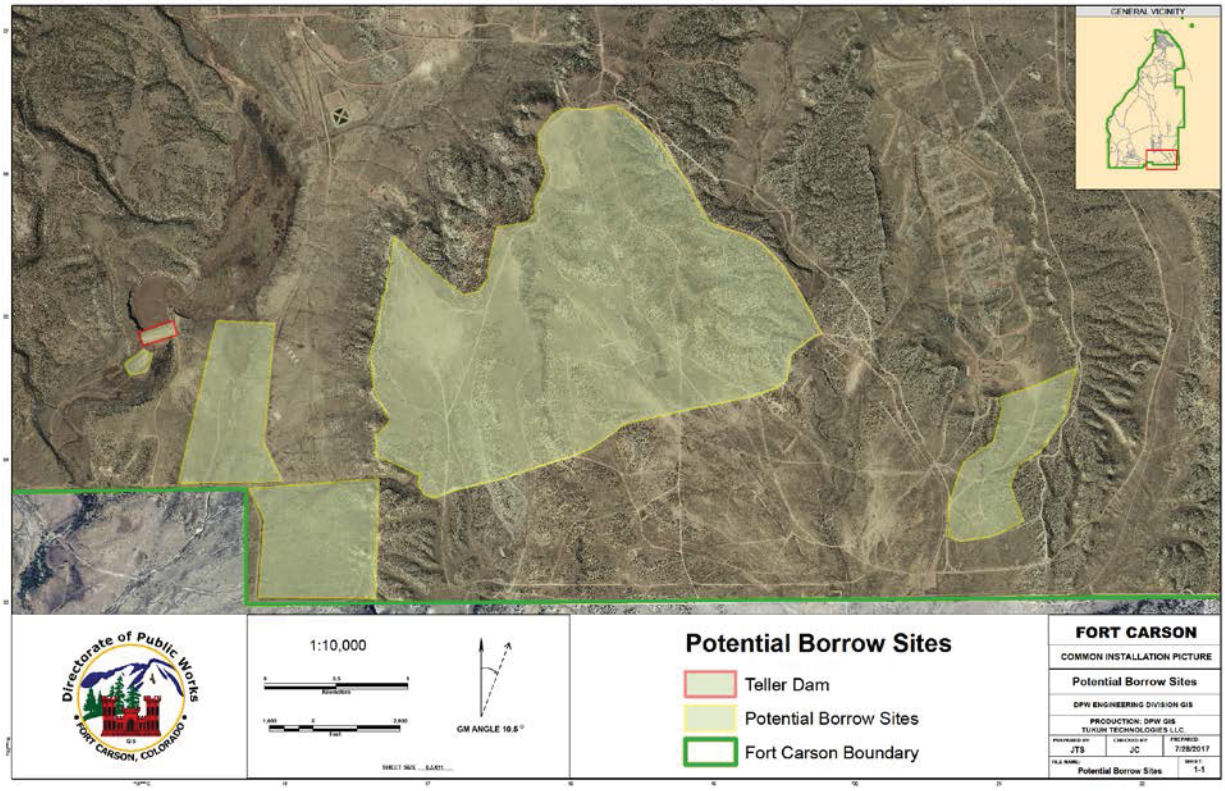

Figure 2.1 Potential Borrow Sites Near Teller Dam, Fort Carson, CO.

2.4 No Action Alternative

Consideration of the No Action Alternative is a requirement of the NEPA process. It provides a basis of comparison for the Proposed Action and also addresses issues of concern by avoiding or minimizing effects associated with the Proposed Action. Under this alternative there would be no repairs or modifications made to Teller Dam. This alternative would not address the high risk potential failure modes of internal erosion due to seepage, or overtopping. In the event of a dam failure, existing conditions could result in a loss of life downstream and large sediment discharges. The risk associated with no action results it in not being considered as a viable alternative. Fort Carson is compelled to take action to reduce the risk of failure. Therefore, this alternative will be considered in the environmental consequences analysis to provide a baseline for environmental conditions only.

2.5 Alternatives Eliminated from Further Consideration

The following potential courses of action were eliminated through the screening process.

Alternatives Eliminated

- Complete Removal of Embankment and Sediment
- Upstream Earthen Embankment to Redirect Turkey Creek into Spillway
- New Dam at or Near Existing Site & Modified or New Spillway
- Enlarging Outlet Works Capacity
- New Upstream Dam within Watershed

- New Fuse Plug Widening
- Spillway Lowering and Widening
- Abutment Treatment and Spillway Lowering and/or Widening
- Abutment Treatment and New Labyrinth Spillway
- Partial Lowering of Embankment and Overtopping Protection
- Embankment Lowering to Existing Sediment Level and Embankment Overtopping Protection

2.6 Valued Environmental Components (VECs) Not Addressed

Initial issue analyses resulted in the elimination of some potential issues because they were not of concern or were not relevant to the Proposed Action and alternatives. Brief discussions of the rationale for these decisions are below.

Environmental Justice

Neither the Proposed Action nor its alternatives would change any existing conditions with regard to minority and low-income populations.

Land Use

Neither the Proposed Action nor its alternatives would change existing land use. Lands affected by the Proposed Action on Fort Carson would continue to be used primarily for military training. Construction and excavation from the borrow sites would temporarily restrict access in the vicinity but upon completion and revegetation, those areas would be returned to their previous uses.

Air Space Use

Neither the Proposed Action nor its alternatives would change existing airspace use on Fort Carson.

Socioeconomics

There may be a slight beneficial economic impact resulting from the construction of the Proposed Action or alternative 2; however this would be short-term and temporary.

Solid and Hazardous Waste

Neither the Proposed Action nor its alternatives would create hazardous wastes or solid waste streams. Materials to be used in the repairs of the dam would adhere to industry standards.

Visual and Aesthetic Resources

Neither the Proposed Action nor alternatives would impact visual or aesthetic resources. In the short term, construction activities would be present, but the dam would remain as would the spillway.

Sustainability

The Proposed Action and alternative would not impact sustainability. By repairing the dam the wetlands and habitats that exist would continue to do so.

Utilities
Neither the Proposed Action nor alternatives would impact utilities as there is no requirement for external power, water, and/or fiber.

3.0 AFFECTED ENVIRONMENT, ENVIRONMENTAL CONSEQUENCES, AND MITIGATION

This section discloses potential environmental effects of each alternative and provides a basis for evaluating these effects in context relative to effects of other actions. Effects can be direct, indirect, or cumulative. Direct effects occur at the same place and time as the actions that cause them, while indirect effects may be geographically removed or delayed in time. Council on Environmental Quality (CEQ) guidance states that a cumulative impact is an effect on the environment that results from the incremental effect of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative effects can result from individually minor, but collectively significant, actions taking place locally or regionally over a period of time.

For the purposes of the cumulative impacts analysis, the Proposed Action Region of Influence (ROI) is defined to include Fort Carson and adjacent lands (including communities around the Installation). Appendix C lists the past, present, and reasonably foreseeable future Army actions (defined as those projects that are well-developed, in mature planning stages, and/or have funding secured), and other actions within the ROI, that were reviewed in conducting the cumulative effects analysis. Conceptual projects, broad goals, objectives, or ideas listed in planning documents that do not meet the above criteria are not considered reasonably foreseeable for the purposes of this analysis.

This EA focuses on resources and issues of concern in the following resource areas:
Environmental Health and Safety Risks for Children
Air Quality
Soils
Water Resources/Wetland Resources
Biological Resources (include Invasive species)
Cultural Resources
Transportation

Areas with no discernible concerns or known effects, as identified in the issue elimination process (Section 2.6, *Valued Environmental Components (VECs) Not Addressed*), are not included in this analysis.

For ease in comparing environmental effects with existing conditions and mitigation specific to each environmental area of concern, each below section will describe existing conditions, describe the effects of each alternative, identify any cumulative effects on that area of concern, and describe site-specific mitigation. A summary of environmental consequences and general mitigation is provided in Chapter 4.

Environmental impacts on each resource can vary in degree or magnitude from a slightly noticeable change to a total change in the environment. For the purpose of this analysis, the intensity of the impacts would be classified as negligible, minor, moderate, or major. The intensity thresholds are defined as follows:

- **Negligible:** A resource would not be affected or the effects would be at or below the level of detection, and changes would not result in any measurable or perceptible consequences.
- **Minor:** Effects on a resource would be detectable, although the effects would be localized, small, or of little consequence to the sustainability of the resources. Mitigation measures, if needed to offset adverse effects, would be simple and achievable.
- **Moderate:** Effects on a resource would be readily detectable, long-term, localized, and measurable. Mitigation measures, if needed to offset adverse effects, would be extensive and likely achievable.
- **Major:** Effects on a resource would be obvious, long-term, and would have substantial consequences on a regional scale. Extensive mitigation measures to offset the adverse effects would be required and success of the mitigation measures would not be guaranteed.

3.1 General Information – Location and Surrounding Land Uses

Fort Carson is located in central Colorado at the foot of the Rocky Mountains in El Paso, Fremont, and Pueblo counties, see figure 3.1. To the north is Colorado Springs, to the east is Interstate-25 and mixed development, to the south are privately-owned ranches, and to the west is State Highway 115. Downtown Colorado Springs and Denver lie approximately 8 miles and 75 miles, respectively, to the north, while the City of Pueblo is located approximately 35 miles south of the main post area.

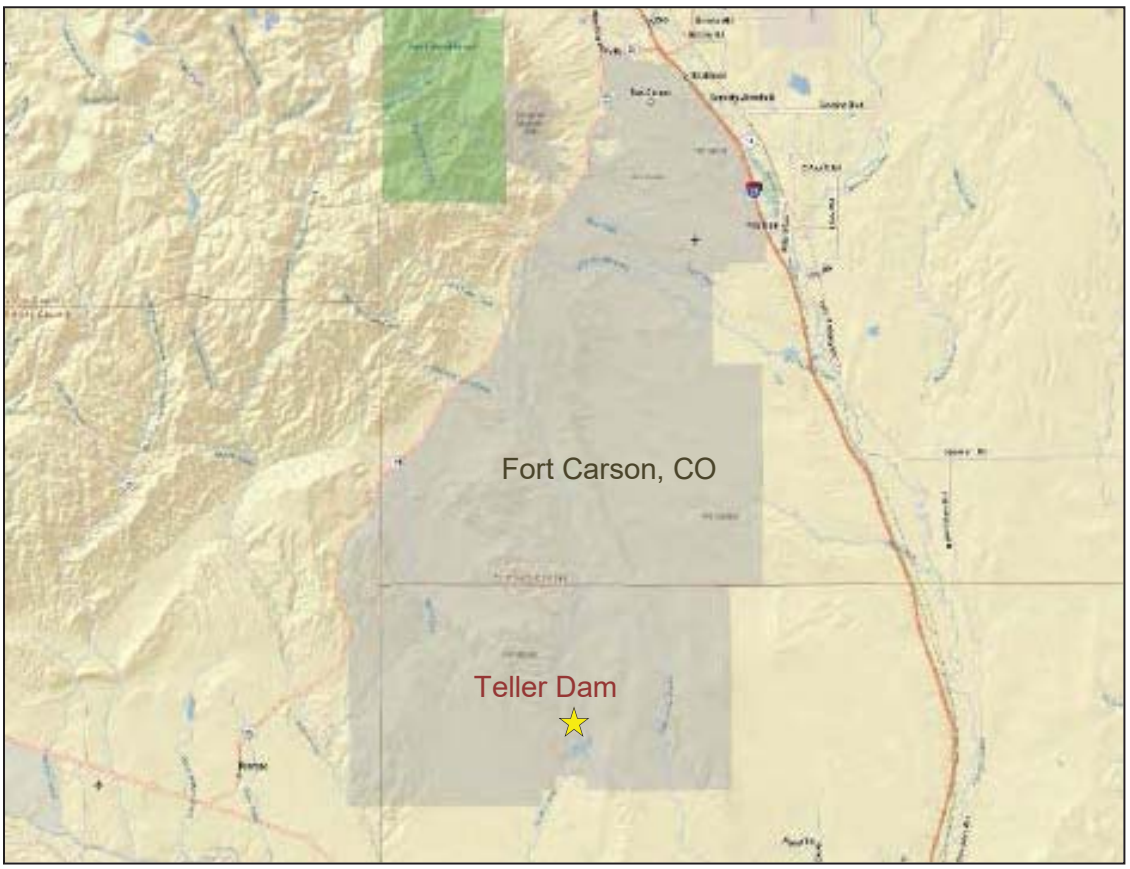

Figure 3.1 Teller Dam Location, Fort Carson CO

Fort Carson covers approximately 137,000 acres, and extends between 2 and 15 miles east to west and approximately 24 miles north to south. The main post area, which consists of developed land and a high density of urban uses, is located in the northern portion of the installation and covers approximately 6,000 acres. The downrange area, which is used for large caliber and small-arms live-fire individual and collective training; aircraft, UAS, wheeled and tracked vehicle maneuver operations; and mission readiness exercises, covers approximately 131,000 acres of unimproved or open lands.

Teller Dam was constructed by a private landowner in 1909 and formally acquired by the US Army on February 23, 1966 during expansion of Fort Carson. The dam is an earthen embankment originally constructed in 1909 with the intent to provide irrigation to the community downstream. The dam is about 85 feet high and 800 feet long. The dam is founded on shale rock in the river valley and lower portions of the abutment

with a small transition zone that appears to have some alluvial materials. Sandstone exists in the upper portions of the abutments to the ground surface. The crest width is 20 feet. The outlet works consist of a concrete conduit through the embankment with an intake tower located within the reservoir and a stilling basin downstream. An uncontrolled earthcut spillway is located about 1,800 feet east of the dam, with an approximately 25-foot-wide bottom and 6-foot-deep channel and a concrete sill approximately 250 feet downstream from the entrance to the spillway. The emergency spillway joins Turkey Creek approximately a mile and half downstream from the spillway entrance.

Over the course of its history, the reservoir has trapped a large volume of sediment behind the dam embankment, with an estimated maximum sediment depth of 55 feet. Downstream of the dam is a cultural site, several road crossings, and a residential area (Pueblo West). The dam is classified as large and high hazard due to the downstream population at risk (PAR) for both state and federal criteria.

Since acquiring the dam, Fort Carson, the USACE, and Colorado State Division of Water Resources has performed inspections. A variety of maintenance and construction projects have been carried out in attempts to keep the dam and outlet works operable. In 2013, the State of Colorado Dam Safety Branch conducted an inspection together with USACE Omaha when water was impounded and flow through the spillway occurred. During the inspection there was considerable seepage through the left and right abutments and a suspected sinkhole was observed on the upstream left abutment. In light of these observations, on April 22, 2014, the State ordered a no storage restriction. In 2014, a bridge to the intake tower was built to provide access to the gate controls from the dam crest, addressing a concern from earlier State of Colorado inspections.

3.1.1 Climate

The region including Fort Carson is classified as mid-latitude semi-arid, characterized by hot summers, cold winters, and relatively light rainfall. July is the warmest month with the average daily maximum temperature of 84.4° Fahrenheit, and January is the coldest with an average daily minimum temperature of 14.5° Fahrenheit.

Mean annual precipitation at Fort Carson increases toward the northwest. Colorado Springs averages 17.5 inches of precipitation annually, with about 80 percent falling between April and September. Average annual snowfall in the region is 42.4 inches. Snow and sleet usually occur from September to May with the heaviest snowfall in March and possible trace accumulations as late as June.

3.2 Environmental Health and Safety Risks for Children

3.2.1 Existing Conditions

The environmental health and safety risks associated with Teller Dam are a driving force for the Proposed Action. The existing condition is an elevated level of risk due to the deficiencies noted above. Attempts to mitigate the structural and design deficiencies over the years have not completely alleviated the problems, which led to

the zero storage order. A risk assessment and potential failure modes analysis study was completed in 2016 (AECOM 2016). It documents a variety of possible failures and studies the impacts to the downstream community and is incorporated by reference into this analysis.

3.2.2 Environmental Consequences

3.2.2.1 Proposed Action Alternative 1 (Dam Raise)

The Proposed Action would fully address the structural and hydraulic capacity deficiencies. By raising the height of the dam, the IDF would not overtop and potentially erode the dam causing failure. Additionally the seepage would be addressed, which reduces the likelihood for dam failure as a result of material transport through the dam. By maintaining the dam and addressing the deficiencies, the flood plain associated with the Proposed Action would be almost identical to current conditions. See appendix F for flood plains associated with each alternative during a 10 year, 100 year, and the probably maximum flood (PMF) event.

Establishing borrow sites and performing the repairs on the dam would have no impact to environmental health and safety risks for children. Access to downrange areas on Fort Carson is controlled. The integrity of the embankment would not be compromised during the construction process

Impacts to environmental health and safety risks for children as a result of the Proposed Action would be beneficial.

3.2.2.2 Alternative 2 (Overtopping Protection)

Flood plains for Alternative 2 are identical to existing conditions and therefore indicate no increase in risks to downstream communities. The potential impacts as a result of this alternative would be positive. By eliminating the identified deficiencies, the potential failure of Teller Dam would be greatly reduced, with impacts similar to the Proposed Action Alternative 1.

Large scale construction, opening borrow pits, and other activities associated with this alternative would occur in controlled environments with little to no access by personnel not directly involved in the project. Impacts to environmental health and safety would be negligible.

3.2.2.3 No Action Alternative

Risks to health and safety would remain if the identified deficiencies are not addressed. The negative impacts to risk levels associated with the no action alternative eliminates it from further consideration. The elimination of alternatives that do not reduce the risk to health and safety was discussed in section 2.0.

3.2.3 Cumulative Impacts

Contributions to cumulative impacts by either the Proposed Action or Alternative 2 would be positive. In its current condition, Teller Dam presents risks to the downstream drainage area. By choosing and implementing the Proposed Action or

Alternative 1, those risks would be reduced, eliminating contributions to cumulative impacts to the region.

3.2.4 Site-specific Mitigation

During repair work the embankment would not be disturbed in a manner that would reduce flood protection or increase risks to downstream residents. Therefore, no mitigation is necessary.

3.3 Air Quality

3.3.1 Existing Conditions

Fort Carson is within the air quality control areas of El Paso, Fremont, and Pueblo counties, including the City of Colorado Springs. Both Fremont and Pueblo counties are in attainment for all criteria pollutants. The Colorado Springs Urbanized Area in El Paso County is in attainment (meeting air quality standards) for all National Ambient Air Quality Standards (NAAQS) criteria pollutants. However, it was classified as a maintenance area for carbon monoxide (CO) in 1999 due to a 1988 violation of the 8-hour CO standard. This CO maintenance area includes the majority of Fort Carson's main post area (north of Titus Boulevard and Specker Avenue. This designation is currently set to run through 2019 (CDPHE, 2009).

Fort Carson stationary and fugitive emission sources, in general, include boilers, high temperature hot water generators, furnaces/space heaters, emergency generators, paint spray booths, fuel storage and use operations, facility-wide chemical use, road dust, military munitions, and smokes/obscurants. Fort Carson's air pollutant emissions generation occurs through the combustion of fossil fuels via equipment such as boilers (a stationary source) and motorized vehicles (a mobile source). Combustion products mainly include Green House Gases (GHGs), predominantly carbon dioxide (CO2); CO; nitrogen oxide (NOx); sulfur dioxide (SO2); and particulate matter (PM), both as inhalable coarse particles (PM10) and fine particles (PM2.5), which is PM whose diameter is less than or equal to 10 and 2.5 micrometers (μm), respectively. Road dust is predominantly a source of PM10.

The Installation manages its air emissions per regulatory requirements, management plans, and Best Management Practices (BMPs) for Fort Carson and PCMS. Key among these is its Clean Air Act (CAA) Title V operating permit (No. 95OPEP110). Fort Carson's BMPs include the Fugitive Dust Control Plan (Fort Carson, 2015), Integrated Wildland Fire Management Plan (Fort Carson, 2011), Title V Paint Booth Operating Standards, and Ozone Depleting Compound Management Plan. BMPs support the Installation in ensuring environmental compliance, stewardship, and sustainability.

The EPA has defined three types of GHG emission sources. They are defined as the following:

- Scope 1 – GHG emissions emitted directly from the facility by stationary, fuel burning sources.

- Scope 2 – GHG emissions emitted indirectly from the facility. This includes the purchase of electricity, heat or steam from a utility.
- Scope 3 – GHG emissions not controlled directly by the facility. This includes employee commuting emissions, wastewater treatment, and solid waste disposal.

The Installation's predominant stationary Scope 1 GHG emission sources are on-post boilers at Fort Carson. Scope 2 includes emissions from utilities in providing power to Fort Carson and PCMS.

The Installation reports GHG emissions from Fort Carson and PCMS, as required, on an annual basis per 40 CFR 98 Subpart C. In 2015, the Army estimated these emissions (Scope 1) to be about 60,000 metric tons CO2 equivalent per year.

Fugitive dust, which is a concern with any major construction project, is managed according to the fugitive dust management plan. Fort Carson periodically applies dust suppressants to high traffic areas downrange.

3.3.2 Environmental Consequences

3.3.2.1 Proposed Action Alternative 1 (Dam Raise)

The Proposed Action would not change regional air quality conditions. The impacts on air quality and GHG from the implementation of the Proposed Action due to construction and/or repair activities would be temporary and minor.

Construction would have short-term adverse impacts on air quality due to increases in fugitive dust (i.e., airborne dust caused by vehicles, equipment, and wind) and vehicle emissions caused by the operation of heavy equipment and fugitive dust. Once the excavation of materials, repairs, and improvements are made and the area is revegetated, there would be no long-term adverse impacts on air quality.

By sourcing material from the immediate vicinity, fugitive emissions from vehicle traffic would be reduced.

Estimated emissions from the construction and operations under the Proposed Action are expected to be below the threshold for prevention of significant deterioration (PSD), and not expected to require changes in air permits for existing stationary emission sources. The specific design and construction activities would undergo an air quality analysis. The Proposed Action doesn't include any permanent air emissions sources. Additionally, this project is outside of the CO maintenance area, and is not expected to emit CO emissions above the Air Pollutant Emission Notice (APEN) threshold.

3.3.2.2 Alternative 2 (Overtopping Protection)

Alternative 2 would not change regional air quality conditions in the long term. Construction activities and earthwork would lead to short term minor fugitive dust concerns, as with the preferred alternative. By hardening the dam with concrete or similar material, earthwork would be reduced, resulting in less particulate emissions.

The opening of a borrow pit and establishment of a temporary concrete batch plant has the potential to create fugitive dust.

If concrete blocks or other materials are produced offsite, the addition of heavy vehicle traffic could increase fugitive dust emissions. The work would require a state issued permit, emissions would be monitored and would be guided by the Fort Carson Fugitive Dust Management Plan.

3.3.2.3 No Action Alternative

Under the No Action Alternative there would be no change to air quality.

3.3.3 Cumulative Effects

Environmental effects from past and current Army actions, when added to the anticipated environmental effects of the Proposed Action, would not result in any significant long-term effects to air quality because operations are within construction permit and fugitive dust permit requirements. These requirements are designed to ensure that emissions do not significantly affect air quality. Therefore, there would be no significant cumulative effect from the combined environmental effects of the Proposed Action and those of past, present and reasonable foreseeable future actions. Temporary increases in air pollution would occur from the use of construction equipment (combustion emissions) and the disturbance of soils (fugitive dust) during construction. Mitigation measures such as the application of magnesium chloride and standard best management practices would prevent emissions from reaching significant levels in the short term.

Under the No Action Alternative, future actions, to include emergency actions, could be required. That action would likely result in a similar level of fugitive dust and heavy equipment operation as with the other alternatives, however, in an emergency, mitigations may not be feasible due to time constraints.

3.3.4 Site-specific Mitigation

The contractor and Omaha District, USACE would submit any required construction and/or land development construction permit applications. Applications would include a fugitive dust control plan and would include all land disturbance associated with this project. Furthermore, the Air Program Manager would review all design and construction documents to ensure that thresholds are not exceeded. Short-term air quality degradation would occur during the construction phase but would be mitigated by a variety of fugitive dust control measures. During periods of high vehicle traffic, water trucks or Magnesium chloride applications could be used to ensure compliance with applicable regulations.

3.4 Soils

3.4.1 Existing Conditions

3.4.1.1 Teller Dam area

The Areas of Potential Effect (APE) for the Proposed Action include the portions of Turkey Creek directly up and downstream of the Teller dam embankment and the

associated spillway. It also includes a large area from which borrow materials would potentially be sourced.

The soil compositions and soil descriptions of the general area were collected from the Natural Resources Conservation Service (NRCS), U.S. Department of Agriculture (USDA) (NRCS 2015) and is available in appendix D

The area is generally comprised of sand, silt, and clay. Of the 20 soil types identified by the custom soil resource report, Penrose-Rock, Penrose-Minnequa, and Manvel silt loam accounts for approximately 60 percent of the area identified. The erosion hazard identified for the area is moderate.

A detailed study of the existing geology of the area of interest was included in the 2006-2007 survey of rare plants on Fort Carson. Excerpts from this document are included in Appendix E.

3.4.2 Environmental Consequences

3.4.2.1 Proposed action Alternative 1 (Dam Raise)

The construction disturbance would impact the soils in multiple locations.

Making repairs to the dam would include excavation and placement of additional materials on the north side of the dam. To increase the height, collection and transport of materials from either the general vicinity and/or off post would be required. Excavation would result it sediment discharge concerns during rain events. Collection of soils from borrow sites and placement of materials on the dam would result in soil disturbance.

Overall, the effects of construction/repair on soils under the Proposed Action would be moderate. Operation of the dam under the Proposed Action would have negligible impacts to soils once the embankment and borrow site are stabilized.

By implementing the Proposed Action seepage and erosion of the embankment would be addressed, reducing large scale erosion and dam failure.

3.4.2.1 Alternative 2 (Overtopping Protection)

Repairing the structural deficiencies would result in the same short term soil disturbances as in the preferred alternative.

Armoring the dam would involve less land disturbance and material usage when compared to building up the embankment. Construction of the concrete overtopping protection would result in short term disturbance. Impacts to soils as a result of this alternative would be minor and short term.

3.4.2.3 No Action Alternative

Under the No action alternative, there would be no change to existing soil conditions, and soil disturbance would not occur unless an emergency action was required.

3.4.3 Cumulative Effects

Cumulative, long term effects on soils resulting in sedimentation and/or fugitive dust, could be potentially significant if left unrepaired, however, Fort Carson policy is to eliminate or minimize the degradation of all water resources on Fort Carson and ensure compliance with all applicable federal, state and local quality standards. Any impacts from the Proposed Action would be mitigated by use of BMPs to catch potential sediment, such as reestablishing the area by reseeding, use of silt fences, rock check dams, rock-lined ditches, and other rehabilitation efforts. It is expected that, with monitoring and employment of standard BMPs, cumulative effects would not be significant. By repairing the dam and greatly reducing the potential for erosion of the embankment during large rain events, the potential for negative impacts to existing soil conditions would be reduced.

3.4.4 Site-specific Mitigation

Careful choice of borrow pit sites and periodic visual monitoring for erosion in accordance with a required Stormwater Pollution Prevention Plan (SWPPP). Building or re-building the earthen berms using material removed from existing dams or other areas requiring excess sediment removal. Install/construct rock-lined ditches, rock check dams in series, hardened crossings, etc. as needed to control any sediment production that might occur along roads and trails.
Standard BMPs would be required during excavation and for a period of time afterwards during revegetation.

As materials are gathered, borrow sites would be chosen and designed in a manner than prevents degradation of the areas. An example of an activity that would be avoided would be excavation on a steep slope or in a natural channel, or where soil depth is minimal and would lead to an inability to reclaim the area.
During the construction process BMPs would be required to ensure materials do not enter Turkey Creek. Stabilization of the Dam would be accomplished once construction is completed.

3.5 Water Resources

3.5.1 Existing Conditions

Fort Carson policy is to eliminate or minimize the degradation of all water resources on Fort Carson and ensure compliance with all applicable federal, state and local water quality standards (Fort Carson Regulation 200-1). Water resources are managed in coordination with U.S. Geological Survey (USGS), NRCS, U.S. Fish and Wildlife Service (USFWS), and many other external agencies. The *Water Resources Management Program* on Fort Carson includes watershed/sedimentation monitoring and management and project reviews to address erosion and sediment control issues. In addition, the *Stormwater Management Plan* (Fort Carson 2016) is designed to reduce the discharge of pollutants from Fort Carson to drainage ways, to protect water quality, and to satisfy Colorado's water quality standards.

3.5.1.1 Surface Water and Watersheds

The primarily undeveloped southern and western portions of Fort Carson drain into the Arkansas River to the south. The highly developed and industrialized portion of Fort Carson (the main post area) consists of four tributaries within the Fountain Creek watershed that provide local surface drainage: B Ditch, Clover Ditch, Infantry Creek (formerly known as Central Unnamed Ditch), and Rock Creek. The constituent of concern in Fort Carson's portion of the Fountain Creek watershed is *E. coli* (5 Code of Colorado Regulation [CCR] 1002-93, Colorado Regulation #93). Fountain Creek also ultimately discharges to the Arkansas River. The main document that currently guides surface water and watershed management at Fort Carson is the Fort Carson Stormwater Management Plan (SWMP) (Fort Carson, 2016). This SWMP is designed to reduce the discharge of pollutants from Fort Carson to the maximum extent practicable and to protect water quality.

Teller Dam is within the Turkey Creek Watershed, which flows to the Arkansas River. Turkey Creek is not listed on the 303(d) list of impaired waterways in the State of Colorado.

3.5.1.2 Hydrogeology and Groundwater

Groundwater at Fort Carson exists in both alluvial and bedrock aquifers. The primary aquifer at Fort Carson is the Dakota-Purgatoire bedrock aquifer. In general, the quality of the groundwater on Fort Carson is good with the exception of localized areas of high dissolved solids and sulfates exceeding secondary drinking water standards and elevated nitrates and Selenium (Se) exceeding primary drinking water standards.

A site wide Se study looking at the occurrence and distribution of Se in groundwater at Fort Carson was conducted in August 2011 (Summit Technical Resources, 2011), with results coordinated with and concurred on by the CDPHE (CDPHE, 2011). Se has been detected at concentrations greater than the Colorado Ground Water Standard (0.05 milligrams per liter [mg/L] (0.05 parts per million [ppm])) and the Fort Carson background concentration (0.27 mg/L [0.27 ppm]) in samples collected from groundwater monitoring wells located primarily within Fort Carson's main post area. Analysis of qualitative and quantitative data from this study indicates a naturally occurring source (Pierre Shale) for relatively high Se concentrations in Fort Carson's compliance monitoring wells (Summit Technical Resources, 2011).

Teller Dam is south of an off-limits area known as the old Battalion Field Training Area (BFTA) which may have been exposed (inconclusive) to artillery spotter rounds containing depleted Uranium (DU). The former BFTA is located within the Fountain Creek Watershed but although the turkey creek watershed was not suspect for exposure, samples were collected from four different areas based on watershed and the possibility of migration due to surface water run-off during heavy rain events. The results of all samples taken were negative for DU.

3.5.1.3 Floodplains

EO 11988, *Floodplain Management*, as amended in 2015 requires federal agencies to avoid, to the extent possible, the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative and to use natural systems, ecosystem processes, and nature-based approaches when developing alternatives for consideration. To accomplish this objective, the Army is required to take actions to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains for certain federal actions. The acquisition, management, and disposal of federal lands and facilities are specific qualifying federal actions addressed within the EO. Subsequently, the EO requires the application of accepted flood-proofing and other flood protection measures for new construction of structures or facilities within a floodplain. Agencies are required to achieve flood protection, wherever practicable, through elevation of structures above the elevation of the floodplain rather than filling in land.

3.5.2 Environmental Consequences

3.5.2.1 Proposed Action Alternative 1 (Dam Raise)

Turkey Creek, which is a US jurisdictional water, has the potential to be impacted during the construction/repair of the Dam due to sediment transport. However, construction and operation of the Proposed Action must meet the regulatory requirements of the Clean Water Act (CWA) Section 404 for wetlands and Section 402 under the National Pollutant Discharge Elimination System (NPDES) as it applies to Fort Carson's Municipal Separate Storm Sewer System (MS4), the Multi-Sector General Permit (MSGP) for Industrial Discharges, and the Construction General Permit (CGP); therefore impacts would be minimized in order to remain in compliance.

In reference to floodplains, by repairing the dam, flood protection would be maintained for residents downstream. Increasing the height of the dam would not have an impact on the function of the dam in all but the most extreme rain events, and even then the water retained by the dam would only be in contact with the raised portion for a short period as the spillway accepts the excess water.

Removing and using materials from locations identified in figure 2.1 would have the potential for short term erosion. The existing spillway was identified as a potential area to borrow materials. Being within a waterway, the potential for soil being transported downstream exists. Other borrow areas would be less likely to contribute to sediment entering a waterway. The potential for erosion would be increased during the construction process, but would be minor and short term.

The Impacts as a result of the Proposed Action has the potential to have short term minor impacts. In the long term, negative impacts on water resources in the area would be reduced repairing the seepage and raising the dam. Long term impacts to water resources would be positive as a result of implementing the Proposed Action.

3.5.2.2 Alternative 2 (Overtopping Protection)

Repairing the dam and providing overtopping protection would result in the dam operating in the same manner as it has historically. The addition of concrete would provide some additional flood protection and protect the dam from failing in an overtopping event. Flood plains would be unchanged. Disturbance related to excavation would have minor impacts to water resources.

Impacts to water resources by employing a concrete batch plant would be negligible. In the long term, this alternative would have beneficial impacts to water resources.

3.5.2.3 No Action

Under the No Action Alternative, there would be no change from current conditions.

3.5.3 Cumulative Effects

Considering past, present and reasonably foreseeable future activities, implementation of the Proposed Action or Alternative 2 would have beneficial impacts to water resources due to prevention of dam deterioration and/or failure. Under the No Action alternative, the condition of the dam would continue to deteriorate and the dam could fail. This would change the flood plains and drastically alter the hydrology of Turkey Creek. The repair of Teller Dam would serve to maintain the status quo and have little to no contribution to cumulative impacts in the area by preventing a catastrophic event that would impact water quality and flood plains for an extended period of time.

3.5.4 Site-specific Mitigation

Design should take into account heavy rainfall and/or flooding patterns to avoid impacting water quality. Additionally, the operation of a large borrow site will require stormwater management to prevent impacts to water quality from erosion, sedimentation, and other potentially pollutant producing activities. A SWPPP must be developed in accordance with the Fort Carson SWMP and submitted to the Fort Carson Stormwater Program for review and approval prior to filing a Notice of Intent (NOI) with the U.S. Environmental Protection Agency (USEPA) for coverage under the Construction General Permit (CGP). Per the CGP permit requirements, all disturbed areas must be stabilized (i.e. landscaping, seed, gravel, etc.) to achieve a stabilization rate of 70 percent of the preexisting condition prior to project completion. Reseeding must only be conducted with Fort Carson approved methods and seed mixes. The Fort Carson Stormwater Program must inspect the construction site and approve the Notice of Termination (NOT) prior to the submittal of the NOT to the USEPA. Extensive BMPs would be required to protect against soil being transported downstream.

3.6 Biological Resources

3.6.1 Existing Conditions

Additional information regarding flora and fauna on Fort Carson is in *Fort Carson's Integrated Natural Resource Management Plan* (INRMP) (Fort Carson 2013). Unless stated otherwise, below information is from those sources.

3.6.2 Vegetation

The *Fort Carson* INRMP contains detailed descriptions of the vegetative communities on Fort Carson and a listing of common and scientific names of plant species known to occur. Integrated Pest Management is used to manage invasive plant populations, such as the exotic invasive tamarisk (*Tamarix ramosissima*), as mandated by DoD. Integrated Pest Management includes biological, chemical, mechanical, and cultural management techniques. As reported in the 2011 *CAB Stationing PEIS*, the main post area and Butts Army Airfield (BAAF) consist primarily of non-native ornamentals and large trees. Within flight pattern zones of BAAF, non-native ornamentals and large trees are removed for aircraft operational needs and to reduce the occurrence of bird air strike hazard (BASH). The Wilderness Road Complex area, with vegetation considered to be in fair condition, consists primarily of a mix of disturbed land, western wheatgrass/blue grama, small soapweed/blue grama, and big bluestem/little bluestem. Further details on vegetation, including noxious weeds, are available in the 2009 *Fort Carson Grow the Army FEIS* (Fort Carson, 2009).

The Teller dam vicinity consists mainly of grasses (Needle and Thread/New Mexico feathergrass) and Four-winged saltbush. There are little to no trees within the area.

There are four plant species on Fort Carson that are former federal Endangered Species Act (ESA) candidate species and are currently on the Army Species at Risk (SAR) list. The plant species Arkansas river feverfew (*Bolophyta tetraneuris*), golden blazing star (*Mentzelia chrysantha*), round leaf four o'clock (*Oxybaphus rotundifolius*), and dwarf milkweed (*Asclepius uncialis*) are localized endemics to the Shale "barrens". Fort Carson biologists, in cooperation with the Colorado Natural Heritage, surveyed for the species on Fort Carson, and determined these species were widely distributed on the installation with many areas not likely to be impacted by maneuvers. Fort Carson has over 40% of the States known population for Arkansas feverfew and Round leaf four o'clock. (Neid 2007)

3.6.3 Wildlife, including Threatened and Endangered (T and E) Species

Federally Listed Species

The Endangered Species Act defines an endangered species as any species in danger of extinction throughout all or a major portion of its range. A threatened species is one that is likely to become endangered in the foreseeable future. Candidate species are those for which the USFWS has sufficient information on their biological status and threats to propose them as endangered or threatened, but listing is precluded by other higher priority species. Table 3.5-3 presents federally-listed endangered, threatened, and candidate species found on Fort Carson. No critical habitat for these species has been designated on Fort Carson.

Species	Scientific Name	Species Type	Status	Distribution on Fort Carson
Mexican spotted owl	*Strix occidentalis*	Bird	Threatened	Rare winter resident

Black-footed ferret	*Mustela nigripes*	Mammal	Endangered	Migrated onto Fort Carson from reintroduction area

Table 3.1 Federally-Listed Endangered, Threatened, and Candidate Species Known to occur at Fort Carson.
Source: Fort Carson, 2013

Mexican Spotted Owl –Threatened Species
The Mexican Spotted Owl occasionally winters in rugged forested canyons west of Fort Carson. It is a rare winter resident on Fort Carson and known to have occurred only on and adjacent to Booth Mountain. It is not known if the species is present annually. A radio tagged owl present on Fort Carson in the winter of 1995-1996 did not return in subsequent years. The species is not suspected of breeding on Fort Carson.

Black-footed ferret – Endangered Species
The Black-footed ferret was reintroduced on adjacent private landowner property in October of 2013. Fort Carson obtained a Programmatic Safe Harbor Agreement as well as the associated Biological Opinion, from the USFWS, to ensure no land use restrictions would occur as result of the ferret reintroduction action. Ferrets have been observed to the south west of Teller dam in the vicinity of the Turkey Creek drainage at the southern boundary of Fort Carson

There are several species that are Federal Candidates, Federal Birds of Conservation Concern, State threatened, endangered, or Species of Special Concern, and Army SAR species that may occur on Fort Carson. An exhaustive list and detailed accounts of all species that occur on Fort Carson can be found in the INRMP (Fort Carson, 2013). Those species that could occur in the proposed project site are discussed in the following paragraphs.

Black-tailed Prairie Dog
The black-tailed prairie dog, a former candidate for federal listing, is common on Fort Carson, but numbers are decreasing. In 2009, there were 65 colonies totaling 6,513 acres and in 2013, 77 colonies were mapped, totaling 2,702 acres. It is listed as a Species of Special Concern in Colorado by the Colorado Parks and Wildlife (CPW) and the Colorado Natural Heritage Program (CNHP). Frequently referred to as a keystone species of the shortgrass prairie ecosystem, the prairie dog plays a significant role in life cycles of several Species of Special Concern on Fort Carson: the ferruginous hawk, bald and golden eagles, mountain plover, and the state-listed burrowing owl. Prairie dogs are managed on Fort Carson according to prescriptions detailed in the installation's management plan for the black-tailed prairie dog. The plan balances conservation with human health and property loss and details circumstances for lethal control of the species on Fort Carson.

Colorado Checkered Whiptail

The Colorado checkered whiptail species is only found in areas of southeastern Colorado (Walker *et. al.* 1997) and was evaluated by the USFWS for listing as a Candidate species under ESA. In July 2015 the USFWS determined that the whiptail species petition did not provide substantial scientific or commercial information indicating that the petitioned action be warranted, but there is a high probability of being re-petitioned in the near future. It is currently listed by CPW and USFWS as a species of special concern and by the Army as a SAR species. The Colorado checkered whiptail habitat occurs in valleys, arroyos (dry creeks), canyons, and on hillsides, in areas dominated by plains grassland or juniper woodland, including areas such as parks with frequent human use and habitat disturbance (Walker et. al. 1997). Little is known about the whiptail on Fort Carson, except occurrence has been documented. Approximately 77,000 acres, including the Teller Dam area, of Fort Carson is considered to be a potential habitat for the species. Colorado checkered whiptails have been observed in the vicinity of Teller Dam.

Birds *(Birds of Conservation Concern, State threatened, endangered, or Species of Special Concern)* on Fort Carson have the potential for impacts during nesting season, which for most bird species on Fort Carson occurs 15 April-15 September.

Mountain Plover
The mountain plover is listed as a Species of Special Concern by the USFWS. Mountain plovers are rare on Fort Carson, and only a small percent of available habitat is occupied; Surveys for this species are conducted annually and it is not known to occur in or near the project area.

Burrowing Owl
The burrowing owl is listed as state threatened by CPW. The burrowing owl is a small, burrow-dwelling owl nesting underground in unoccupied prairie dog burrows. The burrowing owl is not abundant on Fort Carson and the number of prairie dog colonies annually occupied by this species is low (Fort Carson, 2013). Although sylvatic plague does not directly influence nesting burrowing owls, they generally do not nest in colonies where all prairie dogs have been killed by plague. Prairie dog colonies

Golden Eagle
Bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (BGEPA) of 1940. There are two known Golden Eagle eyries in the vicinity of teller dam. The Teller reservoir golden eagle nest/eyrie is located on a high south-facing cliff, which faces Teller dam and Teller Reservoir and is located approximately 0.30 miles from the center point of the crest of the Teller dam. From 1995 to 2017, the Teller reservoir eagle nest has been active every year, with the exception of two years. Another golden eagle nest is located to the east of Teller reservoir and has not been active in the last 10 years, since monitoring and recording of active nests on Fort Carson became routine. In Colorado, golden eagles nesting period usually occurs 1 January-21 August.

Other Birds of Conservation Concern
Great horned owl nesting period usually occurs from 1 December-31 September and red-tailed hawks occurs 15 March-15 August.

3.6.4 Wetlands
Wetlands and activities within them are regulated by Section 404 of the CWA administered by the USACE. There are jurisdictional wetlands within the area of interest of the Proposed Action, The inundation basin and sub irrigated saturation area within and above the Ordinary High Water Mark (OHWM), not including the normal circular pool basin in front of the dam, is a jurisdictional wetland area. It is 105 acres. The area described is between lat/long readings of 38 degrees 27'31.16" N 104 degrees 49'18.75" W at the northern extent, and 38 degrees 26'21.65" N 104 degrees 49'14.45" W at the southern extent (at the emergency spillway crest). The wetland vegetation varies over time, but consists mainly of willows, cottonwood, tamarisk, Russian olive, cattails, rushes and wetland grasses.

3.6.5 Environmental Consequences
3.6.5.1 Proposed Action: Alternative 1 (Dam Raise)
Vegetation
Invasive noxious weeds of several species have been noted in the drainage, mostly in the riparian edges of the Turkey Creek drainage and associated valley bottom. There is the potential for noxious weed spread when disturbed. The dam embankment in its entirety would be disturbed during the repair process which would provide an opportunity for invasive species to spread. Land disturbance at borrow pits would also increase the likelihood of the proliferation of invasive species. Impacts are expected to be minor.

Wildlife
Black-tailed prairie dog colonies have been mapped (figure 3.2) and are periodically monitored. Colonies occur within and adjacent to the potential borrow sites. Approximately 33 acres of a 170.5 acre colony could be disturbed if material is obtained directly east of the spillway. Two of Three additional prairie dog towns are located within the largest polygon in figure 2.1. In 2015 those two measured 76.23 and 5.72 acres. A third town consists of approximately 36 acres, of which 11.acres is included in the potential borrow sites.

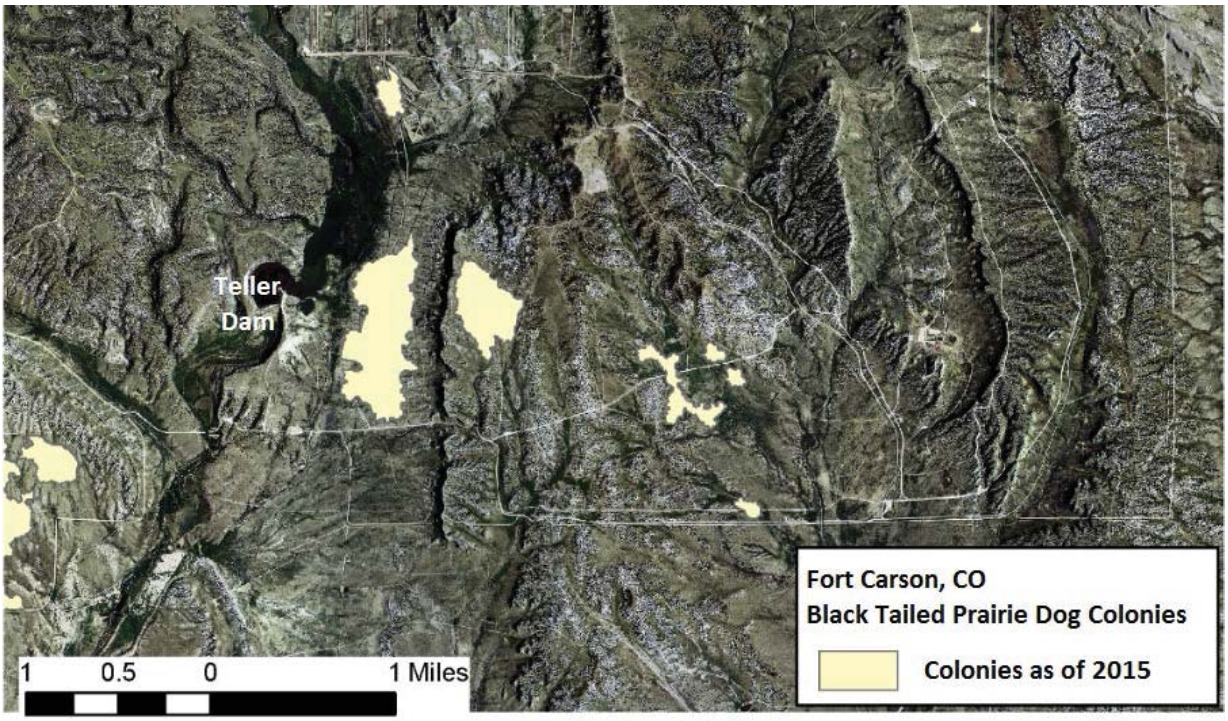

Figure 3.2 Existing Black Tailed Prairie Dog Colonies near Teller Dam, Fort Carson, CO.

Colorado Checkered Whiptail
Potential Colorado checkered whiptail habitat could be impacted by the excavation and repair activities. The overall acreage to be disturbed is less than 50 acres and therefore represents a very small percentage of the overall available habitat, therefore impacts are expected to be negligible.

Birds (Birds of Conservation Concern, State threatened, endangered, or Species of Special Concern)
Mountain plover and burrowing owl habitat is unlikely to be impacted during excavation and repair activities,
Birds, including grassland nesting birds protected under the MBTA and listed as USFWS Species of Special Concern may occur in the construction area. Nesting birds protected under the MBTA, especially ground-nesting birds in grassland habitat could be impacted during construction and within the borrow sites.

Golden Eagle
The golden eagle nest directly south of the embankment could be impacted by the construction and repair activities.

Fort Carson has been in consultation with USFWS on the potential impacts to the Teller Reservoir eagle eyrie during repair activities. The Teller Reservoir eagles have been monitored frequently since 2007. The Teller Reservoir eagles appear to have a high tolerance for disturbance activities. Should a prolonged disturbance occur within the line-of-site of the nest during multiple nesting seasons there is a potential the

eagles could abandon Teller reservoir eyrie. Fort Carson has obtained an incidental eagle take permit that would include this scenario, if unavoidable. Potential mitigations would be to schedule the work to avoid loud or disturbing work, as much as possible, the nesting season. Fort Carson wildlife specialists will monitor progress and make recommendations throughout the construction process

Wetlands
Short term minor impacts to wetlands could occur due to construction and repair activities. However, Fort Carson must comply with the CWA and Section 404, so any potential impacts would be minimal and/or mitigated.

3.6.5.2 Alternative 2, (Overtopping Protection)
Vegetation
Concrete or concrete blocks would reduce the amount of vegetation on dam embankment, as with any disturbance, invasive species may proliferate but it is expected that the construction and repairs would have insignificant impacts to the existing ecosystem. Impacts to vegetation at borrow sites would be short term and minor.

Wildlife
Impacts would be reduced if borrow site usage is decreased. Consultation with US Fish and Wildlife would still be required to address the golden eagle nest to the south of the embankment. Regardless of the specific repair action, any work undertaken within the line of sight of the nest would increase the risk of negative impacts. Based on frequent monitoring, the Teller Reservoir eagles appear to have a high tolerance for disturbance activities.

Colorado checkered whiptail potential habitat would be impacted similarly to the preferred alternative.

This alternative would have negligible impacts on mountain plover, burrowing owl, and prairie dog.

Wetlands
By repairing the seepage and armoring the embankment, large scale construction would be performed directly in the Turkey Creek drainage. Short term impacts to those wetlands would be expected. The end result would be the protection of those wetlands through the maintenance of the dam.

3.6.5.3 No Action
Vegetation
Under the No Action Alternative, there would be no change to vegetation.

Wildlife
Under the No Action Alternative, there would be no change to wildlife.

Wetlands
Under the No Action Alternative, there would be no change to wetlands.

3.6.6 Cumulative Effects

Vegetation
Cumulative impacts are expected to be negligible. Using materials from local borrow pits may lead to the spread of already existing invasive species. The fact that the surrounding area is used somewhat frequently for military maneuver training, the addition of this repair project is unlikely, in combination with other actions, to create significant impacts to vegetation.

Wildlife
Fort Carson has been in consultation with USFWS on the potential impacts to the Teller Reservoir eagle eyrie during repair activities. The Teller Reservoir eagles have been monitored frequently since 2007. The Teller Reservoir eagles appear to have a high tolerance for disturbance activities. Should prolonged disturbance occur within the line-of-site of the nest during multiple nesting seasons there is a potential the eagles could abandon Teller reservoir eyrie. Fort Carson has obtained an incidental eagle take permit that would include this scenario, if unavoidable. Fort Carson wildlife specialists will monitor progress and make recommendations throughout the construction process

If burrowing owls are found in any of the borrow sites, cumulative impacts could occur but are not expected because, according to records, owls have not nested in the area for the last 10 years. Burrowing owls have historically nested in the portion of a prairie dog town that occurs outside the potential borrow sites.

Cumulative impacts to Colorado checkered whiptail and bird species would not be significant and would be of short duration.

The Proposed Action results in a variety of potential impacts, including mortality, disturbance or temporary loss of habitat or nesting or foraging territory. The Proposed Action includes continuation of a number of management measures, such as described in the INRMP and mitigations to avoid and minimize these impacts.

Wetlands
Cumulative impacts for the Proposed Action in combination with other present and planned future actions are and would continue to occur at Fort Carson and in the region. Fort Carson will continue to play a key role in sustaining wetlands through its land management and natural resources programs to minimize these impacts. Fort Carson must comply with the CWA and Section 404, so any potential impacts would be minimal and/or mitigated.

3.6.7 Site-specific Mitigation

Vegetation

Under Executive Order 13751 (2016), Fort Carson is dedicated to prevention of introduction of invasive species and strives to control populations and prevent spread. If the drainage way is to be disturbed during construction, prior coordination with the Invasive Plant Manager would assist in the prevention of potential weed spread. Permitted access when no training is scheduled, would allow for treatment and control of the spread of weeds.

Wildlife
Impacts to prairie dog colonies should cause minimal disturbance and should not need mitigation. If chosen, a proposed borrow site closest to teller is not significant enough that the prairie dogs will recover, or the disturbance is short term.

Pre-disturbance ground nesting bird surveys shall occur within 2 weeks of starting any ground disturbance during nesting season (April 15 to 15 Sept.). Surveys shall include burrowing owl, mountain plover, and any other MBTA protected bird species. Coordination with DPW Wildlife should occur to conduct the surveys. Ground nesting birds found should have a no-disturbance buffer of 50 feet, golden eagles buffer is 0.5 mile and burrowing owl buffer is 0.25 miles, until birds have fledged. If any bird species is found nesting, the proponent must consult the Fort Carson wildlife biologist for USFWS guidance on buffer protection zone sizes and potential take permits.

Prior surveys by DPW-Wildlife should be done to identify Colorado checkered whiptail habitat. To the extent possible, capture and relocation of whiptails would be done by DPW-Wildlife within the project area before any ground disturbance begins between April and September. Coordination with DPW Wildlife should occur one to two months prior to beginning work to determine what mitigation actions would occur.

Fort Carson was granted an Incidental Take Permit for the Teller reservoir golden eagle nest. The permit is valid for five years, starting April 2017. The permit allows for Teller dam ground construction activities associated with replacements, repairs, and construction projects at Teller Dam during active nesting season, but does not authorize intentional take of live eagles, eggs, or young. Despite an Incidental take permit, conservation measures should be applied to minimize disturbance and any abandonment of the nest, if possible. Potential mitigations would be to schedule the work to avoid loud or disturbing work, as much as possible, during the nesting season. Coordination with DPW-Wildlife should occur at least two months in advance of starting any ground disturbance. This coordination would ensure all conditions of the permit are met and conservation measures applied, as applicable, by all parties during all phases the Proposed Action. Some conservation measures that would continue to occur is routine and construction/work related monitoring of the eyrie and closing the area to ground disturbance for all other activity within 0.5 mile of the eyrie when the eyrie is active.

Wetlands
Continued compliance with the CWA and Section 404. Diverting Turkey Creek to the emergency spillway would require a long coffer dam through the wetlands, however,

the long-term saturation/inundation would probably enhance wetland vegetation above the temporary structure.

3.7 Cultural Resources

3.7.1 Existing Conditions

Cultural resources are the non-renewable remnants of past human activities that have cultural or historical value and meaning to a group of people or a society. The term "cultural resources" includes *historic properties*, as defined by the National Historic Preservation Act (NHPA); *cultural items*, as defined by the Native American Graves and Repatriation Act (NAGPRA); *archaeological resources*, as defined by the Archaeological Resources Protection Act; *sacred sites*, as defined in EO 13007, to which access is afforded under American Indian Religious Freedom Act (AIRFA); and *collections*, as defined in 36 CFR Part 79, *Curation of Federally-owned and Administered Archaeological Collections*.

As of March 2017, approximately 99,296 acres of Fort Carson's 137,493 acres have been surveyed for cultural resources, resulting in the recordation of 2,092 buildings, archaeological sites, and isolated finds (IFs), representing every period of human occupation from the Paleoindian stage to the present.

Through consultation with the Colorado State Historic Preservation Officer (SHPO), Native American Tribes, other consulting parties, and the public, Fort Carson has implemented two programmatic agreements (PAs) for compliance with Section 106 of the NHPA: 1) Regarding Construction, Maintenance, and Operational Activities for Select Areas on Fort Carson (Built Environment PA), executed on 27 March 2013; and 2*)* Regarding Military Training and Operational Activities Occurring Down Range Fort Carson (FC Down Range PA), executed on 31 March 2014.

Fort Carson consults with 13 federally-recognized Tribes, who have a cultural affiliation with Fort Carson lands. A Comprehensive Agreement between Fort Carson and 10 Tribes for Tribal access, privacy, and inadvertent discovery of human remains and other cultural items was executed in 2004, and a second comprehensive agreement with the Jicarilla Apache Nation was signed in 2005.

Teller Dam, with its associated ditch and remnants of other water control features, was recorded and evaluated for eligibility on the National Register of Historic Places (NRHP) in November 2013 and was determined to be not eligible (Edward C. Nichols to Carlos Rivera-deAguilar, letter, 4 February 2014, CHS #65322, History Colorado, Colorado). Repairs to the dam, as an updated modern structure which was modified by the Army in 1989, are exempted activities under provisions of the Fort Carson Down Range PA. (Appendix 1, D1b).

3.7.2 Environmental Consequences

3.7.2.1 Proposed Action: Alternative 1 (Dam Raise)

Impacts to Cultural sites would be insignificant as a result of implementing the Proposed Action. The Dam embankment and associated features have been

determined to be ineligible for inclusion on the NHRP, therefore the repairs proposed would have no impact on cultural resources.

Without initiating Section 106 consultation, cultural sites identified through previous survey work would have the potential to be impacted by borrow pit activity. Additionally, culturally significant materials could be unearthed during excavation. Through avoidance, known cultural sites would not be impacted by either alternative. The eligible sites downstream from the embankment would be protected for the foreseeable future as a result of the Proposed Action. Upon selection of the borrow pits, Section 106 consultation would be initiated.

3.7.2.2 Alternative 2, (Overtopping Protection)

Similar levels of impacts to the dam embankment would result from Alternative 2. Impacts as a result of borrow pit activities have the potential to unearth cultural resources which could have negative impacts if done without Section 106 consultation. Avoiding areas where the potential to impact cultural resources is high, would be a priority.

By correcting the deficiencies, the downstream sites would be afforded protection from large rain events and potential dam failure which would impact cultural sites negatively.

3.7.2.3 No Action Alternative

There would be no change in the existing conditions of cultural resources under the No Action Alternative.

3.7.3 Cumulative Effects

Ground disturbing activities have the potential to impact cultural resources. Significant resources have been allocated over the years to identifying and marking cultural resources. This project, when taken into account with past present and future projects, would not have significant impacts on cultural resources. By preserving the dam, the status quo for the area would be maintained, and cultural resources likely to be better protected.

3.7.4 Site-specific Mitigation

Fort Carson would ensure that appropriate protection measures are in place for any identified cultural resources near Teller Dam, or in the vicinity of borrow pits. The inadvertent discovery standard operating procedure (SOP) would be in effect for the entirety of the project and would be provided to onsite personnel.

Additionally, borrow pit activities are not exempted undertakings, therefore Section 106 consultation would be required. Once the specific locations for the borrow pits have been established Fort Carson Cultural Resources Management personnel will initiate consultation on those locations. No work may commence at those location until consultation is completed.

3.8 Transportation

3.8.1 Existing Conditions

Turkey Creek Drainage

Turkey Creek, in route to pueblo reservoir from Teller Dam, passes under dirt and paved roads, major highways, through culverts in residential areas and under train bridges.

Fort Carson

Various Studies have been undertaken to address traffic concerns at the northern part of Fort Carson. A Comprehensive Post-wide Transportation Study (CPTS) was conducted and has been updated periodically since 2005. Some of the major concerns that have been addressed over the years include congestion at incoming gates and force structure realignment that has resulted in both a larger military presence and the addition of infrastructure. Most notable in recent years is the addition of a combat aviation brigade and associated construction at the Butts Army Airfield.

Teller Dam, at the southern end of Fort Carson is geographically isolated and sees infrequent activity. Additionally, military training activities are prohibited in the area during nesting season due to the proximity of a golden eagle.

Vehicle gates are positioned intermittently around the perimeter of Fort Carson, three of which are in the vicinity of teller dam. Gate 15, at the northern end of Stone city road provides the most direct access, though other gates could be used. Stone City road passes through sparsely populated ranchland, some of which is part of the Army Compatible Use Buffer.

3.8.2 Environmental Consequences

3.8.2.1 Proposed Action: Alternative 1 (Dam Raise)

The initial mobilization of construction equipment would lead to short term increases in congestion on the routes and gates that would provide access. Range activity is planned in advance, therefore it would be possible to avoid conflict with training activities if they happen to overlap.

By raising the dam with materials sourced on Fort Carson, vehicle traffic and congestion related to vehicles moving on and off post would be kept to a minimum. Excavation and transport of material could occasionally conflict with training activities. The locations of excavation and loading activities would be briefed to units moving to and from ranges.

Long term impacts resulting from the heightened dam would be negligible. Flood plains would remain almost identical to existing conditions, preserving the roads and bridges that would could be impacted from a failure of the dam.

3.8.2.2 Alternative 2 (Overtopping Protection)
This alternative would involve the same mobilization of construction equipment and would be subject to the same conflicts as the Proposed Action.

By using armoring material instead of locally sourced materials, the impacts to transportation would be increased. If a concrete batch plant is positioned near the dam, the plant and the ingredients would have to be brought on to Fort Carson. This would add vehicles at the gates and possibly on a southern access route, Stone City Road for example. If concrete blocks are brought from offsite, a similar increase in heavy truck traffic would be expected.

Negative Impacts to transportation as a results of the alternative would be short term and insignificant. In the event that stone city road is used an access point, the vehicles would be similar in size and weight to vehicles that have historically used the road.

Positive impacts, as with the Proposed Action, are the maintenance of status quo flood plains and the reduced risk of further degradation

3.8.2.3 No Action Alternative
Under the No Action Alternative, no immediate impacts to transportation are expected. A monitoring program has been initiated for Teller Dam and the embankment is not expected to fail. The potential does exist and therefore the No action alternative could have negative impacts to transportation infrastructure downstream if no action is taken.

3.8.3 Cumulative Effects
Considering past, present, and reasonably foreseeable future activities, the impacts from the Proposed Action or Alternative 2 would be positive. It is reasonable that the community to the south of Teller dam along turkey creek would continue to grow. Correcting the deficiencies would reduce the risk that the dam will fail, which would impact multiple bridges and roads.

3.8.4 Site-specific Mitigation
Site Specific mitigation would include public notices as to when heavy traffic would be expected.

4.0 SUMMARY OF EFFECTS AND CONCLUSIONS

4.1 Unavoidable Adverse Effects Should the Proposed Action Be Implemented
Some adverse effects due to construction cannot be avoided if the Proposed Action is implemented. Disturbance of soils and vegetation would occur, and these effects would be cumulative and long-term. There is a potential to impact US jurisdictional waters and/or wetlands, however Section 404 of the CWA is required to minimize the potential impacts. There would be no effects to federal- or state-listed species. There is a minimal potential for the generation or discovery of hazardous waste or materials;

such waste or materials would be disposed of or remediated according to compliance requirements.

Table 4.1 summarizes potential effects for each alternative, after mitigation. Environmental effects would not be significant within the larger geographic and temporal context in which they would take place.

Resource Area	Environmental Consequence		
	No Action Alternative	Proposed Action (Dam Raise)	Alternative 2 (Overtopping Protection)
Health and Safety Risks		Moderately Beneficial	Moderately Beneficial
Air Quality	No effect	Minor, Temporary	Minor, Temporary
Soils	No effect	Moderate	Moderate
Water Resources	No effect	Minor, Temporary Long Term Slightly Beneficial	Minor, Temporary Long Term Slightly Beneficial
Biological Resources	No effect	Minor	Minor
Wetlands	No effect	Minor, Temporary	Minor, Temporary
Cultural Resources	No effect	Minor	Minor
Transportation	No effect	negligible	negligible

Table 4.1. Summary of Potential Environmental Consequences
* No effect: Actions have no known demonstrated or perceptible effects

4.2 Irreversible and Irretrievable Commitments of Resources
The Proposed Action would involve no irreversible or irretrievable commitment of resources other than the consumption of various expendable materials, supplies, and equipment associated with construction and implementation of environmental mitigation measures.

4.3 General Mitigation
Fort Carson is committed to sustaining and preserving the environment. In keeping with that commitment, the Installation has an active environmental management program that employs a full array of BMPs and environmental management programs to ensure environmental compliance, stewardship, and sustainability of those areas potentially impacted by this action.

Additionally, the existing environmental staff and programs represent a current and foreseeable resource for stewardship and for implementation of existing plans and best practices, including implementation of fugitive dust controls measures, a SWPPP, the Operational Noise Plan, the Programmatic Agreements for historic preservation, a prescribed burning program, and wildlife surveys and management. Additionally, the Installation's land management and restoration staff represent an in-place and funded resource for implementation and monitoring of the effects of land use and the effectiveness of restoration programs. They are a monitoring and enforcement

capability which is currently funded and for which continued funding will be sought and for which the anticipated necessary funding is expected to be available.

4.4 Conclusions

The Proposed Action to repair and improve Teller Dam was analyzed by comparing potential environmental consequences with those of a reasonable alternative, current conditions and potential negative impacts associated with the no action alternative.

The affected environment would not be significantly or adversely effected by proceeding with the Proposed Action. No significant cumulative effects would be expected with the implementation of mitigation.

Short term minor impacts associated with construction activities are outweighed by the need to reduce the risk of dam failure. Failure to act could result in major negative impacts to a variety of VECs including human health and safety.

5.0 PERSONS CONTACTED

Name	Installation/ Affiliation	Role
Benford, Debra	Fort Carson/DPW	NEPA Program Manager
Benford, James	Fort Carson/ DPTMS	Plans, Training, Mobilization, and Security (PTMS), Director
Buccambuso, Emma	Fort Carson/DPW	Noise Program Manager
Davis, Bert	Fort Carson/DPTMS	Range Control Officer
Dunker, Eric	Fort Carson/DPW	Water Program Support Specialist
Fassero, Christopher	USACE, Omaha District	
Gallegos, Joseph	Fort Carson/DPW	Compliance Branch Chief
Guthrie, Vincent	Fort Carson/DPW	Utility PM
Hahn, Chip	Fort Carson/DPW	Stormwater PM
Hennessy, William	Fort Carson/SJA	Environmental Law Specialist
Kulbeth, James	Fort Carson/ENV	Sec 404/Watershed PM
Martin, David	Fort Carson/DPW	Asbestos/Lead/Radon PM
Noonan, Harold	Fort Carson/DPW	Wastewater PM
Peyton, Roger	Fort Carson/DPW	Conservation Branch Chief
Rodriguez, Dawn	Fort Carson/DPW	Invasive Species PM
Smith-Froese, Stephanie	Fort Carson/DPW	Wildlife Biologist
Rohrs, Suzy	Fort Carson/DPW	Environmental Protection Specialist

Thomas, Wayne	Fort Carson/DPW	NEPA/Cultural Branch Chief
Wachter, John	Fort Carson/DPW	Compliance Branch Chief
Wade, Warren	Fort Carson/DPW	Civil Engineer
Whiting, Betty	Fort Carson/ENV	Archaeologist
Zayatz, Jason	Fort Carson/DPW	Installation Forester

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7.0 ACRONYMS

Acronym	Definition
ACBM	Articulated Concrete Block Mat
AIRFA	American Indian Religious Freedom Act
APEN	Air Pollutant Emission Notice
APE	Area of Potential Effect
AR	Army Regulation
BAAF	Butts Army Airfield
BASH	Bird Air Strike Hazard
BFTA	Battalion Field Training Area

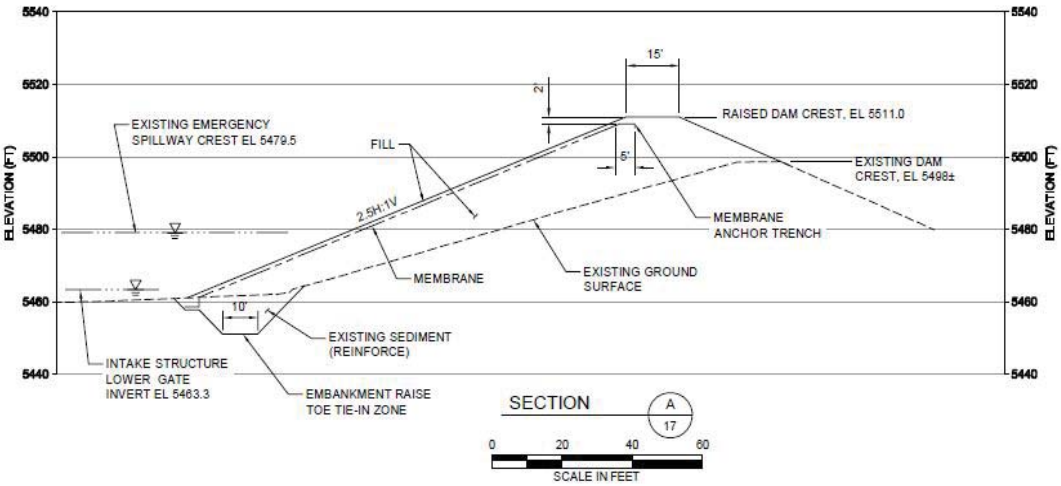
BGEPA	Bald and Golden Eagle Protection Act
BMPs	Best Management Practices
CAA	Clean Air Act
CAB	Combat Aviation Brigade
CCR	Code of Colorado Regulations
CDPHE	Colorado Department of Public Health and Environment
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CGP	Construction General Permit
CNHP	Colorado Natural Heritage Program
CO	Carbon Monoxide
CO2	Carbon Dioxide
CPTS	Comprehensive Post-wide Transportation Study
CWA	Clean Water Act
DPW	Directorate of Public Works
DU	Depleted Uranium
EA	Environmental Assessment
EC	Erosion Control
EIS	Environmental Impact Statement
EO	Executive Order
ESA	Endangered Species Act
FNSI	Finding of No Significant Impact
GHG	Green House Gas
IDF	Inflow Design Flood
INRMP	Integrated Natural Resources Management Plan
MBTA	Migratory Bird Treaty Act
MS4	Municipal Separate Storm Sewer System
MSGP	Multi-Sector General Permit
NAAQS	National Ambient Air Quality Standard
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act

NOA	Notice of Availability
NOI	Notice of Intent
NOT	Notice of Termination
NOx	Nitrogen oxide
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service
OHWM	Ordinary High Water Mark
PAR	Population at Risk
PCMS	Piñon Canyon Maneuver Site
PEA	Programmatic Environmental Assessment
PM	Particulate Matter
PMF	Probable Maximum Flood
ROI	Region of Influence
SAR	Army Species at Risk
Se	Selenium
SHPO	State Historic Preservation Officer
SOP	Standard Operating Procedure
SWMP	Stormwater Management Plan
SWPPP	Stormwater Pollution Prevention Plan
T&E	Threatened and Endangered
USACE	US Army Corps of Engineers
USC	United States Code
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
µm	Micrometers
VEC	Valued Environmental Component

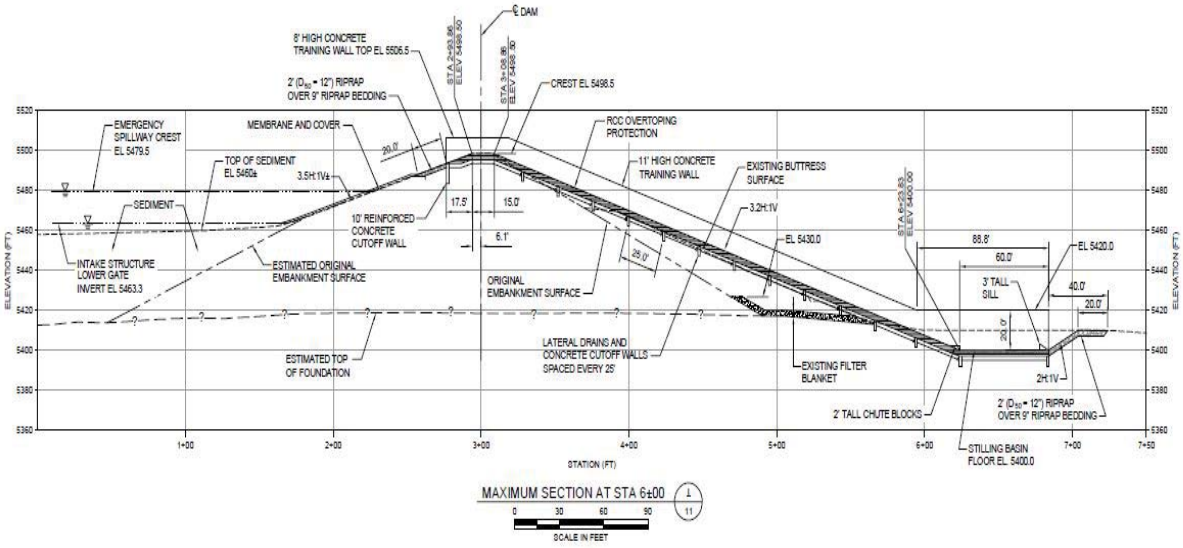
APPENDIX A – Comments Received and Responses

APPENDIX B – Proposed Action and Alternative Designs

General Design of Proposed Action (AECOM 2016)



Potential Design of Alternative 2 (Embankment Armoring)



APPENDIX C –Actions/Projects Considered for Cumulative Impacts Assessment for Fort Carson, CO, 2017

Recently Completed or In Progress Projects at Fort Carson

Completed

- Consolidated BN HQ
- Assault hangar
- Special Forces Tactical Unmanned Aerial Vehicle hangar, battalion operations facility complex, building renovations, and language lab
- Combat Aviation Brigade (CAB) air control tower, ASB hangar, and barracks
- GSAB hangar
- Crowsfoot vehicle bridge and road construction
- Flight simulator

In Progress

- CAB associated construction including infrastructure – Ongoing through FY18
- Central Energy Plant
- AMCOM Aircraft Maintenance Hangar
- Battlefield Weather Support Facility
- National Institute Center of Excellence
- Automated Infantry Platoon Battle Course
- Air Support Operations Squadron Facility Expansion
- Iron Horse Park Area Development
- Family Housing deconstruction and rebuild in Cherokee Village
- Unmanned Aerial System Hangar
- Cheyenne Mountain Trap/Skeet range addition

In Progress or Recently Completed – Off Post

- Sam's Club / Walmart Academy Boulevard South construction
- Southern Delivery System

Foreseeable Future

- Special Forces Mountaineering Facility, Headquarters, and THOR3 facility
- Ammo Supply Point Expansion
- Physical Fitness Facility
- Army National Guard Readiness Center
- 1st Space Brigade Operations Building Improvements
- Charter Oak Ranch road improvement
- Gate 20 Access Control Facility
- Fire Station Turkey Creek
- High Efficiency Boiler Installation – multiple facilities

APPENDIX D – Teller Dam Area Soil Report

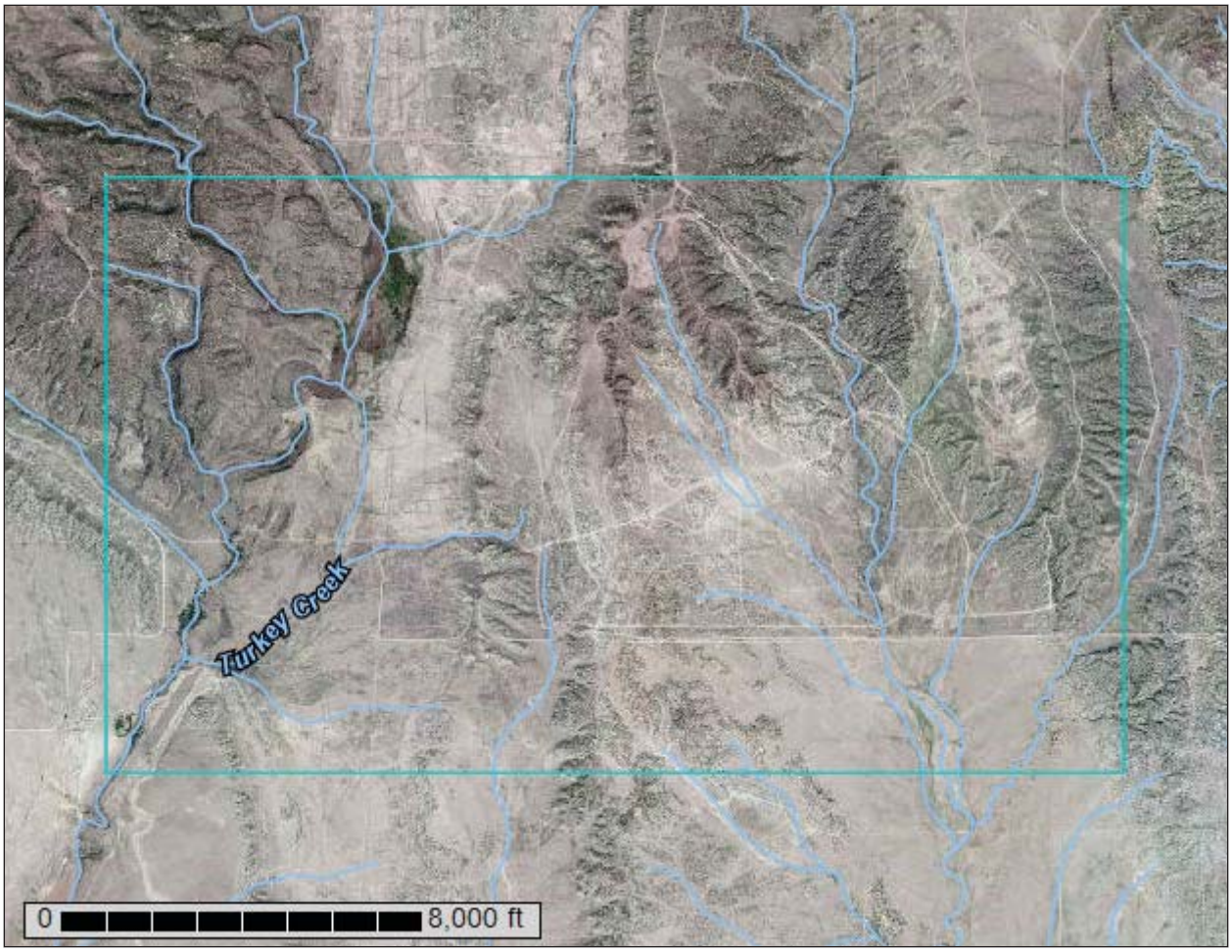
Appendix D: Teller Dam Area Soil Report

United States Department of Agriculture

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Pueblo Area, Colorado, Parts of Pueblo and Custer Counties



June 29, 2017

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

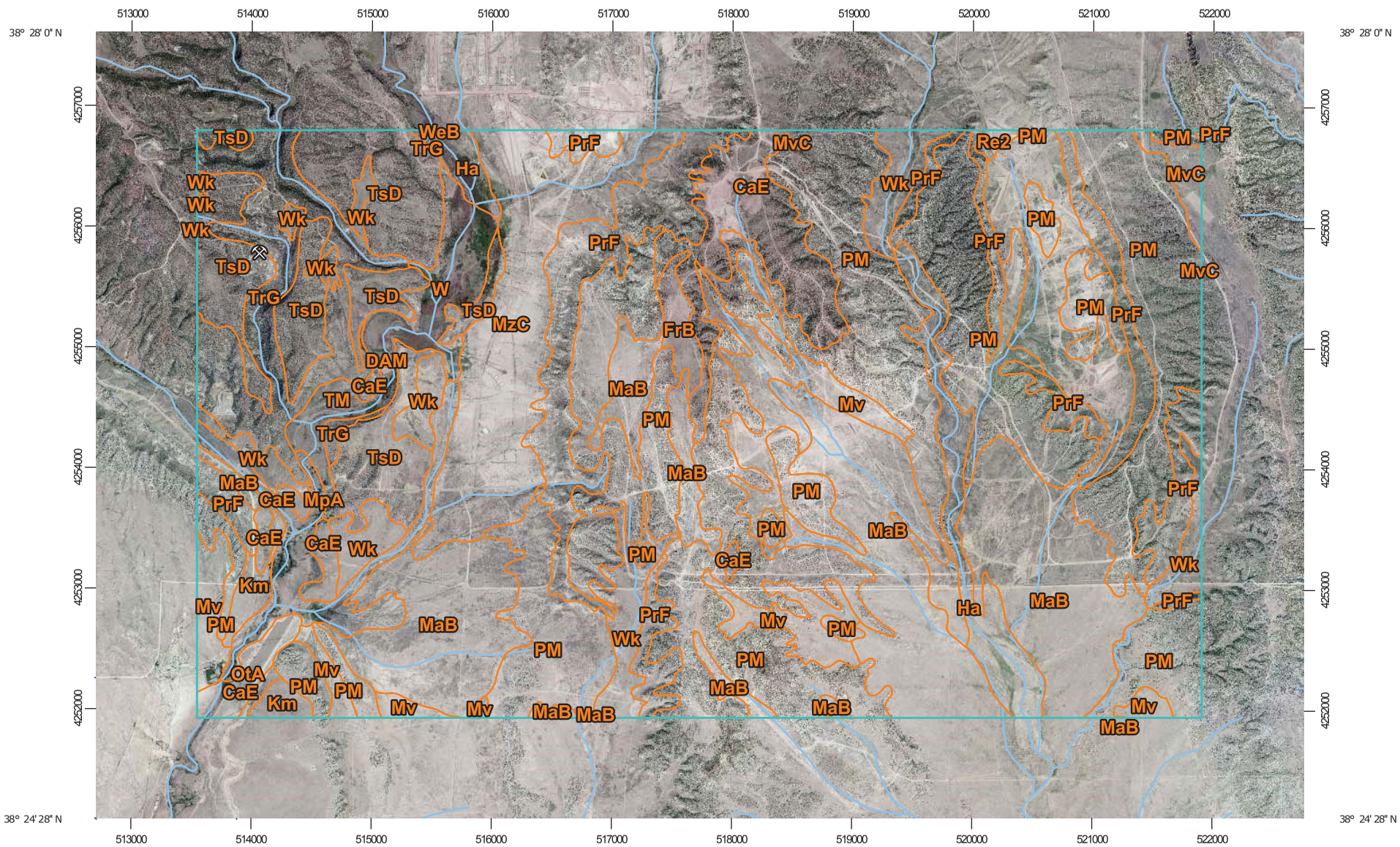
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:46,000 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 500 1000 2000 3000

Feet: 0 2000 4000 8000 12000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Pueblo Area, Colorado, Parts of Pueblo and Custer Counties
Survey Area Data: Version 15, Sep 22, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 15, 2011—Sep 22, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Pueblo Area, Colorado, Parts of Pueblo and Custer Counties (CO626)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
CaE	Cascajo very gravelly sandy loam, 5 to 25 percent slopes	408.1	4.0%
DAM	Orthents	4.5	0.0%
FrB	Fort loam, 1 to 5 percent slopes, cool	56.5	0.6%
Ha	Haversid silt loam, 0 to 2 percent slopes, frequently flooded	271.3	2.7%
Km	Kim fine sandy loam	72.6	0.7%
MaB	Manvel silt loam, 2 to 6 percent slopes, dry	1,895.1	18.8%
MpA	Manzanola silty clay loam, dry, saline, 0 to 2 percent slopes	235.4	2.3%
Mv	Minnequa-Manvel silt loams, 1 to 6 percent slopes, dry	473.5	4.7%
MvC	Manvel silt loam, 2 to 6 percent slopes	52.2	0.5%
MzC	Manzanola silty clay loam, 3 to 9 percent slopes	637.1	6.3%
OtA	Otero clay loam, 0 to 1 percent slopes	65.9	0.7%
PM	Penrose-Minnequa complex, 1 to 15 percent slopes, dry	3,185.9	31.5%
PrF	Penrose-Rock outcrop complex, 25 to 65 percent slopes	817.6	8.1%
Re2	Razor clay, eroded	13.2	0.1%
TM	Table Mountain association	81.4	0.8%
TrG	Travessilla-Rock outcrop complex, 30 to 90 percent slopes	463.9	4.6%
TsD	Travessilla sandy loam, 1 to 9 percent slopes	759.3	7.5%
W	Water	179.7	1.8%
WeB	Wilid silt loam, 0 to 3 percent slopes	0.2	0.0%
Wk	Wiley-Kim loams	432.6	4.3%
Totals for Area of Interest		**10,105.9**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas

shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Pueblo Area, Colorado, Parts of Pueblo and Custer Counties

CaE—Cascajo very gravelly sandy loam, 5 to 25 percent slopes

Map Unit Setting

National map unit symbol: 36c5
Elevation: 4,400 to 6,000 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 145 to 175 days
Farmland classification: Not prime farmland

Map Unit Composition

Cascajo and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cascajo

Setting

Landform: Terraces
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy and gravelly alluvium

Typical profile

A - 0 to 10 inches: very gravelly sandy loam
Bk - 10 to 21 inches: very gravelly sandy loam
C - 21 to 60 inches: stratified extremely gravelly coarse sand

Properties and qualities

Slope: 5 to 25 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 25 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: Gravel Breaks (R069XY064CO)
Hydric soil rating: No

Minor Components

Shale outcrop

Percent of map unit: 10 percent
Hydric soil rating: No

DAM—Orthents

Map Unit Composition

Orthents and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Orthents

Properties and qualities

Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

FrB—Fort loam, 1 to 5 percent slopes, cool

Map Unit Setting

National map unit symbol: 2rgqs
Elevation: 5,500 to 6,500 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 125 to 160 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Fort and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fort

Setting

Landform: Fans, interfluves
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loamy alluvium and/or eolian deposits

Typical profile

A - 0 to 4 inches: loam

Bt - 4 to 12 inches: clay loam
Btk - 12 to 33 inches: clay loam
Bk1 - 33 to 47 inches: loam
Bk2 - 47 to 79 inches: sandy loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 25 percent
Gypsum, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.5 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 3.0
Available water storage in profile: Moderate (about 8.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: C
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy (G069XW017CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Minor Components

Wilid

Percent of map unit: 10 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy (G069XW017CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Oterodry

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: Sandy Plains (R069XY026CO)
Other vegetative classification: Not Suited (G069XW000CO)
Hydric soil rating: No

Ha—Haversid silt loam, 0 to 2 percent slopes, frequently flooded

Map Unit Setting

National map unit symbol: 2tqyn
Elevation: 4,500 to 5,800 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 130 to 170 days
Farmland classification: Prime farmland if protected from flooding or not frequently flooded during the growing season

Map Unit Composition

Haversid, frequently flooded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Haversid, Frequently Flooded

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 6 inches: silt loam
Bw - 6 to 15 inches: silt loam
C - 15 to 79 inches: stratified fine sandy loam to loam to silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Slightly saline (4.0 to 7.9 mmhos/cm)
Available water storage in profile: High (about 9.3 inches)

Interpretive groups

Land capability classification (irrigated): 4s
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Ecological site: Saline Overflow (R069XY037CO)
Hydric soil rating: No

Minor Components

Glenberg, frequently flooded

Percent of map unit: 10 percent
Landform: Flood plains, flood-plain steps
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Sandy Bottomland (R069XY031CO)
Hydric soil rating: No

Km—Kim fine sandy loam

Map Unit Setting

National map unit symbol: 36cl
Elevation: 4,600 to 5,000 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 145 to 175 days
Farmland classification: Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

Map Unit Composition

Kim and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kim

Setting

Landform: Fans, stream terraces
Landform position (three-dimensional): Tread, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

A - 0 to 5 inches: fine sandy loam
AC - 5 to 15 inches: loam
C1 - 15 to 35 inches: silt loam
C2 - 35 to 60 inches: loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water storage in profile: High (about 9.3 inches)

Interpretive groups
Land capability classification (irrigated): 1
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Hydric soil rating: No

Minor Components

Manvel
Percent of map unit: 10 percent
Hydric soil rating: No

Otero
Percent of map unit: 10 percent
Hydric soil rating: No

MaB—Manvel silt loam, 2 to 6 percent slopes, dry

Map Unit Setting
National map unit symbol: 2rgqg
Elevation: 3,600 to 6,000 feet
Mean annual precipitation: 10 to 12 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 130 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition
Manvel, dry, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Manvel, Dry

Setting
Landform: Fans, interfluves
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Side slope, interfluve
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Parent material: Alluvium derived from limestone and shale

Typical profile
A - 0 to 7 inches: silt loam
Bk1 - 7 to 25 inches: silt loam

Bk2 - 25 to 49 inches: silt loam
Bk3 - 49 to 79 inches: silt loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 45 percent
Gypsum, maximum in profile: 3 percent
Salinity, maximum in profile: Nonsaline to moderately saline (1.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy, Limy (G069XW022CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Minor Components

Minnequa, dry

Percent of map unit: 7 percent
Landform: Pediments, ridges
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear, convex
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy (G069XW017CO)
Hydric soil rating: No

Wilid, dry

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy (G069XW017CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Penrose, dry

Percent of map unit: 3 percent
Landform: Scarps
Landform position (two-dimensional): Shoulder

Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: Limestone Breaks (R069XY058CO)
Other vegetative classification: Limestone Breaks #58 (069XY058CO_2)
Hydric soil rating: No

MpA—Manzanola silty clay loam, dry, saline, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2rgrd
Elevation: 4,000 to 5,500 feet
Mean annual precipitation: 10 to 12 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 130 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

Manzanola, dry, saline, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Manzanola, Dry, Saline

Setting

Landform: Interfluves, terraces, drainageways, fan remnants
Landform position (two-dimensional): Summit, footslope
Landform position (three-dimensional): Side slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from shale

Typical profile

A - 0 to 4 inches: silty clay loam
Bt1 - 4 to 11 inches: clay loam
Bt2 - 11 to 20 inches: clay loam
Bky - 20 to 33 inches: silty clay loam
By - 33 to 79 inches: clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 14 percent
Gypsum, maximum in profile: 3 percent

Salinity, maximum in profile: Moderately saline (8.0 to 15.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 12.0
Available water storage in profile: Moderate (about 8.0 inches)

Interpretive groups
Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: C
Ecological site: Saline Overflow (R069XY037CO)
Hydric soil rating: No

Minor Components

Aguilar
Percent of map unit: 5 percent
Landform: Fan remnants
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Salt Flat (R069XY033CO)
Other vegetative classification: Sodic, Sodic/Saline (G069XW027CO), Salt Flat #33 (069AY033CO_2)
Hydric soil rating: No

Haversid
Percent of map unit: 5 percent
Landform: Terraces, drainageways
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Saline Overflow (R069XY037CO)
Hydric soil rating: No

Mv—Minnequa-Manvel silt loams, 1 to 6 percent slopes, dry

Map Unit Setting
National map unit symbol: 2rgqm
Elevation: 4,000 to 6,000 feet
Mean annual precipitation: 10 to 12 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 130 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition
Minnequa, dry, and similar soils: 55 percent
Manvel, dry, and similar soils: 30 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Minnequa, Dry

Setting

Landform: Ridges, pediments
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: Slope alluvium and/or residuum weathered from limestone and shale

Typical profile

A - 0 to 6 inches: silt loam
Bw - 6 to 17 inches: silt loam
Bk - 17 to 35 inches: silty clay loam
Cr - 35 to 60 inches: bedrock

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: 20 to 39 inches to paralithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 45 percent
Gypsum, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.1 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 8.0
Available water storage in profile: Low (about 5.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy (G069XW017CO)
Hydric soil rating: No

Description of Manvel, Dry

Setting

Landform: Fans, interfluves
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Side slope, interfluve
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Parent material: Alluvium derived from limestone and shale

Typical profile

A - 0 to 7 inches: silt loam
Bk1 - 7 to 25 inches: silt loam
Bk2 - 25 to 49 inches: silt loam
Bk3 - 49 to 79 inches: silt loam

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 40 percent
Gypsum, maximum in profile: 3 percent
Salinity, maximum in profile: Nonsaline to moderately saline (1.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy, Limy (G069XW022CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Minor Components

Manvel, deep, dry

Percent of map unit: 10 percent
Landform: Fans, interfluves
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Side slope, interfluve
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy, Limy (G069XW022CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Penrose

Percent of map unit: 5 percent
Landform: Hogbacks, hills, scarps
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Ecological site: Limestone Breaks (R069XY058CO)
Other vegetative classification: Not Suited (G069XW000CO), Limestone Breaks #58 (069XY058CO_2)
Hydric soil rating: No

MvC—Manvel silt loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 2rgqk
Elevation: 3,600 to 6,500 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 125 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

Manvel and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Manvel

Setting

Landform: Fans, interfluves
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Parent material: Alluvium derived from limestone and shale

Typical profile

A - 0 to 5 inches: silt loam
Bk1 - 5 to 32 inches: silt loam
Bk2 - 32 to 48 inches: silt loam
Bky - 48 to 79 inches: silt loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 45 percent
Gypsum, maximum in profile: 5 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy, Limy (G069XW022CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Minor Components

Minnequa

Percent of map unit: 7 percent
Landform: Pediments, ridges
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear, convex
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy (G069XW017CO)
Hydric soil rating: No

Manzanola

Percent of map unit: 5 percent
Landform: Drainageways, fans
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Tread, talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Clayey (G069XW001CO), Saline Overflow #37 (069XY037CO_2)
Hydric soil rating: No

Penrose

Percent of map unit: 3 percent
Landform: Hogbacks, hills, scarps
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Ecological site: Limestone Breaks (R069XY058CO)
Other vegetative classification: Not Suited (G069XW000CO), Limestone Breaks #58 (069XY058CO_2)
Hydric soil rating: No

MzC—Manzanola silty clay loam, 3 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2rgrk

Elevation: 3,700 to 6,200 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 130 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

Manzanola and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Manzanola

Setting

Landform: Fan remnants, hillslopes
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from shale

Typical profile

A - 0 to 5 inches: silty clay loam
Bt - 5 to 26 inches: silty clay loam
Btk - 26 to 37 inches: silty clay loam
Bk1 - 37 to 48 inches: silty clay loam
Bk2 - 48 to 79 inches: silt loam

Properties and qualities

Slope: 3 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 14 percent
Gypsum, maximum in profile: 3 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.5 to 3.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: High (about 11.1 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Clayey Plains (R069XY042CO)
Other vegetative classification: Clayey (G069XW001CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Minor Components

Wilid

Percent of map unit: 5 percent

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy (G069XW017CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Fort

Percent of map unit: 5 percent
Landform: Fan remnants
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy (G069XW017CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Razor

Percent of map unit: 5 percent
Landform: Pediments, hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear, convex
Ecological site: Clayey Plains (R069XY042CO)
Other vegetative classification: Clayey, Dry-Saline (G069XW006CO), CLAYEY PLAINS (069AY042CO)
Hydric soil rating: No

OtA—Otero clay loam, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 36dg
Elevation: 4,400 to 5,200 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 145 to 175 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Otero and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Otero

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits and/or sandy alluvium

Typical profile

Ap - 0 to 12 inches: clay loam
C - 12 to 60 inches: sandy loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Gypsum, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 8.5 inches)

Interpretive groups

Land capability classification (irrigated): 1
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Hydric soil rating: No

Minor Components

Rocky ford

Percent of map unit: 10 percent
Hydric soil rating: No

PM—Penrose-Minnequa complex, 1 to 15 percent slopes, dry

Map Unit Setting

National map unit symbol: 2rgrb
Elevation: 4,000 to 6,000 feet
Mean annual precipitation: 10 to 12 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 130 to 170 days

Farmland classification: Not prime farmland

Map Unit Composition

Penrose and similar soils: 45 percent
Minnequa, dry, and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Penrose

Setting

Landform: Hogbacks, hills, scarps
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium over residuum weathered from limestone

Typical profile

A - 0 to 4 inches: channery loam
C - 4 to 15 inches: channery loam
R - 15 to 79 inches: bedrock

Properties and qualities

Slope: 1 to 15 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 70 percent
Salinity, maximum in profile: Nonsaline (0.1 to 1.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 1.0
Available water storage in profile: Very low (about 1.8 inches)

Interpretive groups

Land capability classification (irrigated): 6s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: Limestone Breaks (R069XY058CO)
Hydric soil rating: No

Description of Minnequa, Dry

Setting

Landform: Ridges, interfluves
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: Eolian deposits and/or residuum weathered from limestone and shale

Typical profile

A - 0 to 6 inches: silt loam
Bw - 6 to 17 inches: silt loam
Bk - 17 to 35 inches: silty clay loam
Cr - 35 to 79 inches: bedrock

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: 20 to 39 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 45 percent
Gypsum, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.1 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 8.0
Available water storage in profile: Low (about 5.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy (G069XW017CO)
Hydric soil rating: No

Minor Components

Manvel, dry

Percent of map unit: 10 percent
Landform: Fans, interfluves
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Side slope, interfluve
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy, Limy (G069XW022CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Rock outcrop

Percent of map unit: 5 percent
Hydric soil rating: No

PrF—Penrose-Rock outcrop complex, 25 to 65 percent slopes

Map Unit Setting

National map unit symbol: 36dk
Elevation: 4,400 to 6,200 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 130 to 175 days
Farmland classification: Not prime farmland

Map Unit Composition

Penrose and similar soils: 50 percent
Rock outcrop: 30 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Penrose

Setting

Landform: Ridges, hills
Landform position (three-dimensional): Side slope, head slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium over residuum weathered from limestone

Typical profile

A - 0 to 6 inches: channery loam
C - 6 to 12 inches: channery loam
R - 12 to 16 inches: unweathered bedrock

Properties and qualities

Slope: 25 to 65 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 75 percent
Gypsum, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 10.0
Available water storage in profile: Very low (about 1.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: Limestone Breaks (R069XY058CO)
Hydric soil rating: No

Description of Rock Outcrop

Setting
Parent material: Limestone

Typical profile
R - 0 to 60 inches: unweathered bedrock

Properties and qualities
Slope: 25 to 65 percent
Depth to restrictive feature: 0 inches to paralithic bedrock
Available water storage in profile: Very low (about 0.0 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Razor
Percent of map unit: 7 percent
Hydric soil rating: No

Shingle
Percent of map unit: 7 percent
Hydric soil rating: No

Manvel
Percent of map unit: 6 percent
Hydric soil rating: No

Re2—Razor clay, eroded

Map Unit Setting
National map unit symbol: 36dn
Elevation: 4,400 to 5,400 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 145 to 175 days
Farmland classification: Not prime farmland

Map Unit Composition
Razor and similar soils: 80 percent
Minor components: 20 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Razor

Setting

Landform: Plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey slope alluvium over residuum weathered from shale

Typical profile

A - 0 to 2 inches: clay
Bw - 2 to 15 inches: silty clay
Cy - 15 to 30 inches: clay
Cr - 30 to 34 inches: weathered bedrock

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 5 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 15.0
Available water storage in profile: Low (about 5.1 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: Alkaline Plains (R069XY047CO)
Hydric soil rating: No

Minor Components

Midway

Percent of map unit: 20 percent
Hydric soil rating: No

TM—Table Mountain association

Map Unit Setting

National map unit symbol: 36dx

Elevation: 5,700 to 6,800 feet
Mean annual precipitation: 16 to 18 inches
Mean annual air temperature: 49 to 52 degrees F
Frost-free period: 115 to 145 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Table mountain and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Table Mountain

Setting

Landform: Stream terraces, valley floors
Landform position (three-dimensional): Tread, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

A - 0 to 7 inches: loam
Bw - 7 to 17 inches: loam
Bk - 17 to 38 inches: silt loam
C - 38 to 60 inches: loam

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: High (about 10.0 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: Loamy Foothill (R049BY202CO)
Hydric soil rating: No

Minor Components

Stony sandy alluvium

Percent of map unit: 8 percent
Hydric soil rating: No

Bouldery sandy alluvium

Percent of map unit: 8 percent

Hydric soil rating: No

Occasionally flooded areas

Percent of map unit: 2 percent
Hydric soil rating: No

Briefly flooded areas

Percent of map unit: 2 percent
Hydric soil rating: No

TrG—Travessilla-Rock outcrop complex, 30 to 90 percent slopes

Map Unit Setting

National map unit symbol: 36dz
Elevation: 4,500 to 5,500 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 130 to 175 days
Farmland classification: Not prime farmland

Map Unit Composition

Travessilla and similar soils: 41 percent
Rock outcrop: 39 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Travessilla

Setting

Landform: Scarps
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous sandy slope alluvium and/or residuum weathered from sandstone

Typical profile

A - 0 to 5 inches: sandy loam
C - 5 to 14 inches: sandy loam
R - 14 to 18 inches: unweathered bedrock

Properties and qualities

Slope: 30 to 65 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 1.6 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: Sandstone Breaks (R069XY053CO)
Hydric soil rating: No

Description of Rock Outcrop

Setting
Landform: Cliffs, canyons
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandstone

Typical profile
R - 0 to 60 inches: unweathered bedrock

Properties and qualities
Slope: 30 to 90 percent
Depth to restrictive feature: 0 inches to paralithic bedrock
Available water storage in profile: Very low (about 0.0 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Kim
Percent of map unit: 10 percent
Hydric soil rating: No

Wiley
Percent of map unit: 10 percent
Hydric soil rating: No

TsD—Travessilla sandy loam, 1 to 9 percent slopes

Map Unit Setting
National map unit symbol: 2q08y
Elevation: 4,700 to 6,500 feet
Mean annual precipitation: 11 to 16 inches
Mean annual air temperature: 48 to 54 degrees F

Frost-free period: 130 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

Travessilla and similar soils: 75 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Travessilla

Setting

Landform: Scarps
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Slope alluvium and/or residuum weathered from sandstone

Typical profile

A - 0 to 5 inches: sandy loam
AC - 5 to 11 inches: sandy loam
Bk - 11 to 14 inches: sandy loam
R - 14 to 79 inches: bedrock

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 1.0
Available water storage in profile: Very low (about 1.6 inches)

Interpretive groups

Land capability classification (irrigated): 6s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: Sandstone Breaks (R069XY053CO)
Other vegetative classification: Needs Field Review (G069XW050CO), Sandstone Breaks #53 (069XY053CO_2)
Hydric soil rating: No

Minor Components

Rock outcrop

Percent of map unit: 10 percent
Landform: Scarps
Hydric soil rating: No

Villedry

Percent of map unit: 4 percent

Landform: Interfluves, plains
Landform position (two-dimensional): Shoulder, summit, backslope
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Kim
Percent of map unit: 4 percent
Landform: Plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Hydric soil rating: No

Olney, bedrock substratum
Percent of map unit: 4 percent
Landform: Ridges
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Sandy Plains (R069XY026CO)
Other vegetative classification: Sandy Plains (069XY026CO_1)
Hydric soil rating: No

Villegreen
Percent of map unit: 3 percent
Landform: Plains
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains (R067BY002CO)
Other vegetative classification: Loamy Plains #2 (067XY002CO_2)
Hydric soil rating: No

W—Water

Map Unit Composition
Water: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Minor Components

Aquolls
Percent of map unit: 5 percent
Landform: Marshes

Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Other soils

Percent of map unit: 5 percent
Landform: Marshes
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

WeB—Wilid silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2qnmq
Elevation: 4,000 to 6,200 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 125 to 175 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Wilid and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wilid

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess and/or eolian deposits

Typical profile

A - 0 to 6 inches: silt loam
Bt - 6 to 10 inches: silty clay loam
Btk - 10 to 30 inches: silty clay loam
Bk1 - 30 to 44 inches: silty clay loam
Bk2 - 44 to 79 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Calcium carbonate, maximum in profile: 40 percent
Gypsum, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.5 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 4.0
Available water storage in profile: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: C
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy (G069XW017CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Minor Components

Almagre

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Footslope, summit
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy (G069XW017CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Minnequa

Percent of map unit: 5 percent
Landform: Pediments, ridges
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Loamy (G069XW017CO)
Hydric soil rating: No

Manzanola

Percent of map unit: 5 percent
Landform: Depressions, drainageways
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Talf
Down-slope shape: Concave, linear
Across-slope shape: Linear
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Other vegetative classification: Clayey (G069XW001CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Wk—Wiley-Kim loams

Map Unit Setting

National map unit symbol: 36f6
Elevation: 4,400 to 5,200 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 49 to 54 degrees F
Frost-free period: 145 to 175 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Wiley and similar soils: 60 percent
Kim and similar soils: 25 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wiley

Setting

Landform: Plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty loess and/or residuum weathered from sandstone

Typical profile

A - 0 to 6 inches: loam
Bt - 6 to 15 inches: silty clay loam
Bk - 15 to 50 inches: loam
R - 50 to 54 inches: weathered bedrock

Properties and qualities

Slope: 1 to 4 percent
Depth to restrictive feature: 40 to 60 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6c

Hydrologic Soil Group: C
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Hydric soil rating: No

Description of Kim

Setting

Landform: Plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear

Typical profile

A - 0 to 5 inches: loam
C1 - 5 to 35 inches: silt loam
C2 - 35 to 60 inches: loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water storage in profile: High (about 9.4 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Ecological site: Loamy Plains, LRU's A & B 10-14 Inches, P.Z. (R069XY006CO)
Hydric soil rating: No

Minor Components

Manzanola

Percent of map unit: 10 percent
Hydric soil rating: No

Travessilla

Percent of map unit: 5 percent
Hydric soil rating: No

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APPENDIX E – Description of Fort Carson Geology

Regional setting

Fort Carson is a 138,303 acre (55,790 ha) military training installation at the southern end of the Front Range in central Colorado (Figure 1). It straddles El Paso, Pueblo, and Fremont counties. It is south of Colorado Springs; its northern end is just south of Highway 83, between Interstate 25 and Highway 115, which skirts the foothills of Pikes Peak to the west. The east border of Fort Carson follows an irregular line south from Fountain. The south border abuts ranchland in northwest Pueblo County, 6-7 miles south of the El Paso-Pueblo county line.

Fort Carson is at the ecotone of the mountains and plains; it is on the west edge of the high plains near their convergence with the Rocky Mountains in southeast Colorado. It is just below Pikes Peak north of the notch in the Rocky Mountain front formed by the Arkansas River and the Cañon City Embayment (Colorado Geological Survey 2003). Fort Carson spans the transition from the Foothills and Shrublands of the Southern Rocky Mountains to the irregular and dissected plains of the Piedmont Plains and Tablelands subsections (Figure 2; Chapman et al. 2006). Between these subsections is a narrow band of Pinyon-Juniper Woodland that occurs on Fort Carson. The moderate to high gradients of the foothills of Pikes Peak transition to shale and limestone hogback ridges and mesas that underlie the sparser Pinyon-Juniper Woodlands before flattening out onto the plains. Elevation on Fort Carson ranges from 5200 feet (1585m) at Beaver Creek in the southwest corner of Fort Carson to 6896 feet (2102m) on Timber Mountain. Terrain generally slopes down in elevation from the northwest to southeast. Lowest points are the plains on the southern border between Pierce Gulch as well as the broad, flat drainage of Young Hollow on the east side of the installation. Highest areas include Timber Mountain, Booth Mountain, and the sharp hogback above Deadman Canyon along Highway 115 southwest of Rock Creek Park.

Climate

Average annual precipitation at Fort Carson is 14.3 inches (36.2cm). More than eighty percent of this precipitation falls between April and September (WRCC 2007). Thunderstorms are common in the mid- to late summer as wind patterns often shift to more southerly directions providing monsoonal moisture to convection storms (Doesken et al. 2003). Colorado's eastern plains have only recently emerged from severe drought conditions. Although drought conditions have ameliorated in the last few years, with record monsoonal moisture in July and August of 2006 and record snow totals in the winter of 2006-2007, the last three years have been among the hottest summer temperatures on record (NOAA 2007).

Geology

Bedrock geology is influenced by the proximity of Fort Carson to the Rocky Mountain front, its uplift and subsequent erosion. The uplift of the mountains tilted and fractured the Mesozoic (Triassic, Jurassic, and Cretaceous) sedimentary layers (Morgan et al. 2006). Subsequent erosion uncovered what is now granitic Pikes Peak and formed a series of hogbacks that expose the various older sedimentary layers such as the Fountain

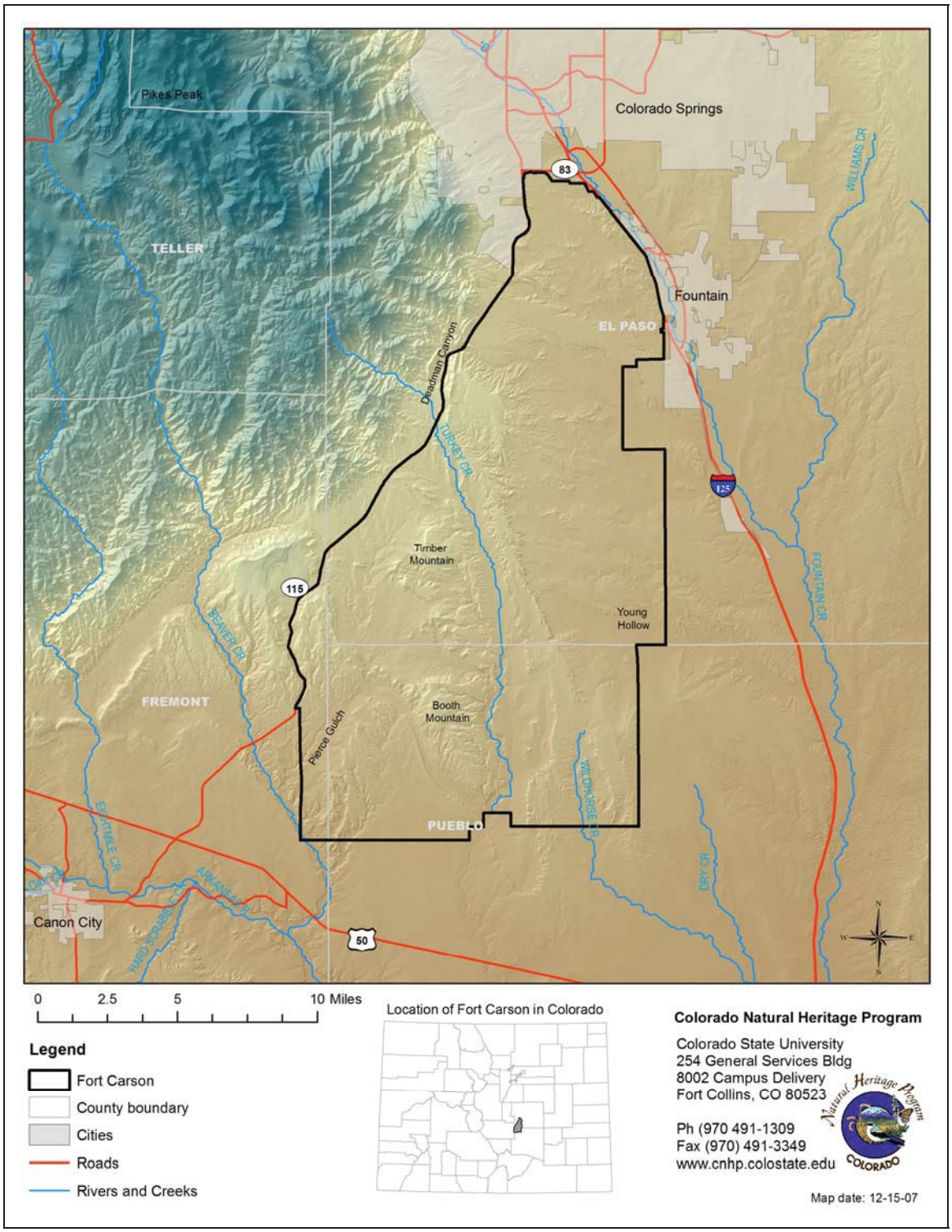


Figure 1. Regional setting of Fort Carson in Colorado.

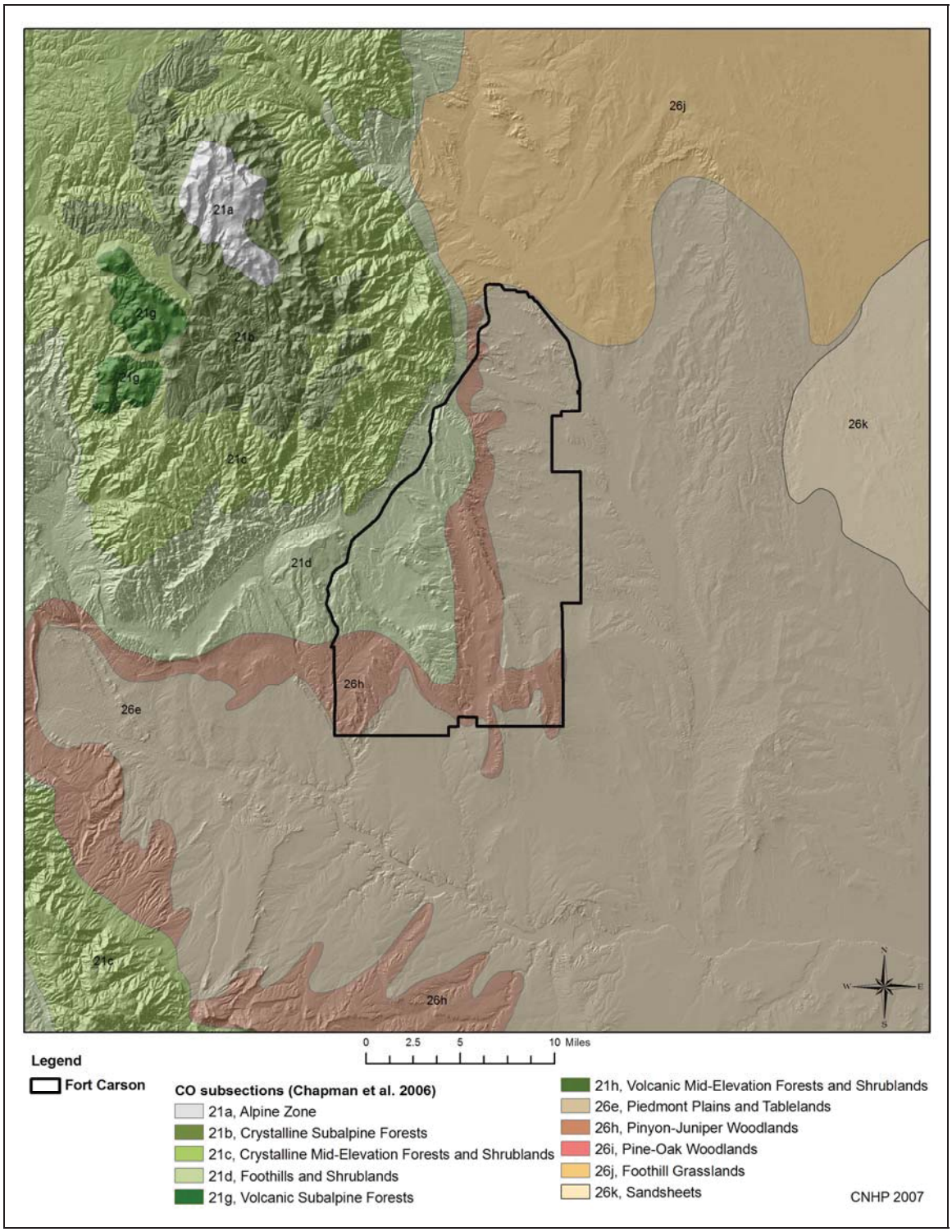


Figure 2. Ecological subsections (Chapman et al. 2006) in the vicinity of Fort Carson.

and Morrison Formations, Lyons and Dakota sandstones, and the Purgatoire Formation. These are represented by sandstone dominated formations and siltstone and mudstone dominated formations (USGS GAP Analysis Program 2004) in Figure 3 (see also Table 2). Abutting these older hogbacks are a series of lower shale ridges and mesas of various Late Cretaceous sedimentary layers (displayed as shale dominated formations in Figure 3)—a composite of Carlile shale, Greenhorn limestone, and Graneros shale—before the low relief plains underlain by the Niobrara Formation (carbonate dominated formations).

Late Cretaceous bedrock forms the shale hogbacks, mesas, and large outcrops in the southern portion of Fort Carson. This bedrock consists of layer upon layer of shales, chalks, and limestones originating from the vast inland seas that covered the interior of the continent during that Period (Scott and Cobban 1964). The series of sedimentary layers is well-described in this region (Scott 1964, Scott 1969) and their relationship to plant distribution is summarized in Kelso et al. (1999, 2003). Layers exposed on Fort Carson include (from older to younger) Graneros shale, Greenhorn limestone, Carlile shale, and Niobrara Formation, with the latter two forming the majority of underlying bedrock and exposed outcrops. Carlile shale is split into various shale and sandstone members with calcerinite as a unique and notable mineral (Scott 1964). The Niobrara Formation is a larger series of calcareous shale, limestone, and chalk layers with bentonite, gypsum, and selenium components in varying proportions. Important Members within the Niobrara Formation include Fort Hays sandstone and Smoky Hills shale, the latter of which is divided into eight units with shale and limestone below alternating layers of chalk and shale (Scott 1964, Scott and Cobban 1964). Where the shale and chalk layers are exposed, they tend to form barrens with little soil development. The rare endemic plant species often occur at the interface of several sedimentary layers, especially at interfaces within the middle and upper chalk units of the Smoky Hills member of the Niobrara Formation and those between Fort Hays and Carlile shales.

Soils

In the rainshadow of the Rocky Mountains where Fort Carson is located, calcification is the predominant soil forming process (Bailey 2001). Soils tend to be rich in base ions and precipitated calcium carbonate because climate conditions are too dry to leach the ions from the top horizons. Soils are primarily a function of topography and bedrock geology at Fort Carson. Shallower, rockier soils occur on ridges, breaks, hogbacks, and foothills and deeper, finer-textured soils occur on the plains. Soil mosaics of various textures occur in drainages (Larsen et al. 1979).

Soils in the southern portion of Fort Carson are a mosaic of Manvel silt loam on mesas and plains and Penrose-Minnequa and Penrose-rock outcrop complexes on the ridges and dissected drainages that have eroded through the underlying limestone and shale bedrock (Larsen et al. 1979). Manvel soils are deep silt loams with slow permeability and high available moisture. Erosion hazard is moderate in these soils. The Penrose-Minnequa complex occurs on shoulder slopes and the sideslopes of drainages and escarpments. These soils are very shallow to bedrock (usually only 10-12 inches deep) and have a very high proportion of rock fragments in the limited loam and silt loam matrix. In the southeast portion of Fort Carson, the plains have inclusions of Kim soils in the mosaic.

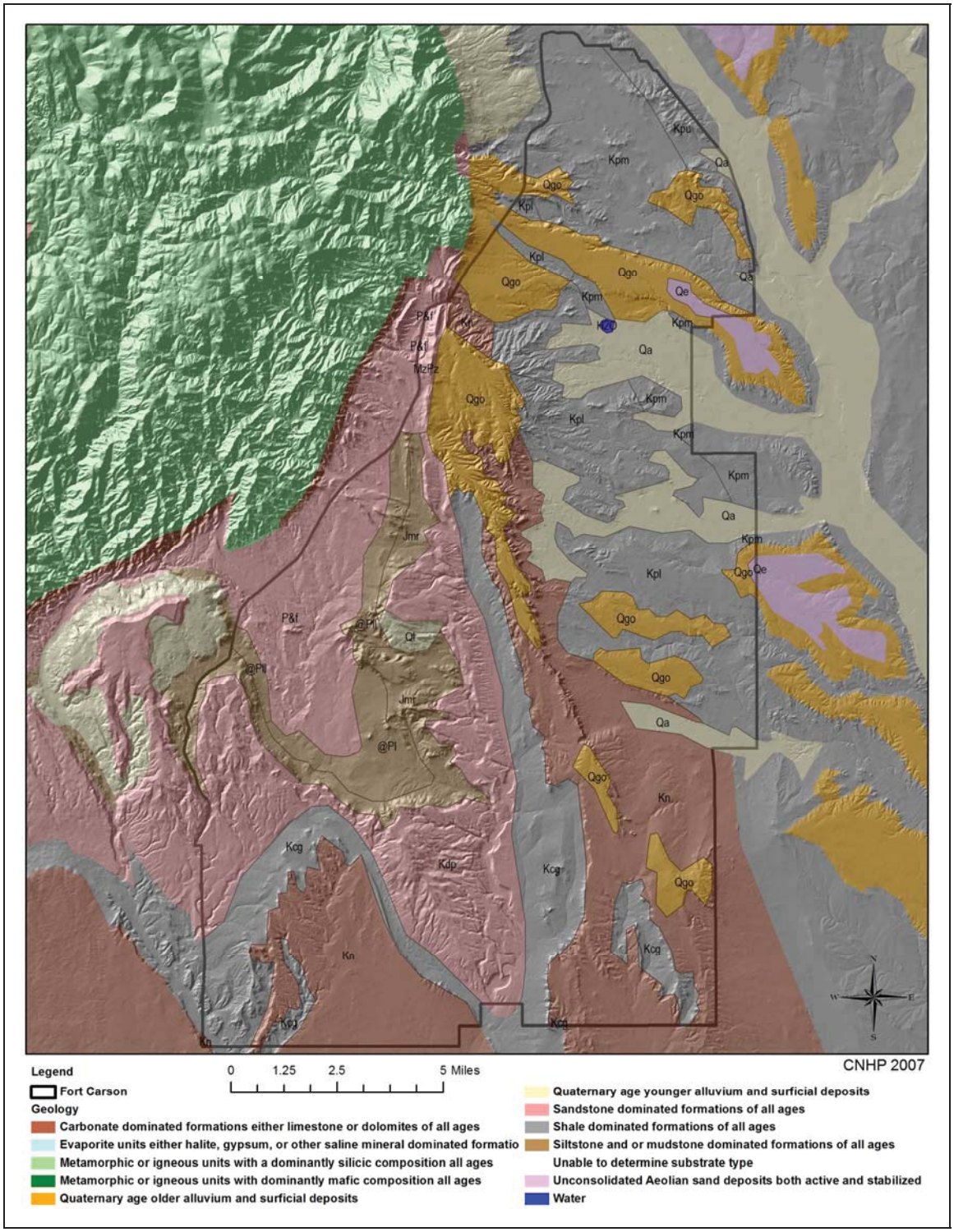


Figure 3. Geology of Fort Carson (USGS GAP Analysis Program 2004). See also Table 2.

Table 2. Descriptions of geologic units shown in Figure 3. Code and name/description is from Tweto (1979) and SW ReGAP substrate and group are from USGS GAP Analysis Program (2004).

Code	Name and description	SW ReGAP Substrate	SW ReGAP Group
@Pl	LYKINS FORMATION--Red siltstone, shale, and limestone	Siltstone and or mudstone dominated formations of all ages	Sedimentary rocks of Triassic age
@Pll	LYKINS FORMATION AND LYONS SANDSTONE	Siltstone and or mudstone dominated formations of all ages	Sedimentary rocks of Triassic age
H2O		Water	
Jmr	MORRISON FORMATION AND RALSTON CREEK FORMATION (CLAYSTONE, SANDSTONE, LIMESTONE, AND GYPSUM)	Siltstone and or mudstone dominated formations of all ages	Sedimentary rocks of Jurassic age
Kcg	CARLILE SHALE, GREENHORN LIMESTONE, AND GRANEROS SHALE	Shale dominated formations of all ages	Sedimentary rocks of Cretaceous age
Kdp	DAKOTA SANDSTONE AND PURGATOIRE FORMATION--Sandstone and shale	Sandstone dominated formations of all ages	Sedimentary rocks of Cretaceous age
Kn	NIOBRARA FORMATION--Calcareous shale and limestone	Carbonate dominated formations either limestone or dolomites of all ages	Sedimentary rocks of Cretaceous age
Kpl	PIERRE SHALE, Lower unit--Sharon Springs Member (organic-rich shale and numerous bentonite beds) in lower part	Shale dominated formations of all ages	Sedimentary rocks of Cretaceous age
Kpm	PIERRE SHALE, Middle unit--In Boulder-Fort Collins area, contains Richard, Larimer, Rocky Ridge, Terry, and Hygiene Sandstone Members; elsewhere, shale between zones of *Baculites reesidei* and *B. scotti*	Shale dominated formations of all ages	Sedimentary rocks of Cretaceous age
Kpu	PIERRE SHALE, Upper unit	Shale dominated formations of all ages	Sedimentary rocks of Cretaceous age
MzPz	MESOZOIC AND PALEOZOIC ROCKS--Mainly as in Mesozoic unit (Mz) plus Permian and Pennsylvanian formations	Sandstone dominated formations of all ages	Sedimentary rocks of Cretaceous age
P&f	FOUNTAIN FORMATION--Arkosic sandstone and conglomerate	Sandstone dominated formations of all ages	Sedimentary rocks of Permian and Pennsylvanian age
Qa	MODERN ALLUVIUM--Includes Piney Creek Alluvium and younger deposits	Quaternary age younger alluvium and surficial deposits	Unconsolidated surficial deposits and rocks of Quaternary age
Qe	EOLIAN DEPOSITS--Includes dune sand and silt and Peoria Loess	Unconsolidated Aeolian sand deposits both active and stabilized	Unconsolidated surficial deposits and rocks of Quaternary age
Qgo	OLDER GRAVELS AND ALLUVIUMS (PRE-BULL LAKE AGE)--Includes Slocum, Verdos, Rocky Flats, and Nussbaum Alluviums in east, and Florida, Bridgetimber, and Bayfield Gravels in southwest	Quaternary age older alluvium and surficial deposits	Unconsolidated surficial deposits and rocks of Quaternary age
Ql	LANDSLIDE DEPOSITS--Locally includes talus, rock-glacier, and thick colluvial deposits	Quaternary age younger alluvium and surficial deposits	Unconsolidated surficial deposits and rocks of Quaternary age

Kim fine sandy loam is represented by deep, well-drained pockets over bedrock containing gypsum. There are minor amounts of other soil types including several silty clay loams (Shingle, Haverson, Heldt, Cascajo), silty clays (Midway) and clays (Razor) that form mosaics in stream drainages that are frequently subject to brief flooding with precipitation events. The majority of soils in the targeted inventory areas at Fort Carson are calcareous and moderately to strongly alkaline.

Vegetation

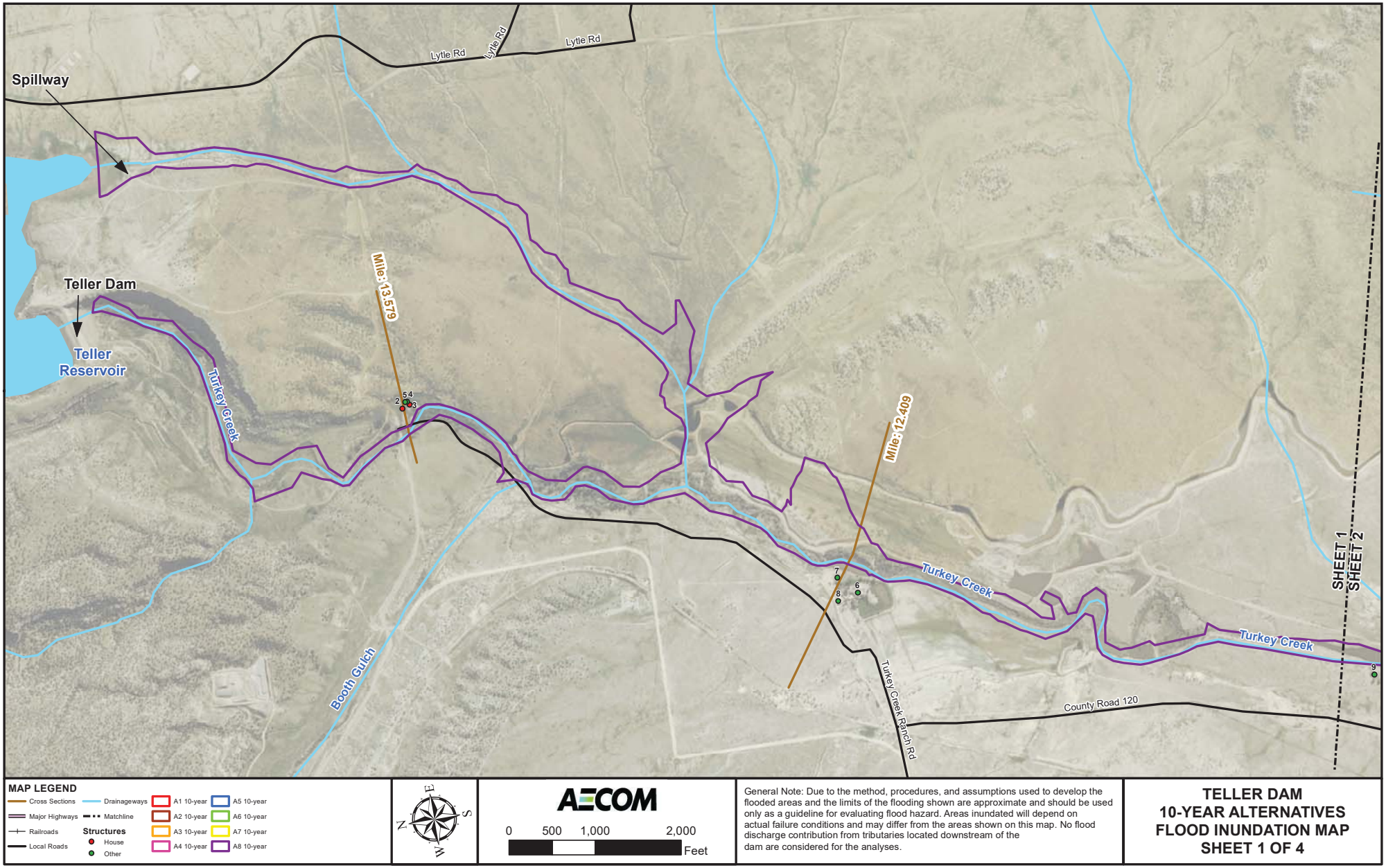
Vegetation at Fort Carson is patterned according to elevation and topography on the installation. Hills at higher elevations are primarily comprised of pinyon-juniper woodlands (*Pinus edulis – Juniperus monosperma*) typical of foothills habitat in this area. It often has a variable shrub component with gambel oak (*Quercus gambelii*) and/or mountain mahoghany (*Cercocarpus montanus*) over a moderately sparse understory. Relatively flat areas at the lower elevations are grasslands that establish in the deeper soils. The grassland mosaic has elements of shortgrasses such as grama grasses (*Bouteloua* spp.), and midgrasses such as galleta (*Pleuraphis jamesii*) and western wheatgrass (*Pascopyrum smithii*). There is a diverse forb component and occasional shrubs, *e.g*., saltbush (*Atriplex canescens*), rabbitbrush (*Chrysothamnus nauseosus*), or yucca (*Yucca glauca*) that may sporadically occur. Intervening shale hogbacks support a unique mosaic of shale barrens plant communities that include shrublands with frankenia (*Frankenia jamesii*) and/or Bigelow sagebrush (*Artemisia bigelovii*), with or without a pinyon-juniper canopy. Fourwing saltbush (*Atriplex canescens*) is also common in finer-textured soils. The unifying feature of these barrens is sparse vegetation cover within the limited soils beneath a pavement of platy shale fragments. There is also a characteristic suite of herbaceous plants adapted to shallow, droughty, low-nutrient soils (Kelso et al. 1999). Many of these species are low-growing cushion plants such as woollycup buckwheat (*Eriogonum lachnogynum*), nailworts (*Paronychia jamesii, P. sessiliflora*), stemless four-nerve daisy (*Tetraneuris acaulis*), bladderpods (*Lesquerella* spp.), and Arkansas River feverfew (*Parthenium tetraneuris*) and grasses including New Mexico feathergrass (*Hesperostipa neomexicana*), galleta, and Indian ricegrass (*Achnatherum hymenoides*).

The target species for this report occupy distinct habitat niches. Arkansas River feverfew and round-leaf four-o'clock (*Mirabilis rotundifolia*) are shale barrens endemics and occur on the sparsely vegetated shale outcrops and hogbacks. Pueblo goldenweed (*Oonopsis puebloensis*) and Arkansas Valley evening primrose (*Oenothera harringtonii*) occur in finer textured soils and tend to concentrate at toeslopes, on sideslopes, and in landscape swales, often below the hogback ridges that support Arkansas River feverfew and round-leaf four-o'clock. Habitat of dwarf milkweed (*Asclepias uncialis* ssp. *uncialis*) is primarily grasslands, especially at the interface with pinyon-juniper woodlands. Habitats occupied by the target species are extensive on Fort Carson.

APPENDIX F – Flood Plains Associated with the Preferred Action and Alternatives

Appendix F: Flood Plains Associated with the Preferred Action and Alternatives

Preferred Action: 10yr Rain Event

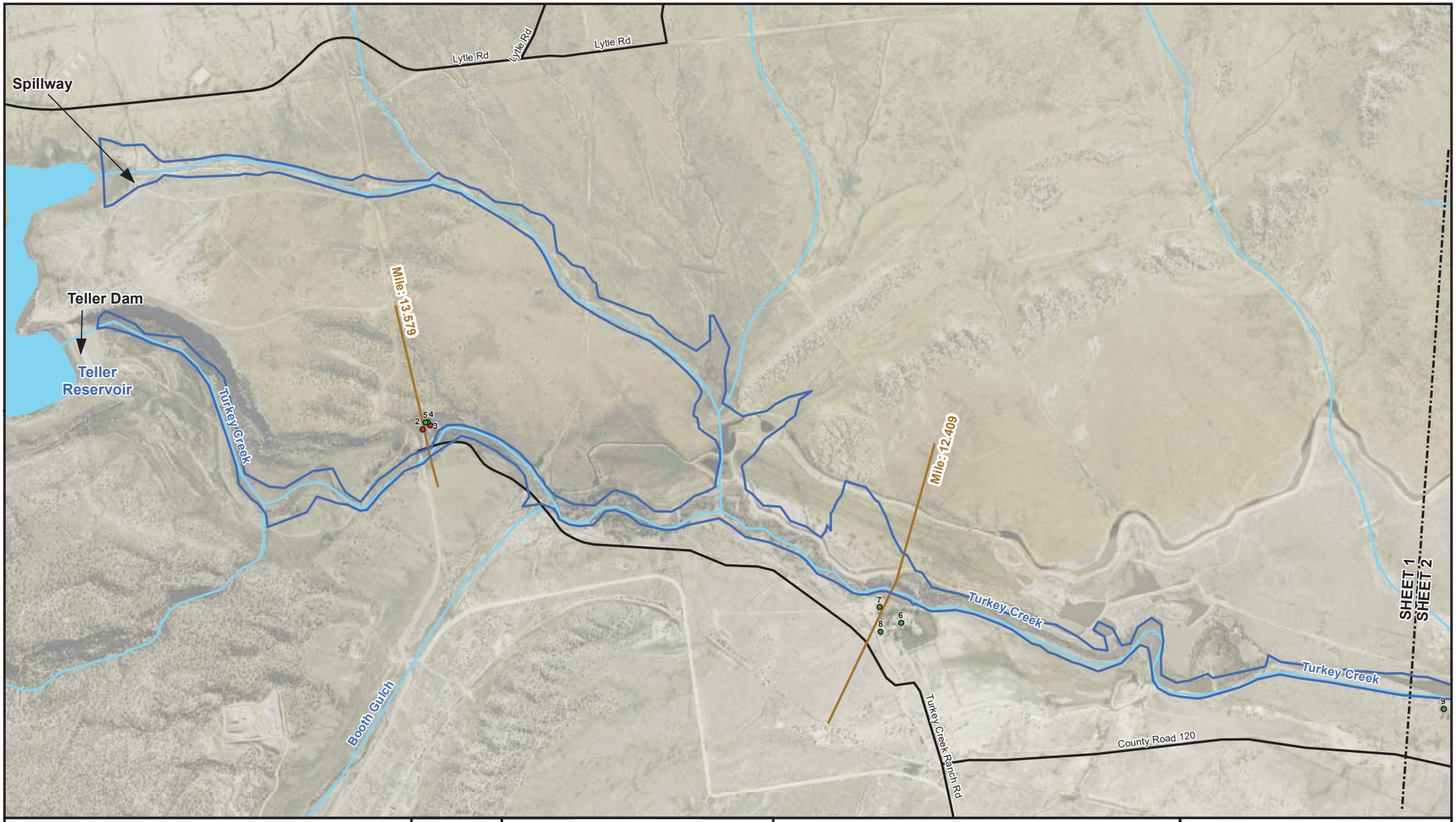


General Note: Due to the method, procedures, and assumptions used to develop the flooded areas and the limits of the flooding shown are approximate and should be used only as a guideline for evaluating flood hazard. Areas inundated will depend on actual failure conditions and may differ from the areas shown on this map. No flood discharge contribution from tributaries located downstream of the dam are considered for the analyses.

TELLER DAM
10-YEAR ALTERNATIVES
FLOOD INUNDATION MAP
SHEET 1 OF 4

Map Revision Date: 4/1/2016

Alternative 2: 10yr Rain Event



MAP LEGEND

- Cross Sections
- Major Highways
- Railroads
- Local Roads
- Drainageways
- Matchline

Structures

- House
- Other

A1 10-year, A2 10-year, A3 10-year, A4 10-year, A5 10-year, A6 10-year, A7 10-year, A8 10-year

AECOM

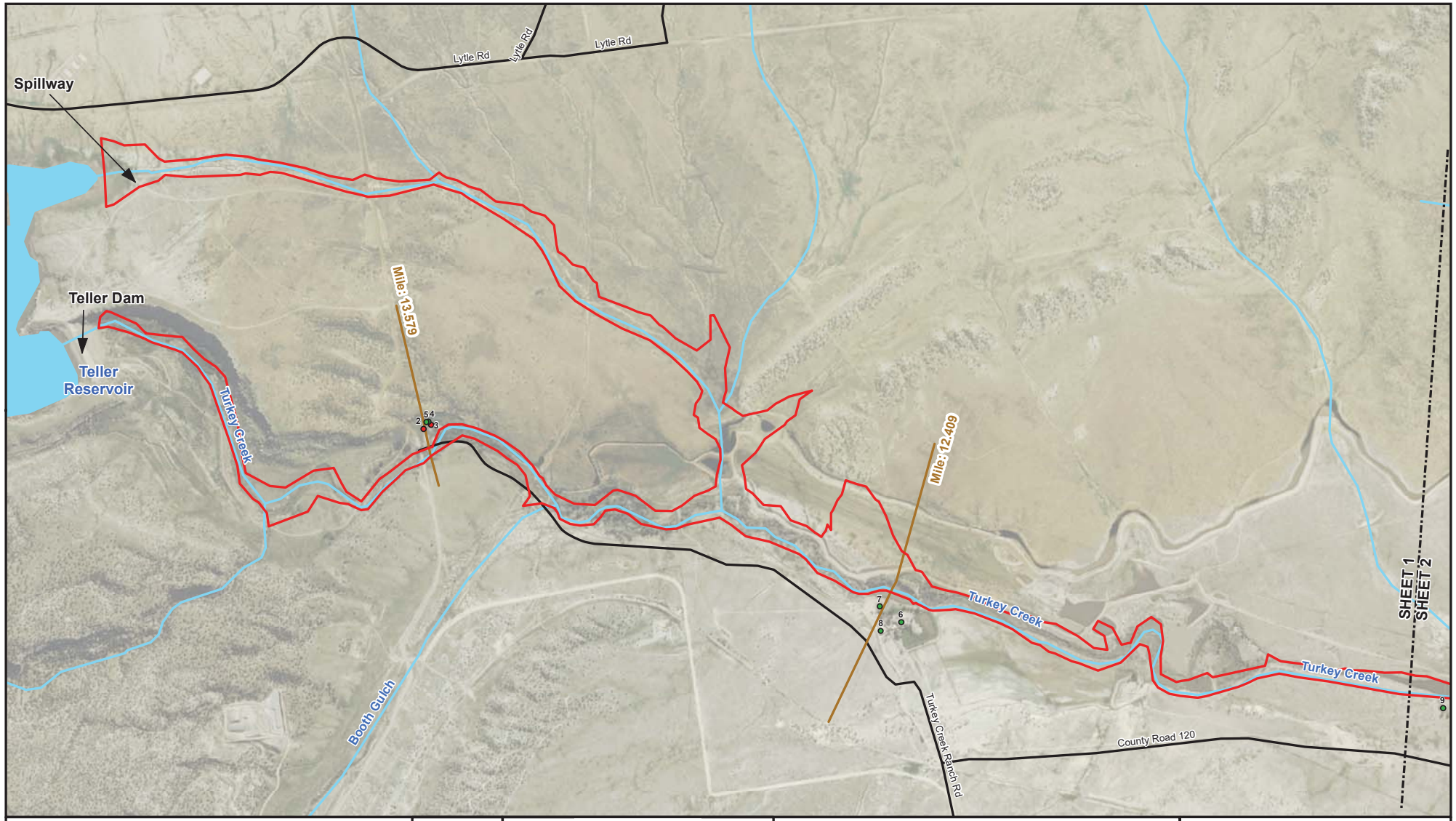
0 500 1,000 2,000 Feet

General Note: Due to the method, procedures, and assumptions used to develop the flooded areas and the limits of the flooding shown are approximate and should be used only as a guideline for evaluating flood hazard. Areas inundated will depend on actual failure conditions and may differ from the areas shown on this map. No flood discharge contribution from tributaries located downstream of the dam are considered for the analyses.

TELLER DAM
10-YEAR ALTERNATIVES
FLOOD INUNDATION MAP
SHEET 1 OF 4

Map Revision Date: 4/1/2016

No Action: 10yr Rain Event



MAP LEGEND

- Cross Sections
- Major Highways
- Railroads
- Local Roads
- Drainageways
- Matchline

Structures

- House
- Other

- A1 10-year
- A2 10-year
- A3 10-year
- A4 10-year
- A5 10-year
- A6 10-year
- A7 10-year
- A8 10-year

AECOM

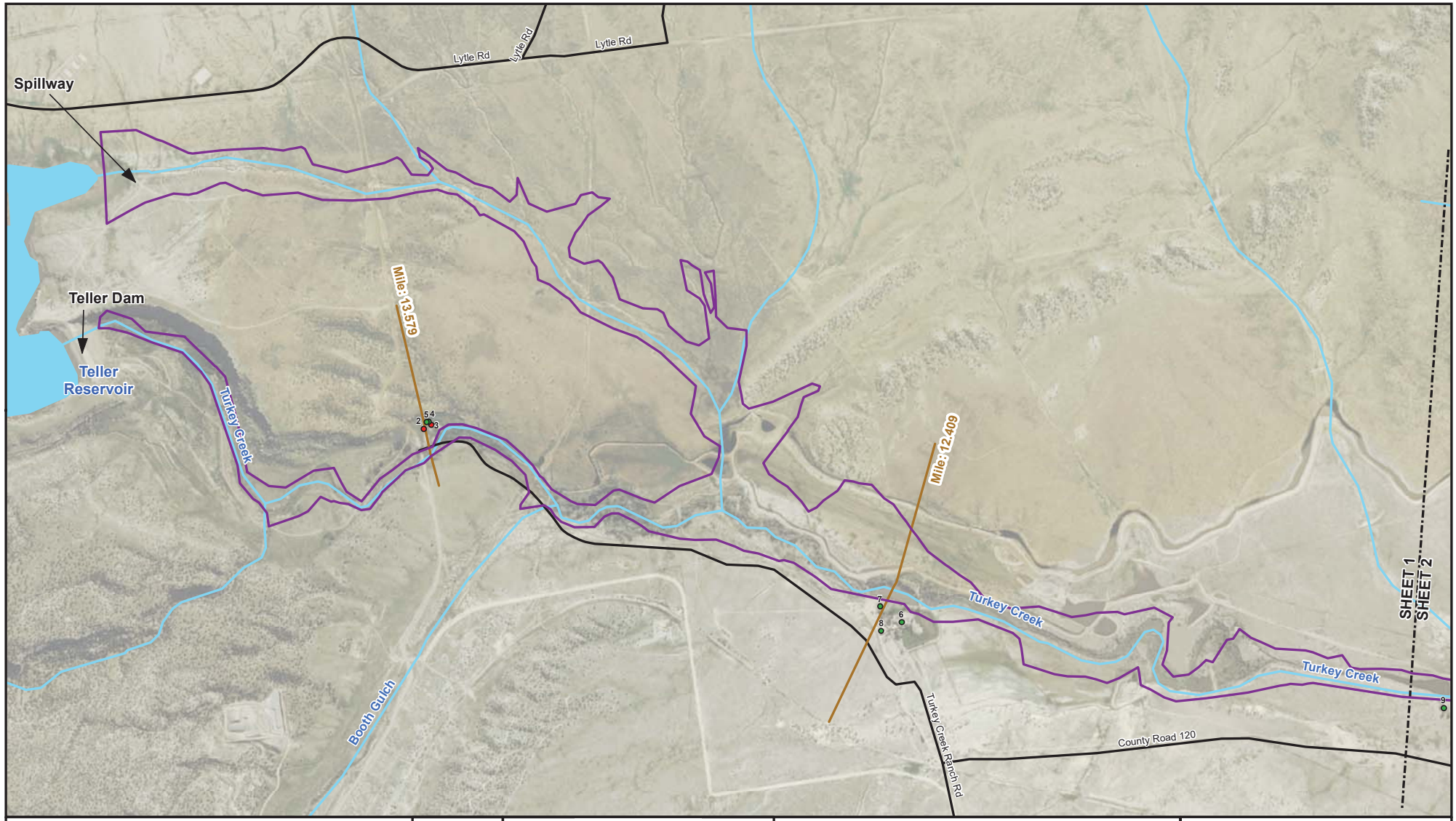
0 500 1,000 2,000 Feet

General Note: Due to the method, procedures, and assumptions used to develop the flooded areas and the limits of the flooding shown are approximate and should be used only as a guideline for evaluating flood hazard. Areas inundated will depend on actual failure conditions and may differ from the areas shown on this map. No flood discharge contribution from tributaries located downstream of the dam are considered for the analyses.

TELLER DAM
10-YEAR ALTERNATIVES
FLOOD INUNDATION MAP
SHEET 1 OF 4

Map Revision Date: 4/1/2016

Preferred Action: 100yr Rain Event



MAP LEGEND

- Cross Sections
- Major Highways
- Railroads
- Local Roads
- Drainageways
- Matchline

Structures

- House
- Other

- A1 100-year
- A2 100-year
- A3 100-year
- A4 100-year
- A5 100-year
- A6 100-year
- A7 100-year
- A8 100-year

N E S W

AECOM

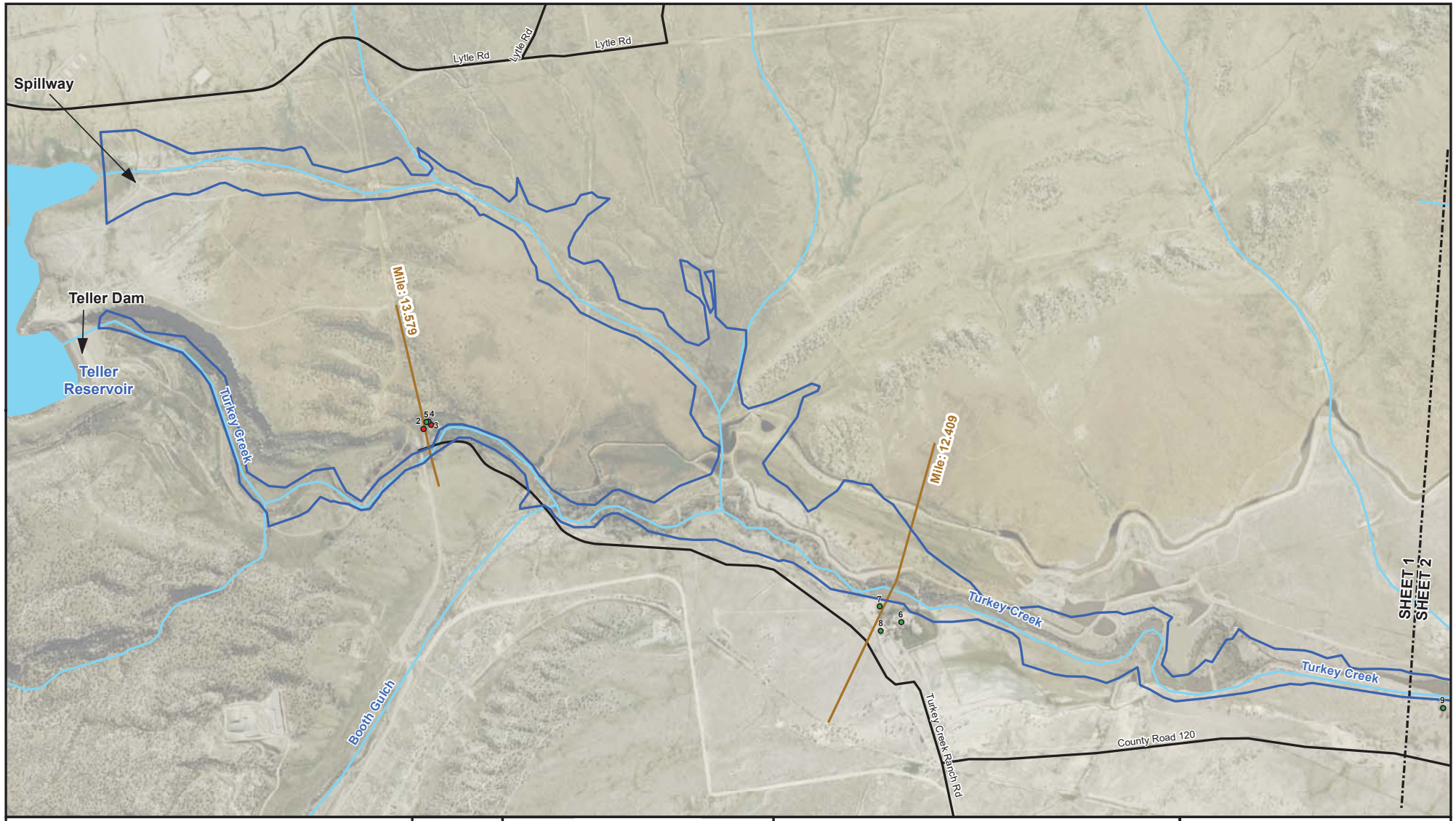
0 500 1,000 2,000 Feet

General Note: Due to the method, procedures, and assumptions used to develop the flooded areas and the limits of the flooding shown are approximate and should be used only as a guideline for evaluating flood hazard. Areas inundated will depend on actual failure conditions and may differ from the areas shown on this map. No flood discharge contribution from tributaries located downstream of the dam are considered for the analyses.

TELLER DAM
100-YEAR ALTERNATIVES
FLOOD INUNDATION MAP
SHEET 1 OF 4

Map Revision Date: 4/1/2016

Alternative 2: 100yr Rain Event



MAP LEGEND

- Cross Sections
- Major Highways
- Railroads
- Local Roads
- Drainageways
- Matchline

Structures

- House
- Other

- A1 100-year
- A2 100-year
- A3 100-year
- A4 100-year
- A5 100-year
- A6 100-year
- A7 100-year
- A8 100-year

N E S W

AECOM

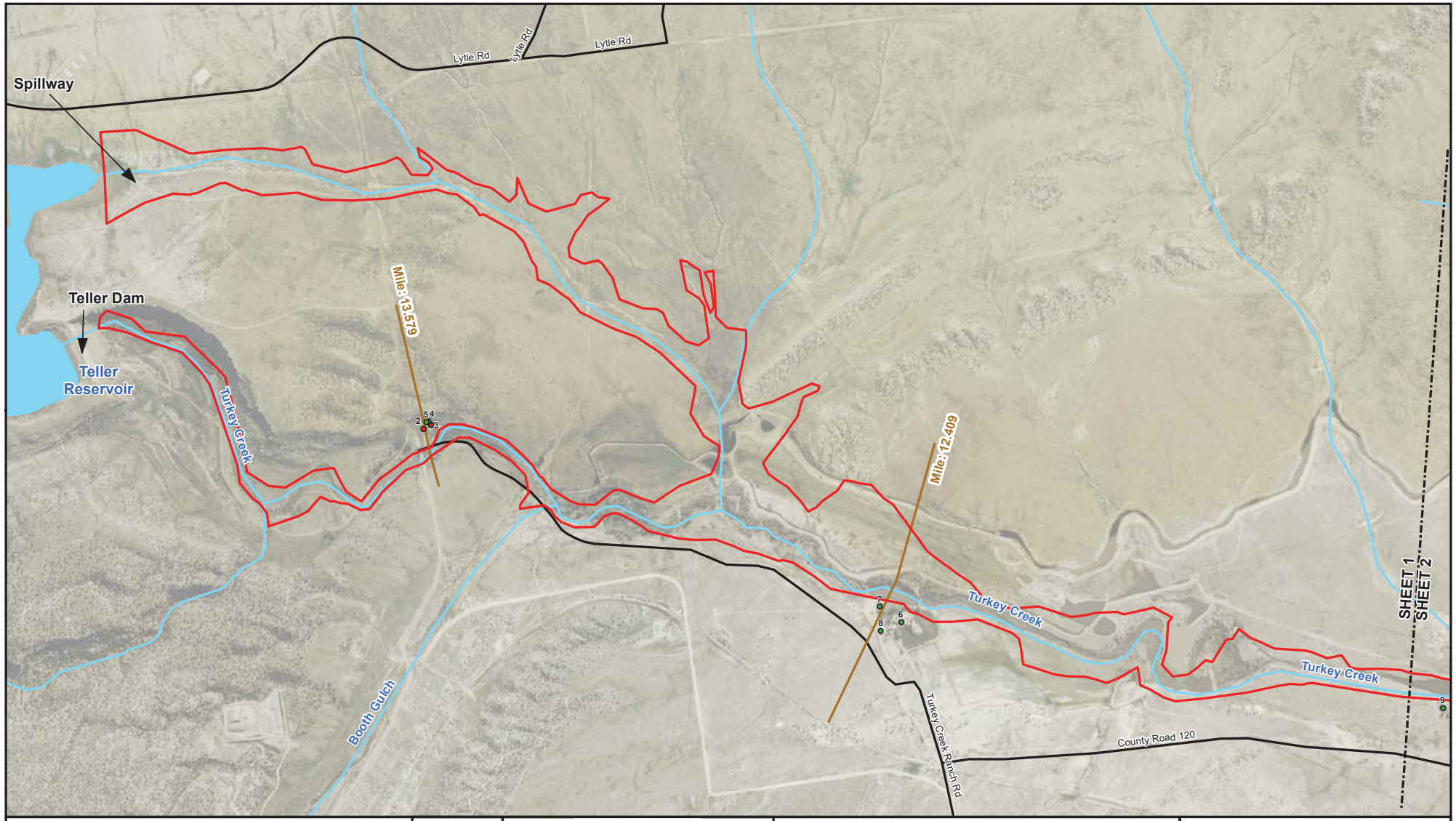
0 500 1,000 2,000 Feet

General Note: Due to the method, procedures, and assumptions used to develop the flooded areas and the limits of the flooding shown are approximate and should be used only as a guideline for evaluating flood hazard. Areas inundated will depend on actual failure conditions and may differ from the areas shown on this map. No flood discharge contribution from tributaries located downstream of the dam are considered for the analyses.

TELLER DAM
100-YEAR ALTERNATIVES
FLOOD INUNDATION MAP
SHEET 1 OF 4

Map Revision Date: 4/1/2016

No Action: 100yr Rain Event



MAP LEGEND

- Cross Sections
- Major Highways
- Railroads
- Local Roads
- Drainageways
- Matchline

Structures

- House
- Other

- A1 100-year
- A2 100-year
- A3 100-year
- A4 100-year
- A5 100-year
- A6 100-year
- A7 100-year
- A8 100-year

N E S W

AECOM

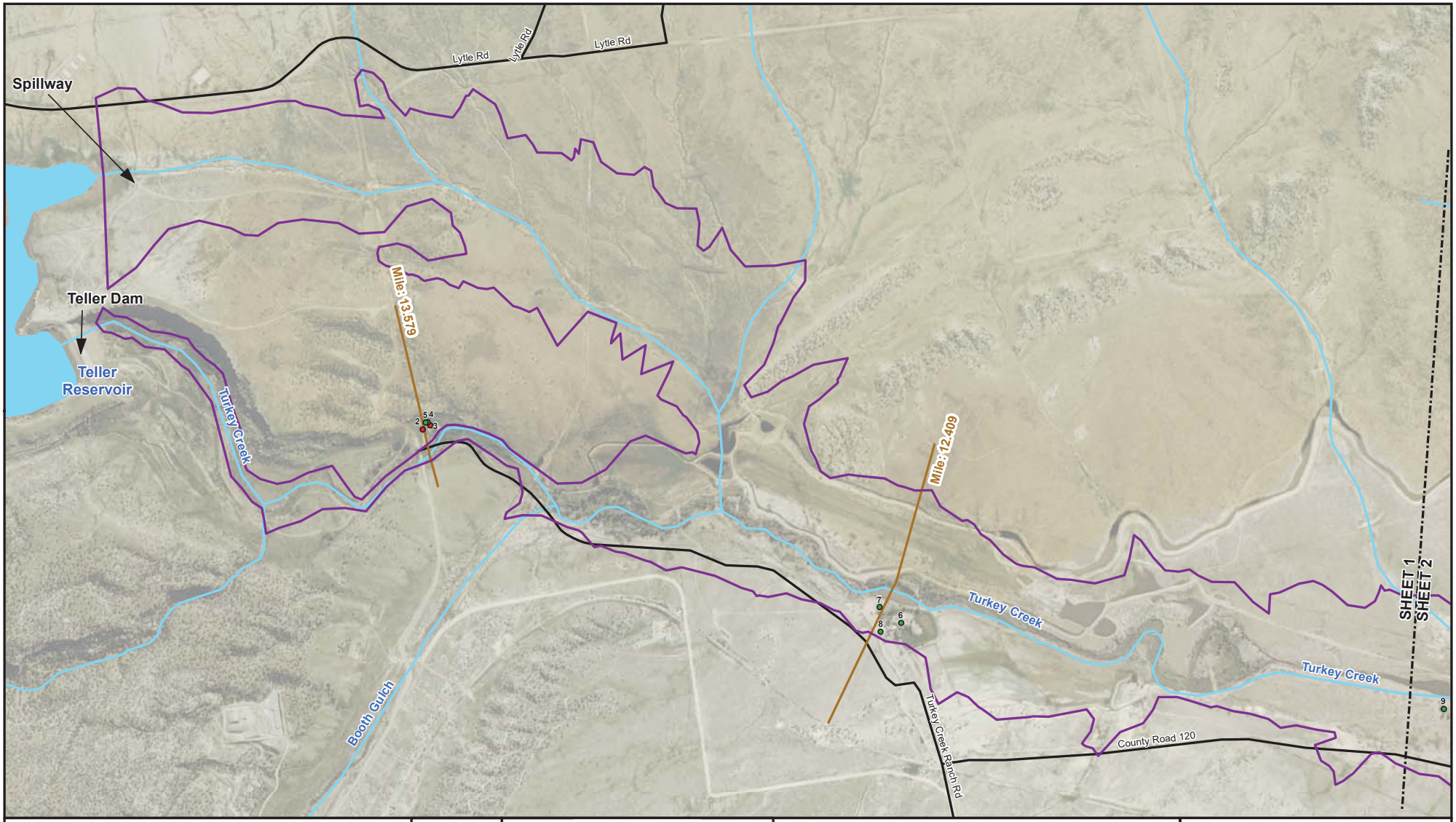
0 500 1,000 2,000 Feet

General Note: Due to the method, procedures, and assumptions used to develop the flooded areas and the limits of the flooding shown are approximate and should be used only as a guideline for evaluating flood hazard. Areas inundated will depend on actual failure conditions and may differ from the areas shown on this map. No flood discharge contribution from tributaries located downstream of the dam are considered for the analyses.

TELLER DAM
100-YEAR ALTERNATIVES
FLOOD INUNDATION MAP
SHEET 1 OF 4

Map Revision Date: 4/1/2016

Preferred Alternative: Probable Maximum Flood(PMF) Event



MAP LEGEND

- Cross Sections
- Major Highways
- Railroads
- Local Roads
- Drainageways
- Matchline

Structures

- House
- Other

A1 PMF, A2 PMF, A3 PMF, A4 PMF, A5 PMF, A6 PMF, A7 PMF, A8 PMF

N E S W

AECOM

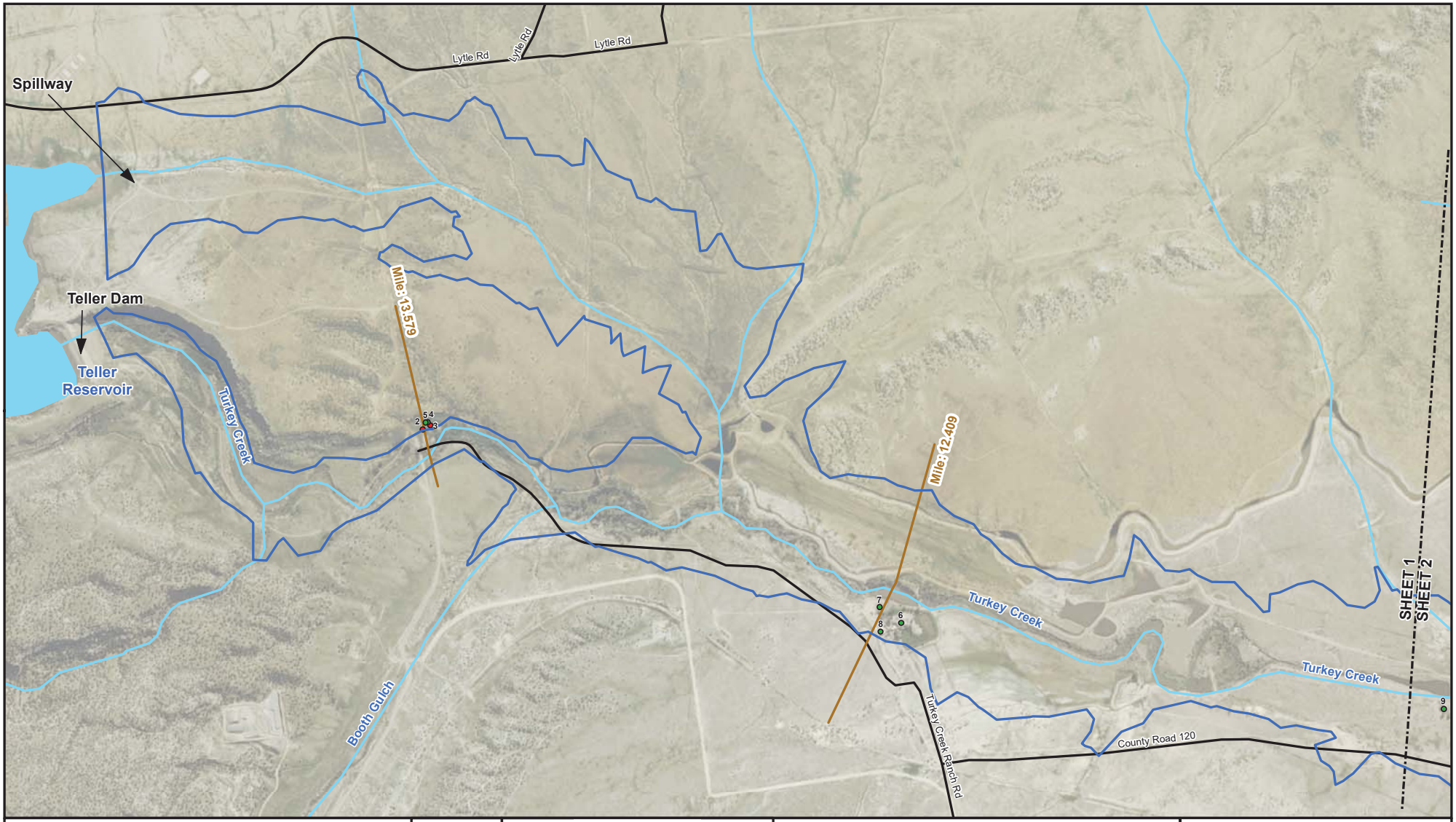
0 500 1,000 2,000 Feet

General Note: Due to the method, procedures, and assumptions used to develop the flooded areas and the limits of the flooding shown are approximate and should be used only as a guideline for evaluating flood hazard. Areas inundated will depend on actual failure conditions and may differ from the areas shown on this map. No flood discharge contribution from tributaries located downstream of the dam are considered for the analyses.

TELLER DAM
PMF ALTERNATIVES
FLOOD INUNDATION MAP
SHEET 1 OF 4

Map Revision Date: 4/1/2016

Alternative 2: PMF Event



MAP LEGEND

- Cross Sections
- Major Highways
- Railroads
- Local Roads
- Drainageways
- Matchline

Structures

- House
- Other

A1 PMF, A2 PMF, A3 PMF, A4 PMF, A5 PMF, A6 PMF, A7 PMF, A8 PMF

N E S W

AECOM

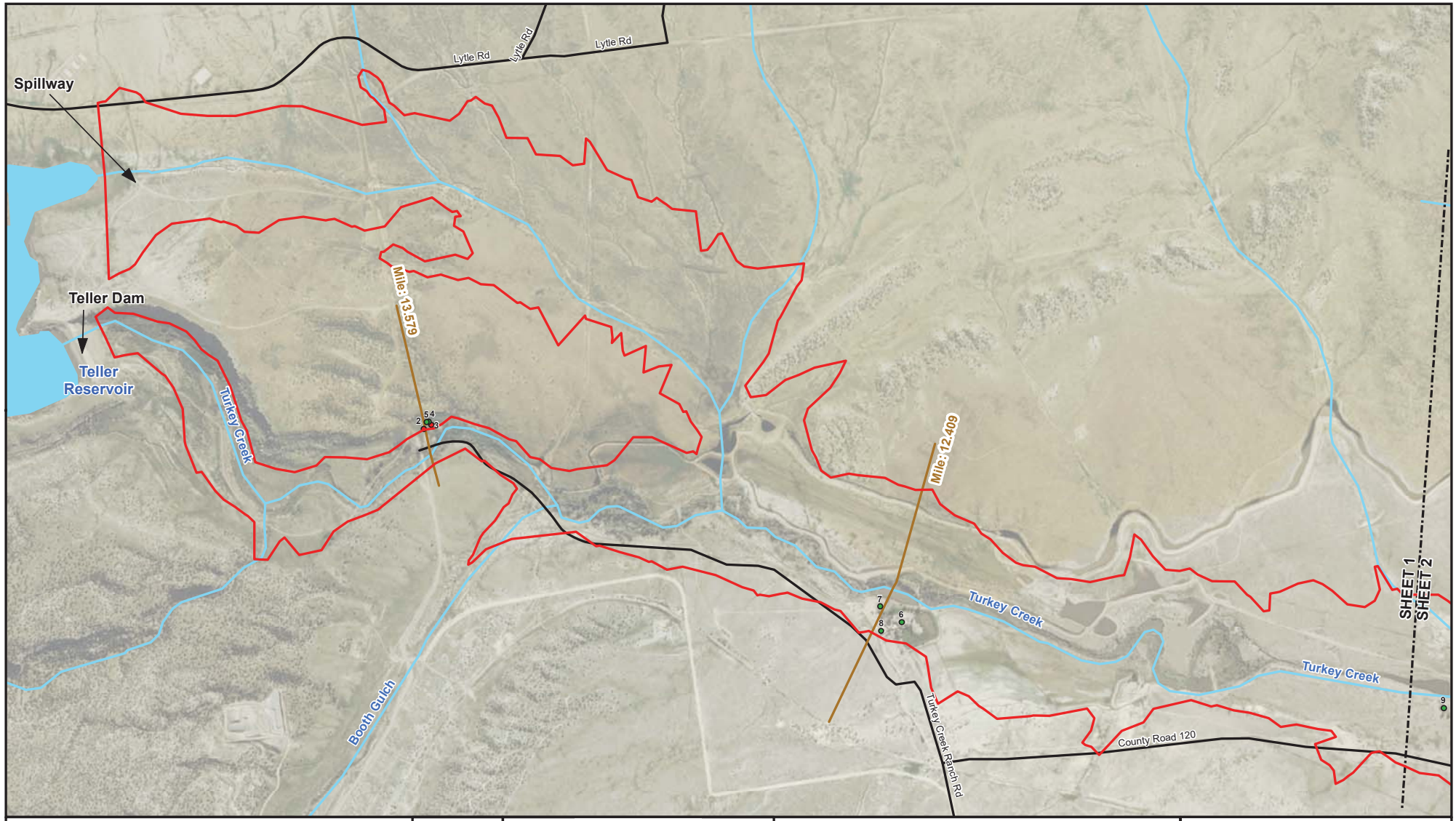
0 500 1,000 2,000 Feet

General Note: Due to the method, procedures, and assumptions used to develop the flooded areas and the limits of the flooding shown are approximate and should be used only as a guideline for evaluating flood hazard. Areas inundated will depend on actual failure conditions and may differ from the areas shown on this map. No flood discharge contribution from tributaries located downstream of the dam are considered for the analyses.

TELLER DAM
PMF ALTERNATIVES
FLOOD INUNDATION MAP
SHEET 1 OF 4

Map Revision Date: 4/1/2016

No Action: PMF Event



MAP LEGEND

- Cross Sections
- Major Highways
- Railroads
- Local Roads
- Drainageways
- Matchline

Structures

- House
- Other

A1 PMF, A2 PMF, A3 PMF, A4 PMF, A5 PMF, A6 PMF, A7 PMF, A8 PMF

N E S W

AECOM

0 500 1,000 2,000 Feet

General Note: Due to the method, procedures, and assumptions used to develop the flooded areas and the limits of the flooding shown are approximate and should be used only as a guideline for evaluating flood hazard. Areas inundated will depend on actual failure conditions and may differ from the areas shown on this map. No flood discharge contribution from tributaries located downstream of the dam are considered for the analyses.

TELLER DAM
PMF ALTERNATIVES
FLOOD INUNDATION MAP
SHEET 1 OF 4

Map Revision Date: 4/1/2016