

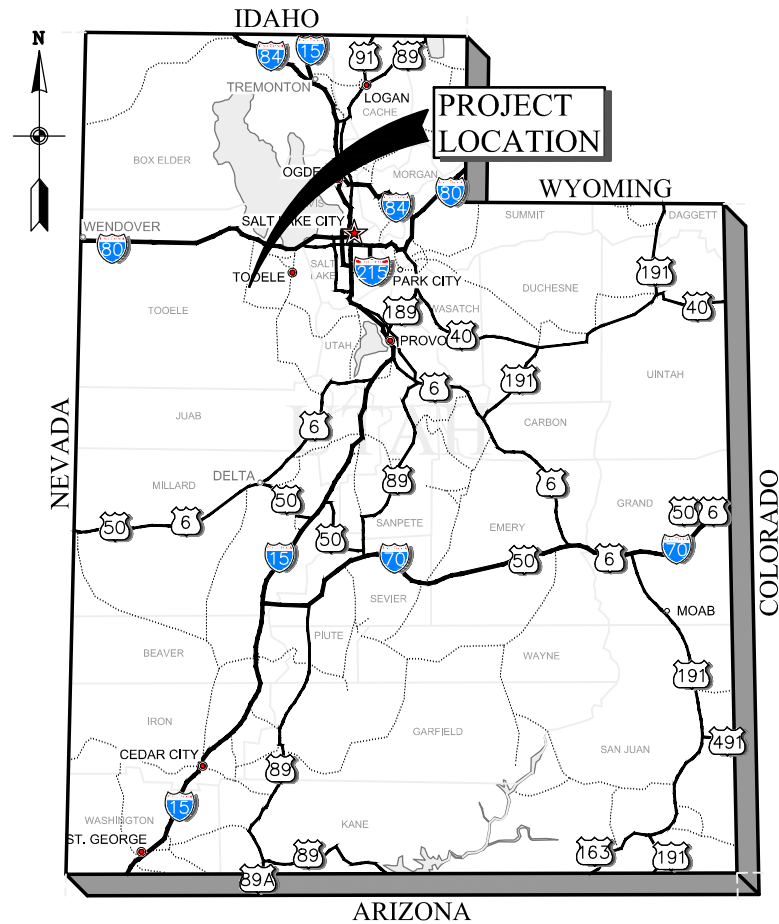
Appendix E

Supporting Information

Concept Design Drawings (Berm and Channel Improvements Full Riprap Alternative)
Concept Design Drawings (Berm and Channel Improvements Reduced Riprap Alternative)
PR&G Analysis Report
Skull Valley Aquatic Resources Report
Biological Assessment
Scoping Report
Skull Valley Watershed EA Hydrology Technical Memorandum
Skull Valley Watershed EA Hydraulics Technical Memorandum
Skull Valley Watershed EA Project Loss of Life Analysis
Cultural Resource Assessment
Addendum Cultural Resource Assessment

Concept Design Drawings
(Berm and Channel Improvements Full Riprap Alternative)

DRAWINGS FOR CONSTRUCTION OF THE WATERSHED PLAN EA TOOELE COUNTY



PROJECT LOCATION MAP

INDEX OF DRAWINGS		
SHT NO	DWG NO	DESCRIPTION
GENERAL		
1	G-01	INDEX OF DRAWINGS, PROJECT LOCATION, AND VICINITY MAPS
2	G-02	ABBREVIATIONS
3	G-03	SYMBOLS
4	G-04	KEY SHEET
CIVIL		
5	C-01	SITE & GRADING PLAN - 1
6	C-02	SITE & GRADING PLAN - 2
7	C-03	SECTIONS - 1
8	C-04	SECTIONS - 2
9	C-05	SECTIONS - 3
GENERAL CIVIL DETAILS		
10	GC-01	CIVIL DETAILS - 1



PROJECT VICINITY MAP



BOWEN COLLINS & ASSOCIATES

100% REVIEW

NOT FOR CONSTRUCTION
FOR REVIEW ONLY

[illegible]

TOOELE COUNTY
WATERSHED PLAN EA
TOOELE COUNTY

DESIGN	REVIEW	VERIFY SCALE BAR IS ONE INCH ON ORIGINAL DRAWING
DESIGN C. NIELSON	CHECKED T. OLSEN	
DRAWN C. NIELSON	APPROVED C. JENKINS	

INDEX OF DRAWINGS, PROJECT LOCATION, AND VICINITY MAPS

DATE:	MAY 2022	PROJECT NUMBER	631-19-01
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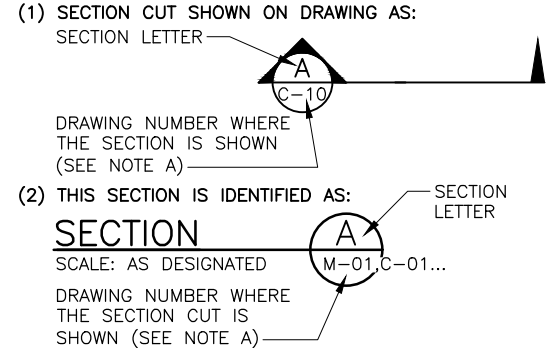
DRAWING NO.

G-01

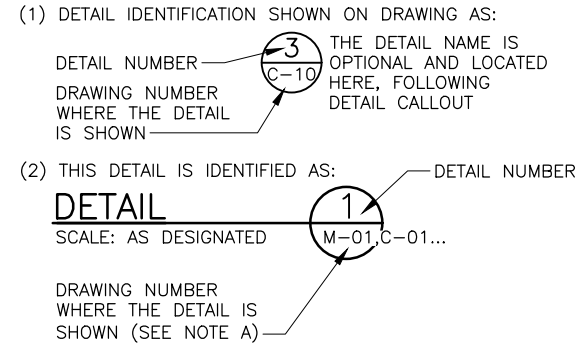
SHEET 1 OF 10

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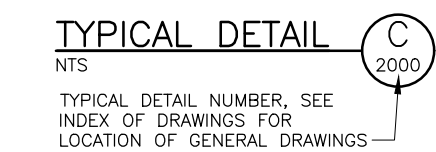
SECTION IDENTIFICATION



DETAIL IDENTIFICATION



TYPICAL DETAIL IDENTIFICATION



DRAWING IDENTIFICATION SYSTEM

LETTER	DISCIPLINE
G	GENERAL
C	CIVIL
GC	GENERAL CIVIL
A	ARCHITECTURAL
GA	GENERAL ARCHITECTURAL
S	STRUCTURAL
GS	GENERAL STRUCTURAL
M	MECHANICAL
GM	GENERAL MECHANICAL
H	HVAC
E	ELECTRICAL
GE	GENERAL ELECTRICAL DETAILS
I	INSTRUMENTATION

S-02

INDIVIDUAL DRAWING NUMBER
DISCIPLINE

NOTES:

- A. IF PLAN AND SECTION (OR DETAIL CALL-OUT AND DETAIL) ARE SHOWN ON SAME DRAWING, DRAWING NUMBER IS REPLACED BY A HORIZONTAL LINE.
- B. ELECTRICAL SYMBOLS SHOWN ON ELECTRICAL DRAWINGS. FOR WELDING SYMBOLS USE AMERICAN WELDING SOCIETY STANDARD SYMBOLS. SEE AMERICAN INSTITUTE OF STEEL CONSTRUCTION MANUAL.

	COORDINATE IDENTIFICATION
	ELEVATION INDICATOR
	SECTION CORNER
	BENCH MARK
	MONUMENT INDICATOR
	POTHOLE
	TEST HOLE
	BORING HOLE
	SECTION LINE
	PROPERTY LINE
	EASEMENT
	PARCEL
	RIGHT-OF-WAY
	NEW ASPHALT
	EXISTING ASPHALT
	CENTERLINE
	CONTOUR LINE, FINISHED GRADE
	CONTOUR LINE, EXISTING GRADE
	FINISHED ELEVATION
	EXISTING ELEVATION
	CUT OR FILL SLOPE TO BE CONSTRUCTED
	SILT FENCE
	FENCE
	RAILING
	DITCH
	CULVERT
	RIPRAP
	TREE LINE/VEGETATION
	EXISTING STRUCTURE OR FACILITY
	NEW STRUCTURE OR FACILITY
	FUTURE STRUCTURE OR FACILITY
	NEW PIPELINE (CIVIL SHEETS)
	NEW PIPELINE 10" DIA AND SMALLER (CIVIL SHEETS)
	EXISTING UTILITY PIPELINE
	ATMS
	CABLE
	COMMUNICATION BURIED
	COMMUNICATION OVERHEAD
	ELECTRICAL BURIED
	ELECTRICAL OVERHEAD
	FIBER OPTICS OVERHEAD
	FIBER OPTICS UNDERGROUND
	GAS
	IRRIGATION
	PETROLEUM LINE
	SANITARY SEWER
	STORM DRAIN
	TELEPHONE BURIED
	TELEPHONE OVERHEAD
	WATERLINE
	CABLE BOX
	CATCH BASIN
	ELECTRICAL BOX
	HYDRANT
	GAS MANHOLE
	SEWER MANHOLE
	STORM DRAIN MANHOLE
	TELEPHONE MANHOLE
	WATER MANHOLE
	WATER METER

	POWER POLE
	TELEPHONE BOX
	LIGHT POLE ONE LUMINAIRE
	LIGHT POLE TWO LUMINAIRS
	LIGHT POLE
	STREET LIGHT WITH BRACKET
	MASONRY
	STEEL
	INSULATION
	GRAVEL
	CONCRETE
	EARTH
	SAND
	ALUMINUM OR METAL DECKING
	CHECKERED PLATE
	GRATING
	PLASTIC, RUBBER OR NEOPRENE
	WOOD (ROUGH FRAMING) OR, OPENING OR DEPRESSION IN SLAB OR WALL
	FIRE HOSE CABINET
	FIRE EXTINGUISHER
	UNIT HEATER
	PRESSURE CLEANOUT TO GRADE
	WALL CLEANOUT
	FLOOR CLEANOUT
	CLEANOUT TO GRADE
	BLOW OFF ASSEMBLY
	HUB DRAIN
	FLOOR DRAIN
	FLOOR SINK
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	CHANGE IN PIPING MATERIAL
	PIPE SIZE AND TYPE/FLUID ABBREVIATION (USE FOR EXISTING PIPE CALLOUT)
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	GATE VALVE
	HOSE BIBB (H/B)
	REDUCER OR INCREASER
	LIQUID SURFACE EL

	REVISION WORK
	REFERENCE TO NOTE
	COLUMN LINE GRID
	WINDOW TYPE
	DOOR NUMBER
	ROOM NUMBER

GENERAL NOTES:

30% REVIEW

NOT FOR CONSTRUCTION
FOR REVIEW ONLY

TOOELE COUNTY
WATERSHED PLAN EA
TOOELE COUNTY

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

REVIEW
CHECKED T. OLSEN
APPROVED C. JENKINS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING

REVISIONS

NO. DATE REV. BY DESCRIPTION

GENERAL
SYMBOLS

DRAWING NO.
G-03

DATE: MAY 2022

PROJECT NUMBER
631-19-01

SHEET 3 OF 10

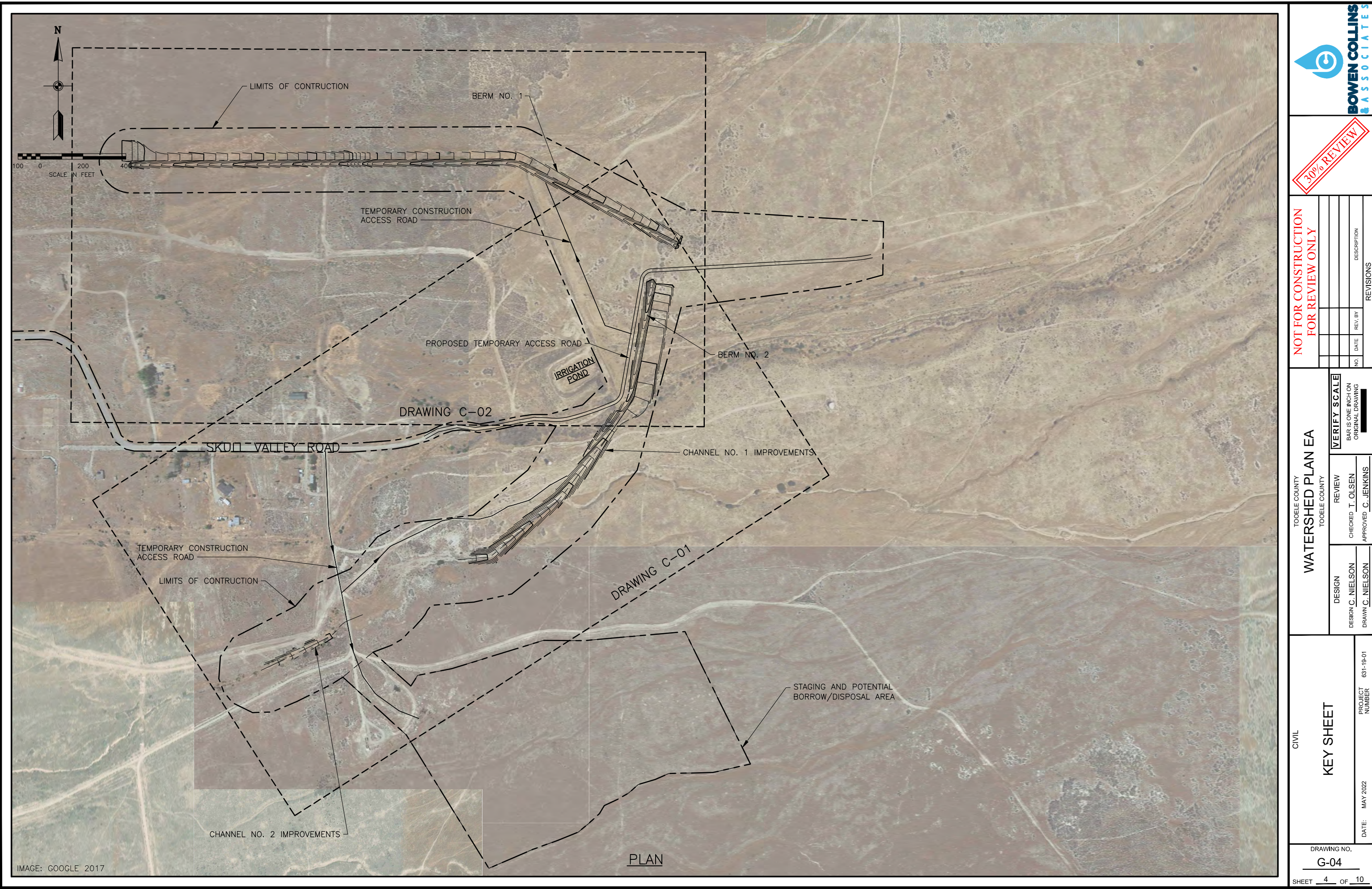


IMAGE: GOOGLE 2017

30% REVIEW

NOT FOR CONSTRUCTION
FOR REVIEW ONLY

NO.	DATE	REV. BY	DESCRIPTION

TOOELE COUNTY
TOOELE COUNTY

DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

REVIEW
CHECKED T. OLSEN
APPROVED C. JENKINS

VERIFY SCALE
BAR IS ONE INCH ON
ORIGINAL DRAWING
1"=100'

CIVIL

KEY SHEET

DATE: MAY 2022
PROJECT NUMBER 631-19-01

DRAWING NO.
G-04

SHEET 4 OF 10



NOTE: THESE VALUES ARE PROVIDED AS AN APPROXIMATION BASED UPON NEATLINE COMPARISON BETWEEN EXISTING AND FINISH GRADE SURFACES.

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**BOWEN COLLINS
& ASSOCIATES**



NOT FOR CONSTRUCTION
FOR REVIEW ONLY

REVISIONS				
NO.	DATE	REV. BY	DESCRIPTION	

TOOELE COUNTY
WATERSHED PLAN EA

TOOELE COUNTY	DESIGN	REVIEW	VERIFY SCALE BAR IS ONE INCH ON ORIGINAL DRAWING
	DESIGN C. NIELSON	CHECKED T. OLSEN	
	DRAWN C. NIELSON	APPROVED C. JENKINS	

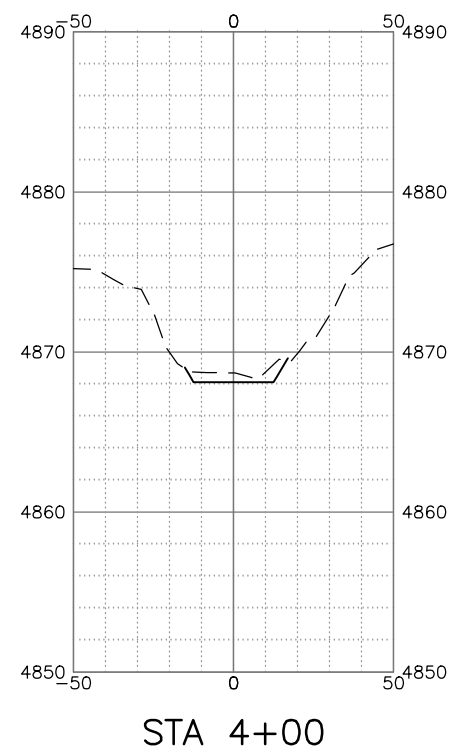
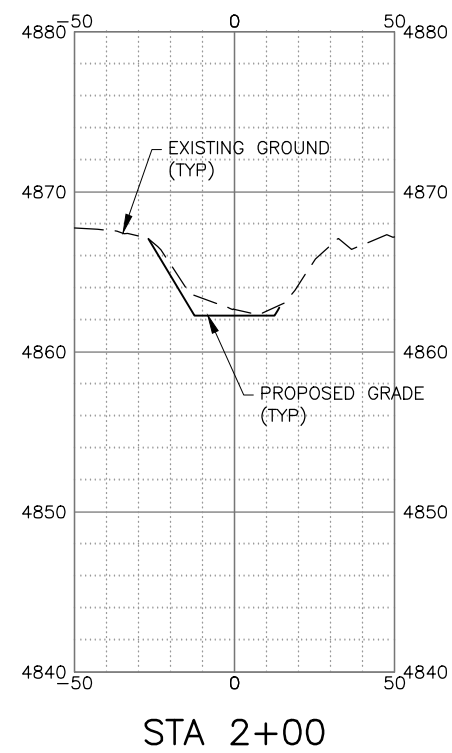
CIVIL

SITE & GRADING PLAN - 2

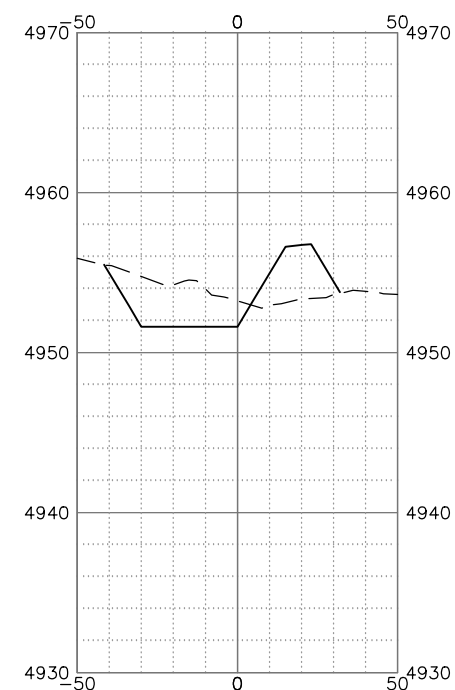
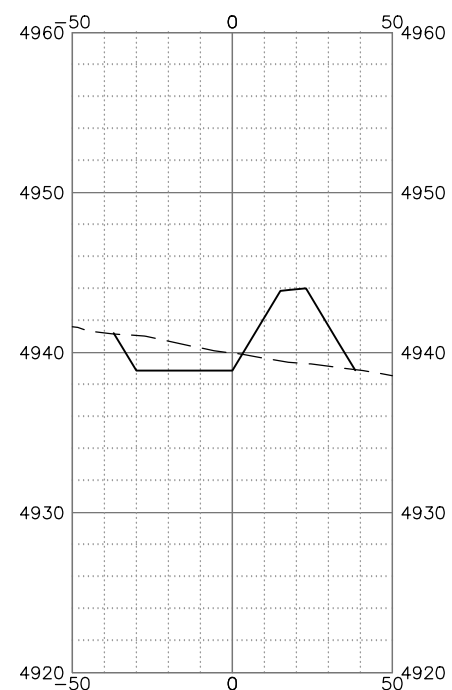
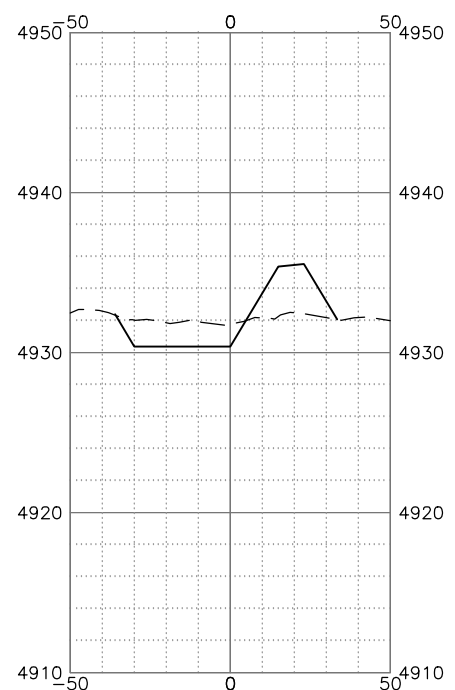
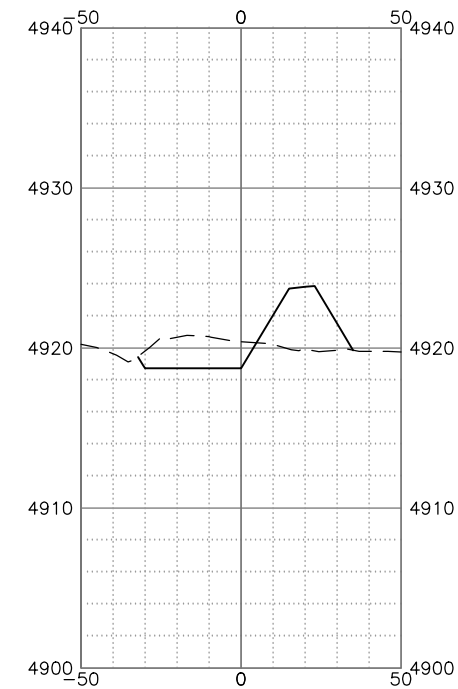
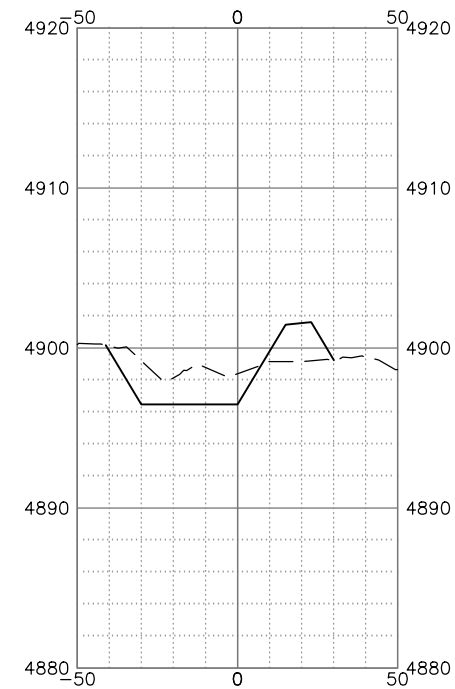
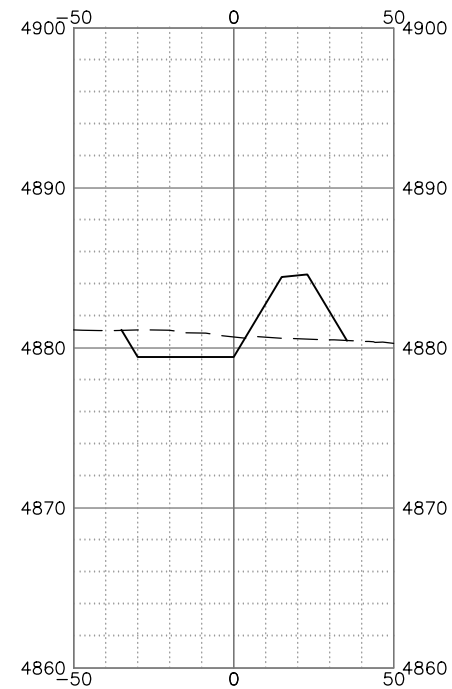
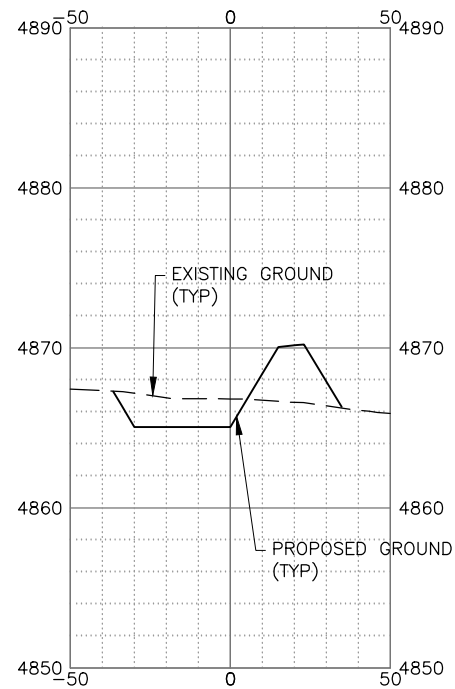
DATE:	MAY 2022	PROJECT NUMBER	631-19-01
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DRAWING NO.
C-02

SHEET 6 OF 10



CHANNEL NO. 2 CROSS SECTIONS

BERM NO. 1 CROSS SECTIONS

30% REVIEW

NOT FOR CONSTRUCTION
FOR REVIEW ONLY

REVISIONS					
NO.	DATE	REV. BY	DESCRIPTION		

TOOELE COUNTY
WATERSHED PLAN EA
TOOELE COUNTY

BAR IS ONE INCH ON
ORIGINAL DRAWING

CHECKED T. OLSEN
APPROVED C. JENKINS

DESIGN C. NIELSON
DRAWN C. NIELSON

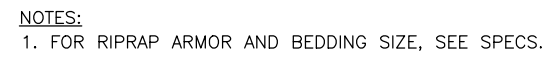
CIVIL

SECTIONS - 3

DATE: MAY 2022 NUMBER 631-19-01

RAWING NO.
C-05

SHEET 9 OF 10



**BOWEN COLLINS
& ASSOCIATES**



FOR REVIEW ONLY				
NO.	DATE	REV. BY	DESCRIPTION	
REVISIONS				

EA

VERIFY SCALE

BAR IS ONE INCH ON
ORIGINAL DRAWING

DESIGN		REVIEW
DESIGN <u>C. NIELSON</u>		CHECKED <u>T. OLSEN</u>
DRAWN <u>C. NIELSON</u>		APPROVED <u>C. JENKINS</u>

CIVIL DETAILS - 1

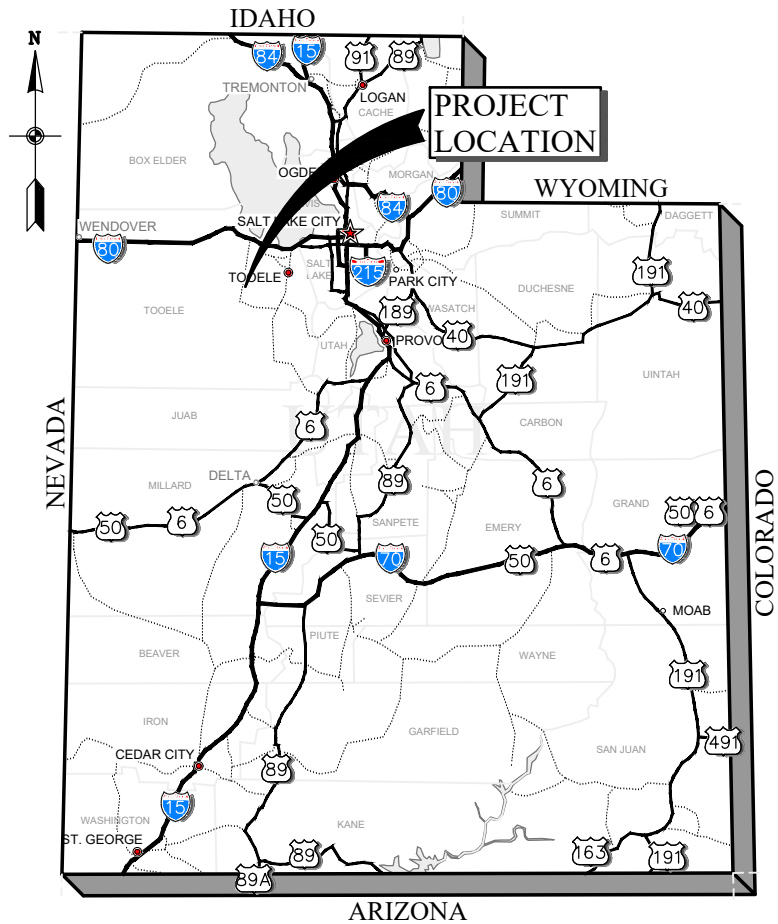
DATE:	MAY 2022	PROJECT NUMBER:	631-19-01
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DRAWING NO.
GC-01

SHEET 10 OF 10

Concept Design Drawings
(Berm and Channel Improvements Reduced Riprap Alternative)

DRAWINGS FOR CONSTRUCTION OF THE
WATERSHED PLAN EA
TOOELE COUNTY



PROJECT LOCATION MAP

INDEX OF DRAWINGS		
SHT NO	DWG NO	DESCRIPTION
GENERAL		
1	G-01	INDEX OF DRAWINGS, PROJECT LOCATION, AND VICINITY MAPS
2	G-02	ABBREVIATIONS
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7	C-03	SECTIONS - 1
8	C-04	SECTIONS - 2
GENERAL CIVIL DETAILS		
9	GC-01	CIVIL DETAILS - 1



PROJECT VICINITY MAP



NOT FOR CONSTRUCTION FOR REVIEW ONLY		REVISIONS	
		NO.	DATE
		REV. BY	DESCRIPTION

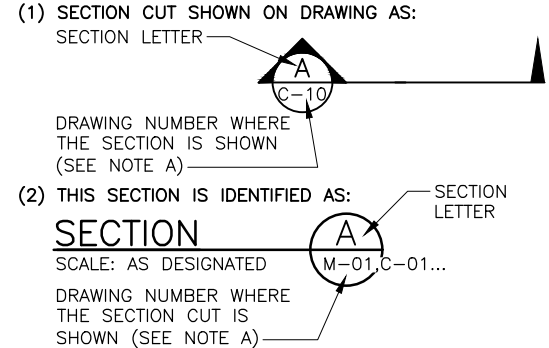
TOOELE COUNTY WATERSHED PLAN EA TOOELE COUNTY		VERIFY SCALE BAR IS ONE INCH ON ORIGINAL DRAWING	
		DESIGN DESIGN C. NIELSON DRAWN C. NIELSON	REVIEW CHECKED T. OLSEN APPROVED C. JENKINS

GENERAL INDEX OF DRAWINGS, PROJECT LOCATION, AND VICINITY MAPS	PROJECT NUMBER	
	DATE: MAY 2022	

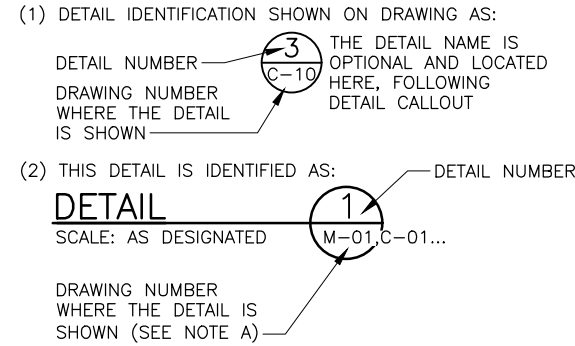
DRAWING NO. G-01	
SHEET 1 OF 9	

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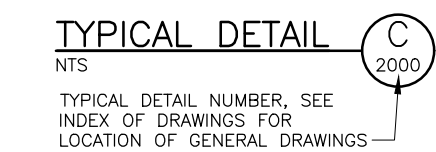
SECTION IDENTIFICATION



DETAIL IDENTIFICATION



TYPICAL DETAIL IDENTIFICATION



DRAWING IDENTIFICATION SYSTEM

LETTER	DISCIPLINE
G	GENERAL
C	CIVIL
GC	GENERAL CIVIL
A	ARCHITECTURAL
GA	GENERAL ARCHITECTURAL
S	STRUCTURAL
GS	GENERAL STRUCTURAL
M	MECHANICAL
GM	GENERAL MECHANICAL
H	HVAC
E	ELECTRICAL
GE	GENERAL ELECTRICAL DETAILS
I	INSTRUMENTATION

S-02

INDIVIDUAL DRAWING NUMBER
DISCIPLINE

NOTES:

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	BENCH MARK
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	PARCEL
	RIGHT-OF-WAY
	NEW ASPHALT
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	CENTERLINE
	CONTOUR LINE, FINISHED GRADE
	CONTOUR LINE, EXISTING GRADE
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	EXISTING ELEVATION
	CUT OR FILL SLOPE TO BE CONSTRUCTED
	SILT FENCE
	FENCE
	RAILING
	DITCH
	CULVERT
	RIPRAP
	TREE LINE/VEGETATION
	EXISTING STRUCTURE OR FACILITY
	NEW STRUCTURE OR FACILITY
	FUTURE STRUCTURE OR FACILITY
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	PETROLEUM LINE
	SANITARY SEWER
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	TELEPHONE BURIED
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	CABLE BOX
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	SEWER MANHOLE
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	TELEPHONE MANHOLE
	WATER MANHOLE
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	POWER POLE
	TELEPHONE BOX
	LIGHT POLE ONE LUMINAIRE
	LIGHT POLE TWO LUMINAIRES
	LIGHT POLE
	STREET LIGHT WITH BRACKET
	MASONRY
	STEEL
	INSULATION
	GRAVEL
	CONCRETE
	EARTH
	SAND
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	CHECKERED PLATE
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	WOOD (ROUGH FRAMING) OR OPENING OR DEPRESSION IN SLAB OR WALL
	FIRE HOSE CABINET
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	PRESSURE CLEANOUT TO GRADE
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	FLOOR CLEANOUT
	CLEANOUT TO GRADE
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	FLOOR DRAIN
	FLOOR SINK
	DRAIN TRAP
	CHANGE IN PIPING MATERIAL
	PIPE SIZE AND TYPE/FLUID ABBREVIATION (USE FOR EXISTING PIPE CALLOUT)
	PIPE CALLOUT (SEE PIPING SCHEDULE)
	EQUIPMENT NUMBER (SEE EQUIPMENT SCHEDULE)
	STOP GATE
	SLIDE GATE
	SLUICE GATE
	GATE VALVE
	HOSE BIBB (H/B)
	REDUCER OR INCREASER
	LIQUID SURFACE EL

	REVISION WORK
	REFERENCE TO NOTE
	COLUMN LINE GRID
	WINDOW TYPE
	DOOR NUMBER
	ROOM NUMBER

GENERAL NOTES:

30% REVIEW

NOT FOR CONSTRUCTION
FOR REVIEW ONLY

TOOELE COUNTY
WATERSHED PLAN EA
TOOELE COUNTY

DESIGN
C. NIELSON
DRAWN
C. NIELSON

REVIEW
CHECKED T. OLSEN
APPROVED C. JENKINS

VERIFY SCALE
BAR IS ONE INCH ON
ORIGINAL DRAWING

REVISIONS

DATE: MAY 2022

PROJECT NUMBER 631-19-01

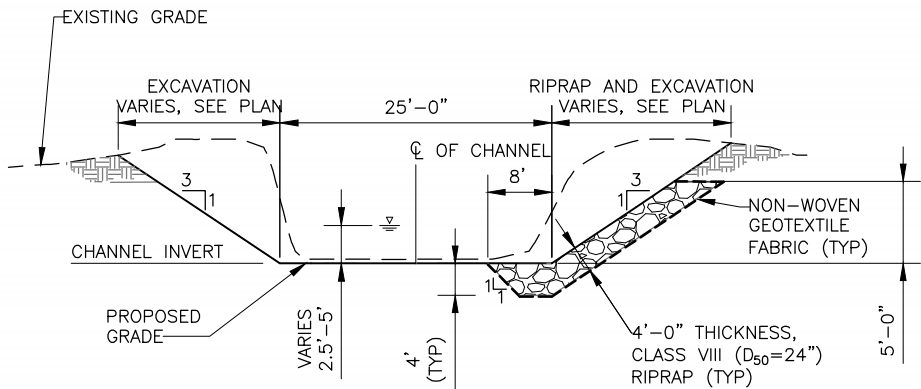
DRAWING NO.
G-03

SHEET 3 OF 9



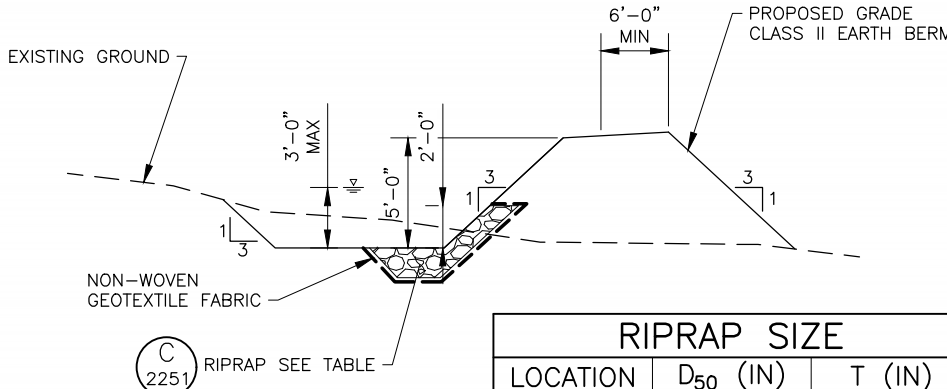
CUT/FILL QUANTITIES	
CUT (CY)	FILL (CY)
12861	3340

NOTE: THESE VALUES ARE PROVIDED AS AN APPROXIMATION BASED UPON NEATLINE COMPARISON BETWEEN EXISTING AND FINISH GRADE SURFACES.



TYPICAL CHANNEL DETAIL
SCALE: NONE

1



RIPRAP SIZE		
LOCATION	D ₅₀ (IN)	T (IN)
BERM NO. 1	6	12
BERM NO. 2	12	24

TYPICAL BERM DETAIL
SCALE: NONE

2

IMAGE: GOOGLE 2017 CONTOURS: 2'

30% REVIEW

NOT FOR CONSTRUCTION
FOR REVIEW ONLY

NO.	DATE	REV. BY	DESCRIPTION

TOOELE COUNTY
WATERSHED PLAN EA
TOOELE COUNTY

DESIGN	REVIEW	VERIFY SCALE
DESIGN C. NIELSON DRAWN C. NIELSON	CHECKED T. OLSEN APPROVED C. JENKINS	BAR IS ONE INCH ON ORIGINAL DRAWING

CIVIL
SITE & GRADING PLAN - 1

DATE: MAY 2022	PROJECT NUMBER 631-19-01
----------------	--------------------------



NOTE: THESE VALUES ARE PROVIDED AS AN APPROXIMATION BASED UPON NEATLINE COMPARISON BETWEEN EXISTING AND FINISH GRADE SURFACES.



REVISIONS			
NO.	DATE	REV. BY	DESCRIPTION

VERIFY SCALE

BAR IS ONE INCH ON
ORIGINAL DRAWING



TOOELE COUNTY

REVIEW

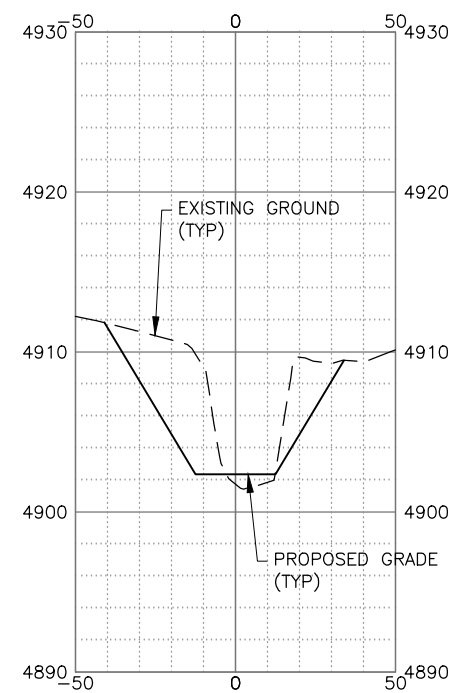
CHECKED T. OLSEN

APPROVED C. JENKINS

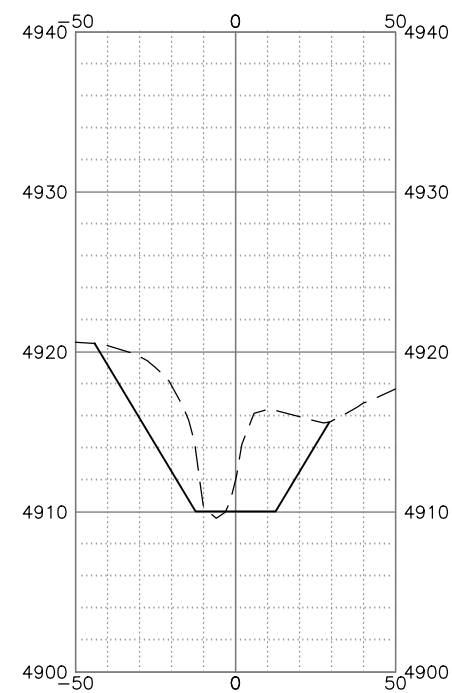
DESIGN
DESIGN C. NIELSON
DRAWN C. NIELSON

DATE:	MAY 2022	PROJECT NUMBER	631-19-01
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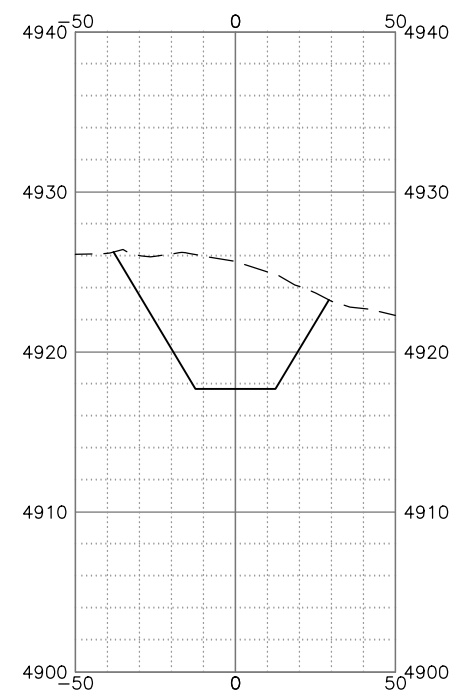
SHEET 6 OF 9



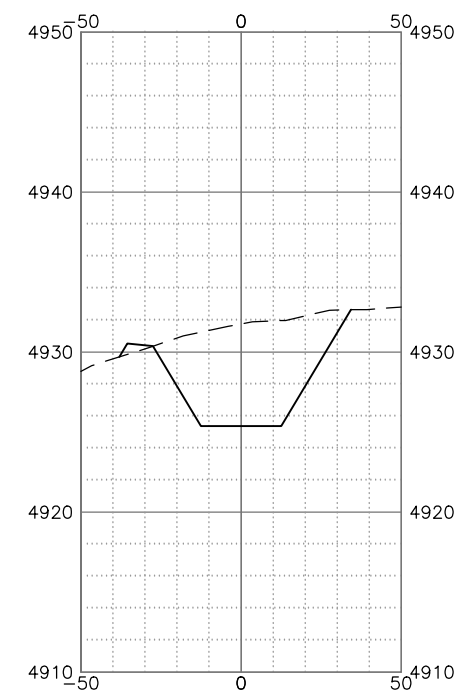
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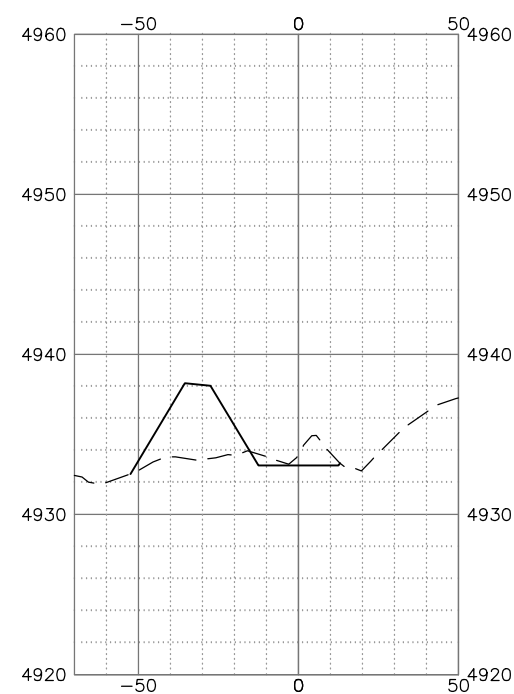
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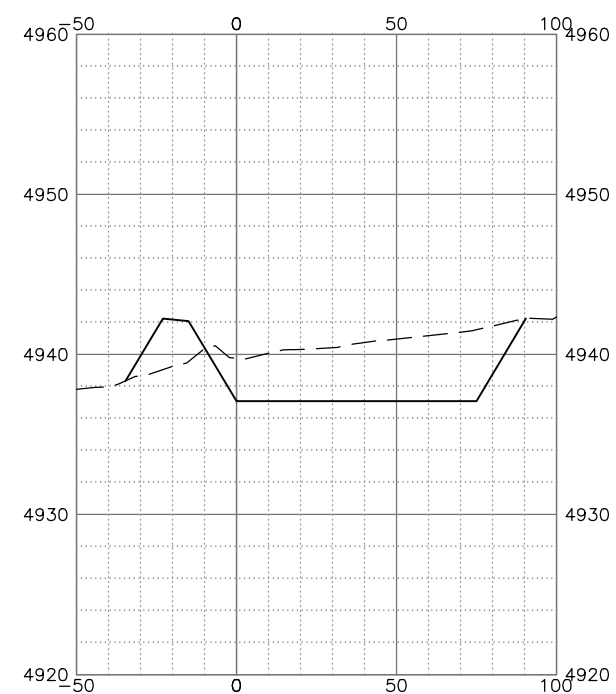
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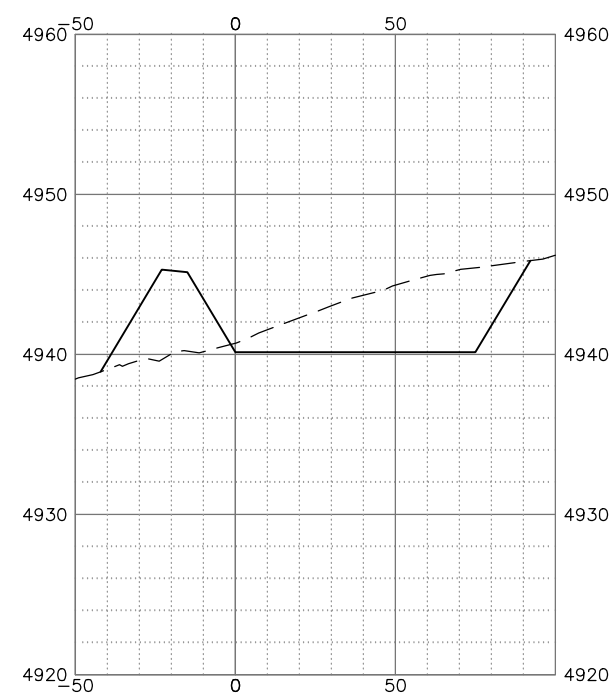
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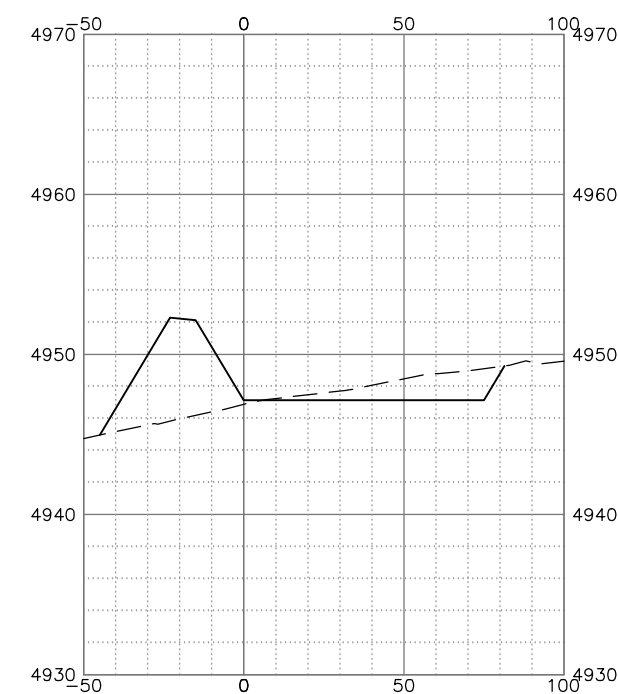
STA 20+00



STA 22+00



STA 24+00



STA 26+00

CHANNEL NO. 1 / BERM NO. 2
CROSS SECTIONS

30% REVIEW

NOT FOR CONSTRUCTION
FOR REVIEW ONLY

REVISIONS					
NO.	DATE	REV. BY	DESCRIPTION		

BAR IS ONE INCH ON
ORIGINAL DRAWING

TOOELE COUNTY
WATERSHED PLAN EA
TOOELE COUNTY

CHECKED T. OLSEN
APPROVED C. JENKINS

NOTES

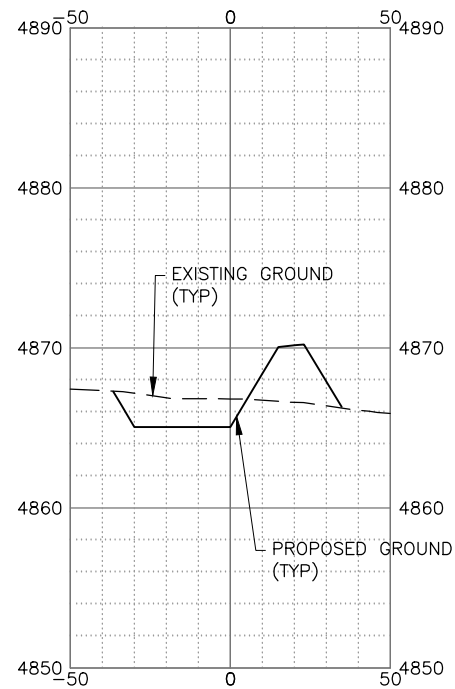
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NUMBER

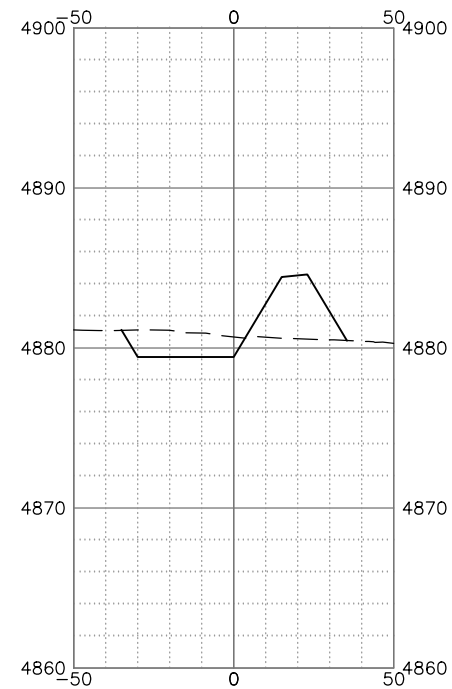
631-19-01

AWING NO.
C-03

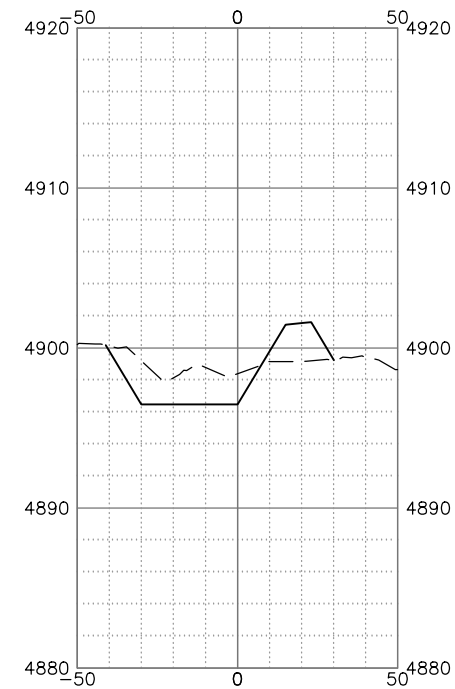
SHEET 7 OF 9



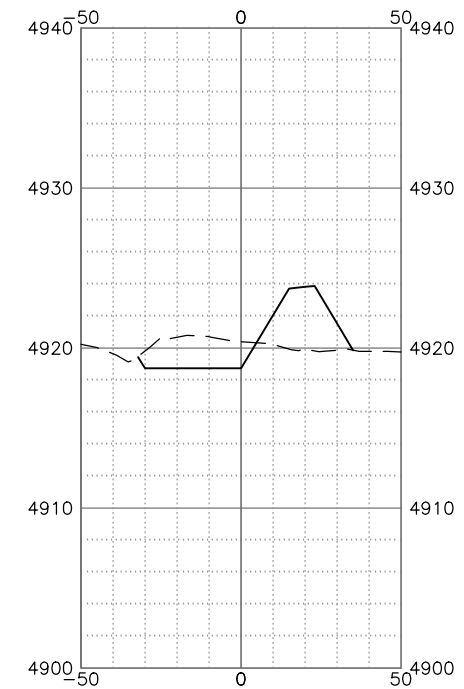
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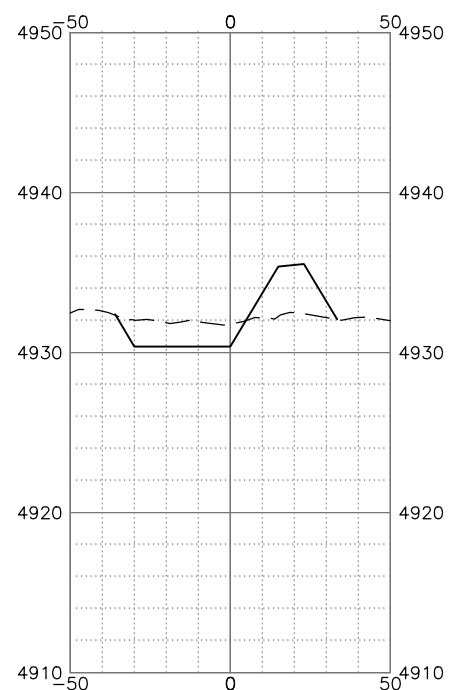
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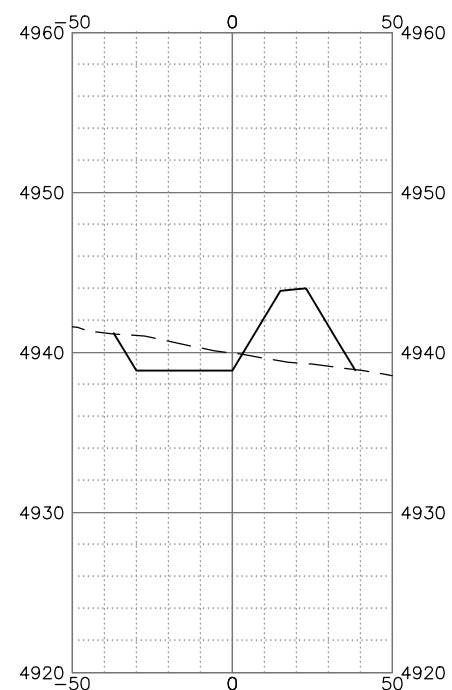
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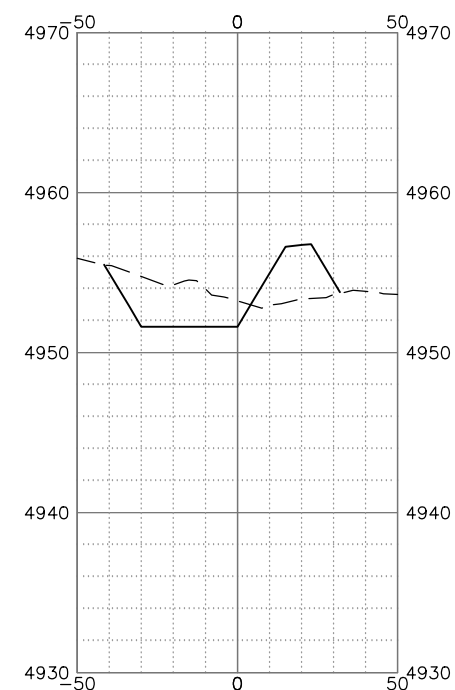
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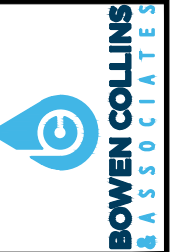
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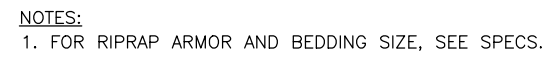
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SECTIONS - 2

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SHEET 8 OF 9



**BOWEN COLLINS
& ASSOCIATES**



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REVISIONS				

EA

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WATERSHED PLAN TOOELE COUNTY	DESIGN	REVIEW
	DESIGN <u>C. NIELSON</u>	CHECKED <u>T. OLSEN</u>
	DRAWN <u>C. NIELSON</u>	APPROVED <u>C. JENKINS</u>

CIVIL DETAILS - 1

DATE: MAY 2022

PROJECT NUMBER: 631-19-01

DRAWING NO.
GC-01

SHEET 9 OF 9

PR&G Analysis Report

Skull Valley Flood Prevention Project Skull Valley Watershed Tooele County, Utah

PR&G Analysis Report

Final

October 2, 2024



Prepared for:



Prepared by:



Long Watershed Planning
Economics, LLC

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1.0 Introduction

A Natural Resources Conservation Service (NRCS) Watershed Plan and Environmental Assessment (Plan-EA) is being prepared for the Skull Valley Flood Prevention Project (Project) located within the Skull Valley Watershed in Tooele County, Utah. The Project is authorized under the NRCS Watershed and Flood Prevention Operations Program and funded through the Watershed Protection and Flood Prevention Act of 1954 (PL 83-566). Tooele County and the Skull Valley Band of Goshute Indians are cooperating in the Project as the Sponsoring Local Organizations (SLOs). The Project consists of flood prevention measures to protect the Skull Valley Reservation (Reservation) developed community from flooding.

The intent of this report is to document Project compliance with Principles, Requirements, and Guidelines for Federal Investments in Water Resources (PR&G) per the *Principles and Requirements for Federal Investments in Water Resources* (Council on Environmental Quality [CEQ] 2013), the *Final Interagency Guidelines* (CEQ 2014), and *NRCS Decision Memorandum for the Acting Chief on PR&G for NRCS Watershed Programs* (NRCS 2018).

2.0 PR&G Evaluation Process Overview

The PR&G evaluation process is based on an eight-step watershed planning process and was completed for the Project as described in this section. The NRCS nine-step planning process was also followed in conjunction with the PR&G evaluation process. The PR&G eight-step evaluation process includes consideration of the federal objective, PL 83-566 general purposes, guiding principles, and ecosystem services. Guiding principles were used to assist in decision making and weighing tradeoffs of Project alternatives, and the use of an ecosystem services framework to describe the comprehensive set of benefits that people receive from nature characterized as ecological goods and services provided by a healthy, functioning environment. The guiding principles are outlined in the PR&G documents and include:

- 1) Healthy and Resilient Ecosystems
- 2) Sustainable Economic Development
- 3) Floodplains (avoiding unwise use of floodplains)
- 4) Public Safety (reducing public health and safety risks)
- 5) Environmental Justice
- 6) Watershed Approach

Ecosystem services benefits have been organized into four service categories that are reflected in the Department of Agriculture Departmental Manual (DM9500-13) and include:

- 1) Provisioning services are tangible goods provided for direct human use and consumption, such as food, fiber, water, timber, or biomass.
- 2) Regulating services maintain a world in which it is possible for people to live, providing critical benefits that buffer against environmental catastrophe – examples include flood and disease control, water filtrations, climate stabilization or crop pollination.

- 3) Supporting services refer to the underlying processes maintaining conditions for life on earth, including nutrient cycling, soil formation, and primary production.
- 4) Culture services make the world a place in which people want to live – recreational use, spiritual, aesthetic viewsheds, or tribal values.

The guiding principles and service categories were evaluated for those that were critical to the decision maker, the analysis, and the stakeholders. A measurement of change in services was determined, where applicable, between the Future without Federal Investment (FWOFI) Alternative, also referred to as the No Action Alternative, and the Future with Federal Investment (FWFI) Alternatives, also referred to as Action Alternatives. An evaluation framework was developed to compare the FWOFI and FWFI Alternatives and is attached in Appendix A. This framework was used to select the “best” alternative that maximized public benefits (environmental, economic, and social goals) with appropriate consideration of costs, and included consideration of the guiding principles and ecosystem services.

3.0 PR&G Eight-Step Evaluation Process

The PR&G eight step evaluation process was used in decision making as outlined in Sections 3.1 through 3.8 below.

3.1 Identify Problems and Opportunities

Problems and opportunities were identified during the Project scoping process. Input from the Sponsors, agencies, the public, organizations, and tribes were solicited as described in Sections 3.0 and Section 7.3.2 of the Plan-EA. A copy of the Scoping Report is provided in Appendix E of the Plan-EA. Engineering analysis was completed to further identify and evaluate problems as documented in the engineering technical memorandums (TMs) attached in Appendix E of the Plan-EA. The purpose and need of the project was formulated with the problems and opportunities in consideration. Where the “purpose” identifies the fundamental reason why the action is being proposed and the “need” describes the problems that the proposed action is intended to address and explains the underlying causes of the problems. The purpose and need of the Project is included in Section 2.1 of the Plan-EA with information supporting the purpose and need and watershed problems in Sections 2.2 of the Plan-EA. The purpose and need of the Project, as stated in the Plan-EA for reference, is included below.

“The purpose of the Project is to prevent flooding to the developed community of the Skull Valley Band of Goshute Reservation for up to a 1 percent annual chance flood (24-hour/100-year flood). There is a need to protect the reservation structures, roads, utilities, and property within the 100-year floodplain.”

3.2 Inventory Existing Resource Conditions

Resources relevant to the proposed action were determined during the scoping process as described in Section 3.0 of the Plan-EA. The existing conditions of resources determined to be relevant are documented in Section 4.0 (Affected Environment) of the Plan-EA. The Affected Environment section of the Plan-EA provides the environmental baseline conditions for resources to be evaluated against alternative actions. The best available data and science was used to

inventory the existing resource conditions at the level and scale of analysis determined reasonable for evaluating alternatives and impacts.

3.3 Forecast Future Conditions

A forecast of future conditions was made for resources, where reasonable to address, in the Affected Environment section (Section 4.0) of the Plan-EA. Additional future conditions forecasting was made for each alternative and associated implementation and O&M costs. Future forecasting of alternative impacts is described in Section 6.0 (Environmental Consequences) of the Plan-EA. The installation and O&M costs for future conditions of each alternative are provided in Section 5.5 of the Plan-EA.

3.4 Develop Array of Alternatives

Project alternatives were formulated following procedures outlined in the National Watershed Program Manual, National Watershed Program Handbook, and PR&G. Alternatives required in the initial consideration per PR&G include the FWOFI Alternative and the FWFI Alternatives consisting of a nonstructural alternative, locally preferred alternative, environmentally preferable alternative, and additional alternatives.

Ten (10) Action Alternatives were developed to resolve the problems identified in the Skull Valley Watershed for flood prevention to the developed community of the Reservation. Descriptions of alternative measures are provided in Section 5.0 of the Plan-EA. Public Law 83-566 provides for federal assistance for these measures under the authorized purposes of flood prevention (flood damage reduction).

Several levels of flood protection were considered as part of the alternative formulation including a 2 percent annual chance flood (50-year flood), 1 percent annual chance flood (100-year flood), and 0.2 percent annual chance flood (500-year flood). The 500-year flood is taken into consideration only for sensitive facilities and infrastructure. No flooding to sensitive facilities or infrastructure occurs during a 500-year flood. Therefore, alternatives to protect sensitive facilities were determined not applicable to the alternative formulation process.

A 50-year level of flood protection was also considered in alternatives development. During modeling efforts conducted by BC&A (BC&A 2022), it was discovered that conveying a 50-year flood through the 100-year flood protection alternative design resulted in a minimal difference in water depth between the two storms in the new and modified channel sections. There was less than 0.25 feet difference in water surface elevation along the proposed north berm and new channel between the 50-year and 100-year flood. For the south berm, new channel, and modified channel segments, the difference in water surface elevations were less than 0.75 feet, with some segments less than 0.5 feet, and others less than 0.25 feet difference. Based on the model results, BC&A determined that the construction costs between a 50-year level of protection and 100-year level of protection would have minimal difference between the two designs. Additionally, the NWPH provides exceptions for disadvantaged communities to increase the level of protection beyond the level that maximizes the net benefits. These exceptions include (NWPH 602.0 (C):

- 1) Housing values in the benefited area are less than 75 percent of state average values.
- 2) The average per capita income for the last three years in the benefited area is less than 75 percent of the national average, or current unemployment in the project area is twice the national average over the past 3 years.
- 3) The project benefit-cost ratio is greater than the ratio of the national 3-year average per capita income to the per capita income in the benefited area.

It was determined by Long Watershed Planning Economics, LLC that the Reservation meets exceptions 1 and 2 above. Documentation for meeting these exceptions is included in Appendix C. Therefore, the 50-year level of protection alternative was eliminated from detailed evaluation in the PR&G analysis and in the Plan-EA based on the following conclusions:

- Engineering data indicates that there would be minimal difference in construction cost between a 50-year and 100-year level of protection.
- The Reservation meets the exceptions for a disadvantaged community to allow for an increased level of flood protection beyond the level that maximizes the net benefits.
- The 50-year level of protection alternative does not meet the purpose and need of the Project.

Other alternatives were removed from further consideration and analysis during the PR&G evaluation if they were determined infeasible, did not meet the purpose and need, conflicted with the federal objective or guiding principles, had exorbitant costs, or determined to be inferior due to other critical factors. In those cases, a brief discussion is included in the evaluation framework table (Attachment A) to identify the reasons for elimination of an alternative. A discussion of the alternatives eliminated and the reasons for elimination are also documented in Section 5.4 of the Plan-EA.

There were three Action Alternatives selected for evaluation in the framework table. These include the Berm and Channel Improvements Full Riprap Alternative with Ford Crossing, the Berm and Channel Improvements Full Riprap Alternative, and the Berm and Channel Improvements Reduced Riprap Alternative, which all meet a 100-year level of flood protection.

The FWOFI Alternative (No Action Alternative) was also evaluated to provide a benchmark for comparison. The FWOFI Alternative consisted of continued O&M for the existing channels and culvert crossing.

3.5 Evaluate Effects of Individual Alternatives

The guiding principles listed in Section 2.0 above and ecosystem services for provisioning, regulating, cultural, and supporting, as applicable, were assessed for the selected FWFI Alternatives and the FWOFI Alternative. The ecosystem services determined to be applicable to Project measures for evaluation are listed below. Because short-term construction impacts would be avoided or minimized, only measurable long-term effects to ecosystem services are considered for the PR&G framework table and determination of applicability.

Provisioning Services

- Food/Biomass (agriculture)

Regulating Services

- Flood Control

Cultural Services

- Well-being and Safety
- Cultural Identity and Heritage

An economic analysis was also completed for the FWOFI and FWFI alternatives evaluated in the framework tables for each site as described in Section 3.5.1 below.

3.5.1 Economic Evaluation

The economic analysis was completed by Long Watershed Planning Economics, LLC. The economic analysis included the FWFI Alternatives determined reasonable for evaluation as part of the alternative development process. The FWFI Alternatives include the Berm and Channel Improvements Full Riprap Alternative with Ford Crossing (hereinafter referred to as Alternative 1), the Berm and Channel Improvements Full Riprap Alternative (hereinafter referred to as Alternative 2), and the Berm and Channel Improvements Reduced Riprap Alternative (hereinafter referred to as Alternative 3).

The economic evaluation considered the benefits and costs of these three FWFI alternatives. The FWOFI or No Action Alternative was also evaluated. The FWOFI is the most likely future condition in the absence of federal action or federal funding which provides the baseline for comparison of the FWFI.

The basis of the economic evaluation is the quantification and valuation of flood damages with and without the project measures, by flooding depth for each modeled storm event. A brief physical description of the damages by depth follows.

3.5.1.1 Flood water depths

Flood depth has a large impact on what is affected in a building by a flood (Risk Factor™). A few inches of water may cause serious damage and necessitate expensive repairs and/or replacement of items. The risk of mold will be increased.

Outside of the buildings, flooding can cause large damage to transportation and public infrastructure. Six inches of flowing water can knock down an adult, while twelve inches may carry away a small automobile. Roads can be made impassable. Driving should not be attempted if flood depth reaches the middle of the vehicles wheel. Roads can be closed due to high sediment deposition, impeding critical emergency services and economic activity.

3.5.1.2 *Typical Impacts of Urban Flooding*

Half a foot to a foot of floodwater:

- Yards (rotted roots, attraction of insects)
- Drywall, exposed insulation, wallpaper (rotting, mold, loss of insulation, requiring replacement)
- Carpeted, laminate, and wood flooring (carpet and padding difficult cleaning, laminate peeling apart, wood warping and rotting, requiring replacement)
- Operating an automobile (stalling, loss of traction)
- Insulated appliances (more than six inches can require replacement due to electrical parts and insulation)

One to Three Feet (all of the above plus below)

- HVAC, furnaces (contaminated or corroded systems may need replacement)
- Electrical outlets (will need replacement if touched by water)
- Automobiles (can float in one foot of water, and engines can be severely damaged)
- Large appliances (dishwashers, washers and dryers may need repair with greater than 2 feet of water)

3 feet+ of water (all of the above plus below)

- Buildings foundation and framework (damage may occur too severe to repair)
- Utilities (water supply, sewage, plumbing may have lasting damage)

3.5.1.3 *Benefit Calculations*

Monetary economic benefits identified for the analysis include flood prevention to buildings and crops. Flooding can also result in mental health issues with associated costs, and forgone income. Floods can destroy livelihoods, cause massive debt, threaten life, and damage homes and ruin prized possessions, turning lives upside down and disrupting communities. Increases in depression, post-traumatic stress disorder, and substance abuse are well documented in the aftermath of floods and can persist for years afterward (MarshMcLennan 2021). These costs were not calculated as part of the flood damages due to uncertainties in calculation methods, but they are important to note as they influence impacted individuals financially.

Flood damage reduction benefits were assessed based on the equivalent annual damage reduction expected through implementation of the FWFI as compared with the FWOFI baseline. The period of analysis for all alternatives is 101 years. There is a 1-year installation period for the FWFI Alternatives. All costs and benefits were discounted to a net present value, then annualized over the 100-year evaluation period using the 2023 Federal Water Resources Discount Rate of 2.5% (NRCS 2023).

Average annual flood damages were calculated using the cumulative probability method as specified in the URB1 manual (SCS 1990). The 5-, 10-, 25-, 50-, 100-, 200-, and 500-year storm events for each alternative were modeled using HEC-RAS. Mapping of the flood extents, and

inundation to structures and lands was calculated through GIS analysis. Damaged structures and lands were classified into one of three categories: inundated less than 1 foot, inundated 1 to 3 feet, or inundated greater than 3 feet, for each storm event. Depth-damage functions were collected from the USACE to use for each type of structure (USACE 2004). These types included permanent homes, a community center, and commercial buildings. Most of the structures damaged were one-story homes without a basement, so this depth to damage function was used for homes. Depth damage functions relate a flooding depth in a structure to a percent damage to the value of the structure, and to the estimated value of its contents. This estimate is coupled with the probability of occurrence of that particular storm event, to arrive at average annual damage figures.

All structures are on the Reservation, where structures are exempt from state taxes and no information was readily available regarding their value through usual procedures (ie. property tax records). No parcel information or tax information is available for any of the structures nor was scope provided to perform a survey of structures to support the analysis. Because of this, values were collected from tax data for structures in adjacent towns (Rush Valley and Terra). For the community center and the commercial buildings, the construction cost was collected from RS Means estimates, then adjusted to arrive at a replacement value suitable for flood damage analysis. Damages were calculated for the structures and their contents.

Calculations of the analysis for the FWOFI Alternative and FWFI Alternatives urban flood damage is included in Table 1 and Table 2. No damage would occur for flood events less than a 5-year flood.

Table 1. FWOFI Alternative Flood Damage for Structures

Storm Event (YR)	Homes		Community Center		Commercial/ Industrial Buildings ¹		Other		Total	Average Annual
	<1 ft	1-3 ft	<1 ft	1-3 ft	<1 ft	1-3 ft	<1 ft	1-3 ft		
5	12	1	1	-	-	-	-	-	\$287,343	\$37,800
10	13	1	1	-	1	-	1	-	\$468,662	\$28,120
25	13	1	1	-	1	-	1	-	\$468,662	\$9,373
50	13	1	1	-	1	-	1	-	\$468,662	\$4,879
100	15	1	1	-	1	-	1	-	\$507,068	\$2,700
200	14	2	-	1	1	-	1	-	\$573,129	\$1,917
500	12	4	-	1	2	-	1	-	\$704,785	\$1,410
Total										\$86,199

1 - Industrial building appears to be a shop. Commercial building is an abandoned gas station that is not flooded until the 500-yr event.

2- Other is a well and well house that supplies the Reservation with potable water.

Table 2. FWFI Alternative Flood Damage for Structures

Storm Event (YR)	Homes		Community Center		Commercial/ Industrial Buildings ¹		Total	Average Annual
	<1 ft	1-3 ft	<1 ft	1-3 ft	<1 ft	1-3 ft		
5	1*	-	-	-	-	-	\$25,583	\$2,558
10	1*	-	-	-	-	-	\$25,583	\$1,535
25	1*	-	-	-	-	-	\$25,583	\$512
50	1*	-	-	-	-	-	\$25,583	\$256
100	1*	-	-	-	-	-	\$25,583	\$128
200	1*	-	-	-	-	-	\$25,583	\$237
500	2*	-	-	-	1*	-	\$132,223	\$264
Total								\$5,490

1 - Commercial building is an abandoned gas station.

*- All flooding is less than 0.5-foot in depth.

Flood damage reduction benefits were calculated based on the equivalent annual damage reduction expected through implementation of the FWFI as compared with the FWOFI baseline, sometimes referred to as a with/without analysis. Table 3 below identifies the calculated damage reduction for structures, and hay/pasture.

Table 3. FWFI Alternative Flood Damage Reduction Summary

Item	FWOFI Flood Damage	FWFI Flood Damage	Annual Flood Damage Reduction
Structures	\$86,200	\$5,500	\$80,700

3.5.1.4 Alternative Costs

Alternative costs were calculated by BC&A for installation of measures and for O&M costs. The FWOFI alternative does not include installation measures and consists only of O&M to maintain the existing channels and culvert crossing. The FWFI alternatives installation costs include construction, engineering, administrative time, and permitting. The FWFI alternative costs also include O&M cost if greater than the FWOFI alternative. The BC&A detailed costs are enclosed in Attachment B for reference.

The annualized installation and O&M costs were calculated for the FWFI using the FY 2023 Water Resources Discount Rate (2.5%), annualized over 100 years with a 101-year period of analysis. Calculated annual costs are provided in Table 4.

Table 4. Alternative Installation and O&M Costs

Improvements	Installation Cost	Average Annual Installation Cost	Average Annual OM&R Costs	Total Average Annual Costs
Alternative 1 (Berm and Channel Improvements Full Riprap with Ford Crossing)	\$3,375,000	\$89,900	\$3,600	\$93,500
Alternative 2 (Berm and Channel Improvements Full Riprap)	\$2,742,000	\$73,100	\$8,000	\$81,100
Alternative 3 (Berm and Channel Improvements Reduced Riprap)	\$1,533,000	\$40,800	\$8,000	\$48,800
FWOFI	-	-	\$6,300	\$6,300

3.5.1.5 Cost Benefit Comparison

The FWOFI and FWFI alternative annualized costs and benefits were compared to determine a benefit cost ratio and total average annual economic benefits (Table 5). The results of the cost benefit comparison were incorporated into the evaluation framework tables included in Appendix A.

Table 5. Cost Benefit Comparison

Improvements	Total Annual Benefits	Total Annual Costs	Benefit Cost Ratio	Net Annual Benefits
Alternative 1	\$80,700	\$93,500	0.8	(\$12,800)
Alternative 2	\$80,700	\$81,100	1.0	(\$400)
Alternative 3	\$80,700	\$48,800	1.7	\$31,900
FWOFI	\$ -	\$6,300	0.0	(\$6,300)

As with all projections of future costs and benefits, there is a degree of uncertainty assumed. Installation costs, O&M costs, usage of conserved resources, and commodity and input prices will all fluctuate. Certain storm events may occur more or less frequently than the probability estimated for them indicates. Fluctuating cost factors impacting benefits include the size and extent of damage, the type of water damage (clean water, grey water, or black water), the materials or items being replaced or restored, and the local market (cost of labor and materials, building code considerations). While economic estimates are not precise, the intention is that they are reasonably accurate and can assist in making good Federal investment decisions.

3.5.2 Environmental Evaluation

An environmental evaluation was completed for each alternative included in detailed study. These include the FWOFI Alternative (No Action Alternative) and two of the FWFI Alternatives (Alternatives 2 and 3). Alternative 1 was eliminated from further analysis based on the results of

the economic analysis showing negative benefits. The potential effects of each alternative included in detailed study were determined for relevant resource categories and are documented in Section 6.0 (Environmental Consequences) of the Plan-EA.

3.6 Compare Alternatives

A measurement of change in services was determined, where applicable, between the FWOFI Alternative and FWFI Alternatives. The alternatives meeting the guiding principles were noted in the framework table for side-by-side alternative comparison. The ecosystem services were also compared in the framework table. The PR&G evaluation comparison tables for decision making are included in Appendix A.

Alternatives were evaluated to determine the locally, environmentally, and socially preferred alternative plans. The locally preferred alternative was coordinated with the those having local interests and oversight for implementation authorities and responsibilities. The local entities included Tooele County and the Skull Valley Band of Goshute Indians. The environmentally preferred alternative was selected based on evaluations and decision making performed during the NEPA process, and from the determination of environmental consequences as documented in Section 6.0 of the Plan-EA. Determination of the socially preferred alternative compared impacts or benefits for each alternative related to the wellbeing and safety of the community.

3.7 Identify Recommended Alternative

The PR&G evaluations resulted in selection of one alternative that “best” maximized public benefits (environmental, economic, and social goals) with appropriate consideration of costs, guiding principles, and ecosystem services. Alternative 3 (Berm and Channel Improvements Reduced Riprap Alternative) was selected as the recommended alternative. This alternative was also selected in consideration of the federal objective, as set forth in the Water Resources Development Act of 2007, that reflect national priorities, encourage economic development, and protect the environment through:

- 1) Seeking to maximize sustainable economic development.
- 2) Seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used.
- 3) Protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems.

Alternative 3 is in line with the federal objective as outlined above. It maximizes sustainable economic development for the Reservation community. The alternative minimizes vulnerabilities to hazards caused from flooding of the developed Reservation community. The recommended alternative minimizes damage to natural systems and no mitigation measures are anticipated.

The intent of the Project is also in line with the PL 83-566 general purposes to

- 1) Prevent damage from erosion, floodwater, and sediment.
- 2) Further the conservation, development, utilization, and disposal of water.

- 3) Further the conservation and proper utilization of land.

Alternative 3 is considered the National Economic Efficiency (NEE) alternative for the Plan-EA based on the results of the PR&G Analysis. Alternative 3 provided the greatest cost-benefit, met the guiding principles, provided the greatest benefits for ecosystem services, and is in line with the federal objective and PL 83-566 general purposes. The Plan-EA incorporates a description of the decision-making process for selection of the NEE alternative in 8.1 (Rationale for Preferred Alternative Selection).

3.8 Implement and Evaluate

Alternative 1 was eliminated from further analysis in the Plan-EA based on the results of the economic analysis showing negative benefits. The NEE alternative (Alternative 3) and Alternative 2 were evaluated in the Plan-EA and environmental consequences of the alternatives are included in Section 6.0 of the Plan-EA. The FWOFI alternative was also evaluated in the Plan-EA to provide a baseline comparison. The effects of alternatives were determined for each resource relevant to the proposed action. The evaluation assessed the proposed alternatives against the baseline data presented in Section 4.0 (Affected Environment) of the Plan-EA.

An additional evaluation of the NEE alternative was completed that included information on implementing the proposed measures. This included recommended measures to be installed, avoidance/minimization measures, required permits and compliance, installation/financing, O&M, costs, cost share, and economic benefits. This is included in Section 8.0 (Preferred Alternative) of the Plan-EA.

4.0 References

BC&A. 2022d. Skull Valley Watershed EA Project Loss of Life Analysis. Dated November 11, 2022.

CEQ (Council of Environmental Quality). 2013. Principles and Requirements for Federal Investments in Water Resources. Dated March 2013. Accessed online at: <https://obamawhitehouse.archives.gov/administration/eop/ceq/initiatives/PandG>.

CEQ. 2014. Interagency Guidelines. dated December 2014. Accessed online at: <https://obamawhitehouse.archives.gov/administration/eop/ceq/initiatives/PandG>.

MarshMcLennan. 2021. Sunk costs: The socioeconomic impacts of flooding. Rethinking Flood Series, Report 1. Accessed online at: <https://www.marshmcclennan.com/insights/publications/2021/june/the-socioeconomic-impacts-of-flooding.html>

NRCS (Natural Resources Conservation Service). 2014. National Watershed Program Handbook, 2nd Edition, April 2014 Parts 600 through 606.

NRCS. 2015. National Watershed Program Manual, 4th Edition, April 2014, as amended January 2015, Parts 500 through 506.

NRCS. 2018. Decision Memorandum for the Acting Chief. Implementation of the Principles, Requirements, and Guidelines (PR&G) for NRCS Watershed Programs. Signed April 2018.

NRCS. 2023. NRCS FY2023 Water Resource Project Discount Rate. Rate for Federal Water Projects for NRCS Economics.

RiskFactor™. Greater Depths of Flooding Cause More Damage. Accessed at:
<https://help.riskfactor.com/hc/en-us/articles/360048265533-Greater-depths-of-flooding-cause-more-damage>

SCS. 1990. Urban Floodwater Damage Economic Evaluation: URB1. Documentation for Computer Program.

USACE. 2004. USACE Commercial Depth Damage Factors. Excel Spreadsheet. Accessed at:
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/nwmc/partners/?&cid=nrcs143_009725.

Appendix A

PR&G Framework and Tradeoff Table

PR&G Framework and Tradeoff Table

Skull Valley Flood Prevention Project

Skull Valley Watershed

Alternatives Considered					
Future Without Federal Investment (FWOFI): No Action Alternative The SLO's most likely course of action would be to continue O&M activities for the existing channel and culvert crossing.					
Future With Federal Investment (FWFI): Action Alternatives Alternative 1: Berm and Channel Improvements Full Riprap with Ford Crossing Alternative Alternative 2: Berm and Channel Improvements Alternative Full Riprap Alternative 3: Berm and Channel Improvements Alternative Reduced Riprap Alternative 4: Relocate Reservation Community (nonstructural alternative) Alternative 5: Debris Basin and Berm Alternative Alternative 6: Landform and Berm Alternative Alternative 7: Berm Alternative Alternative 8: Flood Proofing Alternative Alternative 9: Protection for 50-Year Flood Alternative Alternative 10: Protection for 500-Year Flood for Sensitive Facilities Alternatives 5 through 7 had higher costs than other alternatives included in detailed study without providing any additional benefit and were eliminated from evaluation in the table below. Alternative 4 is the nonstructural alternative, but there are no lands within the Reservation that would be suitable for relocation as they are all exposed to flooding, and this alternative was determined not feasible. Alternative 8 was eliminated from further study in the table below because it left a risk to loss of life. Alternative 9 was eliminated because it did not meet the purpose and need and does not provide the desired flood protection for the disadvantaged community. Alternative 10 was determined not applicable because no sensitive facilities or infrastructure are flooded during the 500-year flood. Alternatives 1, 2, and 3 are included in the evaluation table below. Please refer to Section 5.5 of the Plan-EA for further description of alternatives developed and justification for elimination.					
Summary and Comparison					
Item	FWOFI	FWFI			Comments
		Alternative 1	Alternative 2	Alternative 3	
Alternative Plans					
Locally Preferred				✓	Tooele County and the Skull Valley Band of Goshute Indians are in support of Alternative 3.
Nonstructural					There is not a feasible non-structural alternative that would meet the purpose and need.
Environmentally Preferred				✓	Alternative 3 allows for reduced riprap and maintaining a natural channel bank on the non-reservation bank of the modified channel segments
Socially Preferred		✓	✓	✓	All FWFI Alternatives provide the same flood protection benefit.
National Economic Efficiency				✓	Alternative 3 was determined to be the combination of measures that provided the greatest economic benefits, had the least amount of adverse impacts to the environment, and best met the guiding principals and ecosystem services.
Guiding Principles					
Healthy and Resilient Ecosystems				✓	Alternative 3 is the alternative that has the least amount of environmental impacts while meeting the purpose and need of the Project.
Sustainable Economic Development		✓	✓	✓	All FWFI Alternatives have the same benefits to economic development of the Reservation.
Floodplains		✓	✓	✓	None of the alternatives have measurable adverse long-term environmental impacts to floodplains.
Public Safety		✓	✓	✓	All FWFI alternatives improve public safety equally.
Environmental Justice		✓	✓	✓	All FWFI alternatives benefit the disadvantaged Reservation community with an equal level of flood protection.
Watershed Approach		✓	✓	✓	All FWFI alternatives address the watershed problems identified to reduce flooding for up to and including a 100-year flood for the Reservation community.

Evaluation Framework and Tradeoffs				
Item	FWOFI	FWFI*		
		Alternative 1	Alternative 2	Alternative 3
Provisioning Services				
Food/Biomass	Hay/pasture areas would continue to be at risk of flooding.	Reduces damages to hay/pasture lands with an estimated annual benefit of \$700.	Same as Alternative 1	Same as Alternative 1
Regulating Services				
Flood Control	The developed Reservation community would continue to be exposed to damaging floods.	Protects the developed Reservation community from flooding for up to and including a 100-year flood with an estimated annual benefit of \$80,700	Same as Alternative 1.	Same as Alternative 1.
Cultural Services				
Well-being and Safety	The Reservation community would continue to be threatened from risk of flooding, adversely impacting their mental and physical well-being and threatening their safety. If a large flood were to occur, the community would suffer from substantial mental and physical health impacts from possible injury, loss of life, destruction of property, financial stressors, etc. that would exist in the wake of the flood.	The threat of flooding to the developed Reservation community would be reduced. This would improve the mental and physical well-being for all tribe members present within the floodplain that are currently at risk.	Same as Alternative 1	Same as Alternative 1
Cultural Identity and Heritage	Skull Valley Band of Goshute Indian lands would continue to be flooded, damaging lands and structures that are a part of their cultural identity and heritage.	The developed Reservation community would be protected from flooding for up to a 100-year flood. This would reduce damages to lands and structures that are part of the Skull Valley Band of Goshute Indian cultural identity and heritage.	Same as Alternative 1	Same as Alternative 1
Economic Analysis				
Item	FWOFI	FWFI		
		Alternative 1	Alternative 2	Alternative 3
Costs				
Installation Federal PL 83-566	-	\$2,750,000	\$2,694,000	\$1,502,000
Installation Sponsor	-	\$625,000	\$48,000	\$31,000
Annual Installation Costs	-	\$89,900	\$73,100	\$40,800
Annual O&M Costs	\$6,300	\$3,600	\$8,000	\$8,000
Total Annual Costs	\$6,300	\$93,500	\$81,100	\$48,800
Annual Benefits				
Total Annual Benefits (Flood Damage Reduction)	-	\$81,400	\$81,400	\$81,400
Cost Benefit Ratio and Net Benefits				
Cost-Benefit Ratio	-	0.9	1.0	1.7
Net Benefit	(\$6,300)	(\$12,100)	\$300	\$32,600
Decision-Making Conclusion	The FWOFI alternative is provided for comparison purpose and is not selected as the NEE Alternative.	All FWFI Alternatives provide the same benefit, but Alternative 1 costs more resulting in negative economic benefits. Additionally, Alternative 1 impacts more linear feet of waters of the U.S. than the other FWFI Alternatives. Therefore, this alteranative was not selected as the NEE Alternative.	All FWFI Alternatives provide the same benefit, but Alternative 2 costs more than Alternative 3, resulting in less economic benefits. Additionally, Alternative 3 provides a more environmentally friendly option to maintain a natural unarmored channel bank on the non-reservation side of the modified channel segment. Therefore, this alteranative was not selected as the NEE Alternative.	Selected as the NEE Alternative: Alternative 3 has the greatest benefit to ecosystem services, the greatest economic benefit, and is the locally, socially, and environmentally preferred alternative that meets the purpose and need of the Project.

Appendix B

Cost Estimates

Alternative 1 (Berm and Channel Improvements Full Riprap with Ford Crossing)

Construction Cost Estimate

Item	Quantity	Units	Unit Cost	Cost ¹
Mob/Demob	1	LS	\$168,200	\$168,200
Survey	1	LS	\$33,700	\$33,700
SWPPP	1	LS	\$40,000	\$40,000
Berm/Channels Excavation	22,100	CY	\$7	\$154,700
Berm/Road Fill/Diversion Berm Construction	11,500	CY	\$14	\$161,000
Disposal of Excavated Berm Material	10,600	CY	\$3	\$31,800
Riprap Excavation	13,020	CY	\$7	\$91,140
Riprap	14,100	CY	\$80	\$1,128,000
Riprap Geotextile	16,100	SY	\$3	\$48,300
Berm Natural Seeding	135,000	SF	\$0.20	\$27,000
Ford Excavation and Construction	1,300	CY	\$22	\$28,600
Concrete Ford	300	CY	\$1,100	\$330,000
Ford Base	200	CY	\$65	\$13,000
Ford Riprap	200	CY	\$80	\$16,000
Road Repair Fill and Construction	800	CY	\$30	\$24,000
Road Repair Base	400	CY	\$65	\$26,000
Subtotal				\$2,321,000
Contingency (30%)				\$696,000
TOTAL				\$3,017,000

1 – Rounded to the nearest thousand

Installation Cost

Item	Cost ¹
Construction	\$3,017,000
Engineering	\$232,000
Permitting	\$10,000
Administrative (Sponsor)	\$46,000
Administrative (NRCS)	\$70,000
TOTAL	\$3,375,000

1 – Rounded to the nearest thousand

Operation and Maintenance Cost

Item	Annual Cost	Assumptions
Inspection	\$600	Yearly inspections performed
Berm Grading	\$1,500	Performed every 10 years at a cost of \$15,000 each grading
Riprap	\$2,000	Performed every 10 years at a cost of \$20,000 each grading
Total Annual	\$4,100	

Alternative 2 (Berm and Channel Improvements Full Riprap)

Construction Cost Estimate

Item	Quantity	Units	Unit Cost	Cost
Mob/Demob	1	LS	\$168,200	\$168,000
Survey	1	LS	\$33,700	\$34,000
SWPPP	1	LS	\$40,000	\$40,000
Berm/Channels Excavation	22,100	CY	\$7	\$155,000
Berm/Road Fill/Diversion Berm Construction	11,500	CY	\$14	\$161,000
Disposal of Excavated Berm Material	10,600	CY	\$3	\$32,000
Riprap Excavation	13,020	CY	\$7	\$91,140
Riprap	14,100	CY	\$80	\$1,128,000
Riprap Geotextile	16,100	SY	\$3	\$48,000
Berm Natural Seeding	135,000	SF	\$0.20	\$27,000
Subtotal ¹				\$1,884,000
Contingency (30%) ¹				\$565,000
TOTAL				\$2,449,000

1 – Rounded to the nearest thousand

Installation Cost

Item	Cost ¹
Construction	\$2,449,000
Engineering	\$188,000
Permitting	\$10,000
Administrative (Sponsor)	\$38,000
Administrative (NRCS)	\$57,000
TOTAL	\$2,742,000

1 – Rounded to the nearest thousand

Operation and Maintenance Cost

Item	Annual Cost	Assumptions
Inspection	\$600	Yearly inspections performed
Berm Grading	\$1,500	Performed every 10 years at a cost of \$15,000 each grading
Riprap	\$2,000	Performed every 10 years at a cost of \$20,000 each grading
Culvert Maintenance	\$4,000	Performed every 5 years at a cost of \$20,000 each time
Total Annual	\$8,100	

Replacement Cost

Item	Cost	Assumptions
Culvert Replacement	\$100,000	Replaced 1 time at year 60

Alternative 3 (Berm and Channel Improvements Reduced Riprap)

Construction Cost Estimate

Item	Quantity	Units	Unit Cost	Cost
Mob/Demob	1	LS	\$94,000	\$94,000
Survey	1	LS	\$19,000	\$19,000
SWPPP	1	LS	\$40,000	\$40,000
Berm/Channels Excavation	22,100	CY	\$7	\$155,000
Berm/Road Fill/Diversion Berm Construction	11,500	CY	\$14	\$161,000
Disposal of Excavated Berm Material	10,600	CY	\$3	\$32,000
Riprap Excavation	4,720	CY	\$7	\$33,000
Riprap	5,800	CY	\$80	\$464,000
Riprap Geotextile	8,200	SY	\$3	\$25,000
Berm Natural Seeding	135,000	SF	\$0.20	\$27,000
Subtotal ¹				\$1,050,000
Contingency (30%) ¹				\$315,000
TOTAL				\$1,365,000

1 – Rounded to the nearest thousand

Installation Cost

Item	Cost ¹
Construction	\$1,365,000
Engineering	\$105,000
Permitting	\$10,000
Administrative (Sponsor)	\$21,000
Administrative (NRCS)	\$32,000
TOTAL	\$1,533,000

Operation and Maintenance Cost

Item	Annual Cost	Assumptions
Inspection	\$600	Yearly inspections performed
Berm Grading	\$1,500	Performed every 10 years at a cost of \$15,000 each grading
Riprap	\$2,000	Performed every 10 years at a cost of \$20,000 each grading
Culvert Maintenance	\$4,000	Performed every 5 years at a cost of \$20,000 each time
Total Annual	\$8,100	

Replacement Cost

Item	Cost	Assumptions
Culvert Replacement	\$100,000	Replaced 1 time at year 60

No Action Alternative (FWOFI)

Operation and Maintenance Cost

Item	Annual Cost	Assumptions
Sediment/Debris Removal	\$2,000	Performed every 5 years at a cost of \$10,000 each grading
Culvert Maintenance	\$4,000	Performed every 5 years at a cost of \$20,000 each time
Total Annual	\$6,000	

Replacement Cost

Item	Cost	Assumptions
Culvert Replacement	\$100,000	Replaced 1 time at year 60

Appendix C

Disadvantaged Community Calculations

NWPH 602.0 C:

C. Exceptions have been granted to provide program benefits to disadvantaged communities, to increase flood protection beyond the level that maximizes the net NED benefits, and to enhance fish and wildlife habitat. In order to provide flood prevention program benefits to disadvantaged communities and areas, exception requests may be considered based on the following conditions:

- I. Housing values in the benefited area are less than 75 percent of State average values*
- II. The average per capita income for the last three years in the benefited area is less than 75 percent of the national average, or current unemployment in the project area is twice the national average over the past 3 years.*
- III. The project benefit-cost ratio is greater than the ratio of the national 3-year average per capita income to the per capita income in the benefited area.*

Housing (Criteria I)

The median sale price of homes in Utah in May 2023 was \$529,600. Subtracting out land value (\$100,000, estimated), \$529,600 becomes \$429,600. In economic analysis of flood damage, the replacement value, not the sales price or market value of buildings, is used. During the economic analysis of the flood damage for this project, the replacement value of housing in the watershed was estimated at \$73,154 (excluding land). The replacement value of the state median figure, \$429,600, is estimated at \$343,680.

\$73,154 is 21% of \$343,680, and so meets the threshold of 75% in criteria I.

<https://www.redfin.com/state/Utah/housing-market>

Income (Criteria II)

The Skull Valley Indian Reservation, located in rural Tooele County, Utah, about 45 miles southwest of Salt Lake City, is a closed Tribe, meaning it does not allow visitors on its land. The Reservation is home to the Skull Valley Band of Goshute Indians of Utah, a federally recognized Tribe. The population consists of about 30 people in seven households. Virtually all residents live below the poverty line (2021). The poverty rate in Utah for Native Americans is 27.1 percent, as compared to the national poverty rate of 11.6 percent (2021).

Because the population of the reservation lives below the state poverty line (\$25,750 for a family of four in 2019), their income is no more than 37% of the national median household income (\$69,021 in 2021, 2023). This meets income criteria II.

Caputah.org. (2021). Information on Poverty Related Issues. Accessed at:

<https://caputah.org/what-we-do/advocacy/information-on-poverty-related-issues/poverty-in-utah--update-2021.html#:~:text=Asset%20Development-.Poverty%20in%20Utah,Elder%2C%20and%20Uintah%20counties%20combined>

Census.gov. (2023).

<https://www.census.gov/quickfacts/fact/table/US/INC110221>

Skull Valley Aquatic Resources Report

Skull Valley Aquatic Resources Report

Prepared for:



**Tooele County
Emergency Management**

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February 2022

Executive Summary

The Skull Valley aquatic resource delineation was conducted according to the Corps of Engineers Wetlands Delineation Manual (ACOE 1987) and the Arid West Supplement (ACOE 2008).

A total of 163 acres were surveyed as part of this delineation. A total of five aquatic resources were identified during the delineation which did not include any wetlands but did include 0.61 acres of open water (excavated pond) and 9,597 feet of intermittent streams. The dominant aquatic resource classification for the project area was open water (R4SBC & R4UBC) and the condition of these resources was typical at the time of the delineation.

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INTRODUCTION

This document presents results of a delineation of jurisdictional waters of the United States conducted as part of the Skull Valley Watershed Plan Environmental Assessment (EA) for Tooele County (County) and the National Resource Conservation Service (NRCS) by Bowen Collins & Associates (BC&A). The County is evaluating repairs and floodplain management in this area to protect the Skull Valley Reservation residents and associated infrastructure and the purpose of this delineation is to help identify potential wetland impacts as part of the proposed project.

SITE LOCATION

The project area is located in Tooele County, Utah, in Sections 1, 9, 10, 11, 12, 16 of Township 5S, Range 8W and Section 6, of Township 5S, Range 7W. Directions to the site are as follows: From Salt Lake City, take Interstate 80 West towards Tooele. Travel 42 miles to Exit 77 for UT-196 toward Rowley/Dugway. Travel south 25 miles on UT-196 (Skull Valley Road). The Skull Valley evaluation area is to the east of this location, covering 163 acres on the Skull Valley Reservation (See Site Location Figures, Appendix A).

GENERAL SITE CONDITIONS

The Skull Valley Project area is located in Utah's West Desert, known for arid deserts and low mountain ranges with little water. The area delineated east boundary begins at the mouth of Indian Hickman Canyon where Indian Hickman Creek originates. Moving downstream and west, several other drainages flowing from the associated foothills join the main creek channel or crossed the delineated area. The west observation boundary is the reservation entrance from Highway 196 (Skull Valley Road). The reservation buildings and infrastructure are located between the mouth of the canyon and the highway, but beyond the access road that travels through it, most of the inhabited area was not included in the field investigations. There is no interstate or foreign commerce taking place on or within the delineated waters.

Field work for this delineation was conducted on October 28, 2020 by Merissa Davis of BC&A. The total area delineated was approximately 163 acres and this entire area was observed during the site visits. Field conditions during the survey were clear and the area had not received precipitation for several weeks prior.

METHODOLOGY

National Wetlands Inventory (NWI) data was also examined to obtain the location of possible jurisdictional wetlands on the site (see NWI figure, Appendix B). The wetland delineation was conducted according to the Corps of Engineers Wetlands Delineation Manual (ACOE 1987), Arid West Supplement (ACOE 2008), however no sample points were taken as no potential wetlands were encountered. The field consisted mainly of identifying channel boundaries and sources. Channels, water bodies, and observation points were recorded using a Trimble Geo7X GPS with sub-foot accuracy and ArcCollector with sub-meter accuracy.

Based on the Manual, jurisdictional wetlands were identified using three criteria:

- Hydrophytic Vegetation
- Wetlands Hydrology
- Hydric Soils

All three criteria must be present for a wetland to be considered jurisdictional. An explanation of these wetland criteria follows.

Hydrophytic Vegetation

Hydrophytic plants are plants that are adapted to wet conditions. The National Wetland Plant List for the Arid West Region (ACOE 2012) was used to determine the wetland indicator status of dominant plant species encountered on sample plots. Sight-identification was used to determine most plant species.

Wetland Hydrology

Wetland hydrology is present when an area is inundated either permanently or periodically at mean water depths of two meters, or the soil is saturated to the surface at some time during the growing season of the prevalent vegetation. Primary hydrologic indicators also include high water tables, oxidized root channels, and sediment and drift deposits. Common secondary hydrologic indicators include watermarks, drainage patterns, and the FAC neutral test.

Hydric Soils

In Field Indicators of Hydric Soils in the U.S. (NRCS 2010) the Natural Resources Conservation Service (NRCS) defines hydric soils as soils that are formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the top 12 to 20 inches of soil, depending on soil texture. Hydric properties of soils were assessed using a spade to excavate the soil pit, and Munsell soil color charts to determine soil color.

RESULTS

Vegetation

Vegetation was identified primarily based on flowering parts and structural characteristics. General photos of the vegetation can be found in Appendix F. The delineated area is dominated by juniper, greasewood, rabbitbrush, broom snakeweed, sumac, and cheatgrass. Plants observed at the sampling locations are listed in Table 1 below.

Table 1
Plants Observed at the Skull Valley Site

Latin Binomial	Common Name	Region 8 Indicator Status
<i>Nasturtium officinale</i>	Watercress	OBL
<i>Acer negunda</i>	Ash-Leaf Maple	FACW
<i>Salix exigua</i>	Narrowleaf Willow	FACW
<i>Salix lasiolepis</i>	Arroyo Willow	FACW
<i>Bassia (Kochia) scoparia</i>	Burning Brush	FAC
<i>Leymus cinereus</i>	Basin Wildrye	FAC
<i>Prunus virginiana</i>	Choke Cherry	FAC
<i>Tamarisk chinensis</i>	Five-stamen Tamarisk	FAC
<i>Rumex Crispus</i>	Curly Dock	FAC
<i>Achillia millefolium</i>	Common Yarrow	FACU
<i>Artemisia ludoviciana</i>	White Sagebrush	FACU
<i>Cirsium vulgare</i>	Bull Thistle	FACU
<i>Elymus elymoides</i>	Squirrel Tail	FACU
<i>Salsola iberica</i>	Prickly Russian Thistle	FACU
<i>Rhus aromatica</i>	Fragrant Sumac	FACU
<i>Sarcobatus vermiculatus</i>	Greasewood	FACU
<i>Verbascum thapsus</i>	Common Mullein	FACU
<i>Artemisia tridentata</i>	Big Sagebrush	UPL
<i>Astragalus utahensis</i>	Utah milkvetch	UPL
<i>Bromus tectorum</i>	Cheatgrass	UPL
<i>Eragrostis nauseosa</i>	Rubber Rabbitbrush	UPL
<i>Eriogonum shockleyi</i>	Shockley's Buckwheat	UPL
<i>Gutierrezia sarothrae</i>	Broom Snakeweed	UPL
<i>Halogeton glomeratus</i>	Salt Lover	UPL
<i>Juniperus osteosperma</i>	Utah Juniper	UPL
<i>Medicago sativa</i>	Alfalfa	UPL
<i>Oenothera cespitosa</i>	Tuft Evening Primrose	UPL
<i>Opuntia polyacantha</i>	Plains Pricklypear	UPL
<i>Purshia stansburiana</i>	Stansbury Cliffrose	UPL
<i>Pseudoroegneria spicata</i>	Bluebunch Wheatgrass	UPL
<i>Thinopyrum intermedium</i>	Intermediate Wheatgrass	UPL
<i>Zigadenus elegans</i>	Mountain Deathcamas	UPL
<i>Asteraceae spp.</i>	Daisy species	
<i>Cirsium spp.</i>	Thistle species	
<i>Cryptantha spp.</i>	Borage species	
<i>Cymopterus spp.</i>	Springparsley species	
<i>Helianthus spp.</i>	Sunflower species	
<i>Penstemon spp.</i>	Penstemon species	
<i>Poa spp.</i>	Grass species	
<i>Rosa spp.</i>	Rose species	
<i>Sphaeralcea spp.</i>	Mallow species	

Note: Hydrophytic plant species are shaded gray.

Hydrology

The main water source that creates the hydrologic zone at the project site is Indian Hickman Creek which flows out of Indian Hickman Canyon plus a multitude of other small channels draining from the surrounding foothills. The boundary of these channels is dynamic and due to loose soils and substrate, changes course often depending on flows and flooding. Ordinary high water mark for Indian Hickman Creek was approximately 5,726 feet at the upstream end of the delineated area (mouth of Indian Hickman Canyon) and 4,854 feet at the downstream end. There is also a debris basin which collects water at various times of year depending on flows. Approximately 400 feet of the upper Indian Hickman Creek was flowing above ground at the time of the delineation, but the lower section of the creek and the other unnamed channels were all dry at the time of the field work as was the debris basin (see photo point 14 and 15, Appendix F). Primary hydrologic indicators at the site included surface water and secondary indicators included water marks and drift deposits which were also used to identify the ordinary high water mark.

Soils

The soils at the site consist of alluvium or lacustrine deposits derived from limestone or quartzite, or sedimentary rock; colluvium derived from limestone, or eolian material derived from mixed rock sources. A Custom Soil Resource Report for the Tooele Area and Parts of Box Elder, Davis, and Juab Counties, Utah (NRCS 2020) was referenced to determine soil types for the area. The following soil types occur within the delineated area:

- Abela very gravelly loam (5-15% slopes), well drained, no flooding
- Hiko Peak gravelly loam (2-15% slopes), well drained, no flooding
- Lodar-Lundy-Rock outcrop association (30-60% slopes), well drained, no flooding
- Medburn Fine sandy loam (2-8% slopes), well drained, no flooding
- Tooele Fine sandy loam (0-5% slopes), well drained, no flooding

None of these soils are found on the national and Utah hydric soils lists (NRCS 2015). Soil properties such as texture and composition generally matched the soil descriptions found in the soil survey report.

Sample Points

No potential wetlands were encountered beyond the channels themselves so no sample pits were taken as part of the field data collection.

Wetland Boundaries

There are not wetlands present in the delineated area but a broad network of drainage channels fan out from the Stansbury foothills that spread across the valley below. There is one main channel for Indian Hickman Creek that flows east to west across the site but loose soils and past storm/flood events have caused changes in the main course of the channel as well as created some side channels. Most of the channels and much of Indian Hickman Creek were dry at the time of the field work, but they do flow intermittently, more so in the spring and during storm events.

Within the delineated area a 0.61 acre debris basin and 9,597 linear feet of channel were found to potentially be jurisdictional, as shown in the wetland delineation figures located in Appendix D, as listed in the Aquatic Resources spreadsheet in Appendix E, and as shown in Table 2 on the next page.

Indicators for vegetation, hydrology, and hydric soils were clear and easily identified. The identified wetlands are classified as freshwater ponds (PUB), intermittent streams (R4SB), and perennial stream (R5UB) according to the NWI classification system.

Table 2
Aquatic Resources Within the Survey Area

Aquatic Resource Name	Aquatic Resources Classification		Aquatic Resource Size** (acres)	Aquatic Resource Size (linear feet)
	Cowardin*	Location (UTM)		
W1A	R4SBC	4475261.03 / 357643.48	0.54	2,342
W1B	R4SBC	4475114.83 / 357409.31	0.04	207
W1C	R4SBC	4475030.89 / 357256.93	0.07	405
W1D	R4SBC	4473451.32 / 354791.85	0.12	584
W2A	R5UBC	4474614.02 / 356513.39	0.04	356
W2B	R5UBC	4474461.07 / 356362.16	0.09	532
W3A	R5UBC	4474191.15 / 356117.34	0.26	1,819
W3B	R5UBC	4474229.82 / 356184.99	0.06	369
W3C	R5UBC	4473834.79 / 355675.29	0.02	77
W3D	R5UBC	4473587.58 / 354877.53	0.10	598
W4	PUBFx	4473533.84 / 354754.13	0.61	
W5A	R4SBC	4473277.79 / 354605.66	0.38	1,625
W5B	R4SBC	4473133.54 / 354341.22	0.13	683

*Cowardin Codes:

R4SBC – Riverine Intermittent Streambed Seasonally Flooded

PUBFx – Palustrine Unconsolidated Bottom Semipermanently Flooded Excavated

R5UBC - Riverine Unknown Perennial Unconsolidated Bottom Seasonally Flooded

* **Acreage for channels is included for reference but only the detention pond is reported by acreage for aquatic resource totals while channels are totaled by linear feet.

REFERENCES

- Cowardin, L. M., V. Carter, F. C. Golet, E. T. LaRoe. 1979. *Classification of wetlands and deepwater habitats of the United States*. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. Jamestown, ND: Northern Prairie Wildlife Research Center Online. <http://www.npwrc.usgs.gov/resource/wetlands/classwet/index.htm> (Version 04DEC1998).
- U.S. Army Corps of Engineers (ACOE). 2016. *The National Wetland Plant List for the Arid West*. U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory (CRREL). Hanover, New Hampshire
- U.S. Army Corps of Engineers (ACOE), 2008. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region (Version 2.0)* ed. J.S. Wakeley, R.W. Lichvar, and C.V. Noble. ERDC/EL Tr-08-28. Vicksburg, MS: U.S. Army Engineer Research and Development Center.
- U.S. Army Corps of Engineers (ACOE). 1987. *Corps of Engineers Wetlands Delineation Manual*. Technical Report Y-87-1. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.
- USDA Natural Resources Conservation Service (NRCS). 2018. *Field Indicators of Hydric Soils in the United States, Version 8.2*. L.M. Vasilas, G.W. Hurt, and J.F. Berkowitz,, editors. USDA, NRCS, in cooperation with the National Technical Committee for Hydric Soils.
- USDA Natural Resources Conservation Service (NRCS). 2015a. *National Hydric Soils List*. Access online <http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/use/hydric/>
- USDA Natural Resources Conservation Service (NRCS). 2020. *Soil Survey for the Tooele Area and Parts of Box Elder, Davis, and Juab Counties*. National Resources Conservation Services and Forest Service, in Cooperation with the Utah Agricultural Experiment Station.
- USDA Natural Resources Conservation Service (NRCS). 2020. *The PLANTS Database* <http://plants.usda.gov/> Natural Plant Data Center, Baton Rouge LA 70874-4490 USA.
- Utah State University Extension. 2011. *Grasses and Grasslike Plants of Utah, A Field Guide*. Donna Falkenborg, editor.
- Welsh, S.L., N.D. Atwood, L.C. Higgins, and S. Goodrich. 2003. *A Utah Flora*, Third Edition. Brigham Young University, Provo, Utah.
- Whitson, Tom D., Larry C. Burrill, Steven A. Dewey, David W. Cudney, B.E. Nelson, Richard D. Lee, and Robert Parker. Whitson, Tom D. (ed.) 2010. *Weeds of the West. 10th ed*. Laramie: University of Wyoming.

Appendix A

Site Location Figures



LEGEND

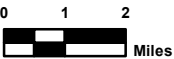
 Project Boundary (163 acres)

Figure Created By
Cara Glabau 02/11/2022
Imagery: Hexagon 2018

NORTH:



SCALE:



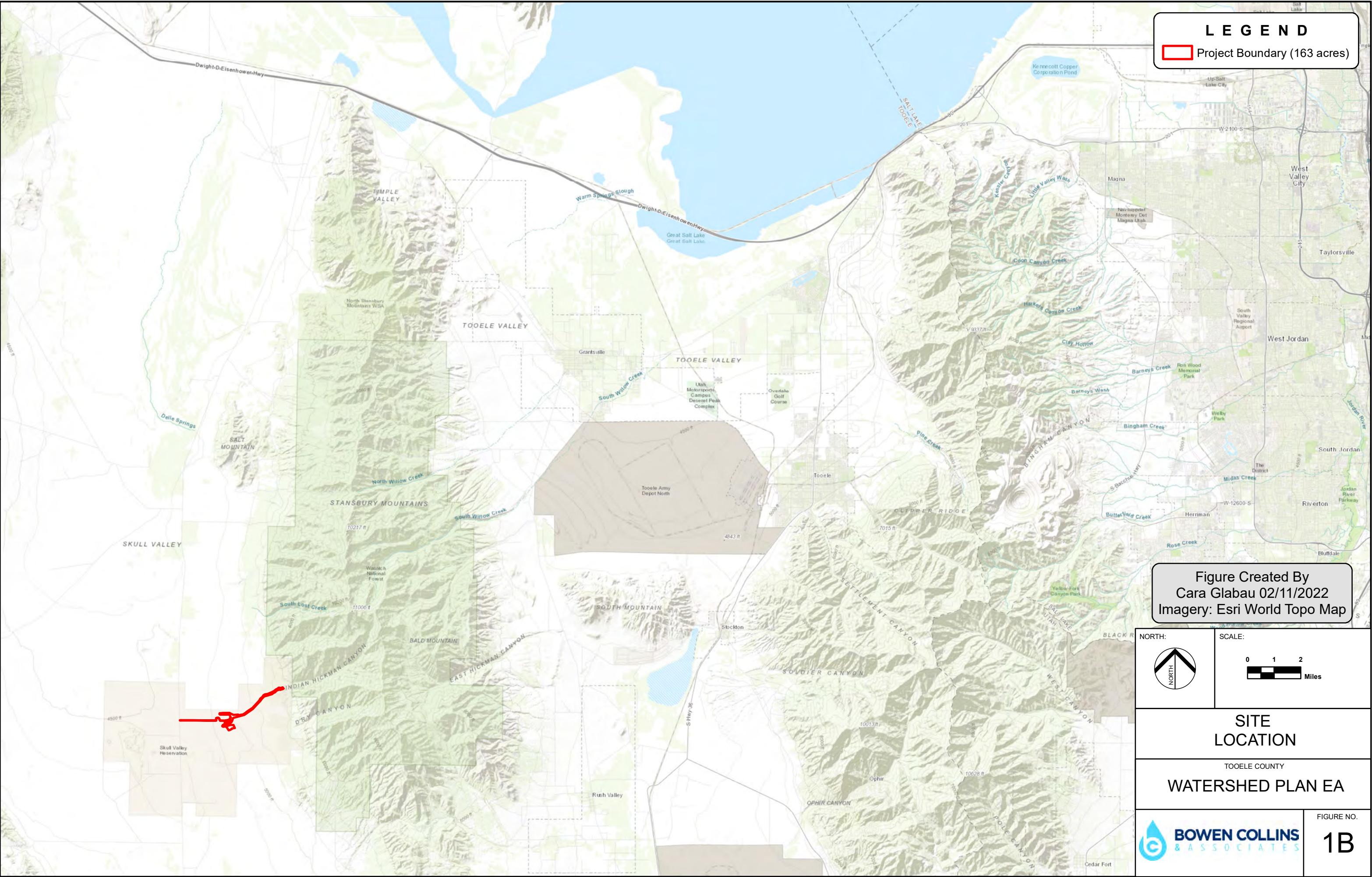
**SITE
LOCATION**

TOOELE COUNTY
WATERSHED PLAN EA



FIGURE NO.

1A



LEGEND

Project Boundary (163 acres)

Figure Created By
Cara Glabau 02/11/2022
Imagery: Esri World Topo Map

NORTH:

SCALE:

SITE
LOCATION

TOOELE COUNTY
WATERSHED PLAN EA

BOWEN COLLINS
& ASSOCIATES

FIGURE NO.
1B



LEGEND

Project Boundary (163 acres)

196

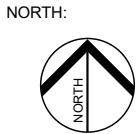
Skull Valley Road

Skull Valley Reservation

Indian Hickman Canyon

Stansbury
Mountain
Range

Figure Created By
Cara Glabau 02/11/22
Imagery: Hexagon 2018



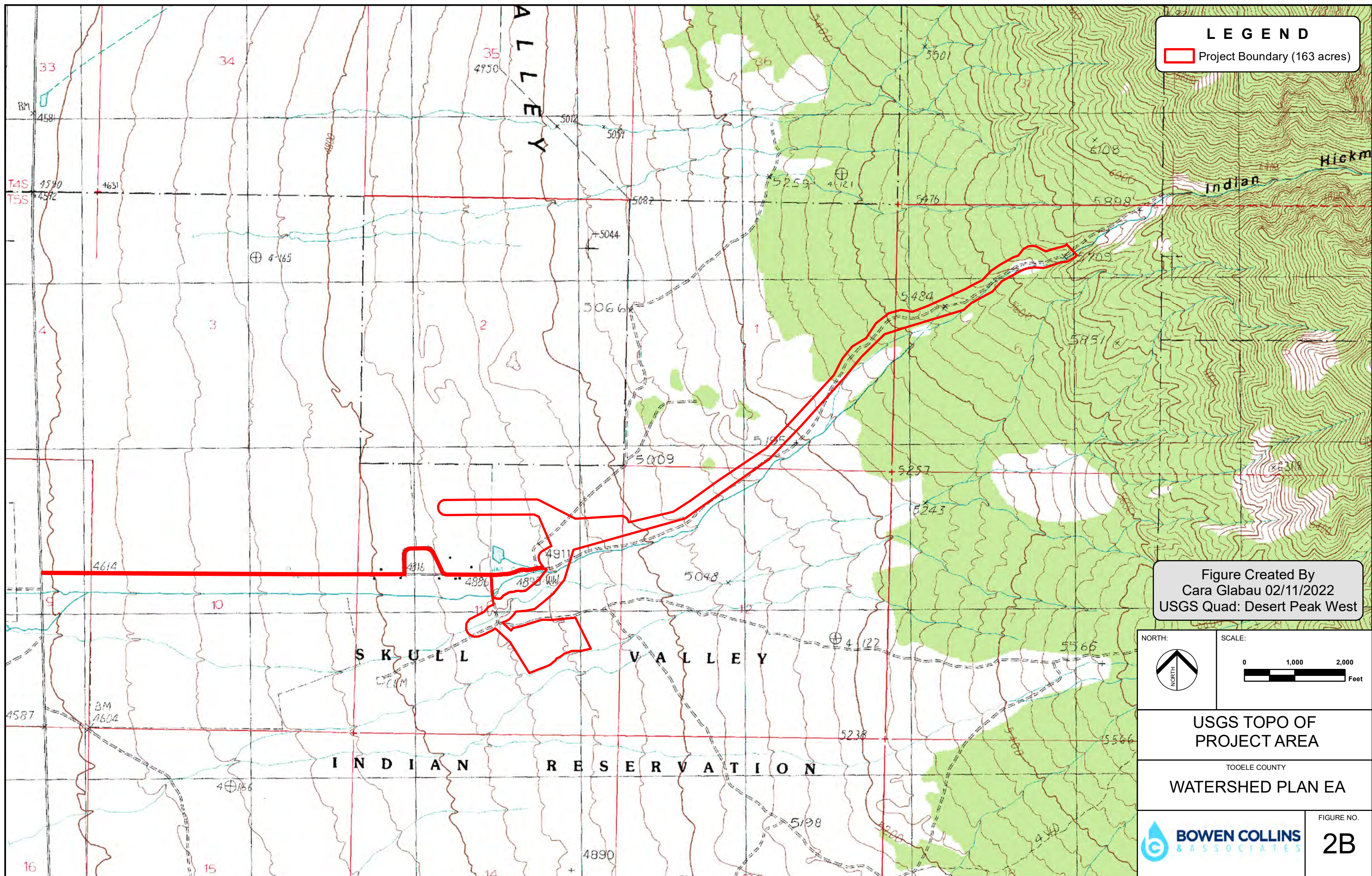
AERIAL IMAGERY OF
PROJECT AREA

TOOELE COUNTY
WATERSHED PLAN EA



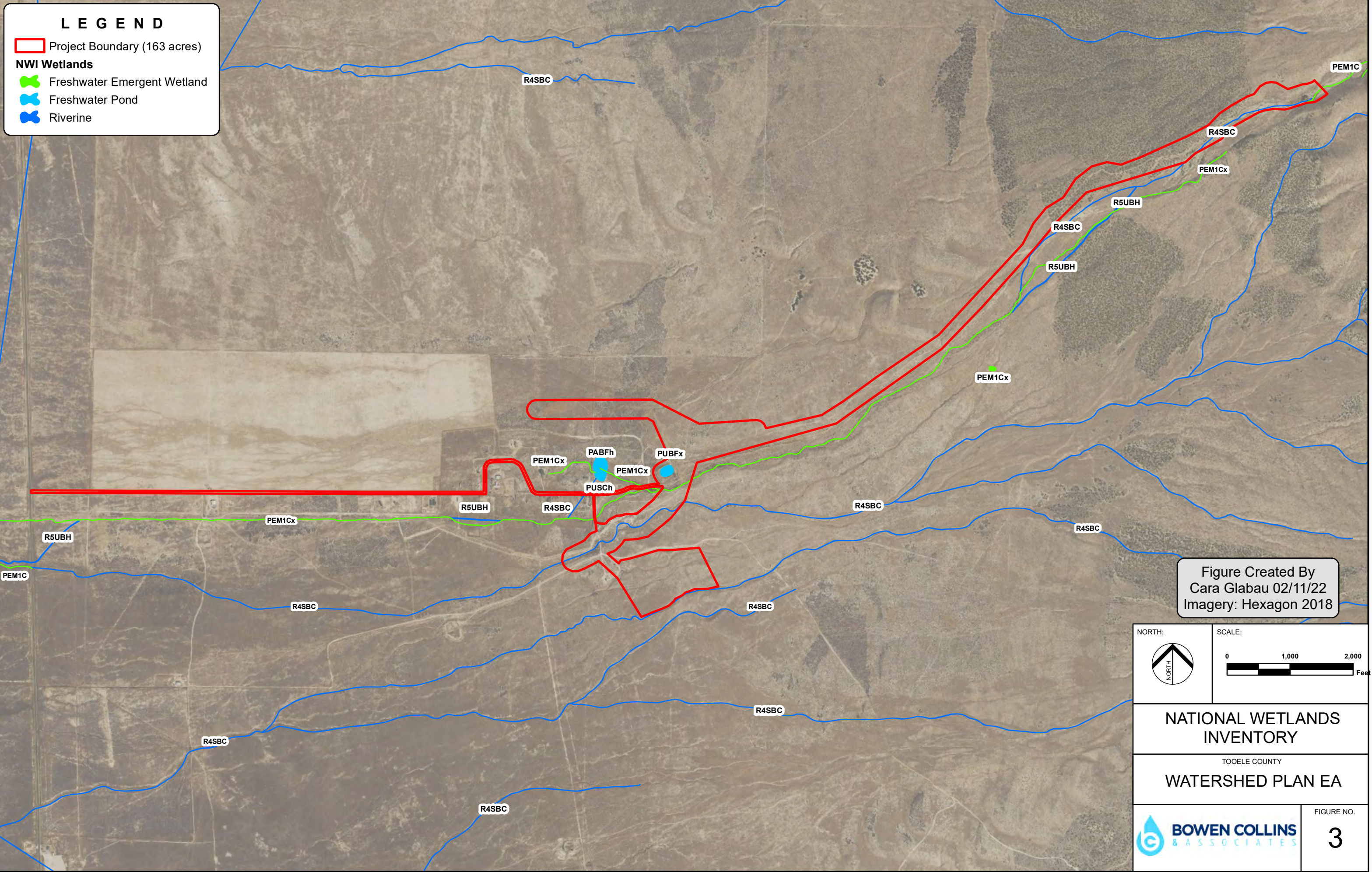
FIGURE NO.

2A



Appendix B

National Wetland Inventory



LEGEND

- Project Boundary (163 acres)
- NWI Wetlands**
- Freshwater Emergent Wetland
- Freshwater Pond
- Riverine

Figure Created By
Cara Glabau 02/11/22
Imagery: Hexagon 2018

NORTH: 		SCALE: 	
NATIONAL WETLANDS INVENTORY			
TOOELE COUNTY WATERSHED PLAN EA			
			FIGURE NO. 3

Appendix C

Soil Map & NRCS Custom Soils Resource Report

A copy of Appendix C can be requested from the Project contacts listed on the fly sheet of the Plan-EA

Appendix D

Delineation Results Figures

LEGEND

Project Boundary (163 acres)

Ordinary High Water Mark

Aquatic Resources

An aerial photograph of a dry, hilly landscape. A red line outlines a project boundary of 163 acres. A dashed black line indicates the ordinary high water mark, which follows a winding path through the terrain. Small blue icons represent aquatic resources. Six rectangular callout boxes, labeled Figure 5B through Figure 5F, are placed along the high water mark to show detailed views of specific areas. Figure 5B is at the top right, Figure 5C is below it, Figure 5D is to the left of 5C, Figure 5E is further left, and Figure 5F is at the bottom left. A large red line runs horizontally across the middle of the map, likely representing a road or a different boundary.

Figure Created By
Cara Glabau 02/11/22
Imagery: Hexagon 2018

NORTH:

SCALE:

0 500 1,000

Feet

DELINEATION RESULTS
FIGURES OVERVIEW

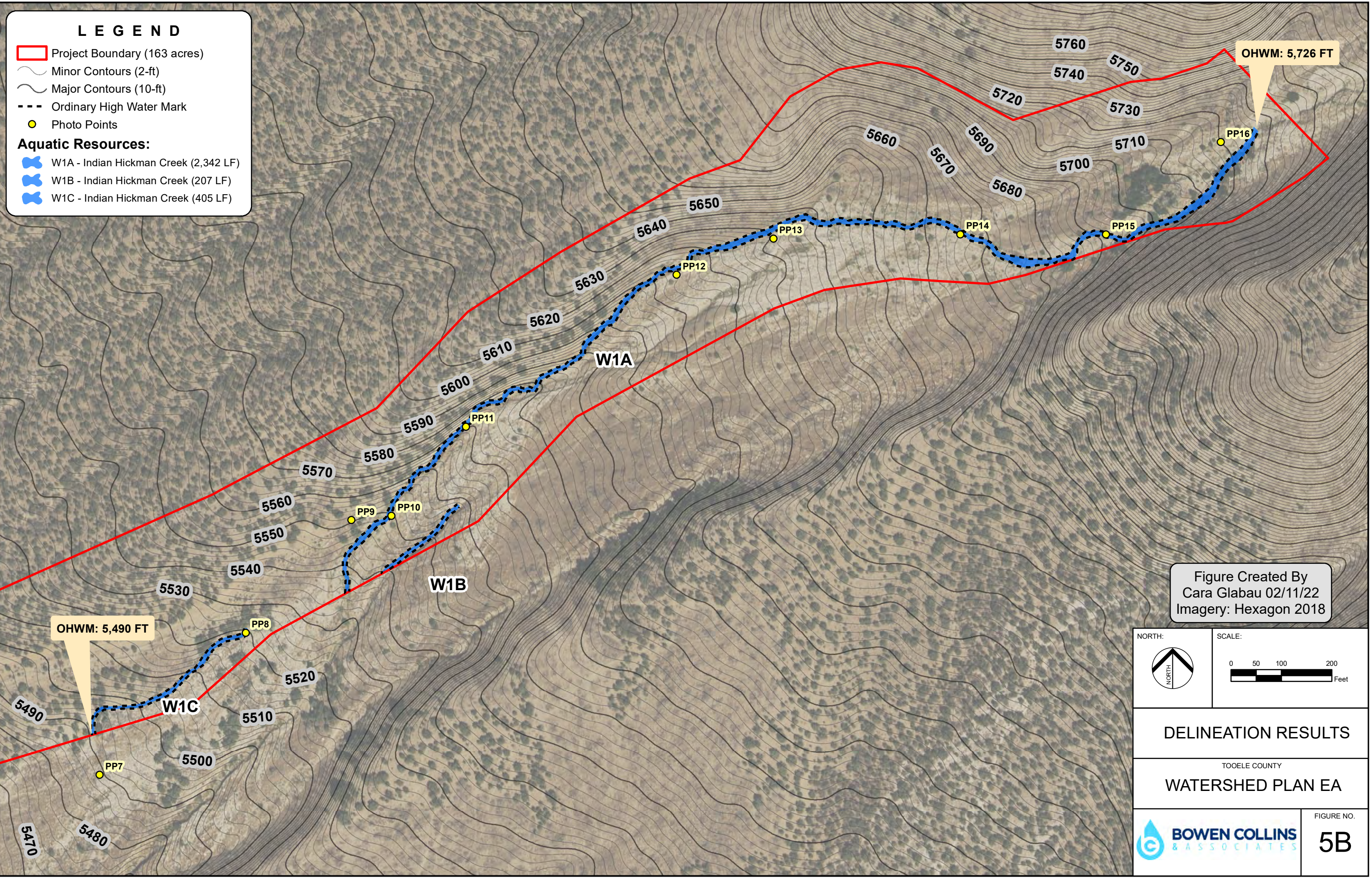
TOOELE COUNTY

WATERSHED PLAN EA

BOWEN COLLINS
& ASSOCIATES

FIGURE NO.
5A

P:\Tooele County\631-19-01 Watershed Plan-EA\4.0 GIS\4.1 Projects\Environmental\Figure 5A - Delineation Results Overview_June2021.mxd cglabau 2/14/2022



LEGEND

- Project Boundary (163 acres)
- Minor Contours (2-ft)
- Major Contours (10-ft)
- Ordinary High Water Mark
- Photo Points

Aquatic Resources:

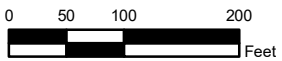
- W1A - Indian Hickman Creek (2,342 LF)
- W1B - Indian Hickman Creek (207 LF)
- W1C - Indian Hickman Creek (405 LF)

Figure Created By
Cara Glabau 02/11/22
Imagery: Hexagon 2018

NORTH:



SCALE:



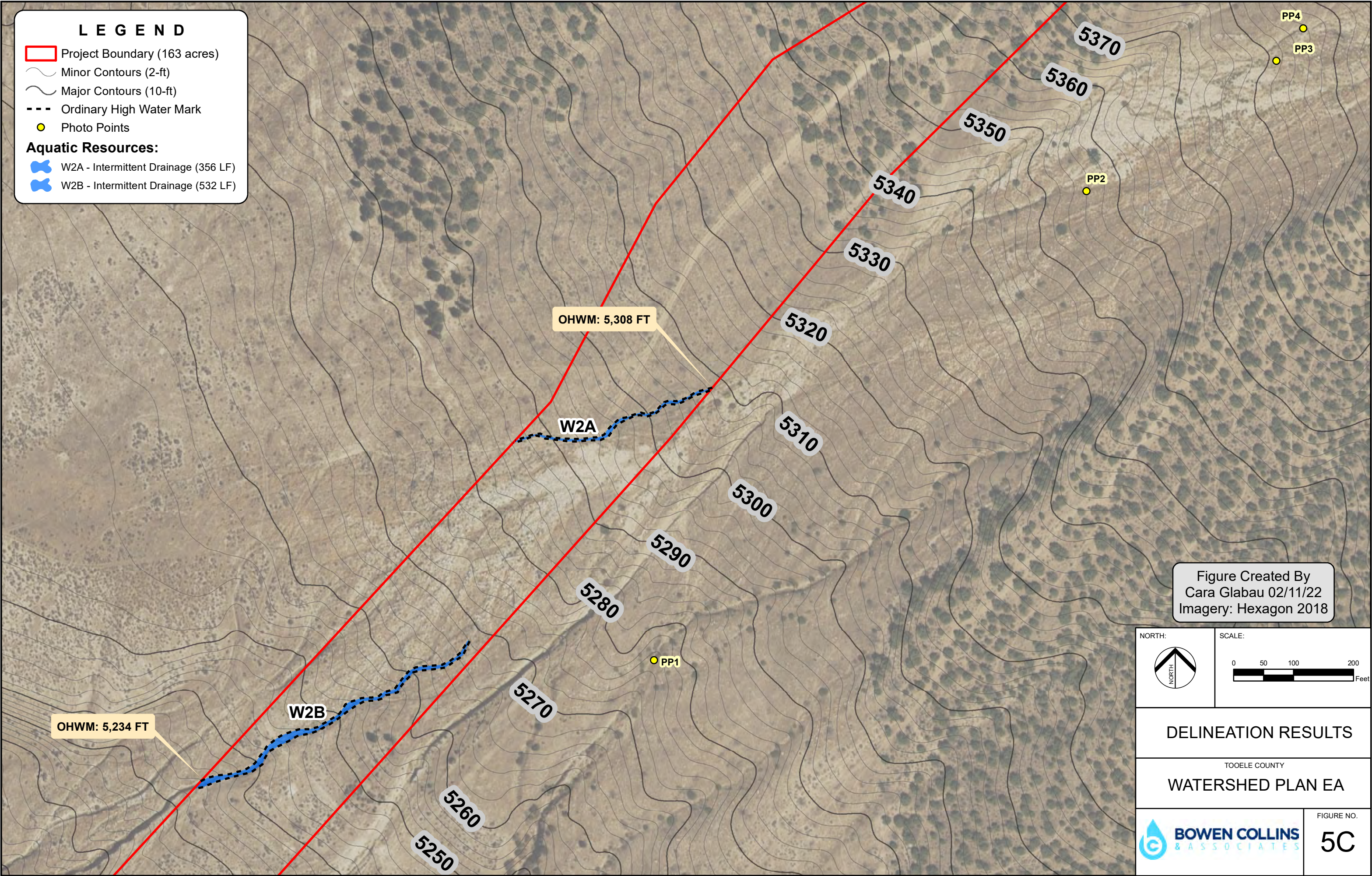
DELINEATION RESULTS

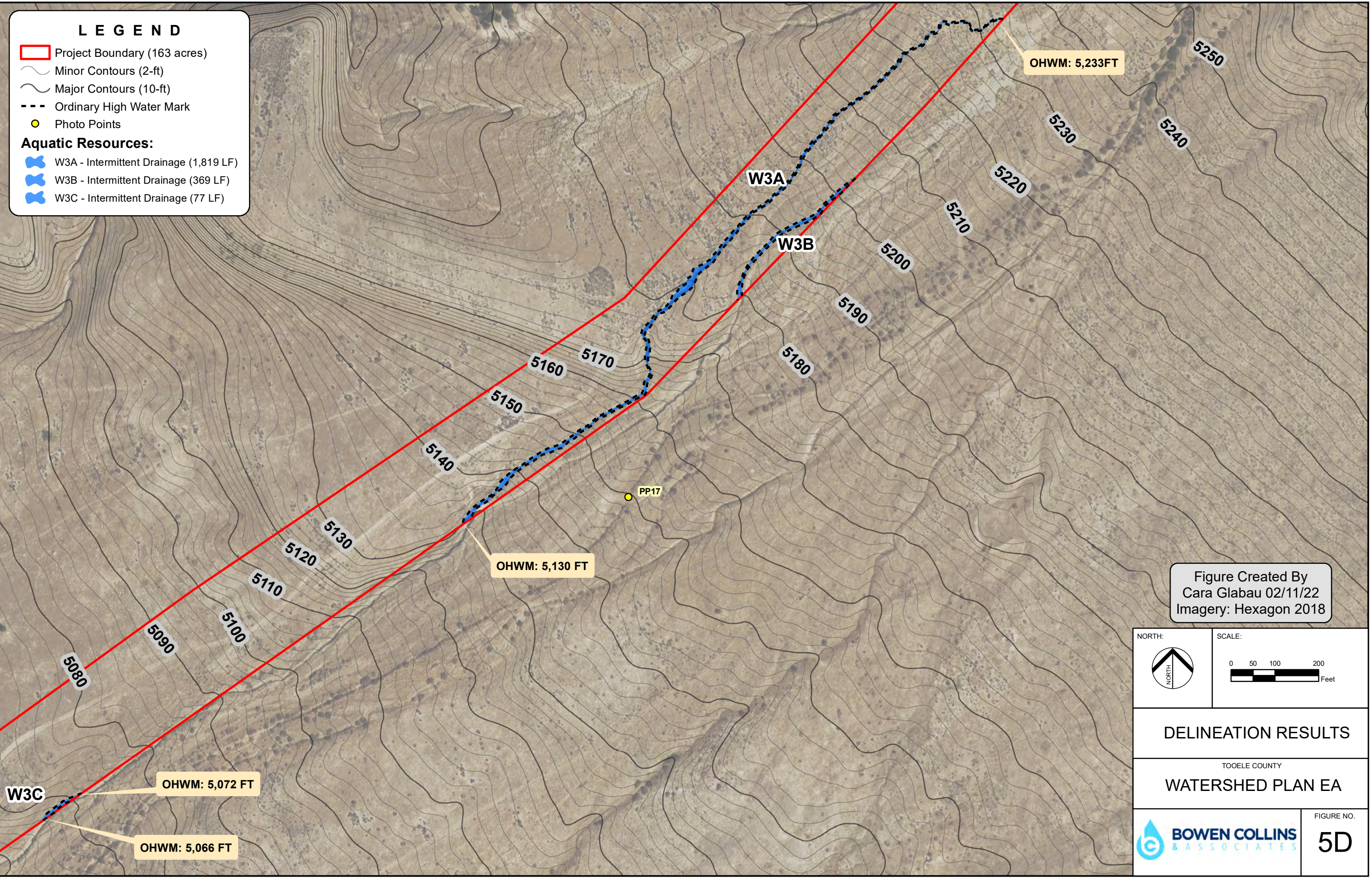
TOOELE COUNTY
WATERSHED PLAN EA

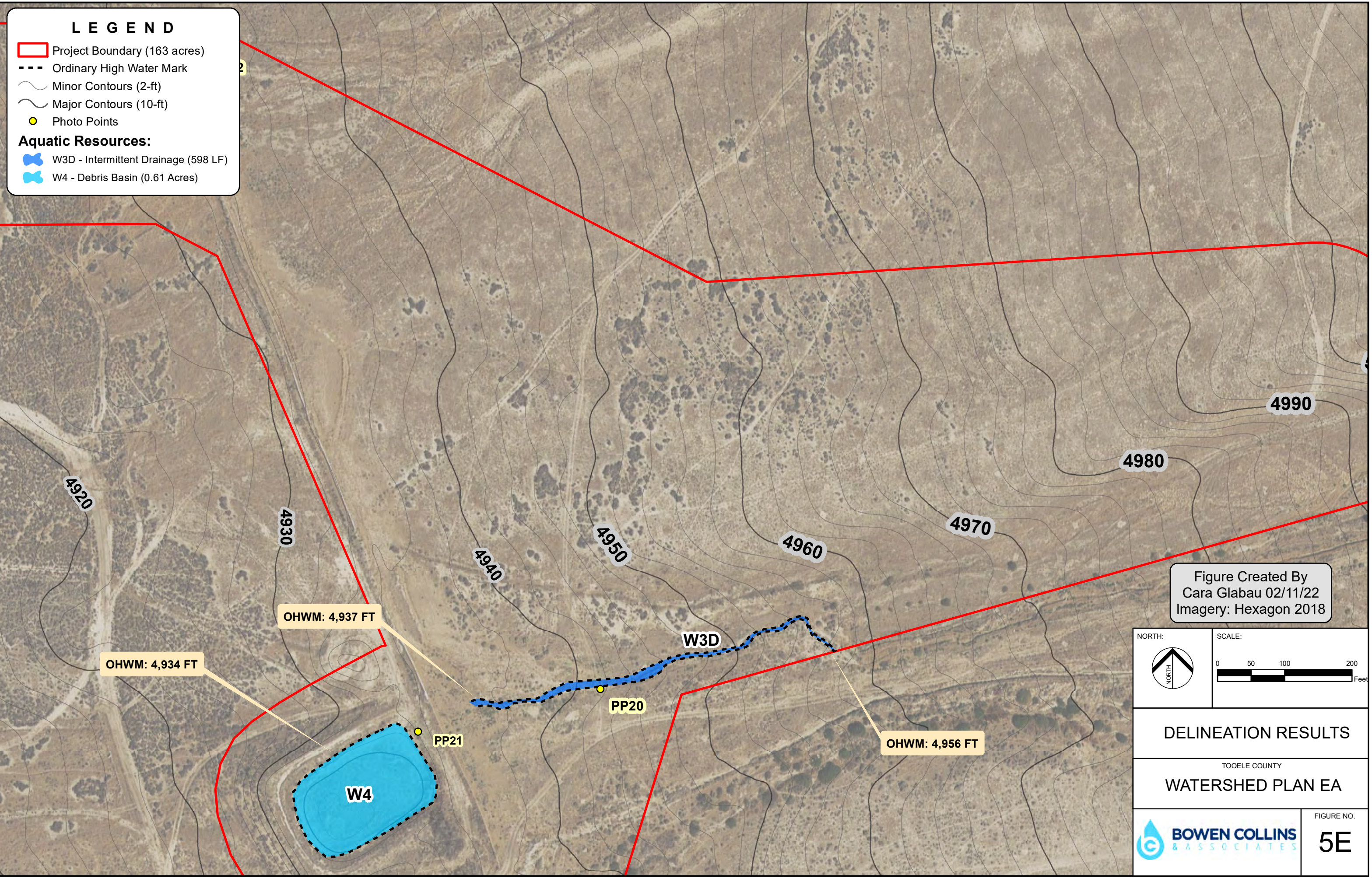


FIGURE NO.

5B







LEGEND

Project Boundary (163 acres)

Ordinary High Water Mark

Minor Contours (2-ft)

Major Contours (10-ft)

Photo Points

Aquatic Resources:

W3D - Intermittent Drainage (598 LF)

W4 - Debris Basin (0.61 Acres)

Figure Created By
Cara Glabau 02/11/22
Imagery: Hexagon 2018

NORTH:

SCALE:

0

50

100

200

Feet

DELINEATION RESULTS

TOOELE COUNTY
WATERSHED PLAN EA

BOWEN COLLINS
& ASSOCIATES

FIGURE NO.
5E



LEGEND

Project Boundary (163 acres)

Ordinary High Water Mark

Minor Contours (2-ft)

Major Contours (10-ft)

Photo Points

Aquatic Resources:

W1D - Indian Hickman Creek (584 LF)

W5A - Intermittent Drainage (1,625 LF)

W5B - Intermittent Drainage (683 LF)

Figure Created By
Cara Glabau 02/11/22
Imagery: Hexagon 2018

NORTH:

SCALE:

050100200Feet

DELINEATION RESULTS

TOOELE COUNTY
WATERSHED PLAN EA

BOWEN COLLINS
& ASSOCIATES

FIGURE NO.
5F

Appendix E

Aquatic Resources Spreadsheet

Skull Valley Wetland Delineation

Aquatic Resources

Waters Name	State	Cowadin Code	HGM Code	Measurement Type	Amount	Units	Waters Type	Latitude	Longitude	Local Waterway
W1A	Utah	R4SBC	Riverine	Linear	2342	Feet	NRPW	4475261.03	357643.48	Indian Hickman Creek
W1B	Utah	R4SBC	Riverine	Linear	207	Feet	NRPW	4475114.83	357409.31	Indian Hickman Creek
W1C	Utah	R4SBC	Riverine	Linear	405	Feet	NRPW	4475030.90	357256.93	Indian Hickman Creek
W1D	Utah	R4SBC	Riverine	Linear	584	Feet	NRPW	4473451.32	354791.86	Indian Hickman Creek
W2A	Utah	R5UBC	Riverine	Linear	356	Feet	NRPW	4474614.02	356513.39	Indian Hickman Creek
W2B	Utah	R5UBC	Riverine	Linear	532	Feet	NRPW	4474461.07	356362.16	Unnamed Intermittent Drainage
W3A	Utah	R5UBC	Riverine	Linear	1819	Feet	NRPW	4474191.15	356117.34	Unnamed Intermittent Drainage
W3B	Utah	R5UBC	Riverine	Linear	369	Feet	NRPW	4474229.82	356184.99	Unnamed Intermittent Drainage
W3C	Utah	R5UBC	Riverine	Linear	77	Feet	NRPW	4473834.79	355675.29	Unnamed Intermittent Drainage
W3D	Utah	R5UBC	Riverine	Linear	598	Feet	NRPW	4473587.58	354877.53	Unnamed Intermittent Drainage
W4	Utah	PUBFx	Riverine	Area	0.61	Acres	IMPNDMNT	4473533.84	354754.13	Debris Basin
W5A	Utah	R4SBC	Riverine	Linear	1625	Feet	NRPW	4473277.79	354605.66	Unnamed Intermittent Drainage
W5B	Utah	R4SBC	Riverine	Linear	683	Feet	NRPW	4473133.54	354341.22	Unnamed Intermittent Drainage

Appendix F

Photos

A copy of Appendix F can be requested from the Project contacts listed on the fly sheet of the Plan-EA

Appendix G

Access Waiver

A copy of Appendix G can be requested from the Project contacts listed on the fly sheet of the Plan-EA

Biological Assessment

BIOLOGICAL ASSESSMENT OF THE SKULL VALLEY WATERSHED EA TOOELE, UTAH

Prepared for:



Emergency Management

Attn: Bucky Whitehouse
15 East 100 South
Tooele, UT 84074
(435)833-8121

Prepared by:



154 East 14075 South
Draper, UT 84020

Updated February 2022

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APPENDIX B – Official USFWS TES Species List
APPENDIX C – Utah Natural Heritage Program Species Report
APPENDIX D – TES Plant Survey Report & Site Photos
APPENDIX E – Plan Drawings

ACRONYMS & ABBREVIATIONS

BA – Biological Assessment

BC&A - Bowen Collins & Associates

County – Tooele County

ESA – Endangered Species Act

DWR - Utah Division of Wildlife Resources

UNHP - Utah Natural Heritage Program

USFWS/Service - U.S. Fish & Wildlife Service

NRCS – National Resource Conservation Service

Reservation – Skull Valley Reservation

INTRODUCTION

This Biological Assessment has been prepared by Bowen Collins & Associates (BC&A), on behalf of Tooele County (County) and the National Resource Conservation Service (NRCS) for the Skull Valley Watershed Plan Environmental Assessment (EA) in Tooele County, Utah (See Site Location Maps, Appendix A). The County is evaluating repairs and floodplain management in this area to protect the Skull Valley Reservation (Reservation) residents and associated infrastructure.

PURPOSE

The purpose of this biological assessment (BA) is to assess the potential environmental impacts of the proposed project on federally-listed plant and animal species in accordance with the requirements of Section 7 of the Endangered Species Act (ESA; 16 U.S.C. 460 et seq., as amended) (See official species list in Appendix B). The federal action agency is the NRCS who is providing funding for the proposed project.

The objective of the proposed action is to provide flood control for the Skull Valley Reservation residents and infrastructure in response to flood hazards created by recent fires. Additional details about the proposed action are included below but in general the project includes the construction of berms, a channel, and a concrete ford to redirect flooding around reservation. These actions have the potential to impact the ESA-listed species that occur in the action area as listed in Table 1 below:

Table 1 – ESA Listed Species Potentially Occurring in the Project Areas

Common Name	Scientific Name	Critical Habitat
Ute Ladies'-tresses	<i>Spiranthes diluvialis</i>	-
Monarch Butterfly	<i>Danaus plexippus</i>	-

This BA, prepared by BC&A, addresses the proposed action in compliance with Section 7 of the ESA. Section 7 assures that, through consultation (or conferencing for proposed species) with the Service, federal actions do not jeopardize the continued existence of any threatened, endangered, or proposed species, or result in the destruction or adverse modification of critical habitat.

BACKGROUND

The purpose of the Skull Valley Watershed Plan EA is to evaluate structural measures that will mitigate potential flood and debris flow impacts on Skull Valley Reservation property that are the result of a recent fire in the upstream watershed.

In August 2013, more than 13,000 acres of public lands above the Reservation land were burned. The fire destroyed a water intake structure near the eastern border of the Reservation land in Indian Hickman Canyon which supplied firefighting, irrigation, and dust suppression water. On September 3-4, 2013, an intense rainstorm occurred over Skull Valley Watershed where more than two inches of precipitation fell over a period of two days. As a result, mud and debris flows mobilized out of Indian Hickman Canyon destroyed the water intake structure.

In August 2014, Indian Hickman and Dry Canyons again experienced several intense rainstorm events that led to flooding on the developed portion of Reservation land. Due to the burned conditions in the watershed and the availability of debris in Indian Hickman Canyon, the irrigation water inlet structure and sections of the associated pipeline that conveyed water from the inlet to the Reservation were destroyed. The areas upstream of the k-rails installed in response to the 2013 flood event were filled with mud, rock, and debris. Water and debris also covered Highway 196, four miles from the mouth of the canyon and an irrigation pond used by the Skull Valley Band of Goshute Tribe for irrigation and fire suppression was filled with sediment and debris and rendered useless.

PROPOSED ACTIONS

The proposed actions for the Skull Valley Project include the following:

- Create two diversion berms (3,450 feet total) to direct run off to existing drainage channels.
- Improve 1,900 feet of existing channel including riprap armoring.
- Reroute the 2,000 feet of washed-out canyon access road.
- Replace undersized culvert with 300-ft concrete ford.
- Replace 13,800 feet of irrigation pipeline with 8-inch pipe to convey spring water from the mountain Indian Hickman Canyon to restored irrigation pond.
- Restore irrigation pond through sediment removal, repairing or replacing outlet and inlet work.
- Equipment staging, borrow for earthen embankments, and disposal of organic materials from clearing and grubbing.

ACTION AREA

The action area totals 163 acres and is located in Utah's West Desert, an area known for arid deserts and low mountain ranges with little water. The east boundary begins at the mouth of Indian Hickman Canyon where Indian Hickman Creek originates. Moving downstream and west, several other drainages flowing from the associated foothills join the main creek channel. The west boundary is the Reservation entrance from Highway 196 (Skull Valley Road). The reservation buildings and infrastructure are located between the mouth of the canyon and the highway, but beyond the access road that travels through it, most of the inhabited area was not included in the

action area. The majority of the action area (159 acres) is on the Reservation property; however, a small portion of the channel work may extend into private lands (4 acres). See Land Ownership Figure 2, Appendix A.

LISTED SPECIES & CRITICAL HABITAT IN THE ACTION AREA

The purpose of this section is to identify protected species and critical habitat that may be present within the action area. Table 2 on the next page includes all potential species as listed on the official Service list of TES that may occur in or be affected by the proposed project (See Official List, Appendix B).

Table 2
Potential TES Species in the Silver Creek Trunkline Rehab Phase III Project Area

Species	Status	Habitat in Action Area	Critical Habitat in Action Area
Insects			
Monarch Butterfly <i>Danaus plexippus</i>	Candidate	No	Not designated
Flowering Plants			
Ute Ladies'-tresses <i>Spiranthes diluvialis</i>	Threatened	No	Not designated

BASELINE CONDITIONS

Most of the action area is open space where wild and some domestic horses roam and graze. As previously described, Indian Hickman flows west through the area intermittently and during storm events as do a number of smaller, unnamed drainages and minor channels. The main reservation road will be used to access the construction area. This road is paved but does not have very much traffic due to the fewer than 20 homes in the area. The exact population of the reservation is unknown but based on the homes, it is assumed the human presence is infrequent in the action area. Wildlife likely frequent the area and may include deer, birds, and other small terrestrial animals. Vegetation is dominated by sagebrush, juniper, snakeweed, rabbitbrush, and sumac. Photos taken at the site on October 28, 2020 are included in the TES Plant Habitat Report, Appendix D.

EFFECTS

Ute Ladies'-tresses

Ute ladies'-tresses, *Spiranthes diluvialis*, is a federally-listed threatened plant that occurs in eight mountain west state including Utah. ULT are found in moist to very wet meadows, along streams and ditches, in abandoned stream meanders, and near springs, seeps, and lake shores. In Utah, it ranges in elevation from 4,200 to 7,000 feet. A member of the orchid family, Ute ladies'-tresses (ULT) is a perennial herb with a flowering stem of ivory-colored flowers, arranged in a spiral spike at the top of the stem, and blooms mainly from late July through August. Due to the nondescript

green stalk that is most typically found amongst similar sized grasses, sedges, and rushes, ULT are usually only identifiable while blooming. Urbanization and stream channelization from agriculture and development have reduced or modified typical riparian habitat for this species. (UDWR, 2020 & USFWS, 2020).

A site visit was conducted on October 28, 2020, by BC&A biologist Merissa Davis and consulting botanist Garrett Billings (See TES Plant Report, Appendix D). Indian Hickman Creek and connecting channels were dry during the site visit except for a short section of the creek at the mouth of the canyon that daylights for about 400 feet in a wide, shallow, rocky channel. No wetlands were encountered in the project area and the channels are known to be dry most of the year except during storm events. (See Hydrology & Habitat Figure, Appendix A). There is no suitable habitat for ULT in the action area and such, it is anticipated that the proposed actions would have *no effect* on the listed species.

Monarch Butterfly

Monarch butterfly, *Danaus plexippus*, is a candidate species for federal listing under the ESA due to a more than 99% decline in the western population since the 1980s (USFWS, 2021c). A number of factors have contributed to the extreme population decline including the loss and degradation of overwintering groves; pesticide use, loss of breeding and migratory habitat, climate change, and parasites or disease. Monarch butterflies are typically found in Utah during the summer breeding months and are dependent on open fields and meadows with milkweed plants which are both a source of nectar and an egg laying site for the insects.

During the site visits, no milkweed was observed, nor were other flowering plants capable of providing a significant nectar source for monarch butterfly. Due to a lack of suitable habitat in the action area this species is not expected to be present and as such, it is anticipated that the proposed actions would have *no effect* on the candidate species.

Migratory Birds

Migratory birds are protected under the Migratory Bird Treaty Act (MBTA; 16 U.S.C., §703, Supp. I, 1989). The MBTA prohibits killing, possessing, or trading of migratory birds except in accordance with regulations prescribed by the Secretary of the Interior. This act encompasses whole birds, parts of birds, and bird nests and eggs. A list of potential migratory birds in the WVDS area is included in the list of species that may be affected by the proposed project included in Appendix B (USFWS 2020b).

Although bird nesting habitat is limited in the action area for this project there are some willows and juniper where migratory birds could potentially forage and nest. Tree removal is not specifically planned as part of the construction, but should it become necessary during the general migratory bird nesting season (February – September), a preconstruction survey will be completed to determine whether nesting birds are present (no more than five days prior to construction). In the event that migratory birds are found nesting in trees that would be removed, construction activities will be postponed until the non-nesting season or until nestlings have fledged and/or the nest fails or breeding behaviors are no longer observed.

CONSERVATION COMMITMENTS

The following conservation commitments are expected as part of the proposed actions.

1. If any trees are to be removed during migratory bird breeding and nesting season (February through September), pre-construction surveys should take place (no more than 5-day prior). If active nests are found, construction activities will be postponed until after the nesting season or until nestlings have fledged and/or the nest fails, or breeding behaviors are no longer observed.
2. Best management practices will be used throughout the action area to reduce impacts to channels including using silt fencing and wattles for erosion and storm water control.

CONCLUSIONS

Channel improvements, berm, and concrete ford construction at Skull Valley Reservation is expected to take place in 2024 pending environmental clearances, permitting, contracts and agreements. No suitable habitat exists for Ute ladies'-tresses or monarch butterfly; therefore it is expected there will be **no effect** to any federally-listed or candidate species with potential to occur in this area. Conservation commitments have been made to minimize impacts to the extent possible.

LITERATURE CITED

- Cline, Chris. 2020a. *Email Correspondence Regarding Ute Ladies'-tresses and potential mitigation plans*. December 8-18, 2020.
- Cline, Chris. 2020b. *Meeting to Discuss Ute Ladies'-tresses in Action Area*. December 8, 2020.
- Reisor, Rita. 2020a. *Email Correspondence Regarding Ute Ladies'-tresses and potential mitigation plans*. December 8-18, 2020.
- Reisor, Rita. 2020b. *Meeting to Discuss Ute Ladies'-tresses in Action Area*. December 8, 2020.
- U.S. Fish & Wildlife Service (USFWS). 2020a. *Information, Planning, and Conservation System (IPAC)*. <https://ecos.fws.gov/ipac/location/index>. Accessed online April 2020, December 2020 and June 2021.
- USFWS. 2021b. *Silver Creek Sewer Trunkline Rehabilitation Phase III - List of TES that may occur in proposed project location, and/or may be affected by your proposed project*. Consultation Code: 06E23000-2021-SLI-0582 Event Code: 06E23000-2021-E-01228. Accessed online June 28, 2021.
- USFWS. 2021c. *Western Monarch Butterfly Conservation Recommendations*. April 29, 2021.
- USFWS. 2020. *Ute Ladies'-Tresses Species Profile*. <https://ecos.fws.gov/ecp/species/2159>. Accessed online December 2020.
- USFWS. 1990. *Interim Survey Requirements for Ute Ladies'-tresses Orchid*.
- Utah Division of Wildlife Resources (UDWR). 2020. *Utah Conservation Data Center*. <https://dwrcdc.nr.utah.gov/ucdc/>. Accessed online December 2020. Utah
- Utah Natural Heritage Program (UNHP). 2020. *Skull Valley Online Species Search Report # 11825*. December 7, 2020.

Appendix A

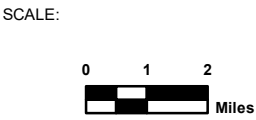
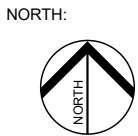
Site Location, Landowner, & Hydrology/Habitat Figures



LEGEND

 Project Boundary (163 acres)

Figure Created By
Cara Glabau 02/11/2022
Imagery: Hexagon 2018

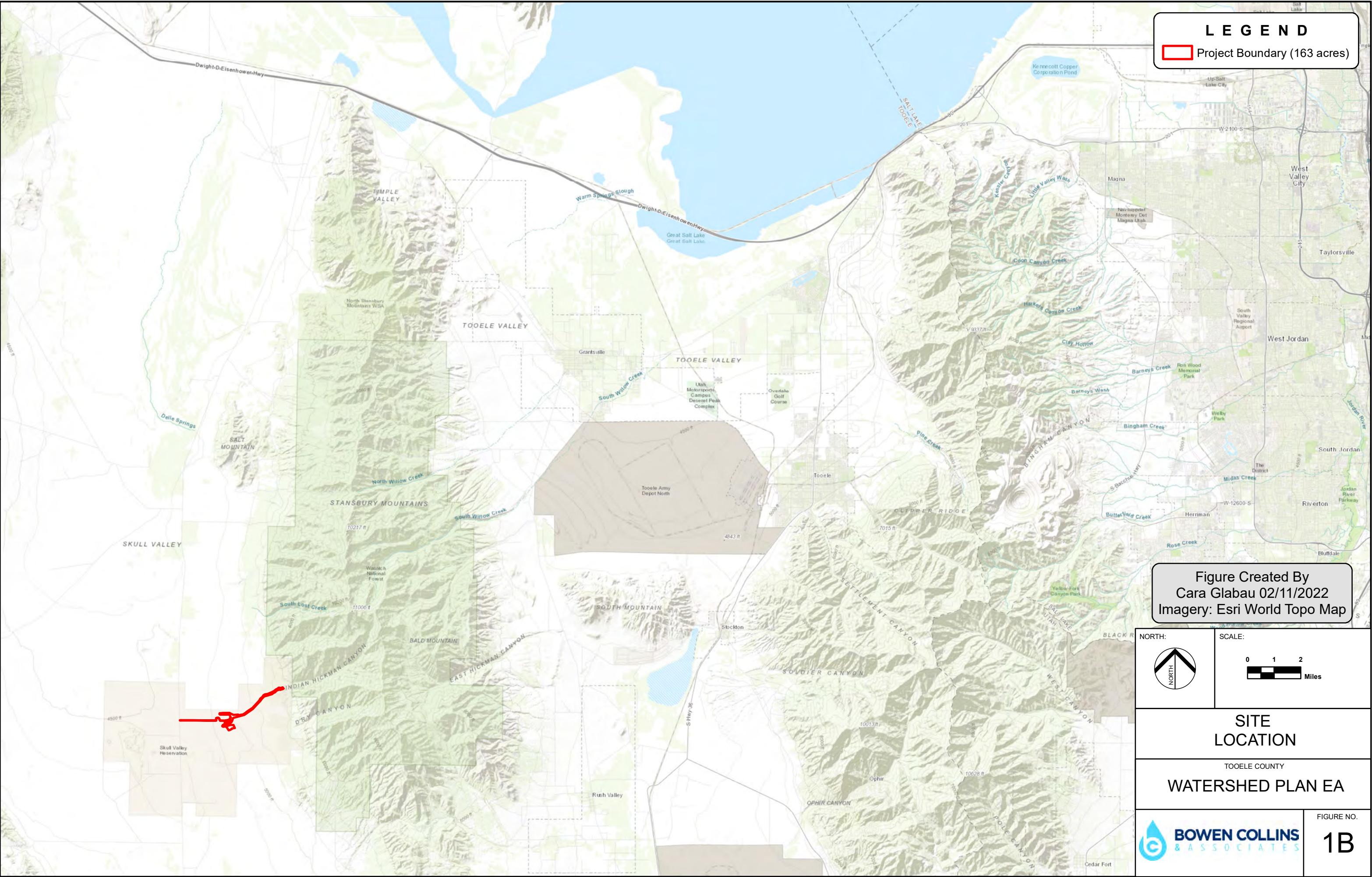


**SITE
LOCATION**

TOOELE COUNTY
WATERSHED PLAN EA



FIGURE NO.
1A



LEGEND

Project Boundary (163 acres)

Figure Created By
Cara Glabau 02/11/2022
Imagery: Esri World Topo Map

NORTH:

SCALE:

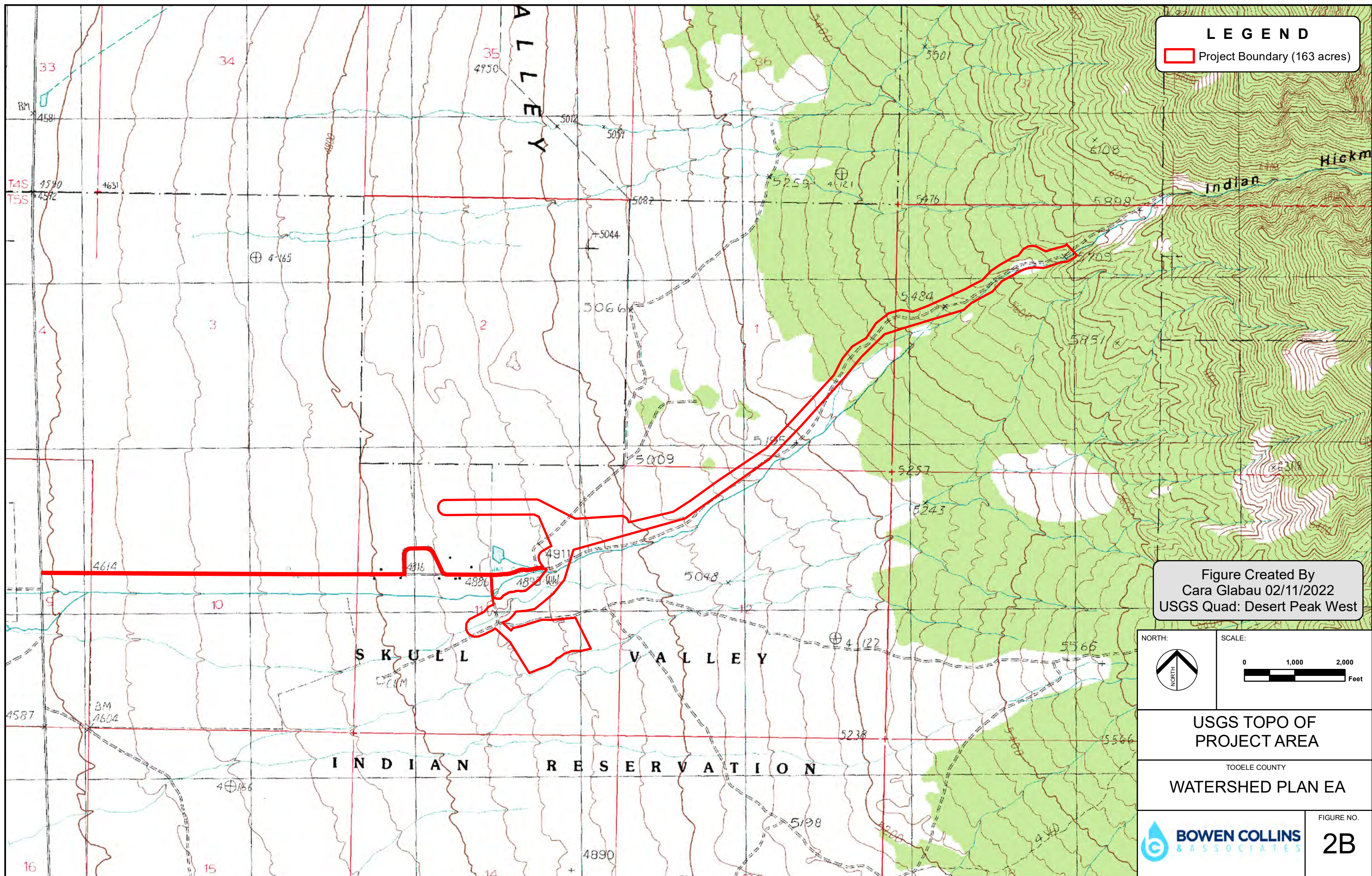
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LOCATION

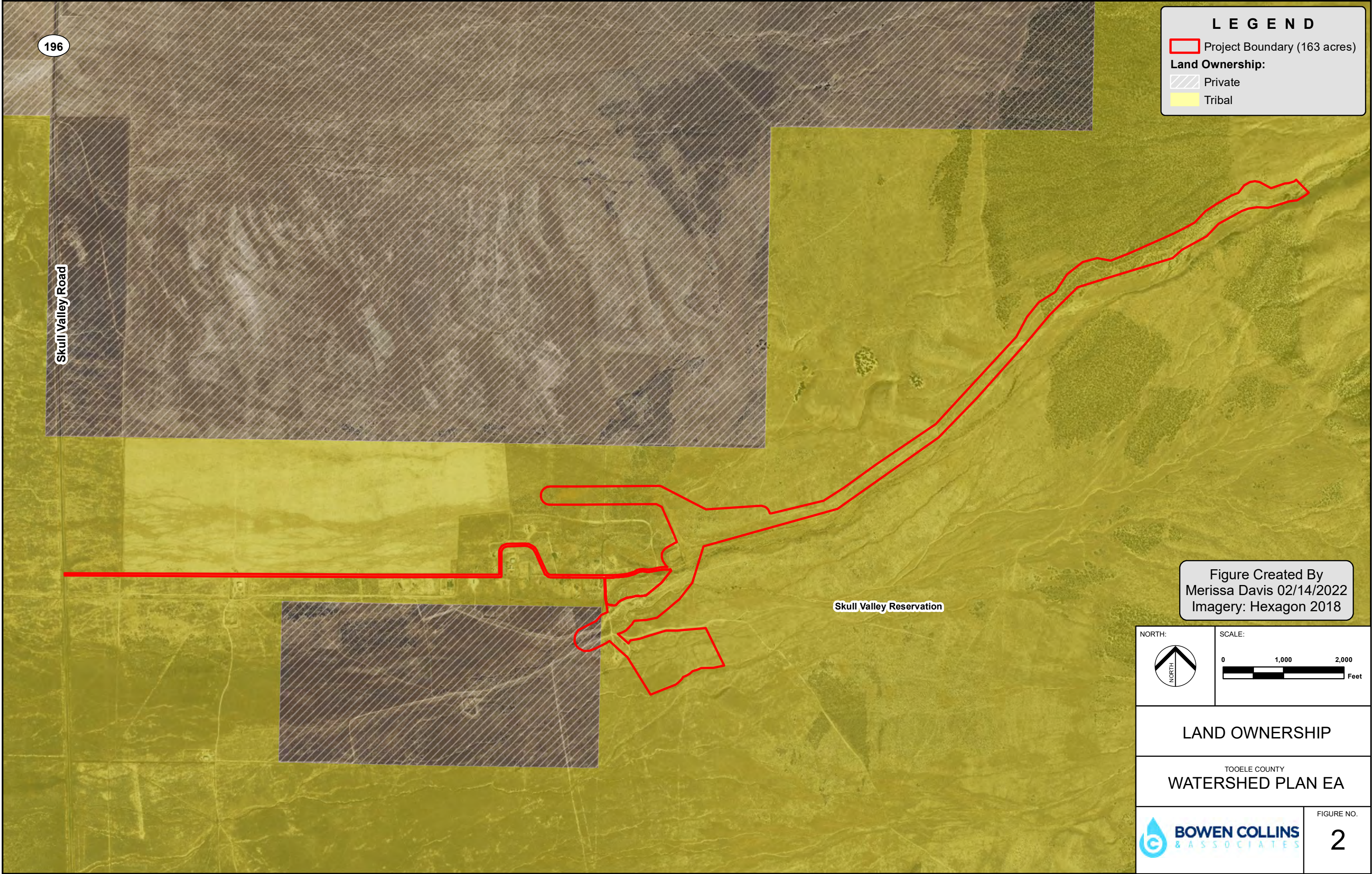
TOOELE COUNTY
WATERSHED PLAN EA

BOWEN COLLINS
& ASSOCIATES

FIGURE NO.
1B







LEGEND

Project Boundary (163 acres)

Land Ownership:

Private

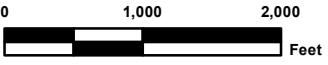
Tribal

Figure Created By
Merissa Davis 02/14/2022
Imagery: Hexagon 2018

NORTH:



SCALE:



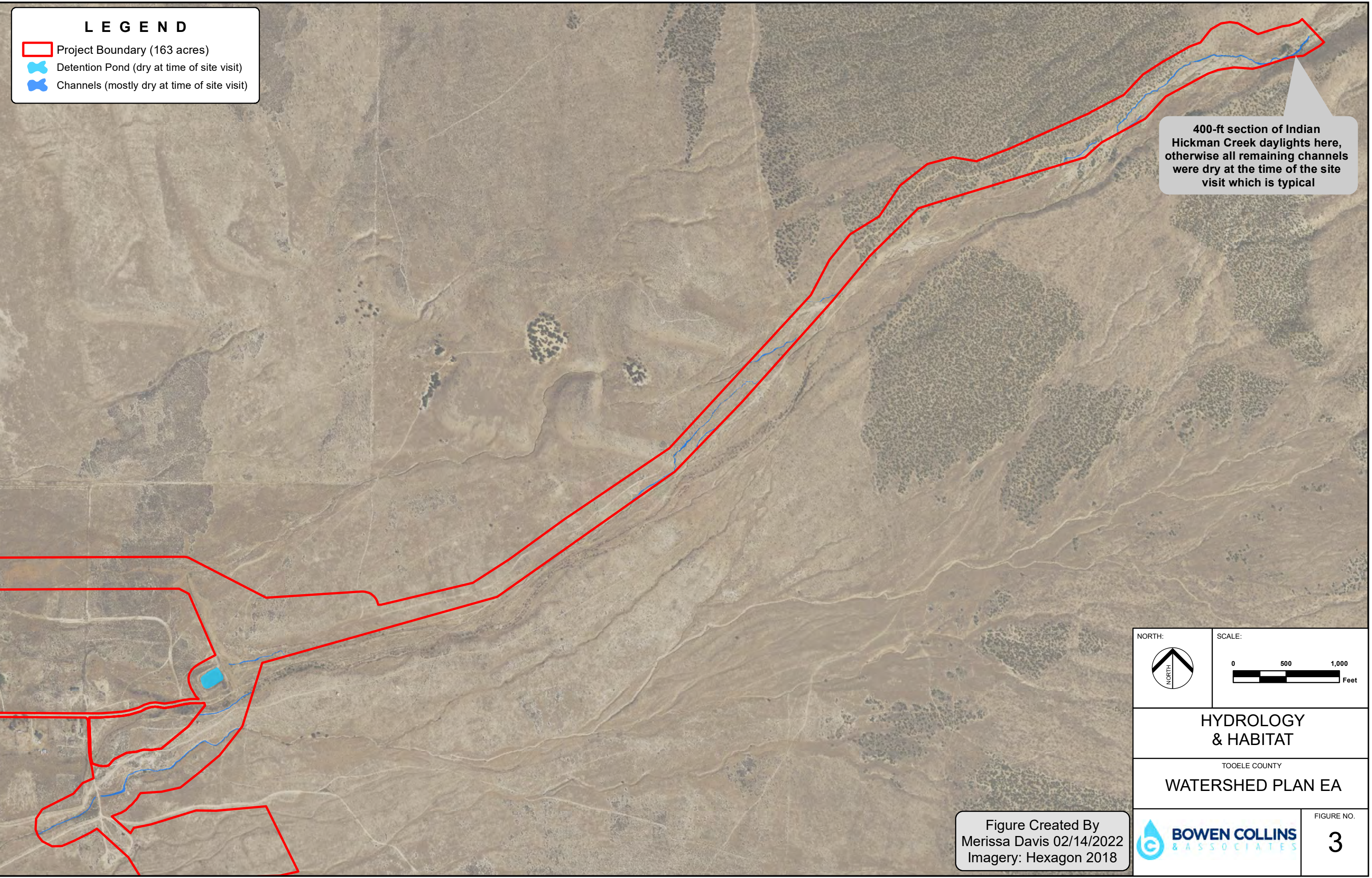
LAND OWNERSHIP

TOOELE COUNTY
WATERSHED PLAN EA



BOWEN COLLINS
& ASSOCIATES

FIGURE NO.
2



LEGEND

Project Boundary (163 acres)

Detention Pond (dry at time of site visit)

Channels (mostly dry at time of site visit)

400-ft section of Indian Hickman Creek daylights here, otherwise all remaining channels were dry at the time of the site visit which is typical

NORTH:

SCALE:

05001,000

Feet

HYDROLOGY
& HABITAT

TOOELE COUNTY

WATERSHED PLAN EA

BOWEN COLLINS
& ASSOCIATES

FIGURE NO.

3

Figure Created By
Merissa Davis 02/14/2022
Imagery: Hexagon 2018

Appendix B

USFWS Official TES Potential List



United States Department of the Interior



FISH AND WILDLIFE SERVICE

Utah Ecological Services Field Office

2369 West Orton Circle, Suite 50

West Valley City, UT 84119-7603

Phone: (801) 975-3330 Fax: (801) 975-3331

<http://www.fws.gov>

<http://www.fws.gov/utahfieldoffice/>

In Reply Refer To:

January 17, 2022

Consultation Code: 06E23000-2021-SLI-0582

Event Code: 06E23000-2022-E-00518

Project Name: Skull Valley Watershed EA

Subject: Updated list of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

<http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF>

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (<http://www.fws.gov/windenergy/>) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at:

<http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm>;

<http://www.towerkill.com>; and

[http://](http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html)

www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List
- USFWS National Wildlife Refuges and Fish Hatcheries
- Migratory Birds

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Utah Ecological Services Field Office

2369 West Orton Circle, Suite 50
West Valley City, UT 84119-7603
(801) 975-3330

Project Summary

Consultation Code: 06E23000-2021-SLI-0582

Event Code: Some(06E23000-2022-E-00518)

Project Name: Skull Valley Watershed EA

Project Type: LAND - FLOODING

Project Description: The County is evaluating repairs and floodplain management in this area to protect the Skull Valley Reservation residents and associated infrastructure (UPDATED ACTION AREA)

Project Location:

Approximate location of the project can be viewed in Google Maps: <https://www.google.com/maps/@40.40529185,-112.69661158374308,14z>



Counties: Tooele County, Utah

Endangered Species Act Species

There is a total of 2 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries¹, as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

-
1. [NOAA Fisheries](#), also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Insects

NAME	STATUS
Monarch Butterfly <i>Danaus plexippus</i> No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9743	Candidate

Flowering Plants

NAME	STATUS
Ute Ladies'-tresses <i>Spiranthes diluvialis</i> No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/2159	Threatened

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

USFWS National Wildlife Refuge Lands And Fish Hatcheries

Any activity proposed on lands managed by the [National Wildlife Refuge](#) system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS OR FISH HATCHERIES WITHIN YOUR PROJECT AREA.

Migratory Birds

Certain birds are protected under the Migratory Bird Treaty Act¹ and the Bald and Golden Eagle Protection Act².

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described [below](#).

1. The [Migratory Birds Treaty Act](#) of 1918.
2. The [Bald and Golden Eagle Protection Act](#) of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

THERE ARE NO FWS MIGRATORY BIRDS OF CONCERN WITHIN THE VICINITY OF YOUR PROJECT AREA.

Migratory Birds FAQ

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

[Nationwide Conservation Measures](#) describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. [Additional measures](#) or [permits](#) may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS [Birds of Conservation Concern \(BCC\)](#) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the [Avian Knowledge Network \(AKN\)](#). The AKN data is based on a growing collection of [survey, banding, and citizen science datasets](#) and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle ([Eagle Act](#) requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the [AKN Phenology Tool](#).

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the [Avian Knowledge Network \(AKN\)](#). This data is derived from a growing collection of [survey, banding, and citizen science datasets](#).

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go to the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: [The Cornell Lab of Ornithology All About Birds Bird Guide](#), or (if you are unsuccessful in locating the bird of interest there), the [Cornell Lab of Ornithology Neotropical Birds guide](#). If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are [Birds of Conservation Concern](#) (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the [Eagle Act](#) requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the [Northeast Ocean Data Portal](#). The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the [NOAA NCCOS Integrative Statistical](#)

[Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf](#) project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the [Diving Bird Study](#) and the [nanotag studies](#) or contact [Caleb Spiegel](#) or [Pam Loring](#).

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to [obtain a permit](#) to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Appendix C

UNHP Species Report



Utah Division of Wildlife Resources
Utah Natural Heritage Program
1594 W. North Temple
PO Box 146301
Salt Lake City, UT 84116

Report Number: 12415
June 28, 2021

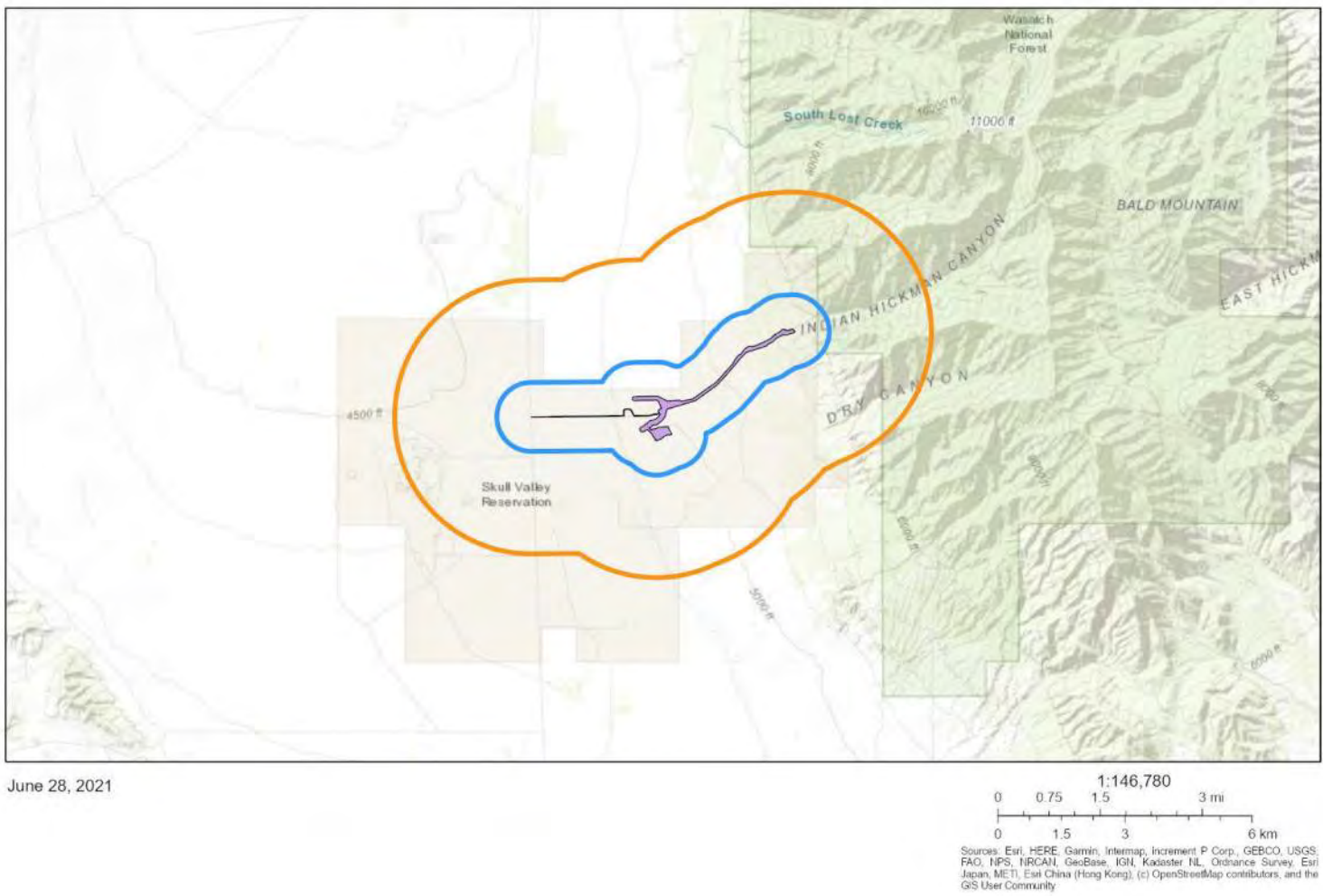
Utah Natural Heritage Program Online Species Search Report

Project Information

Project Name
Tooele County Skull Valley EA

Project Description
The County is evaluating repairs and floodplain management in this area to protect the Skull Valley Reservation residents and associated infrastructure

Location Description
Skull Valley Reservation, Tooele County



Animals within a 1/2 mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
No Species Found				

Plants within a 1/2 mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
No Species Found				

Animals within a 2 mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
Kit Fox	Vulpes macrotis	SGCN		2012
Ferruginous Hawk	Buteo regalis	SGCN		2002

Plants within a 2 mile radius

Common Name	Scientific Name	State Status	U.S. ESA Status	Last Observation Year
No Species Found				

Definitions

State Status

SGCN	Species of greatest conservation need listed in the Utah Wildlife Action Plan
------	---

U.S. Endangered Species Act

LE	A taxon that is listed by the U.S. Fish and Wildlife Service as "endangered" with the probability of worldwide extinction
LT	A taxon that is listed by the U.S. Fish and Wildlife Service as "threatened" with becoming endangered
LE;XN	An "endangered" taxon that is considered by the U.S. Fish and Wildlife Service to be "experimental and nonessential" in its designated use areas in Utah
C	A taxon for which the U.S. Fish and Wildlife Service has on file sufficient information on biological vulnerability and threats to justify it being a "candidate" for listing as endangered or threatened
PT/PE	A taxon "proposed" to be listed as "endangered" or "threatened" by the U.S. Fish and Wildlife Service

Disclaimer

The information provided in this report is based on data existing in the Utah Division of Wildlife Resources' central database at the time of the request. It should not be regarded as a final statement on the occurrence of any species on or near the designated site, nor should it be considered a substitute for on-the-ground biological surveys. Moreover, because the Utah Division of Wildlife Resources' central database is continually updated, any given response is only appropriate for its respective request.

The UDWR provides no warranty, nor accepts any liability, occurring from any incorrect, incomplete, or misleading data, or from any incorrect, incomplete, or misleading use of these data.

The results are a query of species tracked by the Utah Natural Heritage Program, which includes all species listed under the U.S. Endangered Species Act and species on the Utah Wildlife Action Plan. Other significant wildlife values might also be present on the designated site. Please [contact](#) UDWR's regional habitat manager if you have any questions.

Contact the U.S. Fish and Wildlife Service at (801) 975-3330 for the purpose of consultation under the Endangered Species Act.

Please contact our office at (801) 538-4759 or habitat@utah.gov if you require further assistance.

Your project is located in the following UDWR region(s): Central region

Report generated for:
Merissa Davis
Bowen Collins & Associates
154 East 14075 South
Draper, UT 84020
(801) 495-2224
mdavis@bowencollins.com



Appendix D
TES Habitat Survey Report

**Skull Valley Reservoir Project
Threatened & Endangered Plant Species
Survey Report
Tooele, Utah**

December 1, 2020

Prepared by:

Garrett Billings
3356 W 550 N
West Point, Utah 84015
(801) 675-1177

Introduction

The Skull Valley Project area is located about 45 miles Southwest of Salt Lake City in Tooele County, Utah. **Figure 1** shows the project area, including the access road and staging area. The total project area is 132 acres. Representative overview photos of the project site are presented in **Figures 2-16**.

Special Status Plant Species

Spiranthes diluvialis (Ute-ladies' tresses) is the only known T&E species occurring in Tooele County, Utah. Based on herbarium specimens, the nearest occurrence is located about 45 miles east of the project in Davis County, Utah. The nearest occurrence in Tooele County is located 65 miles to the southwest near Fish Springs, Utah. *Spiranthes diluvialis* has a very specific habitat type, growing in wet, moist conditions. This species typically blooms from late July through August.

Methodology

A survey of the Skull Valley project area was conducted on October 28, 2020. The survey consisted of transects throughout the project area that focused on suitable habitat for *Spiranthes diluvialis*. A general floristic survey was also conducted across the project area. Spring annuals and many summer flowering forbs were most likely not observed during this survey due to the late Fall survey date and heavy grazing disturbance.

Spiranthes diluvialis:

The survey focused on suitable habitat within the project area due to the survey date occurring after flowering time. Suitable habitat for this species includes moist meadows, perennial streams and rivers with moist, alluvial soils with moderate vegetation cover, oxbows and floodplains. Any area with flowing water or wet soil was carefully surveyed for any evidence of *Spiranthes diluvialis*.

Results

No suitable *Spiranthes diluvialis* habitat was discovered within the project area. While the Eastern-most section of the project area included a stream with flowing water, no commonly associated species were observed with exception to scattered willows. The soil was extremely rocky and dry with no suitable flood plain habitat. No similar species were discovered.

The shrub dominated plant communities are characterized by *Artemisia tridentata* (Big Sagebrush), *Juniperus osteosperma* (Rocky Mountain Juniper), *Gutierrezia sarothrae* (broom snakeweed), *Ericameria nauseosa* (rubber rabbitbrush) and *Rhus aromatica* (fragrant sumac). **Appendix A** contains a list of plant species observed on site.

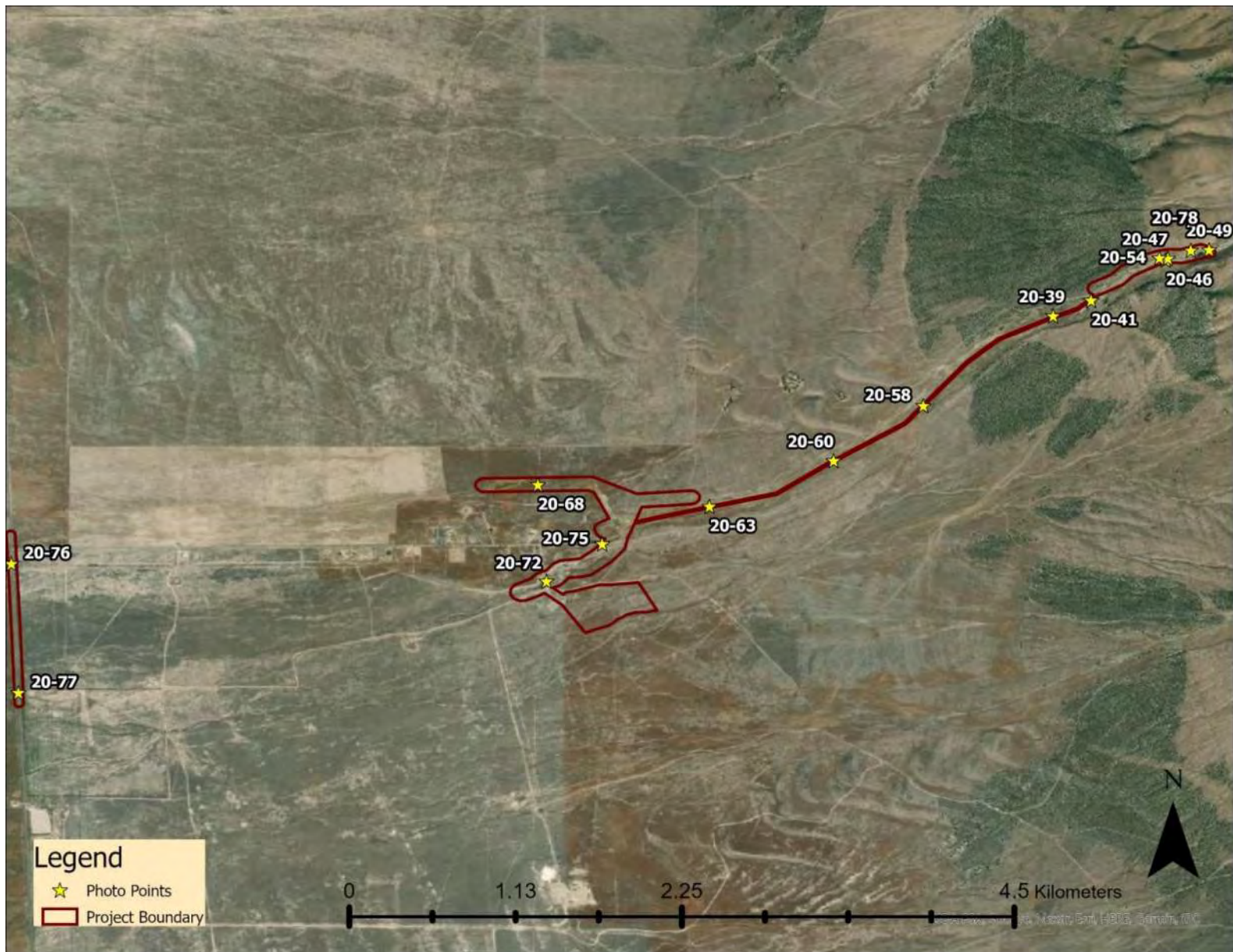


Figure 1: Overview of Skull Valley Project Area

Site Overview Photos



Figure 2 Representative site overview from photo point 20-77. View to North, off of Rd 196 (Skull Valley Road)



Figure 3. Representative site overview from photo point 20-76. View to South, off of Rd. 196 (Skull Valley Road)



Figure 4. Representative site overview from photo point 20-68 looking West



Figure 5. Representative site overview from photo point 20-75 looking East



Figure 6. Representative site overview from photo point 20-72 looking West



Figure 7. Representative site overview from photo point 20-63 looking West



Figure 8. Representative site overview from photo point 20-60 looking West



Figure 9. Representative site overview from photo point 20-58 looking West



Figure 10. Representative site overview from Photo point 20-47 looking West at flowing stream



Figure 11. Representative site overview from photo point 20-49 looking East at cobble river bed



Figure 12. Representative site overview from photo point 20-46 looking Northeast at burned area and cobble bed



Figure 13. Representative site overview from photo point 20-41 looking East



Figure 14. Representative site overview from photo point 20-78 looking East at stream



Figure 15. Representative site overview from photo point 20-54. Stream looking West



Figure 16. Representative site overview from photo point 20-39 looking East

Appendix B

Plant Species Observed

*Locally dominant

Shrubs

Acer negunda

Artemisia tridentata

*Eracameria nauseosa**

Eriogonum shockleyi

*Gutierrezia sarothrae**

*Juniper osteosperma**

Prunus virginiana

Purshia stansburiana

*Rhus aromatica**

Rosa spp.

Salix exigua

Salix lasiolepis

*Sarcobatus vermiculatus**

Tamarisk chinensis

Forbs

Achillea millefolium

Artemisia ludoviciana

Asteraceae spp.

Astragalus utahensis

Cirsium sp

Cirsium vulgare

Cymopterus spp.

Cryptantha spp.

Halogeton glomeratus

Helianthus spp.

Kochia scoparia

Medicago sativa

Nasturtium officinale

Oenothera cespitosa

Opuntia polyacantha.

Penstemon spp.

Rumex crispus

Salsola iberica

Sphaeralcea spp.

Verbascum Thapsus

Zigadenus elegans

Grasses

*Bromus tectorum**

Elymus elymoides

Leymus cinereus

Poa spp.

Pseudoroegneria spicata

Thinopyrum intermedium

**Skull Valley Watershed EA
Hydrology Technical Memorandum**

TECHNICAL MEMORANDUM

TO: Aimee Rohner, P.E.
NRCS Construction Civil Engineer

COPIES: Bucky Whitehouse
Tooele County Emergency Services Director

FROM: Clinton Merrell, P.E., CFM
Bowen Collins & Associates

DATE: August 17, 2020

SUBJECT: Skull Valley Watershed Plan EA Hydrology

JOB NO.: 631-19-01

Revision No.	Revision Date	Notes
0	08-06-2020	Draft Review.
1	08-17-2020	Initial Release, incorporate NRCS Review Comments.

SECTION 1 - INTRODUCTION

1.1 INTRODUCTION

Tooele County, Utah contracted with Bowen Collins & Associates (BC&A) to prepare a new Watershed Plan and Environmental Assessment (Plan-EA) for the Skull Valley Watershed in accordance with USDA Natural Resource Conservation Services (NRCS) guidelines and requirements. The funding for this project was provided by the NRCS through the Watershed and Flood Prevention Operations (WFPO) Program. The Sponsor for this Plan-EA is Tooele County (Sponsor/County). The principal objective of this Plan-EA is to provide the Sponsor and NRCS with National Environmental Policy Act (NEPA) analysis and documents for Sponsor-selected project drainage basins within the larger Skull Valley Watershed. The area needs some structural measures that will mitigate potential flood and debris flow impacts that are the result of a recent fire in the upstream watershed.

This technical memorandum (TM) will summarize the hydrologic analyses performed in support of potential projects identified during the scoping phase of the development of the watershed Plan-EA. During the scoping process, the project team identified Indian Hickman Canyon as the watershed with post-fire issues that pose a hazard to the health and property of tribal residents of the Skull Valley Band of Goshute Reservation (Reservation). Potential projects identified in the scoping phase include:

- Repairs to a washed-out waterline and diversion structure which previously conveyed stream flows from the mouth of Indian Hickman Canyon to a holding pond located to the east of the Reservation.
- Flood control facilities to protect the Reservation from flood and debris flows originating from Indian Hickman Canyon and the foothills just south of the canyon.

In order to evaluate these potential projects, hydrologic analyses were completed including the development of the 1-, 2-, 5-, 10-, 25-, 100-, 200- and 500-year peak discharges for the Indian Hickman Canyon watershed in accordance with NRCS Program requirements. A total of two (2) drainage basins were identified and included in this study as shown in Table 1 and in Figure 1.

Table 1
Drainage Basins and Associated Drainage Areas

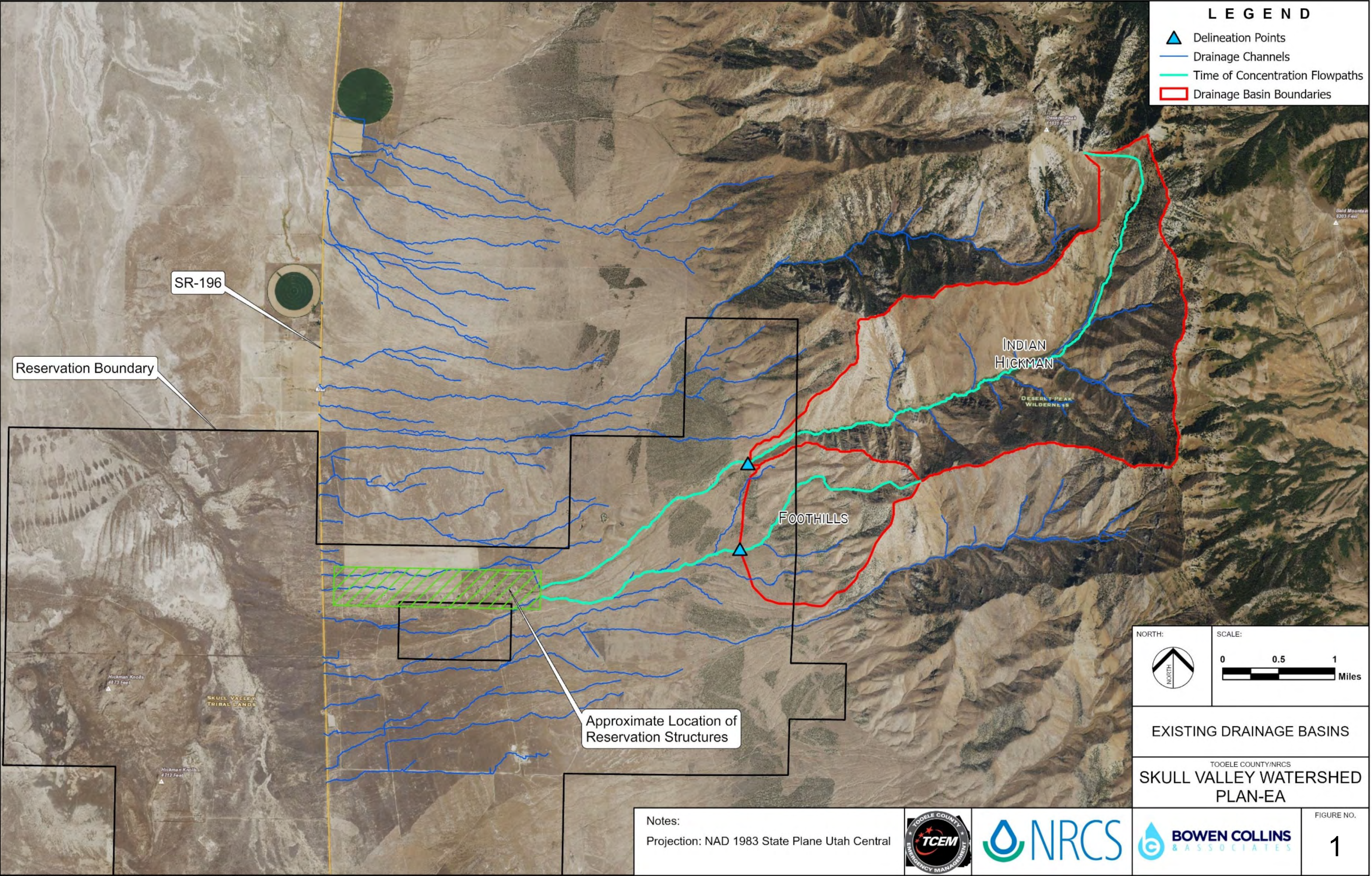
Drainage Basin	Drainage Area (mi²)
Indian Hickman Canyon	5.61
Foothills	1.61

1.2 EXISTING DATA

The hydrologic analysis for the project utilized the data sources presented in Table 2.

Table 2
Study Data Sources

Data	Source	Description
Digital Elevation Model (DEM)	US Geologic Survey (USGS) National Elevation Dataset (NED)	3-meter resolution bare-earth digital terrain model (DTM) data set of project vicinity used to delineate drainage basins and calculate basin physical parameters.
Bare Earth LiDAR Topography	USGS 3D Elevation Program (3DEP)	1-meter resolution bare-earth DTM data set of project vicinity used to verify drainage basin delineation and basin physical parameters.
Aerial Imagery	USDA National Agriculture Imagery Program (NAIP)	1-meter pixel aerial imagery used for the background of figures and to determine existing land uses for hydrologic models.
Soil Data	NRCS Web Soil Survey	Soil Survey Geographic Database (SSURGO) mapping data used to determine Hydrologic soil type for hydrologic models.
Land Cover Data	USGS National Land Cover Dataset (NLCD), 2011 and 2016	Land use classification data to determine surface cover characteristics for hydrologic models.
Rainfall Data	NOAA Atlas 14	Point precipitation frequency estimates used to develop design rainfall depths.



LEGEND

- Delineation Points
- Drainage Channels
- Time of Concentration Flowpaths
- Drainage Basin Boundaries

NORTH:

SCALE:

EXISTING DRAINAGE BASINS

TOOELE COUNTY/NRCS
**SKULL VALLEY WATERSHED
PLAN-EA**

FIGURE NO.

1

Notes:
Projection: NAD 1983 State Plane Utah Central

1.3 BACKGROUND AND PREVIOUS STUDIES

The following studies and reports were reviewed in the preparation of the subject hydrology study:

- Skull Valley Band of Goshute Floodplain Management Plan (FMP), US Army Corps of Engineers (USACE), March 2018.
- Pre / Post Fire Hydrology – Patch Springs, Nathaniel Todea, NRCS, September 23, 2013.
- Hydrology Study, Skull Valley Hydrologic Model, USACE, 2019.

Key points and information from each of these studies are provided in the following sections.

1.3.1 Floodplain Management Plan

In August 2013, the Patch Springs fire burned more than 13,000 acres to the north and east of the Reservation. The fire burned nearly the entire Indian Hickman Canyon drainage area. A map of the fire extents from the Reservation Floodplain Management Plan is shown in Figure 2.

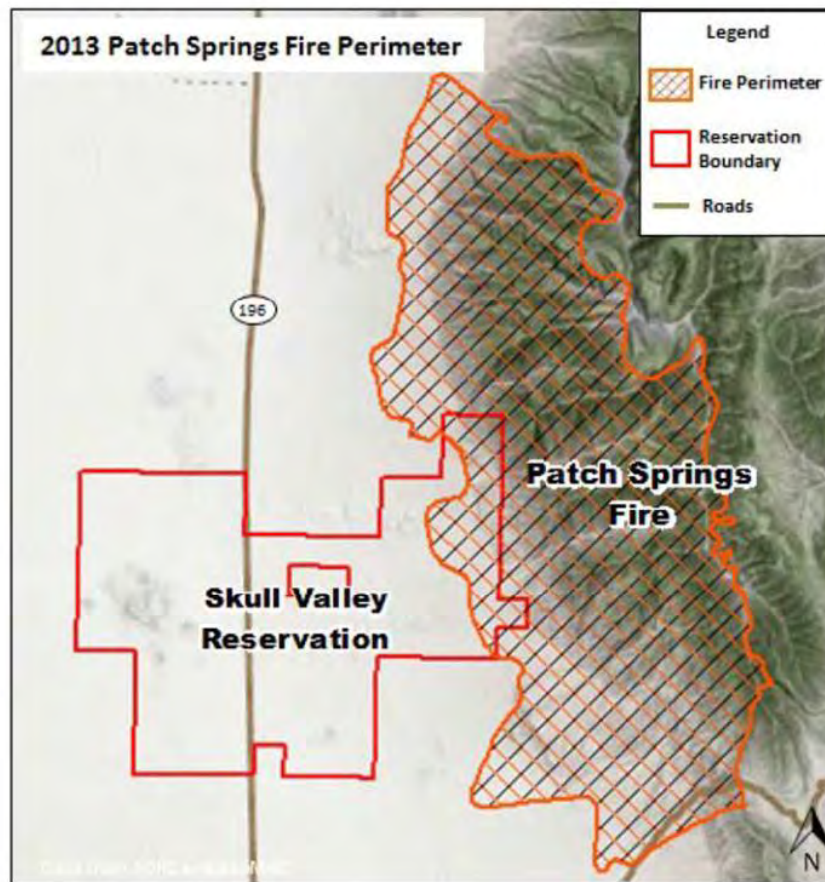


Figure 2. Map of 2013 Patch Springs Fire Perimeter (USACE FMP 2018, Figure 6)

Following the fire, on September 3-4, 2013, a thunderstorm event caused flooding and damage to yards, homes, and other facilities within the Reservation. Then in August 2014, another thunderstorm caused flooding which washed out the existing irrigation water diversion and segments of the associated pipeline at the mouth of Indian Hickman Canyon. According to the Floodplain Management Plan report, this event deposited "several hundreds of thousands of cubic

yards” of debris from the canyon onto the alluvial fan upstream of the Reservation. Photos taken following these two flood events are shown in Photos 1, 2 and 3.



Photo 1. Mudflow east of the Reservation following the 2013 event. (USACE 2018 Figure 7)



Photo 2. Washed out diversion structure following the 2014 event. (USACE 2018 Figure 10)



Photo 3. Washed-out pipeline in August 2019.

1.3.2 NRCS 2013 Pre/Post-Fire Hydrology Study

The NRCS performed a hydrologic analysis for the pre- and post-fire conditions after the 2013 flood event. That study estimated flood flows for various flood frequency return periods from 2-years to 500-years using a rainfall runoff model. The model was developed for the area tributary to the mouth of Indian Hickman Canyon. A summary of the model parameters developed in that study are presented below.

- Drainage basin delineation point: Latitude 40.4165 N, Longitude 112.675 W
- Drainage area: 5.61 sq. mi.
- Loss Method: SCS runoff curve number (CN).
- Runoff Hydrograph Transform method: SCS Unit Hydrograph.
- Precipitation: From NOAA Atlas 14, depths used were not stated. 24-hr storm distributions derived from NOAA Atlas 14 data were used.

The results of the 2013 NRCS Study are summarized in Table 3 below. A copy of the study is included in Appendix A.

Table 3
Results of 2013 NRCS Hydrology Study

Scenario	CN	Travel Vel. (fps)	Tc ¹ (min)	NOAA Atlas 14 Derived Storm								SCS Type II	SCS Type IA
				Estimated Peak Flow by Recurrence Interval (cfs)									
				Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q500	Q100	Q100
Pre-fire	61	7	70	9	23	42	129	265	460	714	1,176	503	108
Post-fire (Moderate Burn)	72	8	60	74	246	129	818	1,174	1,614	2,124	2,981	1,770	397
Post-fire (Severe Burn)	75	9	55	161	406	661	1,113	1,531	2,043	2,640	3,625	2,263	545

Notes:

1. Time of concentration was not stated in the study. Times shown are approximate based on travel velocity and flow path distance.

1.3.3 USACE 2019 Hydrology Study

The USACE performed a hydrology study in 2019 to aid the Skull Valley Band of Goshute Tribe in its efforts to respond to floods and debris flows and to aid in developing strategies for mitigation and prevention of damage from future flood flows. The model developed as part of that study estimated peak flow rates at locations along Indian Hickman Canyon, Dry Canyon and at a main confluence point near State Highway 196. A summary of the model parameters developed in the study are presented below.

- Drainage area: 5.64 sq. mi.
- Loss Method: Initial loss of 0.75 inches, and a constant loss of 0.23 in/hr
- Runoff Hydrograph Transform method: LA S-graph method using the Wasatch Mountain and Valley S-Graph. Basin lag time was 1.02 hrs. Which corresponds to a time of concentration of 1.7 hrs.
- Precipitation: 6-hr rain depths from NOAA Atlas 14 at Deseret Peak, UT. Areal reduction factors were used for an assumed storm area of 15 sq. mi. over Indian Hickman and Dry Canyons. A cloudburst distribution was used.
- Bulked Flows: The study included estimates for flowrates bulked to account for post-fire debris and sediment. Bulking factors of 1.25 and 1.75 were selected to represent sedimentation concentrations of 20% and 43% by volume.

The results of the 2019 USACE study for Indian Hickman Canyon are summarized in Table 4. A copy of the study is included in Appendix A.

Table 4
Estimated Peak Flows for Indian Hickman Canyon, 2019 USACE Study

Scenario	Estimated Peak Flow by Recurrence Interval (cfs)							
	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q500
Clean Water	368	691	967	1,364	1,738	2,177	2,701	3,524
20% Sediment	460	863	1,209	1,704	2,173	2,721	3,377	4,406
43% Sediment	644	1,209	1,693	2,386	3,042	3,810	4,727	6,168

SECTION 2 - HYDROLOGY

This Section summarizes the process and analyses used to develop the recommended hydrology for this Plan-EA which included flood frequency analysis, regression analysis, and a computer model to simulate the rainfall-runoff process. Each of these analyses are summarized below.

2.1 FLOOD FREQUENCY ANALYSIS

A flood frequency analysis is the preferred method for estimating peak flows from gaged watersheds, however, no gage is present in Indian Hickman Canyon. There are a few stream gages on other nearby watersheds. In the 2013 NRCS study, some nearby gages were selected and a statistical flood frequency analysis for each gage was conducted. The estimated peak flows for two of those gages are shown in Table 5.

Table 5
Nearby Stream Gage Statistical Analysis Peak Flows (NRCS 2013)

Name	USGS Site ID	Drainage Area (sq. mi.)	Years of Record	Estimated Peak Flow by Recurrence Interval (cfs)							
				Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q500
South Willow Creek, near Centerville, UT	10172800	4.2	45	33	57	76	103	125	149	175	211
North Willow Creek, near Grantsville, UT	10172805	5.28	13	26	54	81	124	165	214	272	365

The estimated peak flows for these nearby gaged watersheds were used to compare the results of the regression equation analysis and rainfall-runoff model developed for the present study as described in section 2.3.6 below.

2.2 REGRESSION ANALYSIS

The USGS has developed regional regression equations for estimating peak discharge rates in ungaged watersheds throughout Utah. The regression equations are based on flood frequency analyses conducted on gaged watersheds throughout the state. The USGS published equations in 1994 under the National Flood Frequency program (NFF) and again in 2008 under the National Streamflow Statistics program (NSS). Both the NFF (Region 6) and NSS (Region 3) equations were applied to the study drainage basins for the 100-year return period event. A summary of the regression equation estimates for a 100-year flood is provided in Table 6.

Table 6
Regression Analysis Peak Runoff Rates for the 100-year Runoff Event

Drainage Basin	Drainage Area ¹	Mean Basin Elev. ²	Estimated 100-year Peak Discharge(cfs)	
	(sq. mi)	(ft)	NSS ³	NFF ⁴
Indian Hickman	5.61	8170	506	384
Foothills	1.61	6173	346	387

Notes:

1. NSS Region 3 equations are based on data from gages with drainage areas between 5.72 and 66.5 square miles.
2. NFF Region 6 equations are based on data from gages with drainage areas between 0.2 and 210 square miles, and mean basin elevations between 4,770 and 9560 feet.
3. NSS Region 3 estimates have an average standard error of 177%.
4. NFF Region 6 estimates have a standard error of regression in log units of 1.84

2.3 RAINFALL-RUNOFF MODEL

Rainfall-runoff models were developed for both the Indian Hickman Canyon and Foothills drainage areas in the study area using the NRCS WinTR-20 and USACE HEC-HMS computer modeling software as described below.

2.3.1 Study Drainage Basin Boundaries

The drainage area of each studied drainage basin was delineated using Aquaveo Watershed Modeling System (WMS) software. USGS DEM elevation data was imported to WMS and used to delineate flow paths and drainage basin boundaries. The Foothills basin delineation includes the mountainsides and ravines on the foothills between Indian Hickman and Dry Canyons. Basin delineations stopped approximately at the start of the alluvial fans west of the mountains. This was done based on the assumption that little to no runoff is generated from rainfall falling on the coarse-grained alluvial deposits that have been deposited by past flooding events. The resulting drainage area boundaries are shown in Figure 1. The drainage area determined for each basin is summarized in Table 1.

2.3.2 Curve Number

Runoff Curve Numbers (CN) were estimated for each drainage area based on soil type and land use/vegetative cover.

Hydrologic soil group (HSG) maps were obtained from the NRCS Soil Survey Geographic (SSURGO) dataset and are shown on Figure 3. Several soil units in the study area are rock outcrops (Map Unit 51 – Lundy Complex, 30-60 percent slopes) and are not assigned a Hydrologic Soil Group (HSG) in

the SSURGO database. In the 2013 NRCS hydrology study, the geologist who performed the soil mapping was consulted and stated that the rock was fractured, and that study assumed an HSG B applied to those outcrops. This current study makes the same assumption.

Land use or vegetative cover was determined by inspection of aerial imagery, conducting field observations, and using the USGS National Land Cover Dataset (NLCD) mapping data. Land use descriptions from the NLCD data were related to similar land cover descriptions in NEH 630.0901. A map of land uses and vegetative cover present within the study area for both 2011 and 2016 conditions are shown on Figure 4. The 2016 NLCD dataset is assumed to represent present day conditions within the watershed. The 2011 NLCD is provided for comparison between the pre-fire and post-fire vegetative cover conditions.

Using GIS software, composite CN values representing each sub-basin were calculated on a weighted area basis. The CN values used for the various hydrologic soil-cover complexes present within the study area were based on information from NEH 630.0901 and are summarized in Table 7. In the 2013 NRCS study, for the pre-fire condition, all vegetative cover types were assumed to be in “good” hydrologic condition. Although the percentages of the various vegetative cover types have changed since the fire, this study assumes the current vegetation is in “good” hydrologic condition. In addition, since approximately 7 years have passed since the August 2013 fire, any hydrophobic properties of soil in burned areas are assumed to have dissipated.

Table 7
Curve Numbers for Hydrologic Soil-Cover Complexes

Land Use/Vegetative Cover	Hydrologic Soil Group			
	A	B	C	D
Oak Aspen (Good)	-	30	41	48
Pinyon Juniper (Good)	-	41	61	71
Avg. of Oak Aspen and Pinyon Juniper (Good)	-	36	51	60
Sage Brush (Good)	-	35	47	55
Herbaceous (Good)	-	62	74	85
Water/Wetland	98	98	98	98

The calculated composite curve numbers for each drainage basin in the study area are provided in Table 8. The areas of each soil/land cover complex present within each basin are provided in the calculations in Appendix B. For reference, the composite curve numbers used in the 2013 NRCS are also provided in Table 8.

Table 8
Composite Runoff Curve Numbers for Study Drainage Basins

Drainage Basin	Composite Curve Number			
	2013 NRCS Study			Present Study
	Pre-Fire	Post-Fire (Moderate Burn)	Post-Fire (Severe Burn)	Present Day (2016 NLCD)
Indian Hickman	61	72	75	67
Foothills	-	-	-	67

2.3.3 Transform Method

The SCS Unit Hydrograph method was used in the hydrologic model to convert rainfall to runoff. This method requires “lag time” as an input parameter. The watershed lag method described in NEH 630.1502(a) was used to estimate the lag time and time of concentration for each drainage basin:

$$L = \frac{\ell^{0.8} (S+1)^{0.7}}{1,900Y^{0.5}} \quad (\text{eq. 15-4a})$$

Applying equation 15-3, $L=0.6T_c$, yields:

$$T_c = \frac{\ell^{0.8} (S+1)^{0.7}}{1,140Y^{0.5}} \quad (\text{eq. 15-4b})$$

where:

L = lag, h

T_c = time of concentration, h

ℓ = flow length, ft

Y = average watershed land slope, %

S = maximum potential retention, in

$$= \frac{1,000}{\text{cn}'} - 10$$

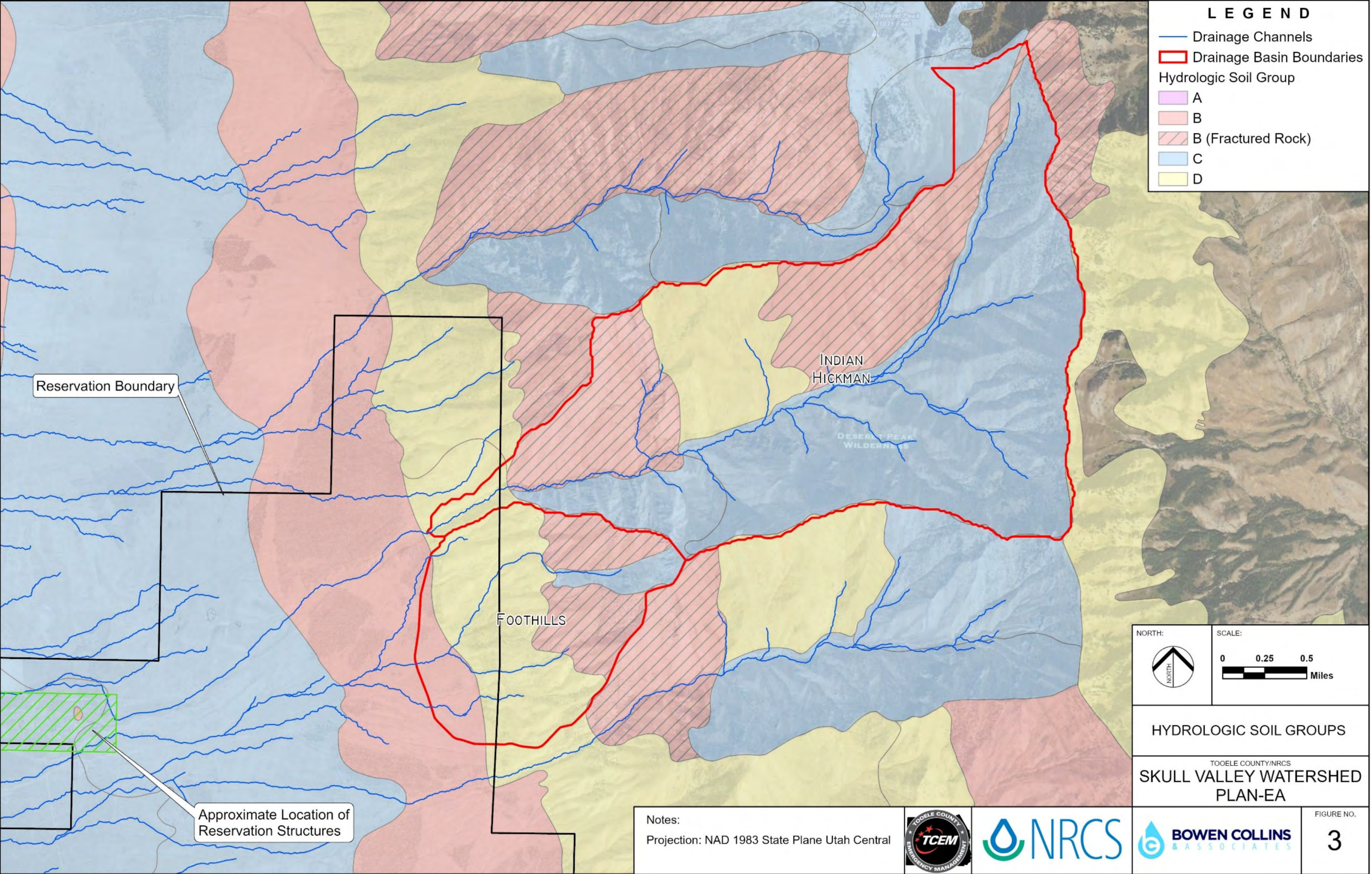
where:

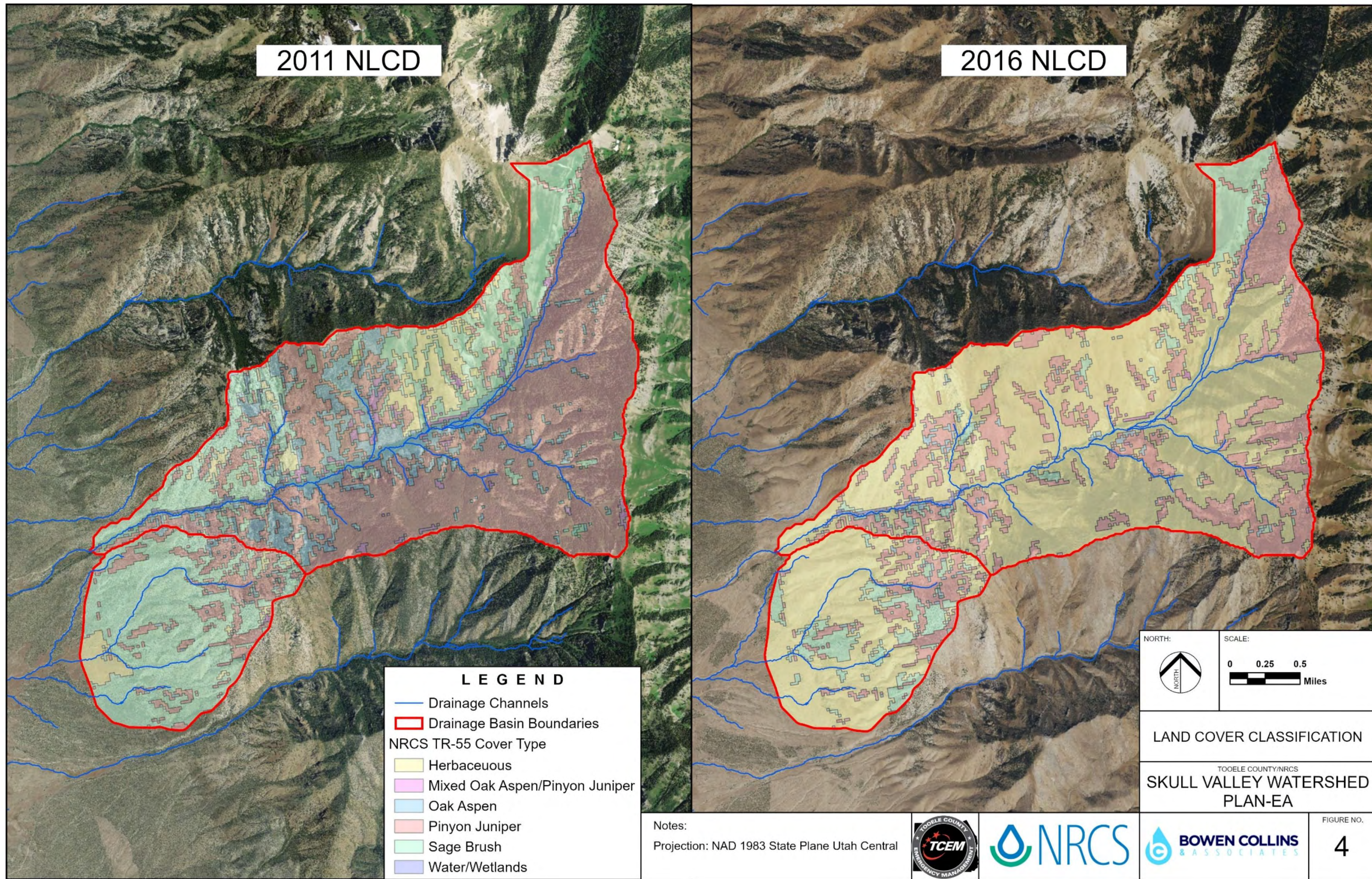
cn' = the retardance factor

The longest flow length and average basin slope parameters were calculated using GIS software. The locations of the flow paths are shown on Figure 1. The basin characteristics and resulting lag time and time of concentration for each basin are provided in Table 9.

Table 9
Basin Lag and Time of Concentration Summary

Drainage Basin	Area	CN	Longest Flow Length (ℓ)	Avg. Watershed Land Slope (Y)	Lag Time (L)		Time of Concentration (T_c)		Average Flow Travel Velocity
	(sq. mi.)		(ft)	(%)	Hours	Minutes	Hours	Minutes	ft/s
Indian Hickman	3,590	67	29,530	55.7	0.92	55	1.54	92	5.3
Foothills	1,028	67	10,399	34.3	0.26	16	0.43	26	3.4





2011 NLCD

2016 NLCD

LEGEND

- Drainage Channels
- ▭ Drainage Basin Boundaries
- NRCS TR-55 Cover Type
 - ▭ Herbaceous
 - ▭ Mixed Oak Aspen/Pinyon Juniper
 - ▭ Oak Aspen
 - ▭ Pinyon Juniper
 - ▭ Sage Brush
 - ▭ Water/Wetlands

NORTH:



SCALE:

0 0.25 0.5
Miles

LAND COVER CLASSIFICATION

TOOELE COUNTY/NRCS
SKULL VALLEY WATERSHED
PLAN-EA

Notes:

Projection: NAD 1983 State Plane Utah Central



FIGURE NO.

4

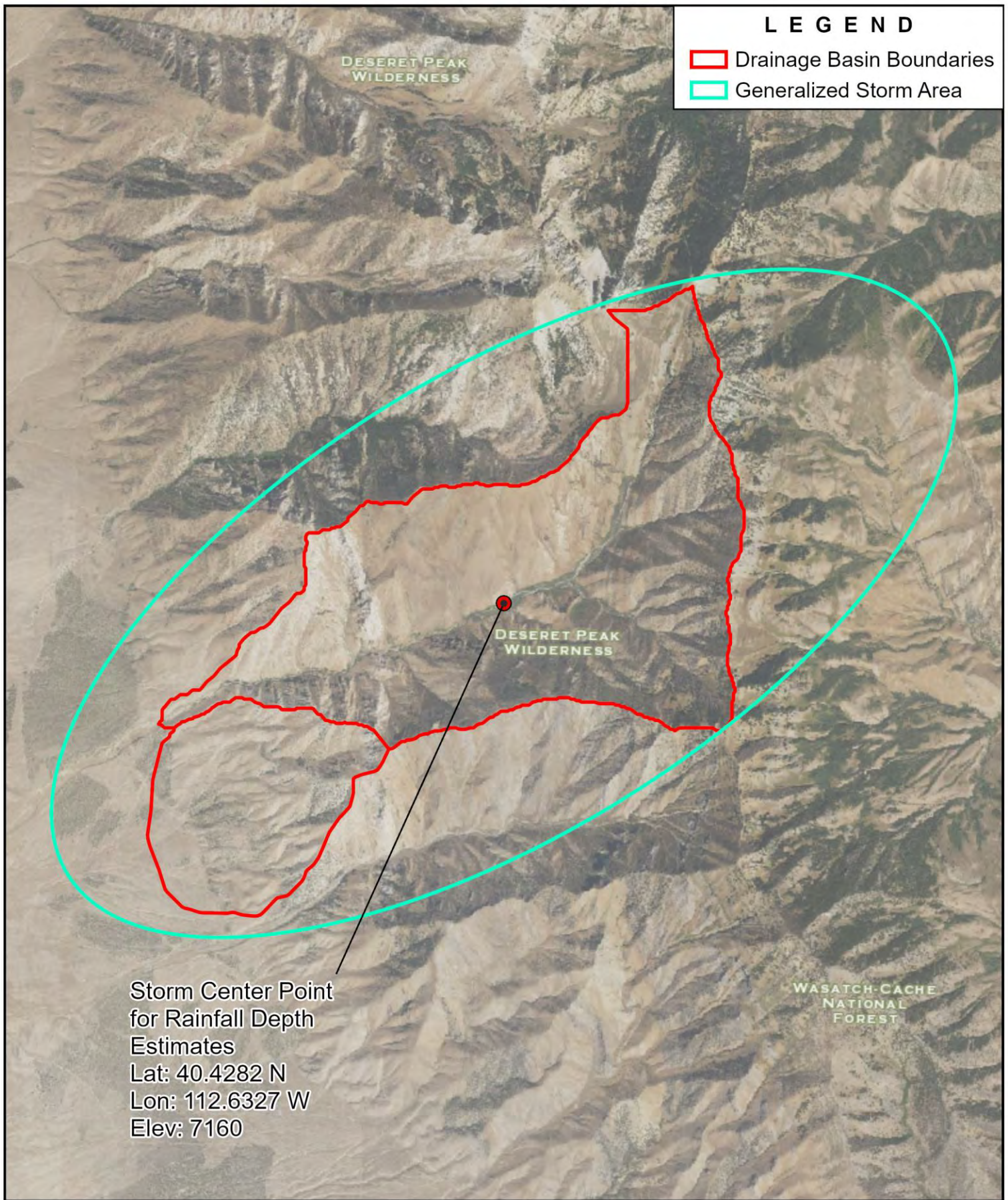
2.3.4 Design Storm Depth

Design storm depths were retrieved from the NOAA Precipitation Frequency Data Server (PFDS) which reports total storm depths for a specific geographic location based on NOAA Atlas 14 for various storm durations and recurrence intervals. For the purposes of this project, a single large storm occurring over all subject drainage basins at the same time was considered. The extent of the considered design storm was approximated by the elliptical area shown on Figure 5. Storm depths were obtained from the NOAA PFDS for the centroid of the ellipse. Point storm depth estimates for recurrence intervals from 1- to 500-years are provided in Table 10.

Using the procedure described in NOAA Technical Report 24, the point storm depths were adjusted using an areal reduction factor to convert the point depths to area-averaged estimates covering the 16.5-square-mile, generalized storm area shown in Figure 5. The areal reduction factor for a 24-hour storm and a 16.5-square-mile area is approximately 0.98. Areal adjusted depths are shown in Table 10. Calculations to determine the areal adjustment factor are provided in Appendix C.

Table 10
24-hr Design Storm Depths

Description	Recurrence Interval (year)								
	1	2	5	10	25	50	100	200	500
NOAA Atlas 14 Point Depth (in)	1.84	2.28	2.78	3.19	3.75	4.18	4.62	5.08	5.70
Areal Adjusted Depth (in)	1.80	2.23	2.72	3.13	3.68	4.10	4.53	4.98	5.59



LEGEND

Drainage Basin Boundaries

Generalized Storm Area

 BOWEN COLLINS & ASSOCIATES	DESIGN STORM AREA	NORTH: 	SCALE: 0 0.5 1  Miles
	TOOELE COUNTY/NRCS SKULL VALLEY WATERSHED PLAN-EA		FIGURE NO. 5

2.3.5 Design Storm Distribution

The selected design storm distributions were determined using NRCS WinTR-20 software. Using the procedures described in NEH 630.04, WinTR-20 software takes the rainfall depth-duration-frequency data obtained from the NOAA PFDS and generates site specific unit rainfall distributions for various recurrence intervals from 1- to 500-years. Using these unit rainfall distributions and the storm depths adjusted for area and seasonality as described above, the final design storm distributions shown in Figure 6 below were developed. Tabulated values for the design storms used are provided in Appendix B.

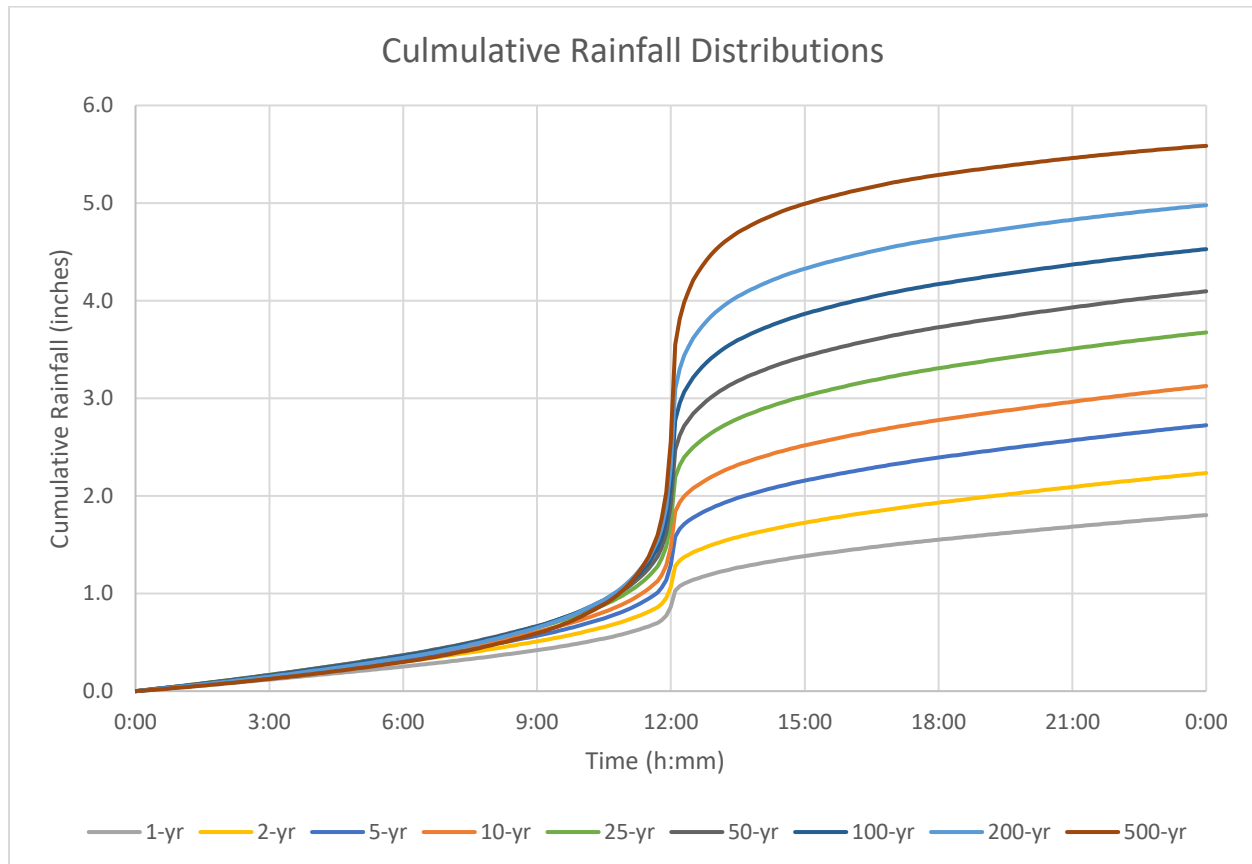


Figure 6. Design Storm Distributions

2.3.6 Model Calibration

As mentioned previously, a flood frequency analysis based on stream gage data is the preferred method of estimating peak runoff flows. In the absence of stream gage data, a comparison of the results from rainfall-runoff model analysis, the regional regression analysis, and the statistical analysis from nearby gages was performed for the 100-year return period discharge event. The results for rainfall-runoff model, regression analysis and statistical analyses for the 100-year event are summarized in Table 11. For additional comparison, the 100-year peak flow rates were normalized based on drainage area (cfs/square mile) and summarized in Table 12.

Table 11
100-year Peak Flowrate Comparison

Basin	Drainage Area	Rainfall Runoff Model	Regression Estimates		Gage Statistical
			NSS	NFF	Analyses
	(sq. mi.)	(cfs)	(cfs)	(cfs)	(cfs)
Indian Hickman	5.61	1918	506	384	-
Foothills	1.61	796	346	387	-
South Willow Creek	4.2	-	463	310	149
North Willow Creek	5.28	-	497	442	214

Table 12
100-year Peak Flowrate Comparison, Normalized by Drainage Area

Basin	Drainage Area	Rainfall Runoff Model	Regression Estimates		Gage Statistical
			NSS	NFF	Analyses
	(sq. mi.)	(cfs/mi ²)	(cfs/mi ²)	(cfs/mi ²)	(cfs/mi ²)
Indian Hickman	5.61	342	90	69	-
Foothills	1.61	494	215	240	-
South Willow Creek	4.2	-	110	74	35
North Willow Creek	5.28	-	94	84	41

The comparison of the rainfall-runoff model results with the regression equation and gage analyses seem to indicate that the rainfall-runoff model predicts much higher peak runoff rates than the other methods. However, in light of changes in the vegetation in the study drainage basins caused by the 2013 fire (see Figure 4), a direct comparison to the regression results or gage analyses of nearby watersheds, which have not been recently burned, may have little value.

An additional comparison of the rainfall-runoff model for the current study of Indian Hickman was made against the results of the 2013 NRCS and 2019 USACE studies and the results are summarized in Table 13.

Table 13
Comparison of Present Study and Previous Studies

Indian Hickman 100-year Peak Flows				
Scenario	Runoff Curve Number	Average Flow Travel Velocity	Rainfall-Runoff Model	
		(ft/s)	(cfs)	(cfs/sq. mi.)
Present Study	67	5.3	1918	342
2013 NRCS Study Pre-Fire	61	7.0	788	140
2013 NRCS Study Moderate Burn	72	8.0	1614	288
2013 NRCS Study Severe Burn	75	8.5	2043	364
2019 USACE Study (Clearwater)	N/A	3.2	2177	386
2019 USACE Study (20% Sediment)	N/A	3.2	2721	482
2019 USACE Study (43% Sediment)	N/A	3.2	3810	676

The rainfall-runoff model developed for this study results in significantly higher runoff rates for the subject drainage areas when compared to the regression analyses and nearby gage analyses as shown in Tables 11 and 12. The results of the present study are consistent with the results of the USACE and 2013 NRCS moderate burn analyses as shown in Table 13. Because the goals of the presently considered projects are associated with flood control and the construction of resilient infrastructure (waterline and diversion), utilizing the flowrates and hydrographs developed by the new rainfall-runoff model should result in conservatively sized facilities.

The design peak discharges for each study drainage basin for recurrence intervals from 1- to 500-years are summarized in Table 14. These peak flows should be used for the design of any flood control facilities proposed to be located at the mouth of Indian Hickman Canyon, or at the base of the foothills.

Table 14
HEC-HMS Analysis Peak Discharge Results Summary

Drainage Basin	Peak Flow by Recurrence Interval (cfs)								
	Q1	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q500
Indian Hickman	40	120	330	580	1010	1420	1920	2520	3510
Foothills	10	40	130	230	410	580	800	1050	1470

2.3.7 Design Hydrographs

Using USACE HEC-HMS software, runoff hydrographs for each study drainage basin were computed based on the standard SCS unit hydrograph. The hydrographs developed for the two studied drainage basins are shown in Figures 7 and 8. Tabulated values for the hydrographs are included in Appendix C. Electronic copies of the hydrology models and GIS data may also be provided for review upon

request. These hydrographs should be used for the design of any flood control facilities proposed to be located at the mouth of Indian Hickman Canyon, or at the base of the foothills.

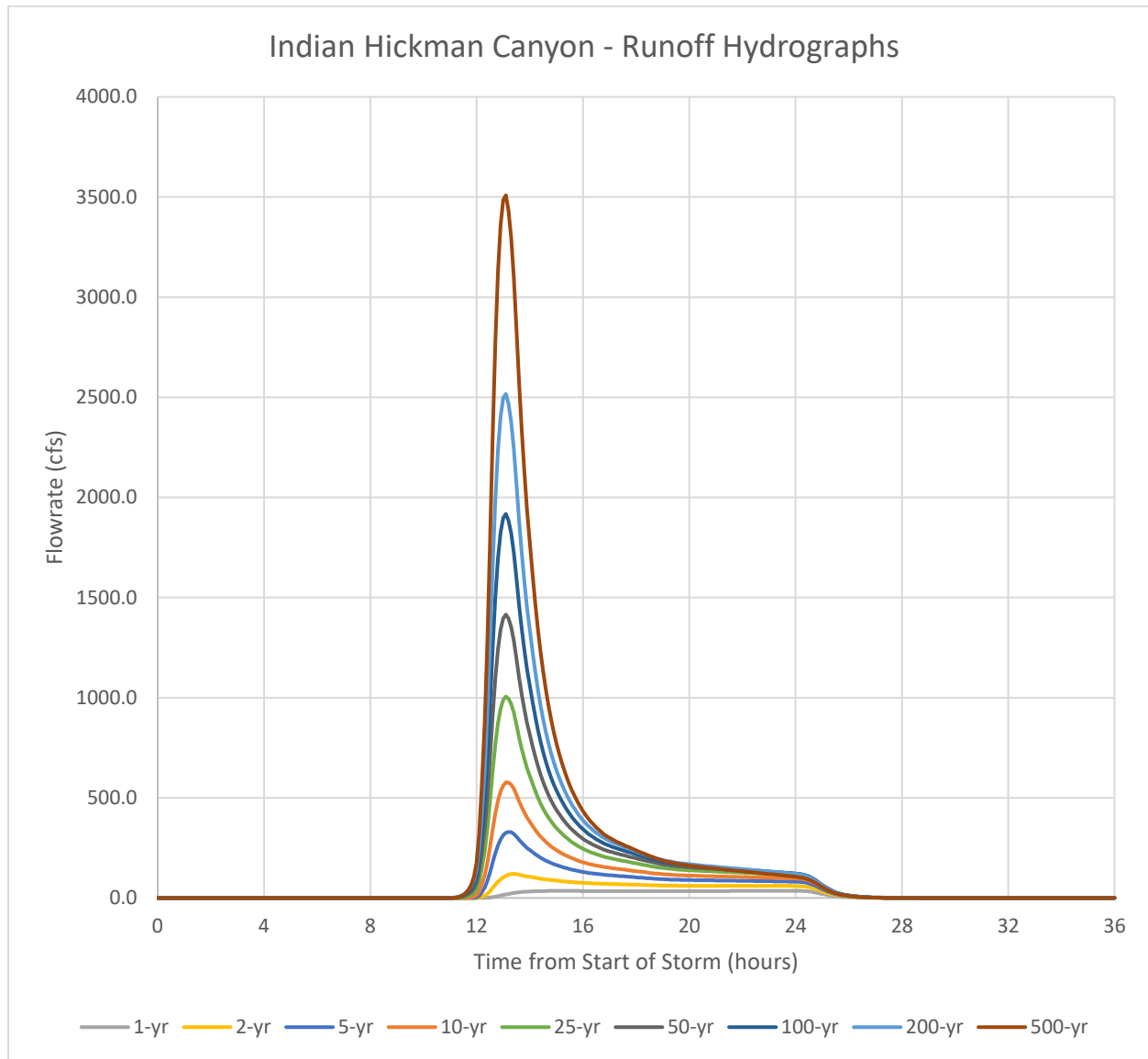


Figure 7. Runoff hydrographs for Indian Hickman drainage basin.

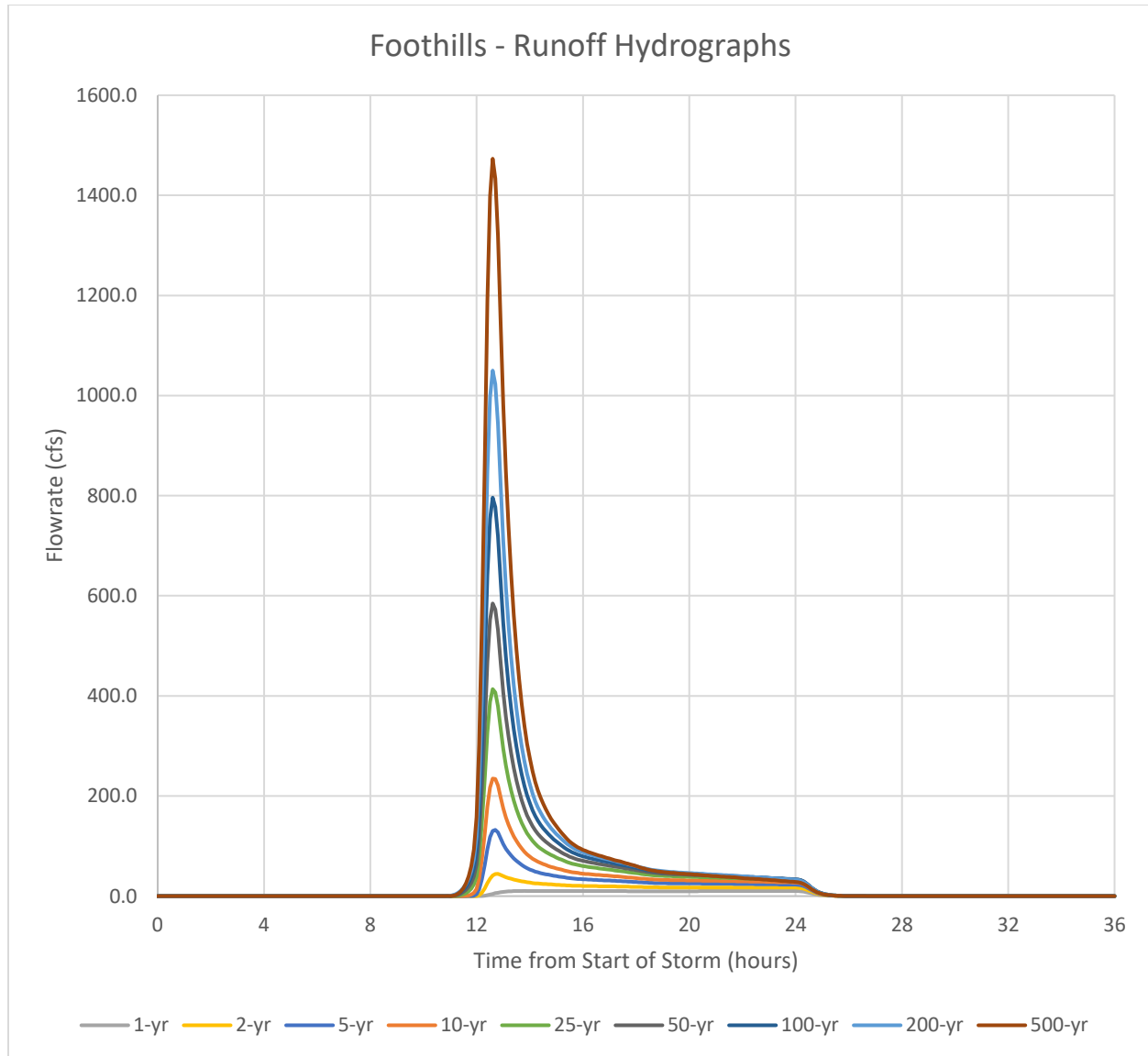


Figure 8. Runoff hydrographs for Foothills drainage basin.

2.3.8 Hydrograph Routing

The basin delineation points used to develop the rainfall-runoff model are located approximately 2.5 miles to the northeast of main group of residences and structures within the Skull Valley Reservation. The flood flows from Indian Hickman Canyon and the Foothills drainage basins flow across the alluvial fan formations to the west and eventually to the Reservation. The LiDAR topography and aerial images indicate the presence of many braided flow paths from east to west. According to the existing topography data, the flows from the two basins do not clearly join, however, flow paths can change unexpectedly during alluvial fan flooding events. Any proposed flood control structure designed to protect the Reservation should assume the flows from these two drainage basins will combine. To estimate the combined flows just upstream of the Reservation, the two hydrographs were routed in the HEC-HMS model using the Muskingum-Cunge flood routing method described in NEH 630.1703. The parameters for the routing reaches are shown in Table 15. The flow paths from the foothills to the Reservation are shown in Figure 1.

Table 15
HEC-HMS Reach Routing Parameters

Reach	Length	Slope	Manning's Roughness	Bottom Width	Side Slopes
	(ft)	(ft/ft)	-	(ft)	_H:1V
Indian Hickman to Reservation	12,560	0.060	0.035	150	2
Foothills to Reservation	10,820	0.045	0.035	35	2

The resulting computed peak flows from routing the two hydrographs are provided in Table 16 and hydrograph plots are shown in Figure 9. Tabulated values for the hydrographs for each modeled time step are included in Appendix C. These peak flows and hydrographs should be used for the design of any flood control facilities proposed to be just east of the Reservation where flows from Indian Hickman Canyon and the foothills basins may combine.

Table 16
HEC-HMS Routing Analysis Peak Discharge Results

Description	Peak Flow by Recurrence Interval (cfs)								
	Q1	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q500
Combined Flows	50	150	420	730	1280	1800	2440	3210	4490

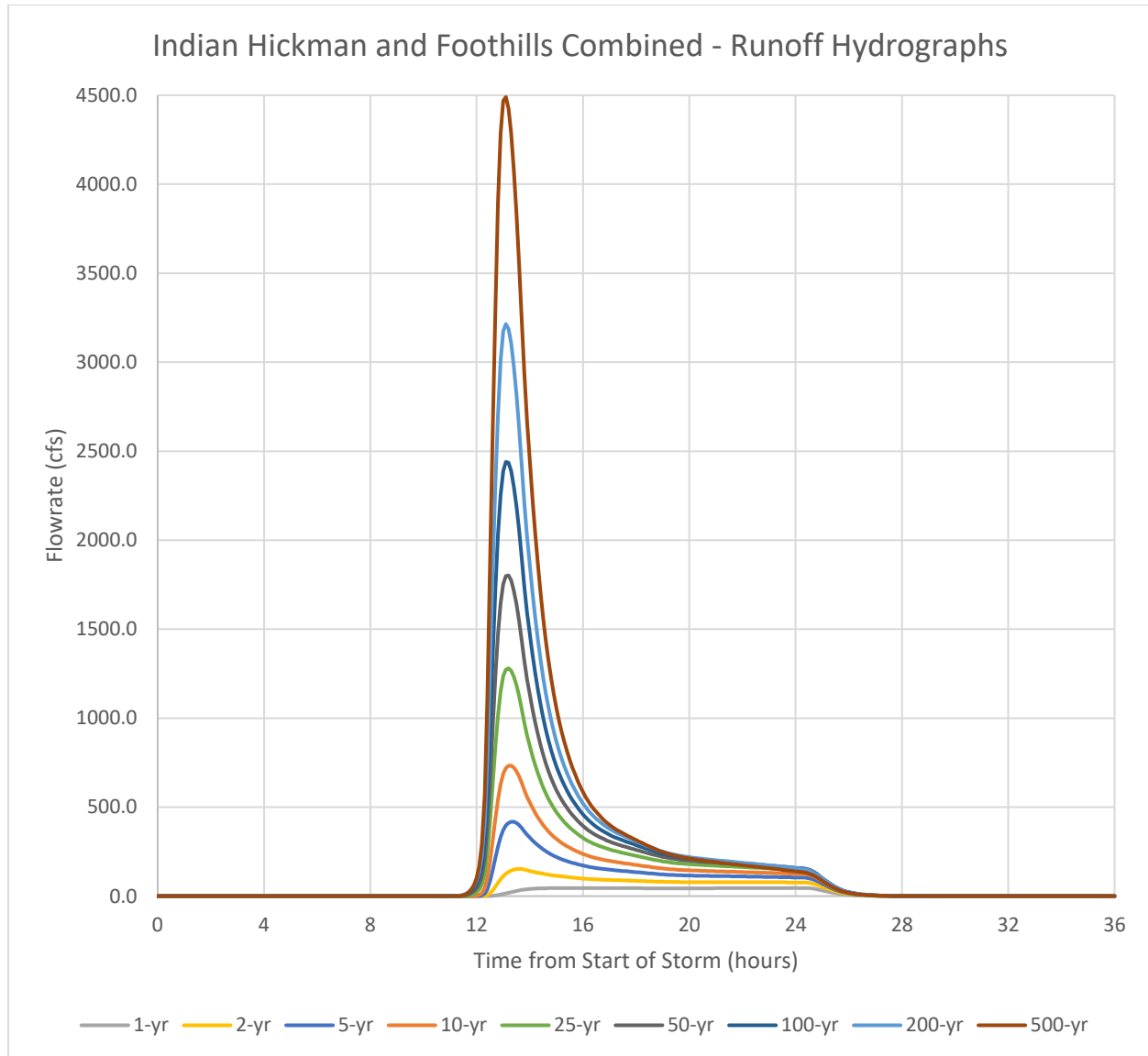


Figure 9. Combined Indian Hickman and Foothills Hydrographs.

2.3.9 Conclusion

Based on the results of the present study and comparisons with the previous studies as described, the estimated peak flows resulting from the rainfall-runoff model will be used to design flood and erosion control measures for the proposed project. These design discharges are summarized in Tables 14 and 16 and the associated hydrographs are provided in Figures 7 to 9. Flowrates with return periods ranging from 1 to 500 years are provided. Depending on the type of facility being designed, a design discharge exceedance probability will be selected according to the relevant NRCS practice standard. Additional details will be provided in separate TMs which will detail the design of proposed facilities.

SECTION 3 - TR-60 HYDROGRAPHS

When designing a dam per NRCS TR-60 requirements, additional hydrographs need to be developed and used to analyze the principal and auxiliary spillways for the dam. These additional hydrographs include:

- Local 6-hour PMP,
- General 24-hour PMP, and
- 100-year 10-Day Principal Spillway Hydrograph.

These additional hydrographs were not developed for the purposes of this TM. If dams or debris basins are included in the alternatives for flood control facilities in the proposed project, information regarding the development of these additional hydrographs will be provided in a separate TM detailing the proposed projects.

SECTION 4 - STATEMENT OF LIMITATIONS

This document represents Bowen Collins & Associates professional judgement based on the information available at the time of its completion, and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the engineering profession currently practicing under similar conditions. No warranty, express or implied, is made.

SECTION 5 - REFERENCES

- Natural Resources Conservation Service, May 2010, National Engineering Handbook, Part 630, Hydrology.
- Natural Resources Conservation Service, Earth Dams and Reservoirs, Technical Release 60, July 2015
- Natural Resources Conservation Service, Pre/Post Fire Hydrology – Patch Springs, September 23, 2013.
- National Oceanic and Atmospheric Administration, 1973, NOAA Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume VI - Utah.
- National Oceanic and Atmospheric Administration, 2006, NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume I, Version 4, Semiarid Southwest.
- US Army Corps of Engineers, Skull Valley Band of Goshute Floodplain Management Plan, March 2018.
- US Army Corps of Engineers, Hydrology Study, Skull Valley Hydrologic Model, 2019, Unpublished.
- U.S. Department of Agriculture, Soil Conservation Service, June 1986, Urban Hydrology for Small Watersheds, Technical Release 55.
- US Geological Survey, 1981, Guidelines for Determining Flood Flow Frequency, Bulletin #17B, September 1981, revised March 1982.
- US Geological Survey, 1994, Methods for Estimating Magnitude and Frequency of Floods in the Southwestern United States, Open File Report 93-419.
- US Geological Survey, 2008, Methods for Estimating Magnitude and Frequency of Peak Flows for Natural Streams in Utah, Scientific Investigations Report 2007-5158.
- USGS StreamStats. Website: https://www.usgs.gov/mission-areas/water-resources/science/streamstats?qt-science_center_objects=0#qt-science_center_objects

APPENDIX A PREVIOUS STUDIES

2013 NRCS Study

Pre / Post fire Hydrology – Patch Springs

By Nathaniel Todea, USDA NRCS Hydraulic Engineer, Utah.

September 23, 2013

Runoff conversions.

NLCD codes and Hydrologic soils group, number of cells by category

NLCD	100? (B)— count	300 (C)- -count	400 (D)— count
31	63	68	1
41	44	324	7
42	1327	8127	2009
43		70	
52	1545	747	158
71	1453	78	56
90	93	35	29

Conversion of HSG and NLCD to RCN

NLCD Code	HSG B	HSG C	HSG D
31	82	87	89
41	30	41	48
42	41	61	71
43	36	51	60
52	62	74	85
71	62	74	85
90		98	98

The study area is estimated to be 5.61 square mile contributing area. The composite RCN is 61.2 → A value of 60 was used. Furthermore SSURGO data was used. For SSURGO ID 51, this was assumed to be a HSG B. After discussions with geologist who contacted mapper, it was determined that the outcrop is fractured. Moreover, after RCN were adjusted it was determined that a RCN of 60 was acceptable with a NOAA Atlas 14 Distribution, comparison to stream gages in the area, and a Tc that averaged 7 fps.

Stream Gage statistics that are pertinent to area

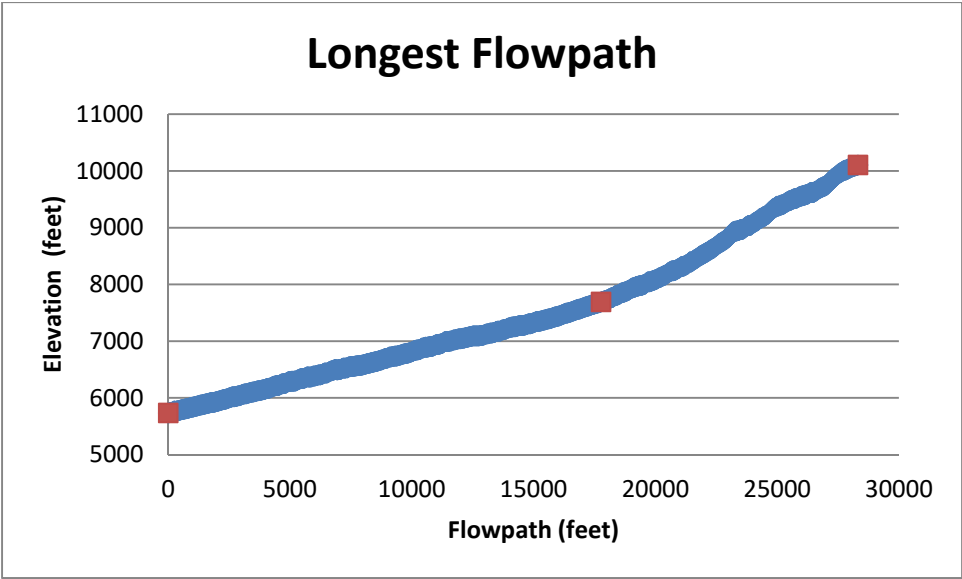
Area Square miles	SIR No.	Stream Gage	Name	2	5	10	25	50	100	200	500	years of record
4.45	94	10172760	CLOVER CREEK NEAR CLOVER, UTAH	13.7	34.3	55.1	91	126	167	218	299	15
6.71	95	10172765	CLOVER CREEK ABOVE BIG HOLLOW, NEAR CLOVER, UTAH	16.2	29.5	40	55	67.3	80.6	94.8	115	17
4.19	98	10172800	SOUTH WILLOW CREEK NEAR GRANTSVILLE, UTAH	32.5	57	76.2	103	125	149	175	211	45
5.28	99	10172805	NORTH WILLOW CREEK NR GRANTSVILLE, UTAH	25.6	54	80.6	124	165	214	272	365	13
1.5	105	10172835	SKULL VALLEY TRIBUTARY NR DELLE, UTAH	0.1	0.8	3.2	12.7	30.2	64.7	128	287	11

CFS / Square mile

USGS Gage Name	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	200 yr	500 yr
CLOVER CREEK NEAR CLOVER, UTAH	3.08	7.71	12.4	20.4	28.3	37.5	49	67.2
SOUTH WILLOW CREEK NEAR GRANTSVILLE, UTAH	7.76	13.6	18.2	24.6	29.8	35.6	41.8	50.4
NORTH WILLOW CREEK NR GRANTSVILLE, UTAH	4.85	10.2	15.3	23.5	31.3	40.5	51.5	69.1
SKULL VALLEY TRIBUTARY NR DELLE, UTAH	0.07	0.53	2.13	8.47	20.1	43.1	85.3	191

Predicted frequency intervals

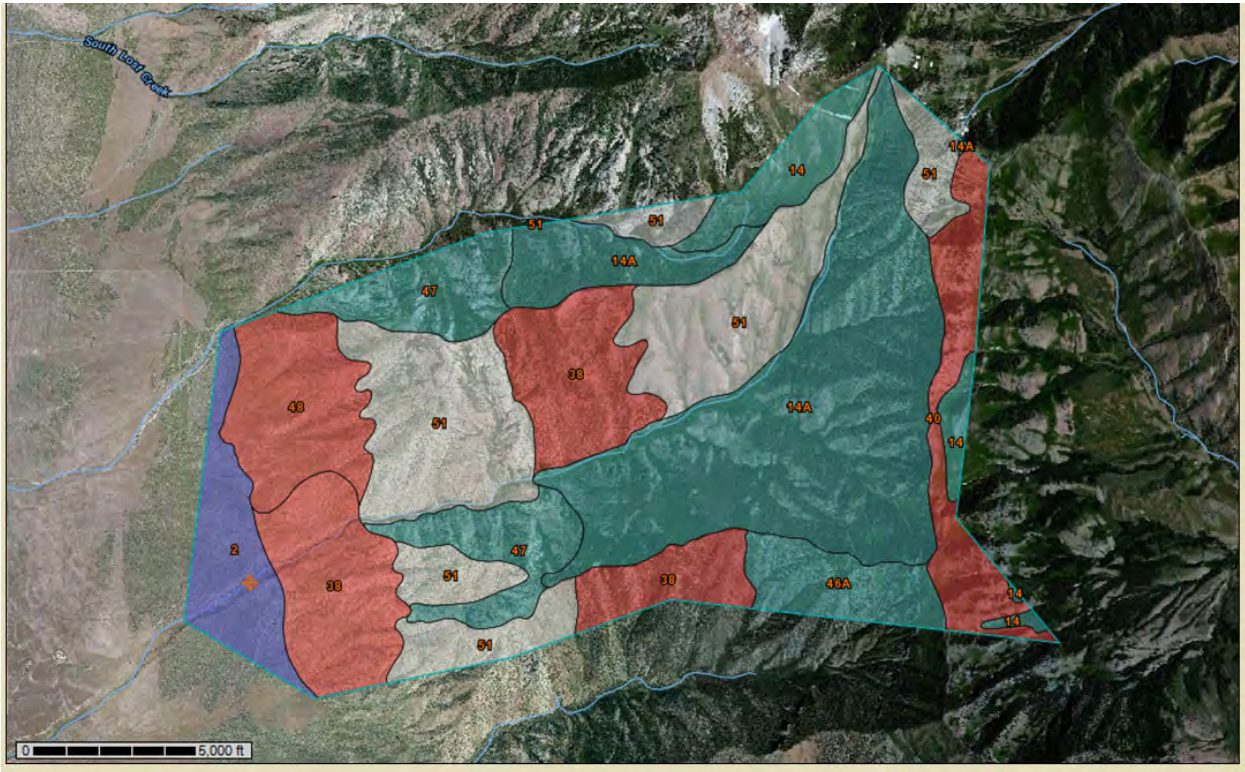
	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	200 yr	500 yr
Predicted CSM for Indian Hickman Canyon	36	75.9	113	<u>174</u>	232	<u>301</u>	382	513



		2 year	5 year	10 year	25 year	50 year	100 year	200 year	500 year	Type II (100 yr)	Type IA (100 yr)
pre60	5.64	8.5	22.5	42.3	129.3	264.5	460.3	713.8	1176	503.2	108.4
pre72tc*	5.64	74	246	449	818.3	1174.2	1613.7	2124	2981.2	1769.8	397.3
pre75tc**	5.64	161.3	406.1	661.3	1113.2	1531.2	2042.8	2640.4	3624.7	2263	545.4

* - Pre72tc – moderate burn, Tc decrease resulting in a 1 fps increase in travel velocity.

** - Pre75tc – severe burn, Tc decrease resulting in a 1.5 fps increase in travel velocity.



Tables — Hydrologic Soil Group — Summary By Map Unit

Summary by Map Unit — Tooele Area, Utah - Tooele County and Parts of Box Elder, Davis and Juab Counties (UT611)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
2	Abela very gravelly loam, 5 to 15 percent slopes	B	372.9	5.1%
14	Datemark-Podmor-Rock outcrop association, 30 to 70 percent slopes	C	295.6	4.0%
14A	Datemark-Podmor, moist-Rock outcrop association, 30 to 70 percent slopes	C	2,065.0	28.2%
38	Lodar-Lundy-Rock outcrop association, 30 to 60 percent slopes	D	1,151.1	15.7%
40	Lundy-Datemark-Rock outcrop association, 30 to 70 percent slopes	D	387.6	5.3%
46A	Podmor, moist-Datemark-Rock outcrop association, 30 to 70 percent slopes	C	275.4	3.8%
47	Podmor-Onaqui-Rock outcrop association, 20 to 60 percent slopes	C	577.6	7.9%
48	Reywat-Broad-Rock outcrop association, 30 to 60 percent slopes	D	474.2	6.5%
51	Rock outcrop-Lundy complex, 30 to 60 percent slopes		1,714.3	23.4%
Totals for Area of Interest			7,313.6	100.0%

Description — Hydrologic Soil Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

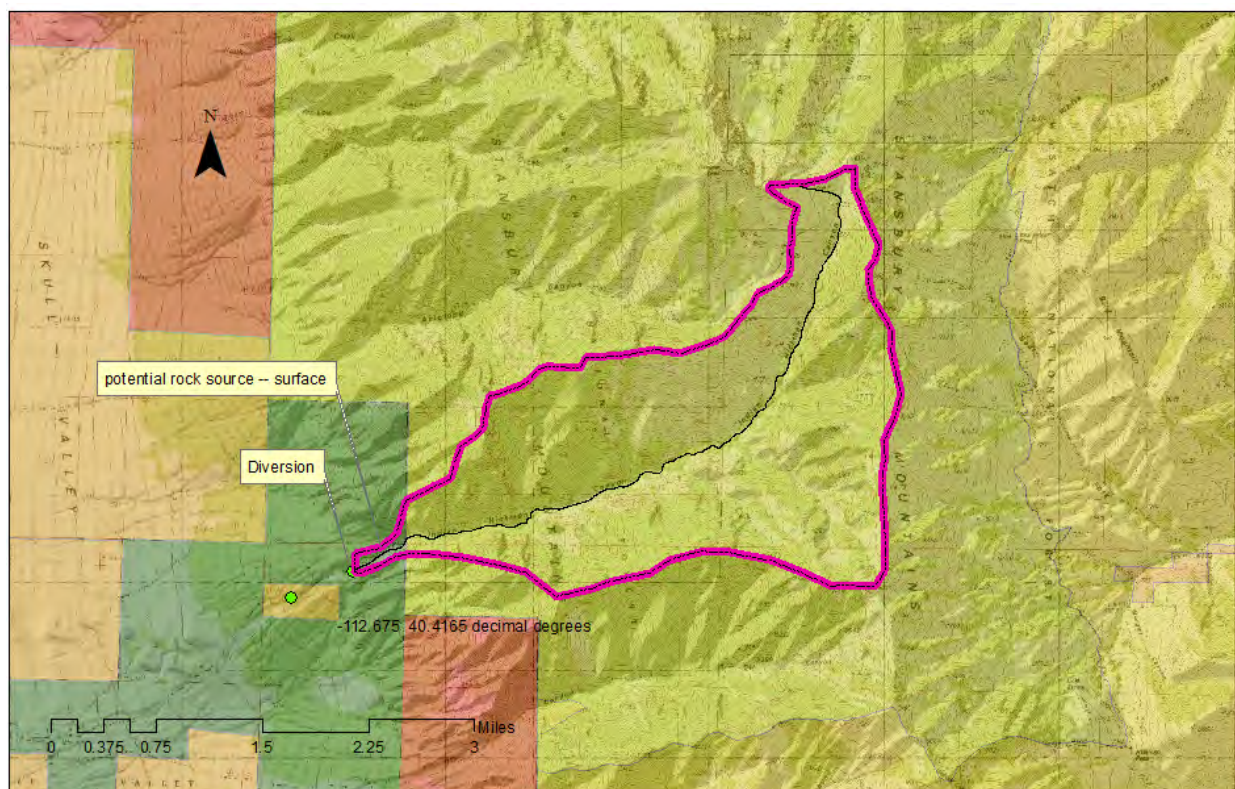
Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

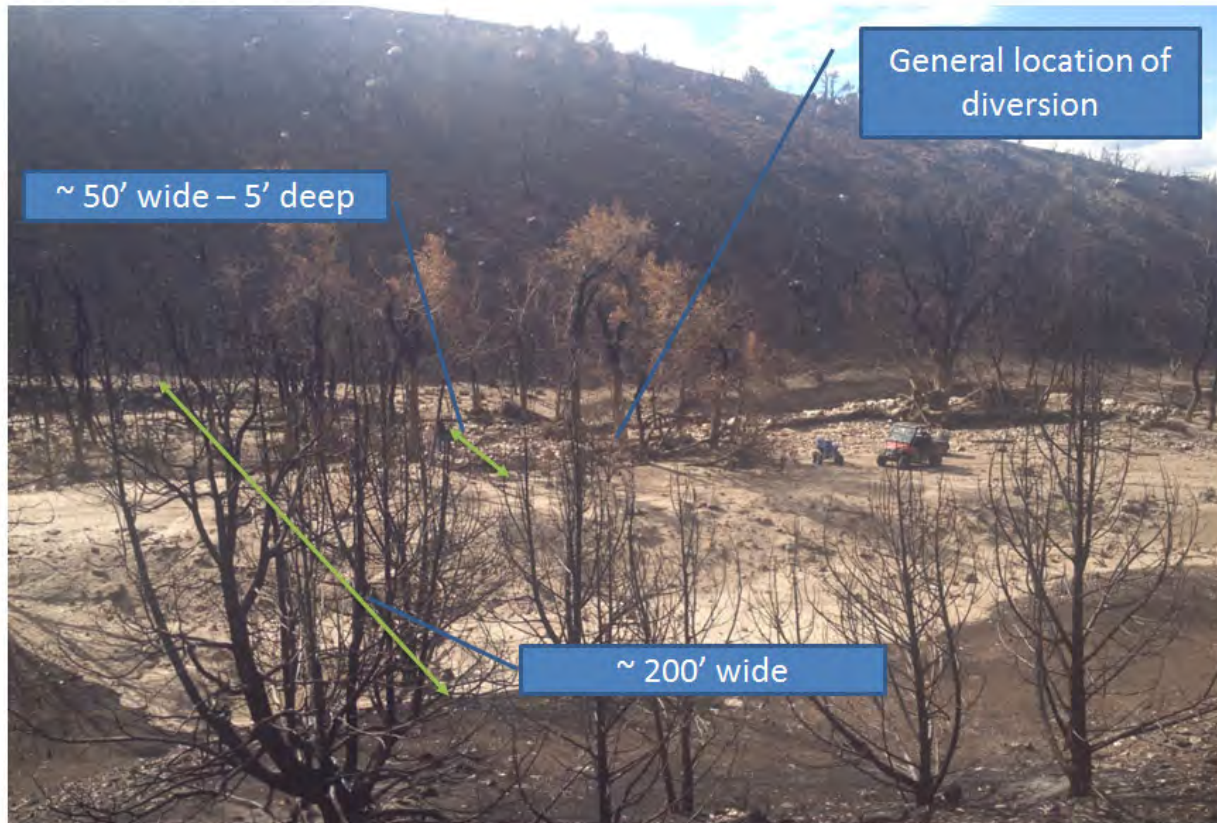
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.





2019 USACE Study

The purpose of the Skull Valley Hydrologic Model is to aid the Skull Valley Goshute Tribe in its efforts to respond to floods and debris flows and to aid in developing strategies for mitigation and prevention of damage from future flood flows. The model will be used to develop flows at locations along Indian Hickman and Dry Creeks and a main confluence point near State Highway 196 where flows from these canyons coalesce with other streams and flow northward into the dry floodplain where they evaporate.

Skull Valley is a north trending valley that extends approximately 50 miles from its southern apex at Lookout Pass in Township 8 South Range 7 West to the southwest shore of Great Salt Lake. The valley is surrounded by the Stansbury and Onaqui Mountains on the eastern rim and the Cedar Mountains on the west rim. Skull Valley is approximately 22 miles wide at its widest point and drains 880 square miles of desert and mountain territory (Hood and Waddell, 1968, Skull Valley band of Goshute, 2017). The main area of interest is the Skull Valley Reservation and the two Canyons that flow directly into the reservation roughly 15 square miles (Figure 1).

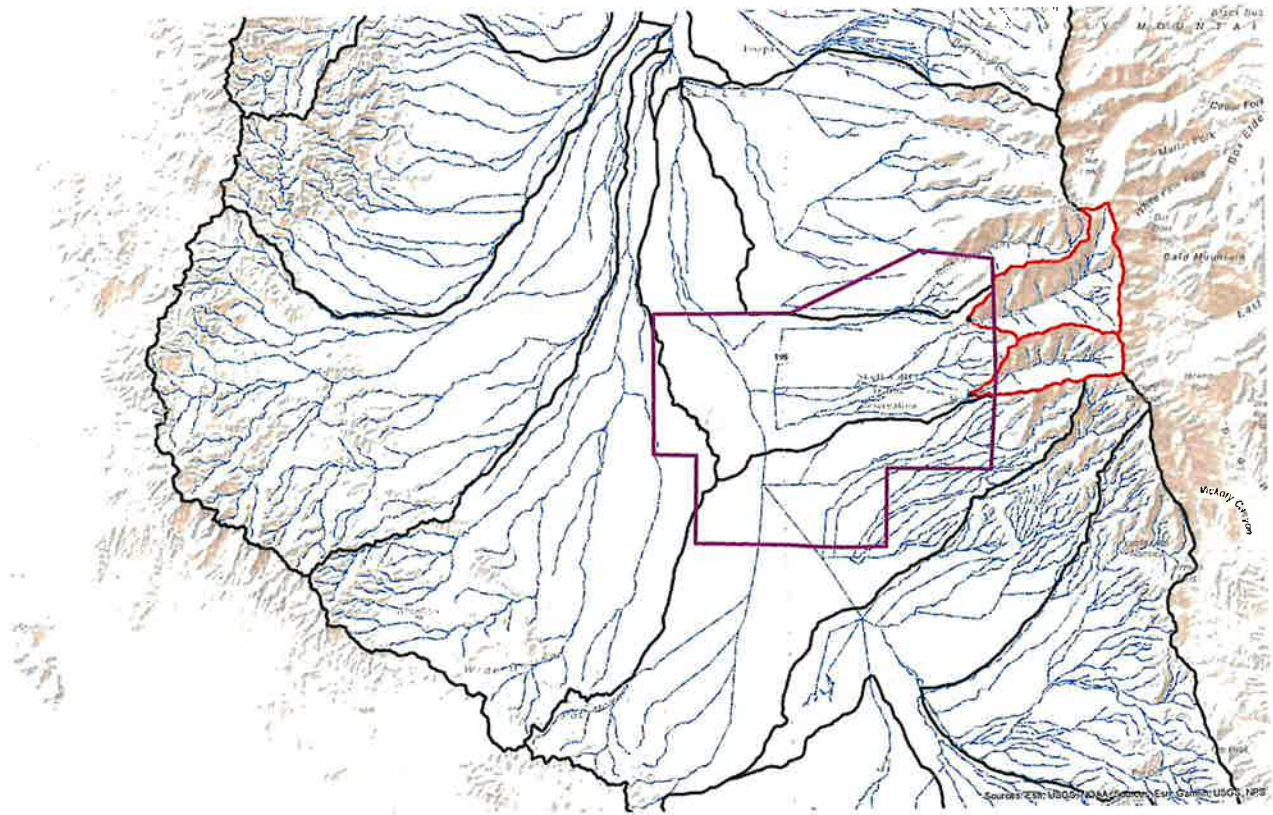


Figure 1 Location of Skull Valley Reservation and Study Area. The two canyons are highlighted in Red. The black lines are the HUC-12 Watershed boundaries and the Lidar Survey boundaries are highlighted in purple.

Data Collection:

Stream Gages:

The first step involves identification of suitable stream gauges to investigate local and regional statistical trends in stream flow including flow per unit area. There are only two flow gauges recording stream flow into Skull Valley: USGS 10172835, Skull Valley Tributary near Delle, which has an 11 year record and USGS 10172890, Government Creek near Dugway, which has a record of 11 years. Gauges immediately outside of Skull Valley were identified for comparison in terms of flow per square mile; these gauges are listed in table 1. Only South Willow Cr near Grantsville, period of record at 57 years and Clover Creek above big Hollow near Clover, period of record 17 years have enough data to be useful for statistical analysis and these gauges are outside of the vicinity of the study area. The other gauges have record lengths less than 15 years and most of them have record lengths of 12 years or less and were terminated prior to water year 2000 (USGS 2018).

Table 1 Flow Gauges in and near Skull Valley, Utah.				
Gauge ID	Name	DA	Elev	Years of Record
10172760	CLOVER CREEK NEAR CLOVER, UTAH	4.45	5050	14
10172765	CLOVER CREEK ABOVE BIG HOLLOW, NEAR CLOVER, UTAH	6.71	5660	17
10172790	SETTLEMENT CANYON NR TOOELE, UTAH	5.77	5760	11
10172791	SETTLEMENT CREEK ABOVE RESERVOIR NEAR TOOELE, UTAH	16.8	5380	10
10172800	SOUTH WILLOW CREEK NEAR GRANTSVILLE, UTAH	4.19	6360	57
10172805	NORTH WILLOW CREEK NR GRANTSVILLE, UTAH	5.28	5960	13
10172835	SKULL VALLEY TRIBUTARY NR DELLE, UTAH	1.5	5240	12
10172890	GOVERNMENT CREEK NEAR DUGWAY, UTAH	59	5040	11
10172830	NF Muskrat Canyon nr Timpie	1.78	5520	11
10172720	East Government Cr Trib nr Vernon	0.95	5840	10
10172810	Mack Canyon nr Grantsville	2.84	5740	12
Sources: USGS 2018, NRCS 2013, USGS 2007				

Previous Studies

Preliminary post fire flood modeling was done on Indian Hickman Canyon in 2013 following the Patch Springs Fire using USGS regression and SCS curve number methods. Pre-fire curve number was set to 60 and post fire curve number was increased to 72 for moderate burn and 75 for severe burn to simulate the difference in pre and post fire conditions (Todea 2013, USFS 2013). Todea (2013) reports results of pre-fire and post fire peak flows for frequencies ranging from 1 in 2 year to 1 in 500 year and for SCS type IA and II storms as well as cloudbursts as shown in table 2 below.

Table 2 Pre- and Post-Fire Peak flow, Indian Hickman Canyon (DA=5.64 sq mi) Using SCS Curve Number Method. Flows in CFS.											
RunID	Frequency	1/AEP								SCS II	SCS IA
Pre60	Pre burn curve no 60	8.5	22.5	42.3	129.3	264.5	460.3	713.8	1176	503.2	108.4
Pre72tc	Moderate burn resulting in 1 fps increase in velocity	74	246	449	818.3	1174.2	1613.7	2124	2981.2	1769.8	397.3
Pre75tc	Severe burn resulting in 1.5 fps increase in velocity	161.3	406.1	661.3	1113.2	1531.2	2042.8	2640.4	3624.7	2263	545.4
Notes	Assume Moderate burn curve number 72 and severe burn curve number 75 and frequency runs are computed using a cloudburst storm except for SCSII and SCS IA which are SCS type general rain storms.										

USFS (2013) BAER report for the Patch Springs Fire gives results for 1 in 2 year floods in Indian Hickman and Dry Canyons using USGS regression and SCS curve number methods yielding results shown in Table 3 below.

Table 3 Pre and Post Fire 1 in 2 year floods Patch Springs Fire, Indian Hickman and Dry Canyons, Skull Valley UT.				
Location	Pre burn USGS	Pre burn USFS	Post Burn USGS	Post Burn USFS
Indian Hickman	25.5	1.2	39.7	69.5
Dry Canyon	21.2	0.7	32.8	38.6
Notes: 1) Soil burn severity for Indian Hickman Canyon was 15% High, 49% Moderate, 27% Low and 9% Unburned. 2) Soil Burn severity for Dry Canyon was 14% High, 51% Moderate, 29% Low and 6% Unburned.				

Precipitation Design Storm:

NOAA Atlas 14 was used to obtain precipitation depth frequencies for the vicinity of the Skull Valley reservation as shown in table 4. The storm that is most likely to cause damaging debris flows in Indian Hickman and Dry Canyons is a cloudburst type of storm which usually occurs in early to mid-Summer as a result of the North American Monsoon bringing humid air into Utah

Table 4

Point Precipitation for Deseret Peak, UT.
Values in inches

1/ACE (years)	1	2	5	10	25	50	100	200	500
15-min:	0.31	0.46	0.58	0.75	0.48	1.10	1.31	1.65	1.96
1-hr:	0.52	0.77	0.96	1.26	0.48	1.83	2.18	2.74	3.26
2-hr	0.64	0.91	1.11	1.43	0.48	2.04	2.42	3.02	3.56
3-hr	0.74	1.01	1.22	1.53	0.48	2.13	2.51	3.12	3.67
6-hr	1.00	1.31	1.53	1.84	0.48	2.39	2.75	3.37	3.91

The storm area is 15 square miles which is the smallest elliptical area that can enclose Upper Indian-Hickman Canyon and Upper Dry Canyon (See USACE 2008). Precipitation was aerially adjusted using reduction factors for local storm PMP from HMR 49 (Table 5). The storm precipitation is tabulated in table 6. The large debris flows and flood that occurred in August of 2014 following the Patch Springs fire in 2013 resulted from a cloudburst storm that was centered over both Indian Hickman and Dry Canyons (Skull Valley Band of Goshute 2017). Therefore, the design storm for this study is constructed using the concentric ellipse method in USACE 2008 with the watershed being divided into zones. Zone 1 is the area centered over Indian Hickman and Dry Canyons upstream of the reservation boundary. Zone 2 is centered over portions of Antelope Canyon, Upper Spring Creek, and Barlow Canyon. (see figure 2).

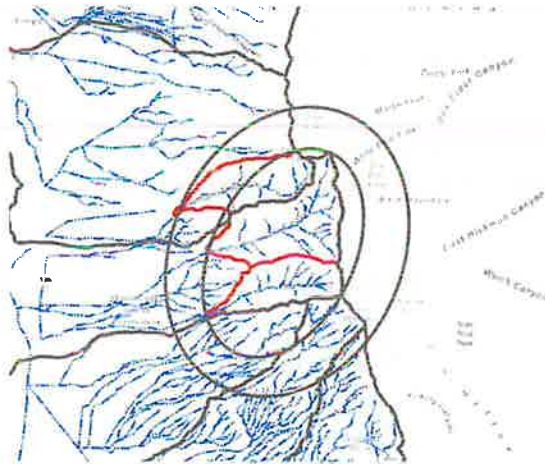


Figure 2 Design Storm development. The inner ellipse is the area over which the storm is centered and the difference between the inner and outer ellipse defines the concurrent rainfall.

Because the storm area is slightly larger than the total area of zone 1, it seems that the upper portions of zone 2 would have some concurrent rain even though this storm is only a cloudburst. Thus concurrent rainfall is computed using the concentric ellipse method in USACE 2008. These rainfall amounts are shown in table 7.

Table 5: HMR 49 Depth Area Reduction Factors for Local Storm PMP (in)						
inc DA (sq mi)	5	10	15	25	50	150
15 min	0.850	0.700	0.660	0.530	0.450	0.340
1hr	0.890	0.820	0.790	0.660	0.600	0.400
2hr	0.900	0.840	0.830	0.750	0.660	0.500
3hr	0.920	0.860	0.850	0.790	0.700	0.520
6hr	0.930	0.890	0.870	0.820	0.740	0.600

Table 6 Local Storm Series for Indian-Hickman and Dry Canyons, Skull Valley UT (in).								
1/AEP	2	5	10	25	50	100	200	500
15 min	0.20	0.30	0.38	0.50	0.60	0.72	0.86	1.09
1hr	0.41	0.60	0.76	0.99	1.20	1.44	1.72	2.17
2hr	0.53	0.75	0.92	1.19	1.42	1.69	2.01	2.50
3hr	0.63	0.86	1.04	1.30	1.53	1.81	2.14	2.65
6hr	0.87	1.14	1.33	1.60	1.81	2.08	2.40	2.93

Table 7 Concurrent Rain for Portions of the Downstream Sub-Basins near Indian-Hickman and Dry Canyons, UT (in)								
1/AEP	2	5	10	25	50	100	200	500
15 min	0.08	0.12	0.15	0.20	0.24	0.29	0.35	0.44
1hr	0.17	0.25	0.32	0.42	0.51	0.61	0.73	0.91
2hr	0.29	0.40	0.49	0.64	0.76	0.91	1.07	1.34
3hr	0.35	0.47	0.57	0.71	0.84	0.99	1.17	1.46
6hr	0.56	0.73	0.85	1.02	1.16	1.33	1.53	1.87

Hydrologic Model

Sub Basin Parameters:

The HUC12 watersheds for all of Skull Valley were obtained from the USGS StreamStats program and loaded into ArcMap10.3. Information including drainage area, percent impervious and basin slope, incorporated in the USGS StreamStats reports was imported into HEC-HMS along with lengths of the longest flowpath and distance along the longest flowpath to the basin centroid. The lengths of these flowpaths were obtained using measuring tools in ArcMap 10.3 and StreamStats. Loss method is the initial and constant loss method. Initial loss is set at 0.75 inch based on studies in the Wasatch region and surrounding desert areas in Utah, (USACE 2004, 2003A, 2003B, 1998, 1995A, 1995B). The constant loss rate is computed based on percentage of drainage area covered by each hydrologic soil group as shown in table 8 (NRCS 1982, SCS 1986, Skaggs and Khaleel 1982). The areal distribution of each soil group in the study area is shown in figure 2 below. The percentage of impervious area was initially obtained from USGS StreamStats and later checked using the NRCS hydrologic soil group map in figure 2.

Table 8		
Hydrologic Soil Groups and Infiltration Rates		
Soil Group	Description	Range of Loss Rates (in/hr)
A	Deep sand, deep loess, aggregated silts	0.30-0.45
B	Shallow loess, sandy loam	0.15-0.30
C	Clay loams, shallow sandy loam, soils low in organic content, and soils usually high in clay	0.05-0.15
D	Soils that swell significantly when wet, heavy plastic clays, and certain saline soils	0.00-0.05
References: NRCS 2018, USACE 2000, SCS 1986, Skaggs and Khaleel 1982.		

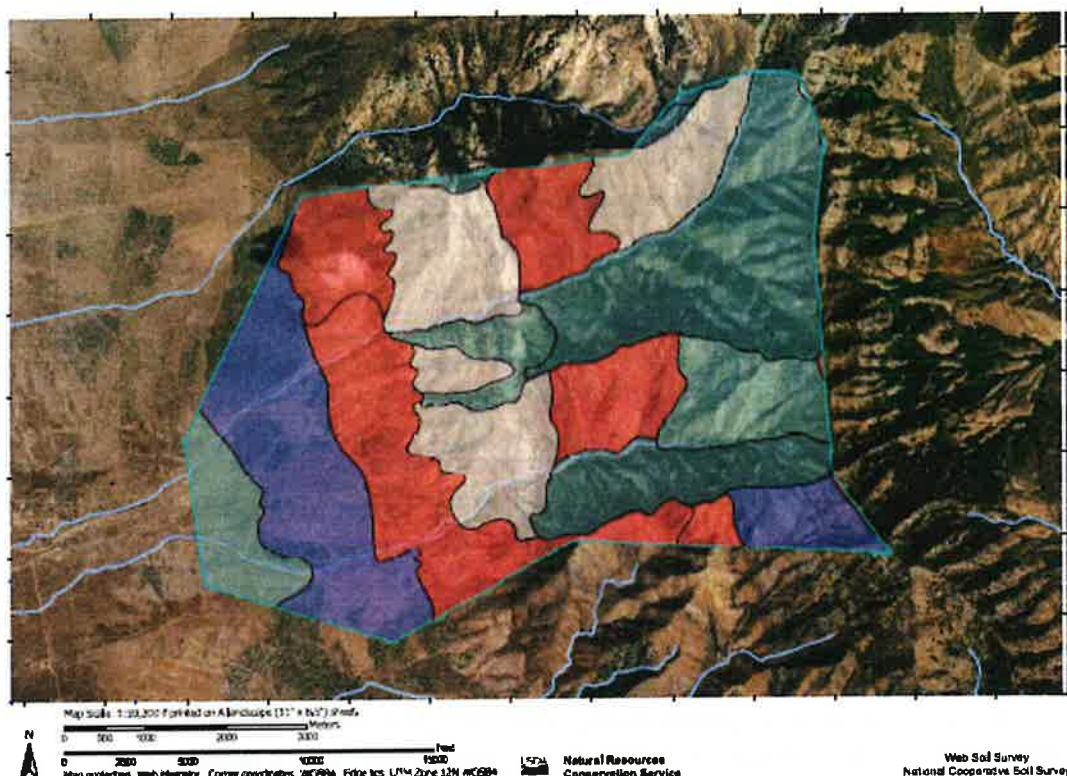


Figure 3 Hydrologic Soil Groups of the study area. Purple shading represents hydrologic soil group B, hydrologic soil groups C and D are represented by blue and red shading respectively. The tan shading represents areas of solid rock outcrop that are not rated. No areas of hydrologic soil group A are represented.

Transform method is the LA S-graph method using the Wasatch Mountain and valley S-graph (SGR33 and SGR35). Base flow was set to none in the HMS model. This study area is in a desert region in which there is no baseflow during dry periods. Likewise, the routing reaches are set to null routing. Basin lag time was computed using the methodology in USACE 1962, "LA Method Unit Hydrographs: Improved Procedure for Determining Drainage Area Lag Values" as follows:

$$(1) \text{Lag time (hours)} = C_t(LL_{ca}/S^{0.5})^m$$

where C_t and m ($=0.38$) are the slope and intercept of the line derived from plotted log values of observed lag time as a function of $LL_{ca}/S^{0.5}$; S is the average basin slope; L is the length of the longest flow path; and L_{ca} is the length along the longest flow path from the basin centroid to the outlet. Manning's basin roughness coefficient (n) is used to compute the C_t coefficient as follows: $C_t = 24 * n$. C_t and basin roughness (n) values for the three common types of watersheds are shown in table 9 below. In the Wasatch region, basin roughness coefficients typically range from 0.075 to 0.1 because of the steep slopes and rocky terrain (USACE 2004, 2003A, 2003B, 1998, 1995A, 1995B).

Table 9 C_t and basin n for three types of watersheds (USACE 1962)		
Type of Drainage Area	C_t	Basin n
Mountain	1.2	0.05
Foothill	0.72	0.03
Valley	0.35	0.015

Thus the C_t coefficients would range from 1.80 to 2.4 for watersheds in Skull Valley.

The watershed parameters used in the model are tabulated by sub basin in table 10.

Watershed ID	Drainage Area (Sq Mi)	LA S graph ID	Lag Time (hrs)	Slope (Ft /Mi)	Stream Length (Mi)	Flow path to Centroid Lca (Mi)	Ct	Constant Loss Rate (in/hr)	Initial loss (in)	impervious (%)
Upper Indian Hickman	5.64	SGR 33	1.02	3068.0	3.76	1.58	2.4	0.23	0.75	0.23
Upper Dry	3.31	SGR 33	0.94	2888.0	2.79	1.66	2.4	0.23	0.75	0.22
Antelope Canyon	3.49	SGR 33	1.30	2909.8	4.70	2.30	2.4	0.23	0.75	0.10

Modeling Results

Clean Water peak flow results from the HMS modeling on Indian-Hickman, Dry and Antelope Canyons at the reservation boundaries are shown in tables 11 and 12 below. It is necessary to model pre-burn and post-burn conditions because this region experiences large wild fires on a consistent basis and the tendency of post-fire conditions to exacerbate flood flows from storms occurring immediately after the fires.. Post-fire conditions are simulated in this study by assuming a 100% burn area and setting the initial loss to zero to reflect hydrophobic soils and the loss of ground cover. A basic bulking factor is applied to post-burn flows to account for the effects of sediment and debris being entrained in the post-fire runoff. Table 11 shows pre fire results and table 12 shows post fire clean water results.

Watershed ID	Drainage Area (Sq Mi)	Exceedance Frequency (1/AEP)							
		2	5	10	25	50	100	200	500
Indian Hickman	5.61	0	132.5	368.9	870.4	1,284	1,802	2,415	3,234
Dry Canyon	3.31	1.16	85.51	217.9	524.0	770.1	1,078	1,447	1,933
Antelope Canyon	3.49	0.11	0.15	0.19	1.37	63.64	208.4	387.8	704.2
Notes:	Results computed in HEC-HMS. initial loss set at 0.75 inches.								

Table 12 Six-Hour Cloudburst Clean Water Peak Flow Results, Post Fire Conditions, Skull Valley Reservation, UT									
Watershed ID	Drainage Area (Sq Mi)	Exceedance Frequency (1/AEP)							
		2	5	10	25	50	100	200	500
Indian Hickman	5.61	368	691	967	1,364	1,738	2,177	2,701	3,524
Dry Canyon	3.31	222.	414	577	812	1,034	1,296	1,608	2,097
Antelope Canyon	3.49	7.85	82.18	144.0	238.1	344.1	479.1	631.0	874.0
Notes:	Results computed in HEC-HMS. Initial loss set to zero to simulate the loss of ground cover and the hydrophobic characteristics of the soils.								

Peak Flow Bulking Factors

Because post wildfire flows entrain large amounts of sediment and debris from the recently burned areas, peak flows will be increased or “bulked” by the presence of those debris. These bulked hydrographs are computed as follows:

$$1) Q_{\text{bulked}} = Q_{\text{clear water}} + Q_{\text{sediment}}$$

where Q_{sediment} is the discharge of sediment. In the present study, sediment bulking is accounted for by applying a bulking factor to the peak flow such as the following:

$$2) BF = (Q_{\text{clear water}} + Q_{\text{sediment}}) / Q_s = 1 / (1 - C_v).$$

Where C_v is the maximum sediment concentration in percent. At sediment concentrations of 20%, the flood flow begins to take on the characteristics of hyper concentrated flow and at 43% the flow takes on the characteristics of a full mud or debris flow (USFS 2016, O'Brien and Fullerton 1989, Elliot et al. 2005). Hydrologic studies of specific wildfires in Utah and Colorado (NRCS 2016, Elliot et al. 2005) compute bulking factors of 1.25 for areas of moderate to severe burn and 1.1 for areas of light burn. Todea (2012) applies a 20% bulking factor to each incremental flow of the post fire hydrographs and thus obtains bulked hydrographs and sedimentation hydrographs for each of the three sub-basins. The total volume of each sedimentation hydrograph is converted to tons by using a unit weight factor of 108 pounds per cubic foot. In the current study, bulking factors of 1.25 (essentially representing a sediment concentration of 20% by volume) and 1.75 (essentially representing a sediment concentration of 43%) are multiplied to the post burn clean water hydrographs for each of the three canyons of interest in the study. The bulked hydrographs will be used in the hydraulic model. The 20% bulked hydrograph peak flows are tabulated in table 13 and the 43% bulked hydrographs are tabulated in table 14. The hydrographs can then be further used and further refined in a hydraulic model of the watersheds and area around the Skull Valley Reservation. Note that the hydrographs that are bulked to the 43% sediment concentration are the ones that will be used for debris flow modeling as these represent the point at which flows would be fully concentrated with sediment and debris

Table 13									
Six-Hour Cloudburst Bulk Peak Flow Results, Skull Valley Reservation, UT, Flows in CFS.									
Watershed ID	Drainage Area (Sq Mi)	Frequency (1/AEP)							
		2	5	10	25	50	100	200	500
Indian Hickman	5.61	460.0	863.3	1,209	1,704	2,173	2,721	3,377	4,406
Dry Canyon	3.31	277.9	517.0	721.8	1,015	1,293	1,620	2,010	2,621
Antelope Canyon	3.49	9,808	102.7	180.0	297.6	430.1	598.9	788.7	1,093
Notes:	Note: Bulking factor of 1.25 translates to a sediment concentration of 20% at which flood begins to assume characteristics of a debris flow.								

Table 14									
Six-Hour Cloudburst Peak Flow Results bulked to 43 % sediment/debris concentration, Skull Valley Reservation, UT, Flows in CFS.									
Watershed ID	Drainage Area (Sq Mi)	Frequency (1/AEP)							
		2	5	10	25	50	100	200	500
Indian Hickman	5.61	644.0	1,209	1,693	2,386	3,042	3,810	4,727	6,168
Dry Canyon	3.31	389.1	723.8	1,011	1,421	1,810	2,267	2,814	3,670
Antelope Canyon	3.49	13.7	143.8	252.1	416.6	602.1	838.4	1,104	1,530
Notes:	Note: Bulking factor of 1.75 translates to a sediment concentration of 43% at which the flow is completely a non-Newtonian debris flow.								

Model Verification

Because there are no long term flow gauges within Skull Valley, an envelope curve is used to test the validity of the model results. These curves are developed for a given region by plotting the largest peak flows for all gauge sites against the drainage areas of the gauge sites. With a long enough cumulative streamflow, a limiting relation (envelope curve) between peak flows and drainage area can be interpreted. A series of envelope curves for Utah from Kenny et al. 2007, "Methods for Estimating Magnitude and Frequency of Peak flow for Natural Streams in Utah" is presented along with the HMS results in figure 4. Crippen and Bue (1977) defined 17 hydrologic regions for the continental United States with most of Utah being in region 14, western Utah in region 16 and northeastern Utah in region 13 (see inset on figure 3). Because physiographic and atmospheric characteristics are determining factors of maximum flood flow, different regions will have different envelope curves. Figure 4 shows envelope curves for three regions of the western United States and a fourth envelope curve from Costa 1987 for all of the continental United States. The HMS results for the 1% AEP event in Skull Valley fall within the envelopes for Utah.

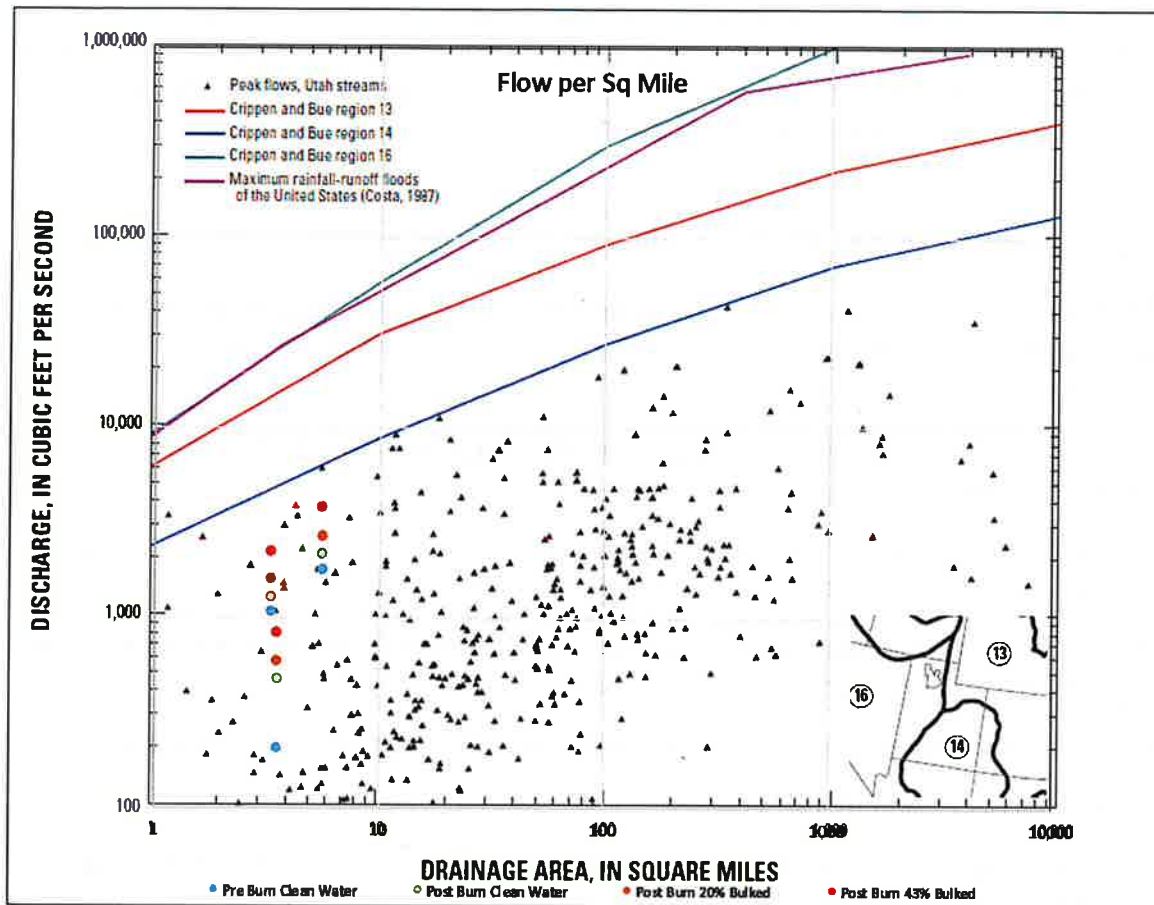


Figure 4 maximum instantaneous (peak) flow for any site in Utah plotted with Crippen and Bue (1977) envelope curves for regions 13, 14 and 16 along with Costa (1987) envelope curve of maximum rainfall runoff floods of the United States (magenta curve) and the HMS and the HMS model results for the 1% event at Skull Valley Reservation and points upstream. The brown dots represent the discharge from HMS using the initial and constant loss method and the blue dots represent HMS results with the SCS curve number method. Inset shows flood region boundaries from Crippen and Bue (1977).

Conclusions

Six hour cloudburst floods were computed for Indian-Hickman, Dry and Antelope Canyons using NOAA 14 point precipitation data, initial and constant loss rates and the LA S-graph method. Pre fire hydrographs were computed with initial loss set at 0.75 inches and post fire hydrographs were computed with initial loss set at zero. The post fire hydrographs were increased volumetrically (bulked) to account for sediment entrainment that would come as a result of intense short duration rainfall on steep slopes where wildfires may have affected the vegetation and soil properties. A bulking factor of 1.75 translates to a sediment concentration of 43 percent was applied to the post-fire clean water hydrographs to produce bulked hydrographs. These hydrographs are used in a hydraulic model to construct flood plain and debris flow maps of the areas downstream of Indian-Hickman, Dry and Antelope Canyons. . These hydrographs are identified with a pathname A-Part of "Bulked 43%" in the accompanying DSS file: "2019-04-30 SKV Clear Water and Bulked Hydrographs.dss".

The clean water flows generated in this study are compatible with those of the previous (SCS 2013) modeling for Indian Hickman Canyon except at the more common frequencies and this may be due to

differences in the meteorological models used in the two studies. Future studies can consider other methods for computing sediment yield, such as the Modified Universal Soil Loss Equation and Western United States Regional Equation, to improve bulking estimates. The inputs for these methods are readily available from the USGS Stream Stats and NRCS Web Soil Survey.

References Cited

Kenny, T.A. Wilkowske, C.D., and Wright, S.J., 2007, **Methods for Estimating Magnitude and Frequency of Peak flow for Natural Streams in Utah** : Scientific Investigations Report 2007-5158. Version 4.0, March 10, 2008. 28p.

Crippen, J.R. and Bue, C.D., 1977, **Maximum Flood Flows in the conterminous United States**: USGS Water Supply Paper 1887, 52p.

Costa, J.E., 1987, A Comparison of the largest rainfall-runoff floods in the United States and those of the Peoples Republic of China and the world: Journal of Hydrology, v.96p. 101-115.

USACE 1962, **LA Method Unit Hydrographs: Improved Procedure for Determining Drainage Area Lag Values**: US Army Corps of Engineers, Los Angeles District.

USACE Hydrologic Engineering Center (HEC), 2014, Hydrologic Modeling System (HMS) version 4.2

ESRI, 2010, ArcMap GIS version 10.3

USGS, 2018, **StreamStats Version 4** <https://streamstats.usgs.gov/ss>: Page last modified: 06/05/2018 08:08:40

USDA NRCS, 2018, Web Soil Survey

Hood, J.W. and Waddell, K.M., 1968, **Hydrologic Reconnaissance of Skull Valley, Tooele County, Utah**: State of Utah Department of Natural Resources Technical Publication no. 18.

National Oceanic and Atmospheric Administration, 2018, NOAA Atlas 14

Skull Valley Band of Goshute, 2017, Skull Valley band of Goshute, Floodplain Management Plan

USDA NRCS, 2013, Pre/Post Fire Hydrology – Patch Springs, UT unpublished.

Todea, N., 2013, Predicting and Comparing Measured Bulking and Peak Discharge using Multiple Methods for Post Fire Hydrologic and Sedimentation Analysis on the Dump Fire in Saratoga Springs, UT, USDA – NRCS.

Todea, N. 2019, Oral communication regarding bulking factors and modeling of Indian Hickman Canyon, 24 April 2019.

USDA-USFS, 2013, Burned Area Report, Patch Springs Fire, Stansbury Mountains, UT, FSH 2509.13

USDA-NRCS, 20163, Hydrologic Analyses of Post Wildfire Conditions, NRCS Hydrology Technical Note no. 4, August 2016.

Cannon, S., Gartner, J.E., Parret, C., and Parise, M., 2003, Wildfire-related debris-flow generation through episodic progressive sediment-bulking processes, western USA, **Debris-Flow Mitigation: Mechanics, Prediction and Assessment**, Rickenmann and Chen, (eds) Millpress, Rotterdam, ISBN 90 77017 78 X.

Giraud, R.E., and McDonald, G., 2007, The 200-2004 Fire-Related Debris Flow in Northern Utah, Utah Geological Survey, Salt Lake City, UT.

Elliot, J.G. Smith, M.E., Friedel, M.J., Stevens, M.R., Bossong, C.R., Litke, D.W., Parker, R.S., Costello, C., Wagner, J., Char, S.J., Bauer, M.A., Wilds, S.R. 2005. Analysis and Mapping of post – fire hydrologic hazards for the 2002 Hayman, Coal Seam, and Missionary Ridge wildfires, Colorado. USGS Scientific Investigations Rept 2004-5300, 80 p.

O'Brien, J.S., and Fullerton, W.T., 1989, Hydraulic and sediment transport study of Crown Pointe flood wall: Breckenridge, Colorado. Lenzotti and Fullerton Consulting Engineers Inc., 34 p.

Mussetter Engineering Inc. (MEI), 2008, Sediment and Erosion Design Guide: prepared for Southern Sandoval County Arroyo Flood Control Authority, Rio Rancho, New Mexico. MEI, Fort Collins, Co.

USACE 2004, **City of Alpine, Utah County, Utah: Flood Insurance Study, Hydrology Office Report**, Sacramento District US Army Corps of Engineers, 60 p.

USACE, 2003A, **Snow Creek, Layton, Davis County, Utah, Floodplain Management Services Study, Hydrology, Hydraulics, and Floodplain Delineation**. Water Management and Hydraulic Design Sections, Civil Design Branch, Sacramento District, 37 p.

USACE 2003B, **Dry Canyon, Cache County, UT: Hydrology Office Report**, Civil Design Branch Sacramento District US Army Corps of Engineers.

USACE 1998, **Centerville, UT: Floodplain Mapping Services Study Hydrology Office Report**, Civil Design Branch, Sacramento District US Army Corps of Engineers.

USACE 1995A, **Cottonwood Canyon: Flood Insurance Study**, Hydrology Office Report, Civil Design Branch, Sacramento District US Army Corps of Engineers.

USACE 1995B, **Monroe County: Flood Insurance Study, Hydrology Office Report**, Civil Design Branch Sacramento District US Army Corps of Engineers.

APPENDIX B PRECIPITATION DATA

A copy of Appendix B can be requested from the Project contacts listed on the fly sheet of the Plan-EA

APPENDIX C

CURVE NUMBER CALCULATIONS

A copy of Appendix C can be requested from the Project contacts listed on the fly sheet of the Plan-EA

**Skull Valley Watershed EA
Hydraulics Technical Memorandum**

TECHNICAL MEMORANDUM – FINAL

TO: Aimee Rohner, P.E.
NRCS Civil Engineer

COPIES: Bucky Whitehouse –
Tooele County Emergency Services Director

FROM: Cameron Jenkins PE, CFM
Bowen Collins & Associates

DATE: June 1, 2022

SUBJECT: Skull Valley-Watershed EA - Hydraulics

JOB NO.: 631-19-01

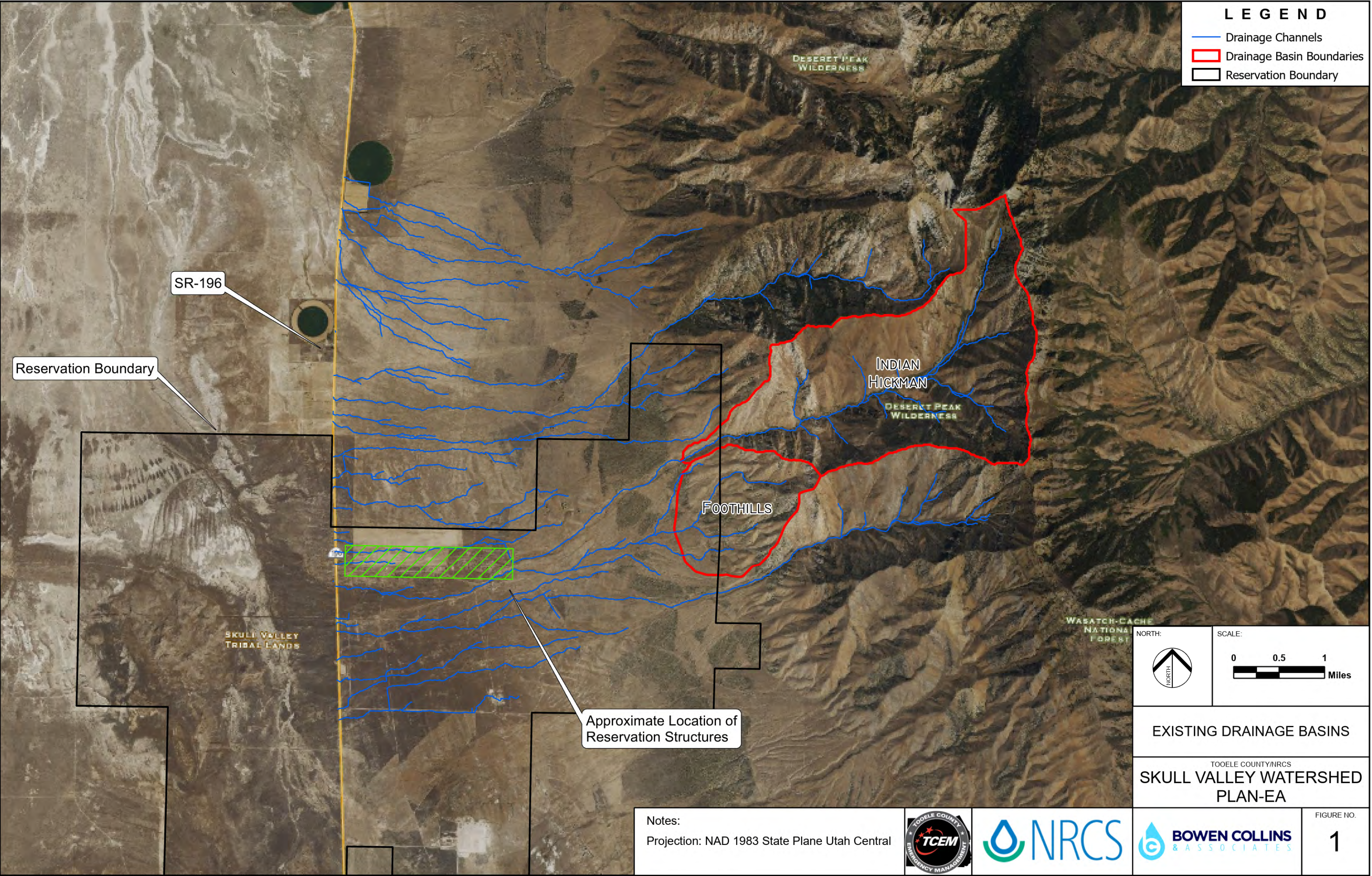
Revision No.	Revision Date	Notes
0	10-26-2020	Draft Review
1	06-18-2021	Updated Design and Cost Estimate
2	01-22-2022	Updated Cost Estimate
3	06-01-2022	Removed Pipeline Alternative from Preferred Alternative

SECTION 1 - INTRODUCTION

1.1 INTRODUCTION AND BACKGROUND

Tooele County, Utah contracted with Bowen Collins & Associates (BC&A) to prepare a new Watershed Plan and Environmental Assessment (Plan-EA) for the Skull Valley Watershed in accordance with USDA Natural Resource Conservation Services (NRCS) guidelines and requirements. The funding for this project was provided by the NRCS through the Watershed and Flood Prevention Operations (WFPO) Program. The Sponsor for this Plan-EA is Tooele County (Sponsor or County). The principal objective of this Plan-EA is to provide the Sponsor and NRCS with National Environmental Policy Act (NEPA) analysis and documents for Sponsor-selected project drainage basins within the larger Skull Valley Watershed. The area needs some structural measures that will mitigate potential flood and debris flow impacts on Skull Valley Reservation property that are the result of a recent fire in the upstream watershed.

This technical memorandum (TM) will summarize the hydraulic analyses performed in support of potential projects identified during the scoping phase of the development of the watershed Plan-EA. The Skull Valley Watershed encompasses an area of approximately 7.2 square miles. It encompasses two distinct drainage basins: Indian Hickman Canyon (5.61 square miles) and Foothills (1.61 square miles), as shown in Figure 1. Much of the Skull Valley Reservation land is on an alluvial fan and contains multiple flow paths and braided stream channels.



LEGEND

- Drainage Channels
- Drainage Basin Boundaries
- Reservation Boundary

SR-196

Reservation Boundary

Approximate Location of Reservation Structures

NORTH:

SCALE:

EXISTING DRAINAGE BASINS

TOOELE COUNTY/NRCS
SKULL VALLEY WATERSHED
PLAN-EA

FIGURE NO.
1

Notes:
Projection: NAD 1983 State Plane Utah Central

A scoping meeting was held with personnel from the NRCS, Tooele County, Skull Valley Band of Goshute Indian Tribe, and stakeholders from the Skull-Valley area to discuss potential projects to include in this Plan-EA. The specific projects that were identified include the following:

1. Repairs to a washed-out waterline and diversion structure which previously conveyed stream flows from the mouth of Indian Hickman Canyon to a holding pond located to the east of the Reservation.
2. Flood control facilities to protect the Reservation from flood and debris flows originating from Indian Hickman Canyon and the foothills to the east.

1.2 EXISTING DATA

Hydrologic and hydraulic analysis for the project area were performed in accordance with NRCS guidelines to define the areas that are prone to damage from post-fire flooding and debris flows. The data sources utilized in this analysis are listed in Table 1.

Table 1
Study Data Sources

Data	Source	Description
2018 Bare Earth LiDAR Topography	USGS 3D Elevation Program (3DEP)	1-meter resolution bare-earth DTM data set of project vicinity. Used to generate hydraulic model and used to verify drainage basin delineation and basin physical parameters.
Aerial Imagery	USDA National Agriculture Imagery Program (NAIP)	1-meter pixel aerial imagery used for the background of figures and to determine existing land uses for hydraulic models.
Field Survey	BC&A Field Reconnaissance	Field reconnaissance completed by BC&A
Previous Studies	US Army Corps of Engineers (USACE)	The USACE developed a Floodplain Management Plan (FMP) in 2018 and a Hydraulic Analysis Study in 2020

1.3 PROJECT TOPOGRAPHIC DATA, DATUM, AND COORDINATE SYSTEM

Topographic data used for the Existing Conditions hydraulic analyses, flood inundation mapping, and alternatives analyses were based on the 2018 Lidar from the AGRC with a 1.0-meter resolution.

The datum and coordinate system used for this project are as follows:

- Vertical Datum: North American Vertical Datum of 1988
- Geodetic Datum: North American Datum of 1983
- Coordinate System: State Plane Utah Central.

SECTION 2 - HYDROLOGY

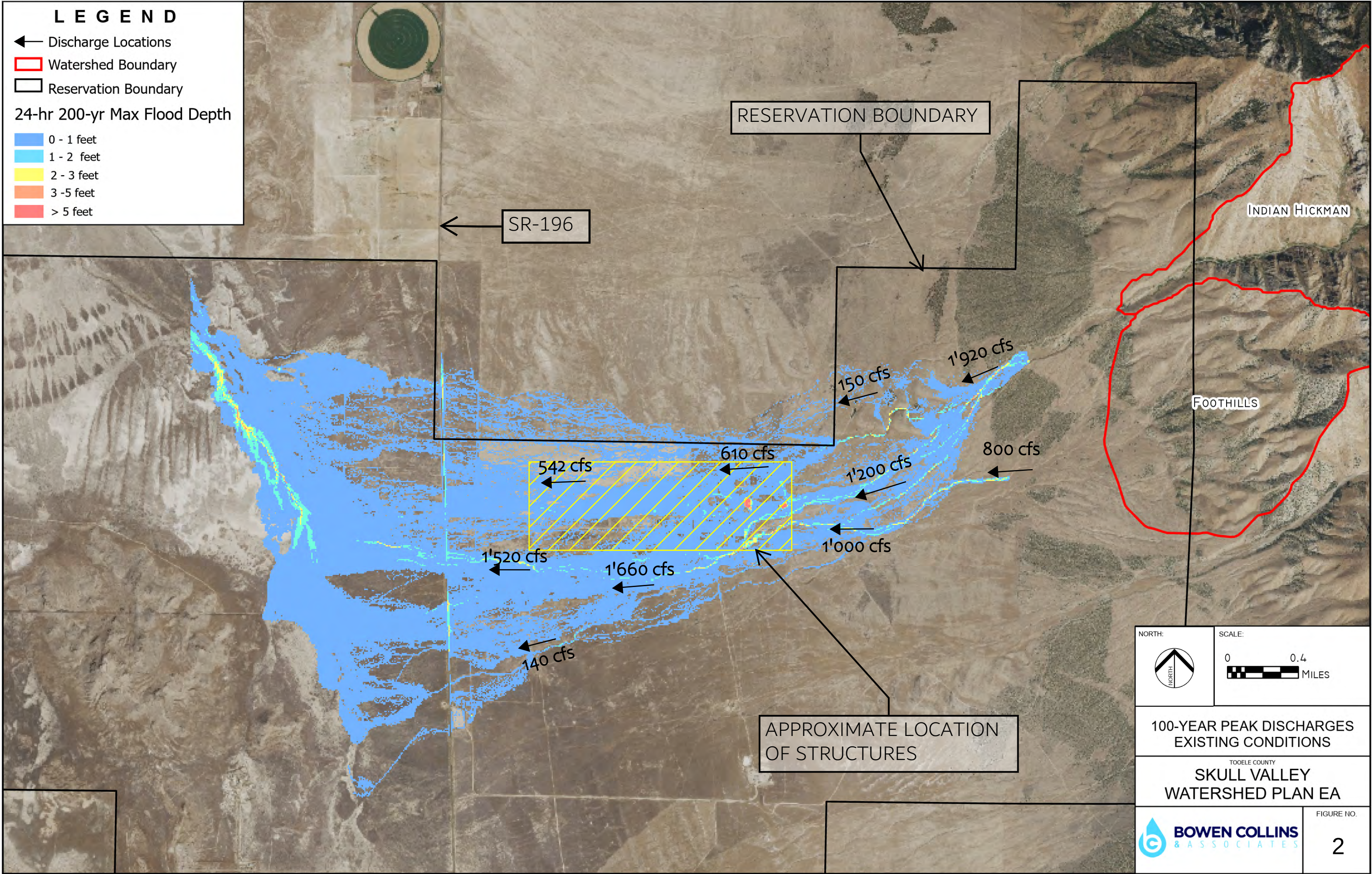
The hydrologic analysis for this project was completed by BC&A with results documented in a Technical Memorandum titled Skull Valley Watershed Plan-EA Hydrology, dated August 17, 2020. The computed discharges for various storm return intervals for the project area are presented in Table 2.

Table 2
Skull-Valley Watershed Summary of Discharges for Various Storms

Drainage Basin	Peak Flow by Recurrence Interval (cfs)								
	Q1	Q2	Q5	Q10	Q25	Q50	Q100	Q200	Q500
Indian Hickman	40	120	330	580	1,010	1,420	1,920	2,520	3,510
Foothills	10	40	130	230	410	580	800	1,050	1,470
Combined Flows	50	150	420	730	1,280	1,800	2,440	3,210	4,490

The 5- to 500-year discharges were analyzed using the HEC-RAS computer hydraulic modeling software. In accordance with NRCS criteria, flood control improvements must be based on the peak discharge associated with a 100-year design storm. Dynamic runoff hydrographs developed during the hydrologic analysis were used as input at the mouth of Indian Hickman canyon and the foothills in the hydraulic model to perform hydraulic analyses.

The computed discharges in Table 2 only represent the discharge at the inflow location and not the discharge in the braided channels that occur downstream. Figure 2 shows the estimated discharges at various locations under existing conditions in the study area.



SECTION 3 - FLOODING ANALYSIS

3.1 INTRODUCTION/BACKGROUND

According to the Utah Division of Emergency Management (DEM), the main type of flooding in the Skull Valley Reservation is alluvial fan flooding. There are two types of alluvial fan flooding affecting the Reservation: streamflow and debris flow. Alluvial fan flooding in Skull Valley is caused by intense rainfall that falls at a rate that significantly exceeds the infiltration capacity of the Stansbury Mountain Range. The runoff from intense rainstorms can result in high amounts of debris flows through the alluvial fans of Indian Hickman and Dry Canyon (Foothills). Due to the lack of stream gage records in the area, records of historical flooding in the project area is difficult to document. Nevertheless, anecdotal evidence as well as physical evidence from deposits of debris indicates that there is a long history of flooding in the project area.

The recorded Cadastral Survey data from 1871 shows that there was only one major flow path that was shown on that map – the one coming from Indian Hickman Canyon. That ephemeral stream was originally a braided channel as shown on Figure 3. Over time it appears that the major flood flow paths have changed, which is normal for an alluvial fan. There are now two main channels: one from Indian Hickman Canyon and one from Dry Canyon. Both channels convey significant runoff caused by large precipitation events similar to those discussed in this report.

3.1.1 2013 Flood Event

In August 2013, more than 13,000 acres of public lands above the Reservation land were burned, as shown in Figure 4. The fire destroyed a water intake structure near the eastern border of the Reservation land in Indian Hickman Canyon. This waterline supplied firefighting, irrigation, and dust suppression water. On September 3-4, 2013, an intense rainstorm occurred over Skull Valley Watershed where more than two inches of precipitation fell over a period of two day (NOAA). A post-flood assessment performed by the Bureau of Indian Affairs (BIA) showed that mud and debris flows mobilized out of Indian Hickman Canyon destroying the water intake structure. Figure 5 shows a mud flow path on the east of the Skull Valley Band of Goshute Reservation. In 2013, the BIA, as documented in a Burned Area Emergency Response (BAER) plan, spent \$90,000 on emergency restoration and flood control efforts as shown in Figure 6. NRCS placed over 2,800 feet of K-rail (precast concrete road barrier) to divert flood waters and debris flows away from habitable structures, as shown Figure 7.

3.1.2 2014 Flood Event

In August 2014, Indian Hickman and Dry Canyons again experienced several intense rainstorm events that led to flooding on the developed portion of Reservation land. According to the BIA, it is estimated that a maximum storm intensity of two inches per hour occurred in one event. Due to the burned conditions in the watershed and the availability of debris in Indian Hickman Canyon, the irrigation water inlet structure and sections of the associated pipeline that conveyed water from the inlet to the Reservation were destroyed (Figure 8). The areas upstream of the k-rails installed in 2013 were filled with mud, rock, and debris (Figure 9). NRCS estimated the peak flow rate near the irrigation diversion at the mouth of Indian Hickman to be between 10,000 to 15,000 cfs. Water and debris covered Highway 196, four miles from the mouth of the canyon. An irrigation pond used by the Skull Valley Band of Goshute Tribe for irrigation and fire suppression was filled with sediment and debris and rendered useless. The Tribe would like to restore the pond and replace the damaged water supply pipeline from the mouth of Indian Hickman Canyon. As of 2020, the pond and pipeline have not been restored or replaced.

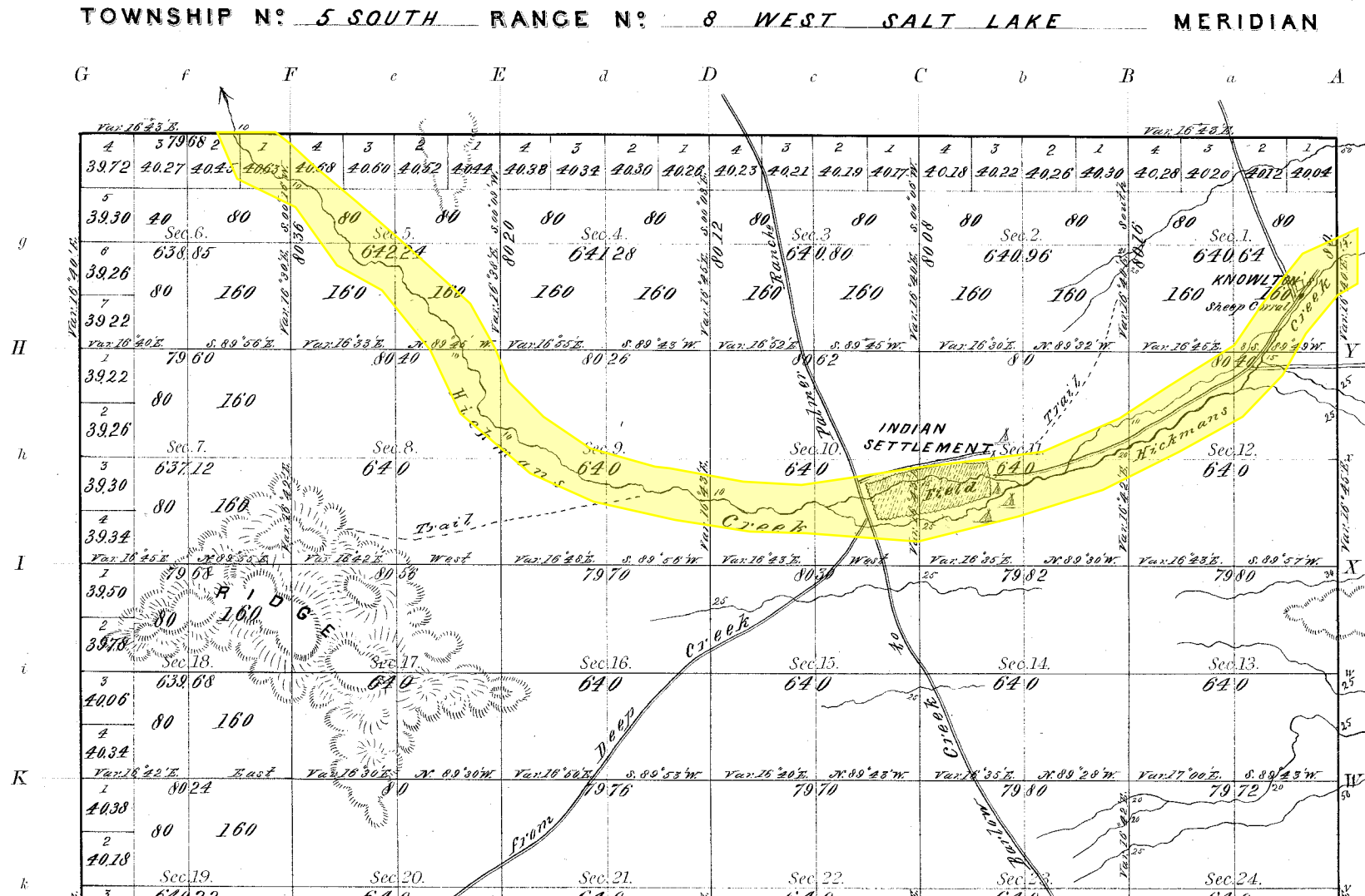


Figure 3. 1871 BLM Cadastral Survey

In response to the 2014 flood events, the BIA commissioned a Flood Assessment Plan including \$59,000 in emergency stabilization efforts. They relocated 28 K-rails and installed 300 sandbags (Figure 10) on top of the existing K-rails installed in 2013, replaced an undersized culvert and spent \$50,000 on debris removal. UDOT installed “flood area” signs along Highway 186 and warned traffic of possible flooding with Variable Message signs (VMS). In the fall of 2013 and winter 2014 the BLM invested \$1.5 million to implement several Emergency Stabilization and Rehabilitation (ESR) treatments on the Patch Springs fire area to stabilize soil that was exposed by the fire, reduce the threats of flash flooding and combat cheatgrass invasion. A total of 98,200 pounds of seed was aerially seeded on 6,497 BLM acres surrounded by 13 miles of fence to protect it (USACE 2018).

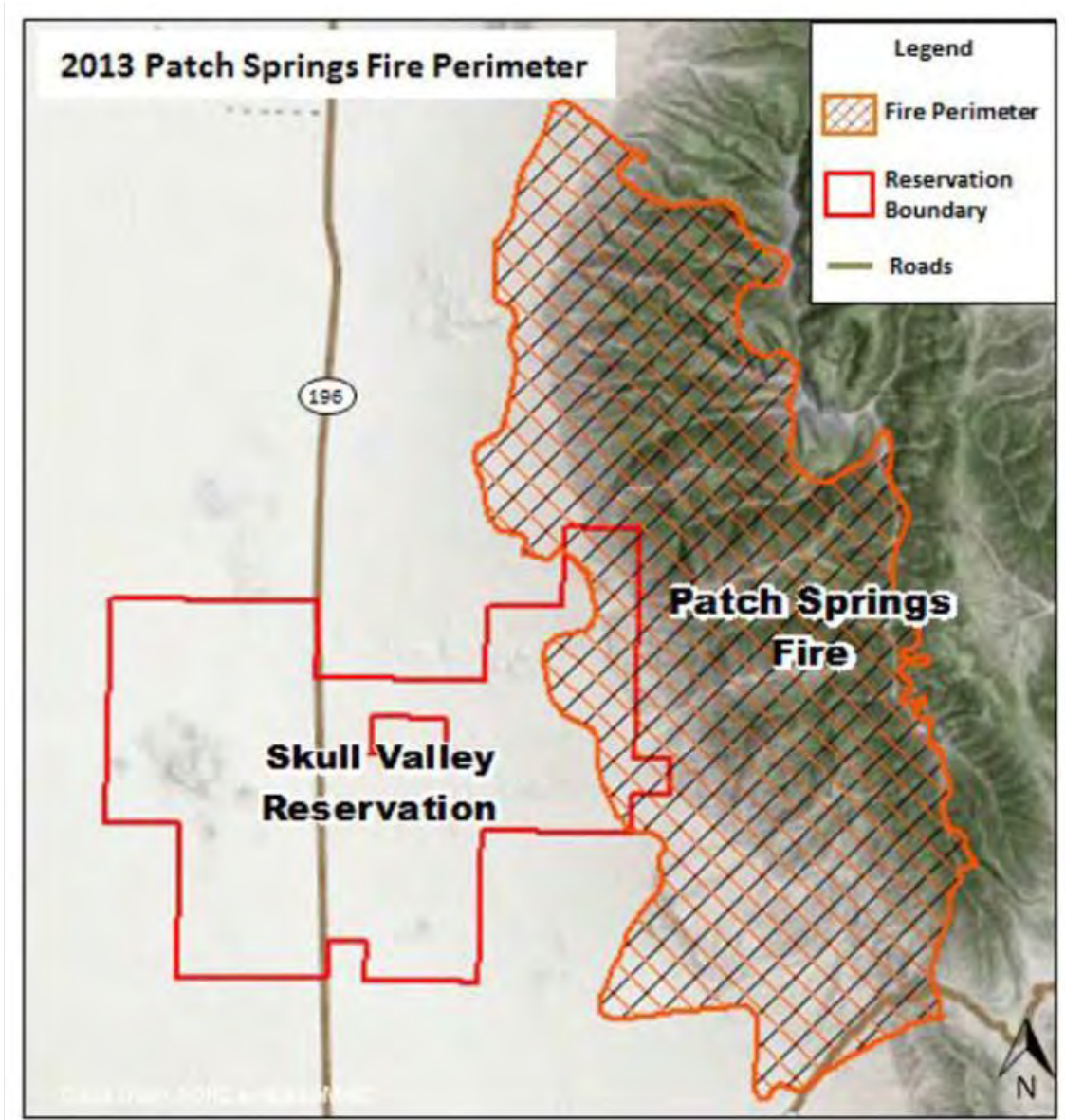


Figure 4. Map of 2013 Patch Springs Fire Perimeter (from USACE 2018, Figure 6)



Figure 5. Mudflow from Indian Hickman Canyon following 2013 flood event.

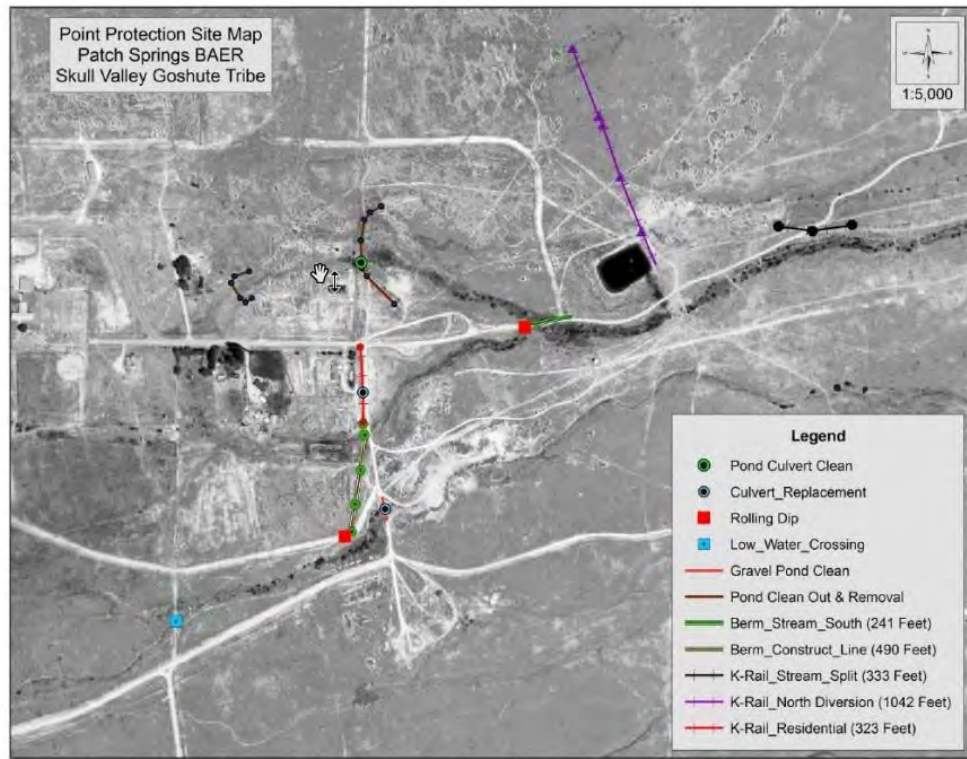


Figure 6. BIA 2013 Emergency Restoration and Flood Control Efforts (USACE 2018)



Figure 7. K-rails installed after 2013 flood event.



Figure 8. Water Intake structure destroyed in Indian Hickman Canyon



Figure 9. Sediment and debris accumulation upstream of K-rails installed in 2013



Figure 10. New K-rail installation after 2014 flood

3.2 FLOODPLAIN HYDRAULIC MODEL DEVELOPMENT

3.2.1 Hydraulic Model Approach

HEC-RAS hydraulic modeling software (version 5.0.7) was used to develop hydraulic models to evaluate existing flood conditions and the impacts of multiple improvement alternatives (see Section 4). Since major overland flooding occurs throughout the alluvial fan floodplain, it was determined that the best modeling approach would be a two-dimensional (2D) flow analysis. A 2D hydraulic model has five main components: unsteady flow data, 2D flow areas, surface roughness values, hydraulic structures, and model boundary conditions at the upstream and downstream ends of the hydraulic model. Two models were developed for two scenarios, Existing Conditions and Alternative 4 Conditions (see Section 4). The data and processes that were used to develop the model elements are described below.

3.2.2 Unsteady Flow Data

The 2D hydraulic model requires unsteady flow hydrograph data. Inflow hydrographs computed by the hydrologic computer model were used as input data at points near the outlets for the two major subbasins that drain into the project area. The runoff hydrographs for the watershed were entered into the Existing Conditions hydraulic model to simulate the runoff for the higher storm event frequencies (i.e. 25-, 50-, 100-, 200-, and 500-year events) as the lower frequencies had little to no runoff. For the Alternative 4 model, only the NRCS-required 100-year design event was simulated as other events are not required.

3.2.3 2D Flow Area

The 2D flow area within a HEC-RAS model is generated based on several inputs that include the following: a perimeter, computational cell size, and break lines/refinement regions. First, a perimeter was created that extended from the mouth of the Indian Hickman Canyon and the Foothills downstream to the west side of Highway 186. A maximum cell size of 20'x20' was set as this was considered detailed enough to capture the topographic relief of the study area. Break lines were also added to the 2D flow area to align the cells faces with natural breaks in the underlying terrain. These breaks mainly consisted of roadway crests, embankments, and channels. This resulted in a grid of the entire model consisting of approximately 588,000 cells.

3.2.4 Terrain

The hydraulic model creates detailed hydraulic table properties for each cell based on the underlying terrain. In this case one surface elevation source was used to create the underlying terrain model: 2018 LiDAR from the AGRC. These tables incorporate details from the underlying terrain to represent the cell and cell faces, thus maintaining the details from the underlying terrain.

3.2.5 Surface Roughness Values

A Manning's roughness coefficient (n-value) must be given to each computational cell within the model. This was done by subdividing the floodplain area into various surface roughness subareas based on land use as indicated by aerial imagery. The n-value was then chosen based on the surface roughness representative of the land use of each subarea. A default value was assigned to all areas that are not delineated. Table 3 provides a summary of the roughness coefficients used in the hydraulic model.

Table 3
Roughness Coefficients used in Hydraulic Model

Description	Manning's n Value Used
Channel	0.045
Overbank	0.06
Road	0.02

3.2.6 Hydraulic Structures

There is a total of 12 hydraulic structures (culverts) in the hydraulic model that are shown on Figure 11. Eleven of the structures cross under Highway 196 and one structure is on the foothills flow path just south of the Reservation. The culverts were located and sized based on existing UDOT data, the USACE model that was completed in 2020 (USACE 2020), and field investigations by BC&A, or assumptions based on aerial photographs, terrain, and nearby structures. All culverts were modeled as being 100% open and inverts were estimated using terrain data. The culverts were modeled as either concrete boxes, concrete pipes, or corrugated metal with the corresponding roughness factor ($n=0.015$ for concrete and $n = 0.024$ for corrugated metal).

The Federal Highway Administration (FHWA) software, HY-8 version 7.60 was used to assess the existing culvert capacities. The Model inputs for culvert invert elevations and top of road were determined by using the available LiDAR. Existing culvert material and sizes were input based on information obtained during field visits or from the UDOT data.

Evaluation of the existing culverts was performed to determine how much water the existing culverts can pass during the 100-year flood event and show if overtopping of the roadway or banks of channel occurs. The capacities of the existing culverts for this study are based on when overtopping of the culvert occurs and are provided in Table 4 and are shown in Figure 11. The culverts on the figure are identified by an ID number as shown on Table 4.

To help analyze flood mitigation alternatives, the existing culvert sizes were modified to be compatible with the proposed channel improvements and eliminate overtopping of the roadway during the 100-year peak flow. This will be discussed further in the section below.

3.2.7 Model Boundary Conditions

Upstream and downstream model boundary conditions were required at each model inflow area and at the downstream outflow location of the model. Normal depth was set to 0.01 ft/ft slope for all outflow locations as they were far away from the main project area and would have minimal impact on overall results. The downstream boundary conditions were located west of Highway 196. The upstream boundary conditions (model inflow locations) were placed approximately at the mouth of each drainage subbasin. The upstream boundary condition used the unsteady flow data as previously described.

3.2.8 Existing Conditions Floodplain Mapping

Floodplain maps were created for the 5-, 10-, 25-, 50, 100-, 200-, and 500-year events and are included in Appendix A. The results show that water starts to break out of Indian Hickman Canyon and Foothills channels for the 25-year event at multiple locations. As the magnitude of the runoff events get larger, more and more water overtops the channel banks and flows westward. The 100-year event shows depths ranging from 0- to about 3-feet deep except in two old ponds where depths get up to 6 ft. The deeper flood depths are directly adjacent to raised roads that act as a restriction, resulting in a wide shallow floodplain.

Table 4
Existing Culverts Capacity Along Channel

Culvert ID	Name	Number of Barrels	Size (ft Span x Rise)	Capacity (cfs)
1	Culvert 1	1	3' Pipe	55
2	Culvert 2	1	1.5' Pipe	12
3	Culvert 3	1	2' Pipe	23
4	Culvert 4	1	1.5' Pipe	6
5	Culvert 5	1	2' Pipe	23
6	Culvert 6	1	2' Pipe	21
7	Culvert 7	1	3' Pipe	51
8	Culvert 8	1	2' Pipe	26
9	Culvert 9	1	4' Pipe	106
10	Culvert 10	1	2' Pipe	26
11	Culvert 11	1	1.5' Pipe	13
12	Culvert 12	2	3' Pipe	81

LEGEND

- Streams
- Culverts

SR-196

1

2

3

4

5

6

7

8

9

10

11

12

Culvert ID	Name	Number of Barrels	Size (ft Span x Rise)	Capacity (cfs)
1	Culvert 1	1	3' Pipe	55
2	Culvert 2	1	1.5' Pipe	12
3	Culvert 3	1	2' Pipe	23
4	Culvert 4	1	1.5' Pipe	6
5	Culvert 5	1	2' Pipe	23
6	Culvert 6	1	2' Pipe	21
7	Culvert 7	1	3' Pipe	51
8	Culvert 8	1	2' Pipe	26
9	Culvert 9	1	4' Pipe	106
10	Culvert 10	1	2' Pipe	26
11	Culvert 11	1	1.5' Pipe	13
12	Culvert 12	2	3' Pipe	81



BOWEN COLLINS
& ASSOCIATES

EXISTING SR-196 AND RESERVATION CULVERT CAPACITIES

TOOELE COUNTY
SKULL VALLEY WATERSHED PLAN EA

NORTH:



SCALE:



FIGURE NO.

11

SECTION 4 - PROPOSED FLOOD MITIGATION ALTERNATIVES

4.1 BACKGROUND

The following alternatives were evaluated to mitigate post-fire flood hazards on the developed portion of Reservation land:

1. Debris Basin and Berm
2. Landform and Long Berm
3. Berm or Diversion Dike
4. Berm (diversion dike) and Channel Improvements
5. Do nothing

Each of these alternatives will be discussed below. It should be noted that the downstream extent of most of these alternatives ends about one mile east of SR-196. During the scoping meetings with the stake holders, it was discussed that potential flood control measures should protect homes and community structures from hazards associated with flooding and debris flows. Some of the alternative improvements include modifying, repairing, or replacing flood mitigation measures that were installed after the floods in 2013 and 2014 to improve flood protection.

4.2 ALTERNATIVE 1 – DEBRIS/DETENTION BASIN AND BERM

The first alternative evaluated includes a large detention/debris basin at the mouth of the Indian Hickman Canyon along with two berms near the developed part of Reservation land and replacing an undersized culvert on an ephemeral wash with a concrete ford, as shown in Figure 12. The purpose of the detention/debris basins would be to reduce the debris downstream and attenuate the magnitude of flood flows and help reduce flood depths. The berms near the reservation would redirect alluvial fan floods from flowing through the developed portion of Reservation land.

The following sections discuss in detail the potential improvements associated with this alternative.

4.2.1 Debris/Detention Basin Design

One of the first objectives that needs to be completed for the evaluation of a proposed detention basin is to determine if it is feasible to construct a facility that is large enough to store the volume of water and sediment needed to attenuate the peak discharge to the desired value so impacts downstream would be minimal.

The Indian Hickman Canyon watershed is a mountain watershed that discharges onto an alluvial fan where the flow pattern may change during or after each major runoff event. The existing conditions hydraulic model results for all events (Appendix A) shows flood water spreading out in multiple flow paths. To minimize the flow path uncertainty and impacts downstream, the 5-yr discharge of 330 cfs was chosen as the desired discharge rate out of the debris/detention basin. Based on the 100-year inflow flood event of 1,920 cfs, a water storage volume of 202 ac-ft, and a 3.25-ft diameter outlet pipe would be required to reduce the discharge to 330 cfs.

LEGEND

- Berm
- Debris Basin
- Watershed Boundary
- Streams

CONSTRUCT DEBRIS BASIN
WITH A 202 AC-FT WATER
STORAGE VOLUME

CONSTRUCT
DIVERSION BERM

REACH 1

REACH 2

REMOVE EXISTING CULVERT AND
REPLACE WITH CONCRETE FORD

USDA FSA, GeoEye, Maxar



BOWEN COLLINS
& ASSOCIATES

POTENTIAL ALTERNATIVE 1 IMPROVEMENTS

TOOELE COUNTY
SKULL VALLEY WATERSHED PLAN EA

NORTH:



SCALE:

0 0.25
MILES

FIGURE NO.

12

Debris flows in the watershed have been an issue since the Patch Fire in 2012 and sediment and debris accumulation would impact the basin over time. The National Engineering Handbook Section 3 Sedimentation notes: *"The design life of a reservoir is the period required for the reservoir to fulfill its intended purpose. Structures designed by the SCS in the watershed protection and flood prevention programs usually are designed for a life of 50 or 100 years. Provision must be made to ensure the full design storage capacity for the planned design life. This may mean cleaning out deposited sediment at predetermined intervals during the design life or, as is generally the situation, providing enough capacity to store all the accumulated sediment for the reservoir's design life without diminishing the design water storage"*. Following the methodology outlined in NEH Section 3 (SCS 1983), including trap efficiency, the USDA map of sedimentation rates in Utah (Bridges 1973), assuming a 100-year design life and no maintenance, it was estimated that a minimum sediment volume of 92 ac-ft would be needed to store sediment accumulation over the 100-year service life in addition to water storage requirements.

With the construction of a debris/detention basin near the apex of the alluvial fan and the total basin volume of 294 ac-ft (water and sediment), a 80 ft tall dam would be required along with excavation to provide the needed storage volume. The dam that would create the debris/detention basin would require approximately 225,000 cubic yards of fill and excavation of 194,000 cubic yards material. Alternative 1 was not pursued any further since it would cost more than \$7 million just for fill/excavation required to construct just the dam, (not including an emergency spillway and outlet structures). In addition, flood diversion berms would still need to be constructed just upstream of the developed portion of Reservation land to protect that area from shallow alluvial fan flood hazards. This alternative was considered to be cost-prohibitive and undesirable due to the amount of maintenance that would be required to maintain the debris/detention basin.

4.3 ALTERNATIVE 2 – LANDFORM AND LONG BERM

The second alternative includes constructing a landform, an 8,250 ft long berm north of the reservation on the Indian Hickman drainage, to redirect alluvial fan flood waters to the north and protect the developed part of Reservation land from flooding. It also includes replacing an existing undersized culvert on an ephemeral wash with a 600-ft long concrete ford. Landforms are made up of earth mound impediments in a scattered format that slow the flow down to promote sediment and debris deposition which would help reduce debris issues along the berm. A The proposed locations of the landform, berm and ford are shown on Figure 13. Conceptual details of landforms and berms are shown in Figure 14.

The proposed berm improvements would be designed to protect the developed portion Reservation land from flooding associated with the 100-year, 24-hour design storm event with a peak discharge of 1,920 cfs at the mouth of Indian Hickman Canyon and divert runoff north of the developed area. The conceptual berm design is broken up into multiple reaches based on slope of the terrain and based on a minimum top width of 5 ft and side slope of 3:1. The proposed concrete ford would be designed for a peak flow of 800 cfs from the Foothills watershed to replace the undersized existing 36" culvert with riprap on the downstream side for erosion protection. Armoring is recommended to be placed 3 ft below ground and a 2 ft above the water surface elevation. The design criteria are summarized in Table 5. Typical details are show in Figure 15 to Figure 17.

An Excel spreadsheet utilizing the Manning's Equation (solving for normal depth) and the existing conditions 2D HEC-RAS model were used to size the proposed improvements to the flood channel and shown in Appendix B.



POTENTIAL ALTERNATIVE 2
IMPROVEMENTS

TOOELE COUNTY
SKULL VALLEY WATERSHED PLAN EA



SCALE:
0 0.25
MILES

FIGURE NO.
13

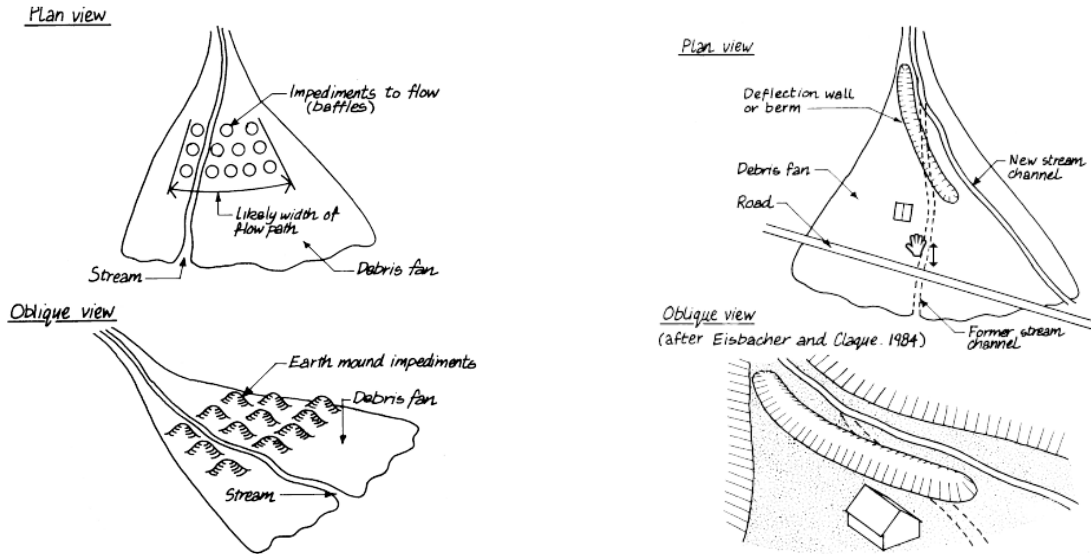


Figure 14. Landform and Berm Conceptual Details (Taken from VaneDine 1996)

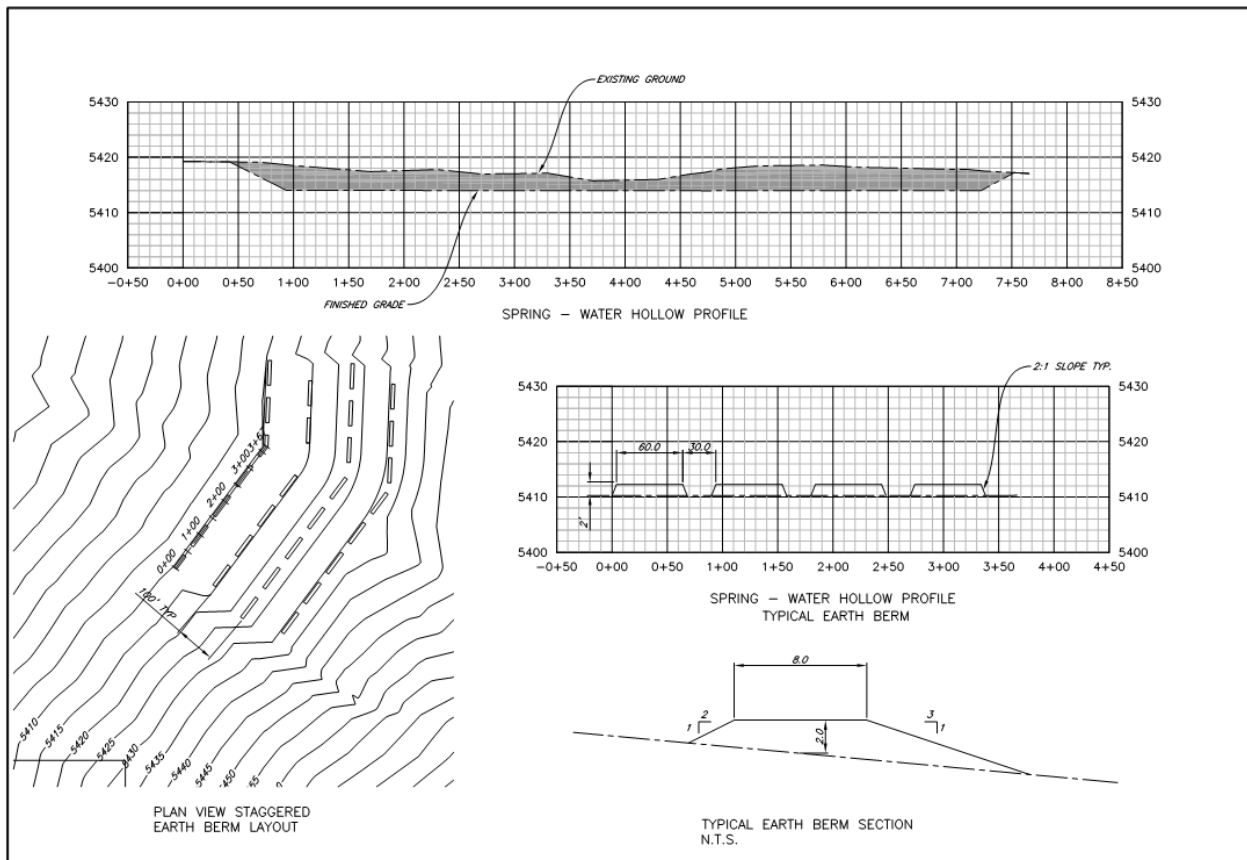


Figure 15. Typical Landform Concept Detail (Provided by NRCS)

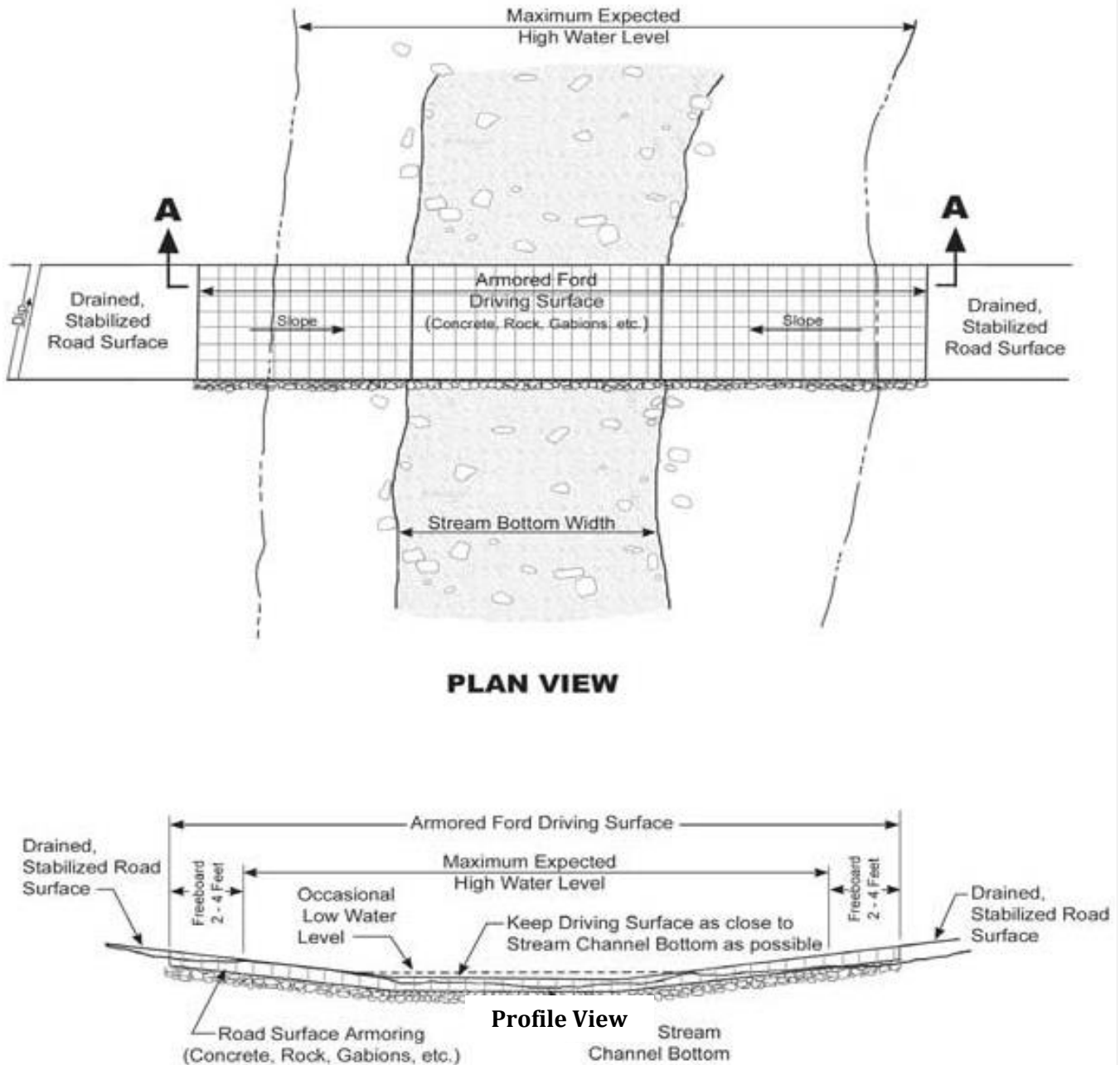


Figure 16. Typical Ford Concept (Provided by USDA Forest Service)

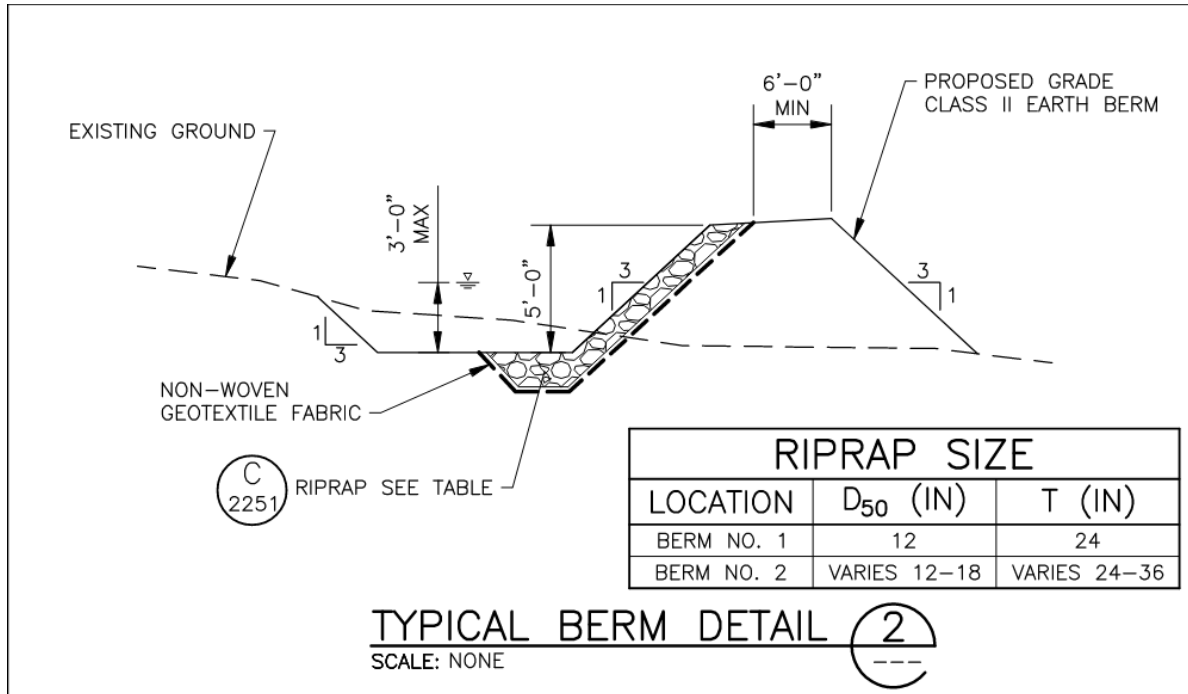


Figure 17. Typical Diversion Berm Concept

Table 5
Summary of Alternative 2 Flood Berm/Ford Hydraulic Design Criteria

Reach	Length (ft)	Flow Rate (cfs)	Manning's "n" Roughness Value	Channel Bottom Width (ft)	Estimated Flood Depth (ft)	Channel Slope (%)	Side slope m:1	Average Velocity (fps)
1	8,415	1,920	0.045	5 - 75	2.0 - 2.3	3.5 - 5.9	3	10.6 - 12.1
Ford	300	800	0.045	150	1.0	3.38	6	5.8

Berm and Ford Erosion Protection

The average 100-year flood velocities for the berm and concrete ford range from 5.8 to 12.1 fps; therefore, erosion is a concern and rock riprap armoring, or another reliable means of bank erosion protection should be installed. Riprap should also be placed on the downstream side to protect from erosion. The riprap was sized based on average velocities, water depth during the design storm, channel slope, riprap properties, and safety factors.

Five different methods were evaluated based on the proposed channel geometry and flow characteristics during the 100-year design storm event and Table 6 shows the riprap sizing recommendations that have been developed based on the results of this evaluation. Riprap calculations including a summary comparing the various methods are included in Appendix B.

Table 6
Summary of Proposed Flood Riprap Criteria Alternative 2

Location	D50 (in)	Minimum Riprap Layer Thickness (in)
Reach 1	12 to 26	24 - 39
DS side Ford	12	18

4.3.1 Estimated Construction Cost – ALTERNATIVE 2

The estimated construction cost for the landforms and long diversion berm alternative is summarized in Table 7.

Table 7
Conceptual Construction Costs for Alternative 2 Improvements-

Item	Quantity	Unit	Unit Cost	Cost
Mobilization/Demobilization	1	LS	\$ 820,000	\$ 820,000
Survey	1	LS	\$ 160,000	\$ 160,000
SWPP	1	LS	\$ 40,000	\$ 40,000
Berm Excavation and Construction	55,500	CY	\$ 24	\$ 1,332,000
Berm Riprap	55,000	CY	\$ 80	\$ 4,400,000
Berm Natural Seeding	330,000	SF	\$ 0.2	\$ 66,000
Non-Woven Geotextile Fabric	20,600	SY	\$ 3	\$ 61,800
Landform Excavation and Construction	78,000	CY	\$ 22	\$ 1,716,000
Ford Excavation and Construction	1,300	CY	\$ 22	\$ 28,600
Ford Concrete	300	CY	\$ 1,150	\$ 225,000
Ford Base	200	CY	\$ 65	\$ 13,000
Ford Riprap	300	CY	\$ 80	\$ 24,000
Subtotal:				\$ 8,991,400
Contingency (30%):				\$ 2,697,420
Total (rounded to nearest \$1,000):				\$ 11,689,000

4.4 ALTERNATIVE 3 – BERMS AND FORD

The Alternative 3 improvements include constructing multiple flood diversion berms, a relocated canyon access road, and replacing an undersized culvert with a 600 ft long concrete ford as shown in Figure 18. The berms included with this alternative include a 2,650 ft berm north of the developed part of the Reservation, a 2,320 ft berm east of the developed portion of the Reservation that would also serve as an access road embankment, and a 950 ft berm south of the developed part of the Reservation. With a total length of 6,920 ft, the diversion berms would redirect shallow alluvial fan flooding to the north and south to protect the existing developed area from flooding.

The proposed berm and ford improvements would be designed to protect against and convey runoff from the 100-year, 24-hour design storm event to the north and south of the developed area on Reservation land as summarized in Table 8 and shown Figure 18. The proposed berms are divided into flood diversion berms and canyon access road berms. The flood diversion berms are proposed to have a minimum of 6 ft top width and 3:1 side slope while road berms would be designed with a 15 ft top width and 5:1 side slope. The road berms would be designed to maintain access to the mouth of Indian Hickman Canyon as some of the flood control improvements impact existing dirt roads. The potential concrete ford design detail would be the same as the one described with Alternative 2.

Table 8
Summary of Alternative 3 Flood Berm/Ford Hydraulic Design Criteria

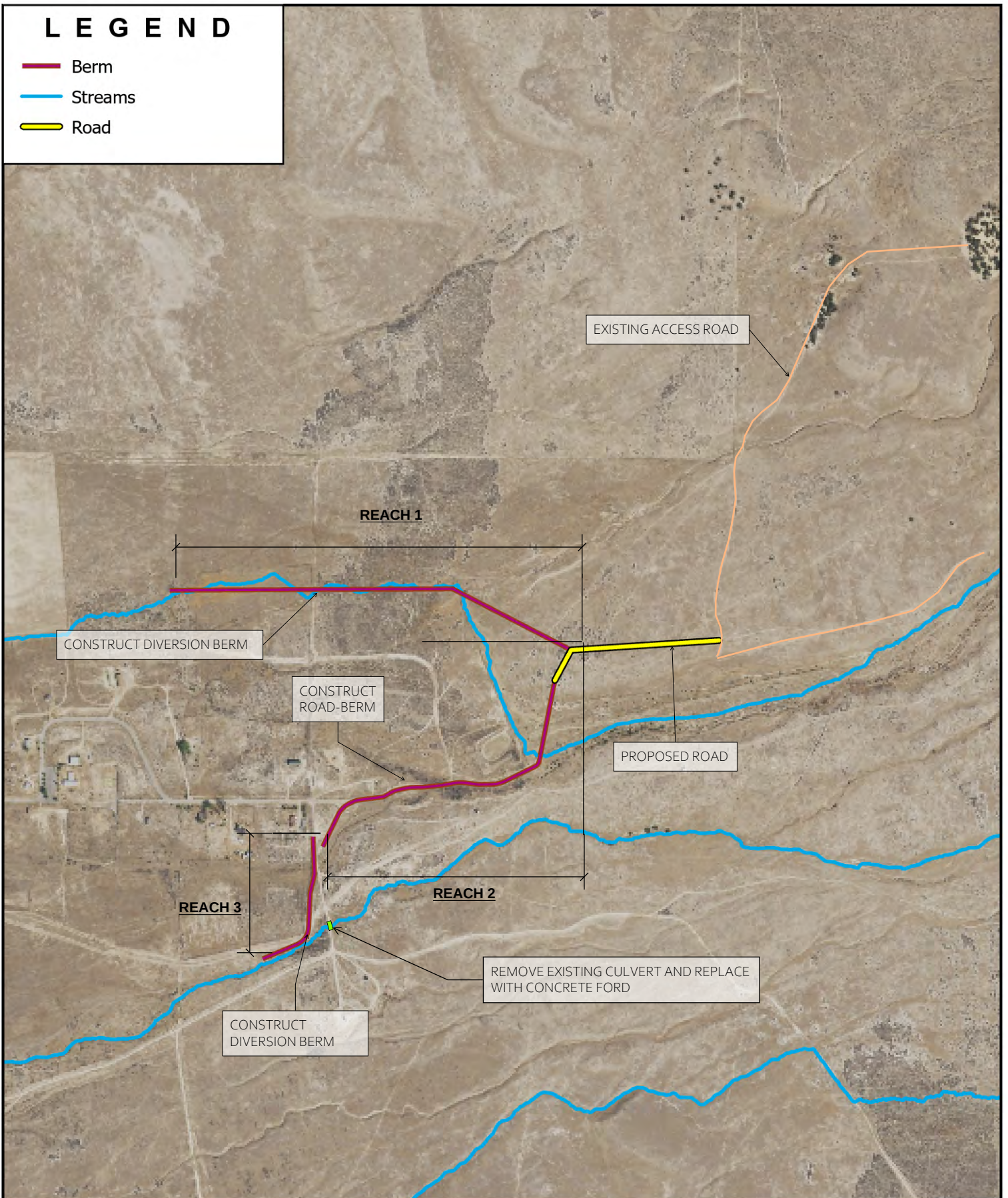
Reach	Type	Length (ft)	Flow Rate (cfs)	Manning's "n" Roughness Value	Channel Bottom Width (ft)	Estimated Flood Depth (ft)	Channel Slope (%)	Side slope m:1	Average Velocity (fps)
1	Berm	2,650	150	0.045	5 - 25	0.9 - 1.1	2.37 - 6.13	3	5.0 - 7.1
2	Road Berm	2,320	1,200	0.045	5 - 75	1.6 - 2.4	1.29 - 5.27	3	6.3 - 10
3	Berm	950	1,200-2,200	0.045	5 - 75	1.7 - 2.8	0.8 - 4.2	3	5.6 - 11.4
-	Concrete Ford	600	1,000	0.045	150	1.1	3.2	6	6.1

Design of the berm also considered several other factors, including the following:

- The locations of flood diversion berms should be placed so the existing Indian Hickman and Foothills drainage pattern is maintained as much as possible. If there is a possibility to shorten the diversion berm length it should be evaluated during final design.
- All diversion berm embankments should be designed to provide a minimum 2-ft of freeboard during the design storm.
- Riprap armoring protection is recommended through the entire reach of improved berm along the bank, a minimum of 2 ft above 100-year depth, and buried below ground.

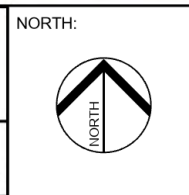
LEGEND

- Berm
- Streams
- Road



POTENTIAL ALTERNATIVE 3 IMPROVEMENTS

TOOELE COUNTY
SKULL VALLEY WATERSHED PLAN EA



SCALE:
0 0.15
MILES

FIGURE NO.
18

Berm and Ford Erosion Protection

The average 100-year flood velocities along the berms and concrete ford range from 5.0 to 11.4 fps; therefore, erosion is a significant concern and rock riprap armoring, or another reliable means of bank protection should be installed along the banks and downstream side of the ford. The riprap was sized based on average velocities, water depth during the design storm, channel slope, riprap properties, and safety factors. Five different methods were evaluated based on the proposed channel geometry and flow characteristics during the 100-year event and Table 9 shows the riprap sizing recommendations that have been developed based on the results of this evaluation. Riprap calculations including a summary comparing the various methods are included in Appendix B.

Table 9
Summary of Proposed Flood Riprap Criteria for Alternative 3

Reach	D50 (in)	Minimum Riprap Layer Thickness (in)
1 (Berm)	12	18
2 (Road Berm)	12 - 17	18 - 26
3 (Berm)	12 - 21	18 - 32
DS side of Concrete Ford	12	18

4.4.1 Estimated Construction Cost – ALTERNATIVE 3

The estimated construction cost for the landforms and the long diversion berm alternative is summarized in Table 10.

Table 10
Conceptual Construction Costs for Alternative 3

Item	Quantity	Units	Unit Cost	Cost
Mobilization/Demobilization (10%)	1	LS	\$ 380,000	\$ 380,000
Survey	1	LS	\$ 80,000	\$ 80,000
SWPP	1	LS	\$ 40,000	\$ 40,000
Berm Excavation and Construction	48,100	CY	\$ 24	\$ 1,154,400
Berm Riprap	24,000	CY	\$ 80	\$ 1,920,000
Berm Natural Seeding	229,000	SF	\$ 0.2	\$ 45,800
Non-Woven Geotextile Fabric	17,800	SY	\$ 3	\$ 53,400
Ford Excavation and Construction	1,300	CY	\$ 22	\$ 28,600
Ford Concrete	300	CY	\$ 1,100	\$ 330,000
Ford Base	200	CY	\$ 65	\$ 13,000
Ford Riprap	200	CY	\$ 80	\$ 16,000
Road Repair Fill and Construction	800	CY	\$ 30	\$ 24,000
Road Repair Base	400	CY	\$ 65	\$ 26,000
Subtotal:				\$ 4,111,200
Contingency (30%):				\$ 1,233,360
Total (rounded to nearest \$1,000):				\$ 5,345,000

4.5 ALTERNATIVE 4 – BERM AND CHANNEL IMPROVEMENTS

Alternative 4 improvements include multiple berms, channel improvements, a rerouted canyon access road, and replacing an undersized culvert with a 300 ft long concrete ford as shown in Figure 19. The berms that are part of this alternative include a 2,650 ft flood diversion berm north of the developed part of Reservation land, an 800 ft flood diversion berm with the access road adjacent to it east of developed Reservation land that would divert shallow alluvial fan runoff to one of the existing major drainage channels. This alternative also includes a 1,900 ft reach of channel improvements along an unnamed ephemeral wash that conveys runoff from the foothill area westward. The berms and channel improvements would redirect flow to the north and south of the developed part of the Reservation to protect existing structures from flooding.

The potential diversion berm and associated diversion channel and ford improvements would be designed to manage runoff from the 100-year, 24-hour design storm event and would mitigate alluvial fan flood hazards on the developed portion of Reservation land as summarized in Table 11 and shown in Figure 19. Berms are designed with a minimum of 6 ft top width and 3:1 side slope. There is a gap between the Reach 1 and 2 berms that still allows access up the alluvial fan as some of the flood control improvements impact existing dirt roads. The proposed channel was designed to have a minimum of a 3:1 side slope and match existing slope as much as possible. The proposed concrete ford uses the same design as Alternative 2 except for a larger discharge.

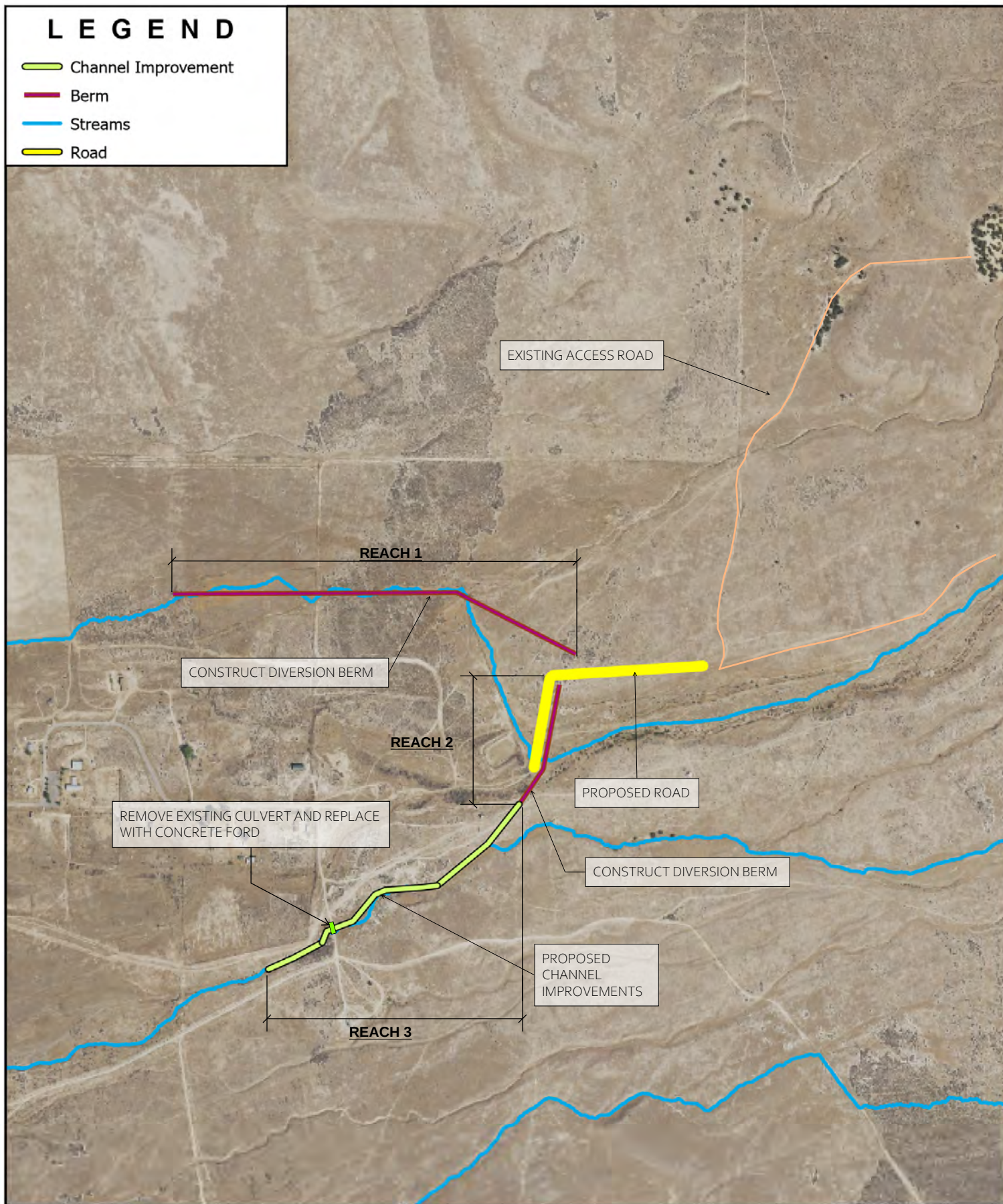
An Excel spreadsheet utilizing the Manning's Equation (solving for normal depth) and the existing conditions 2D HEC-RAS model were used to size the proposed improvements for the berm and provided in Appendix B. The results for the improved berm are summarized in Table 11.

Design of the berm and the proposed channel improvements (Reach 3) should consider several other factors, including the following:

- The locations of berms should be placed so existing channel alignment is maintained as much as possible. If there are possibilities of potentially shortening the berm lengths, that will be evaluated during final design.
- All berm and channel embankments should be designed to allow for a minimum 2-ft of freeboard during the design storm.
- Riprap armoring protection is recommended through the entire reach of improved berm and channel along the banks, at a minimum of 2 ft above the 100-year depth and buried below ground.

LEGEND

- Channel Improvement
- Berm
- Streams
- Road



BOWEN COLLINS
& ASSOCIATES

POTENTIAL ALTERNATIVE 4 IMPROVEMENTS

TOOELE COUNTY
SKULL VALLEY WATERSHED PLAN EA

NORTH:



SCALE:

0 0.15
MILES

FIGURE NO.

19

Table 11
Summary of Alternative 4 Flood Diversion Berms Channel, and Ford Hydraulic Design Criteria

Reach	Type	Length (ft)	Flow Rate (cfs)	Manning's "n" Roughness Value	Channel Bottom Width (ft)	Estimated Flood Depth (ft)	Channel Slope (%)	Side slope m:1	Average Velocity (fps)
1	Berm	2,640	150	0.045	5 - 25	0.9 - 1.1	2.37 - 6.13	3	5.0 - 7.1
2	Berm	800	1,200	0.045	5 - 75	1.6 - 2.5	1.32 - 5.27	3	6.6 - 10.0
3	Channel	1,900	2,200	0.045	25 - 75	2.6 - 4.5	3.07 - 4.15	3	10.8 - 14.4
	Concrete Ford	300	2,200	0.045	150	1.7	0.032	6	8.3

Berm, Flood Channel, and Ford Erosion Protection

The average 100-year velocities range from 5.0 - 10.0 fps in the conveyance channels along the diversion berms and 8.3 - 14.4 fps for the improved channel and the concrete ford; therefore, erosion is a concern and rock riprap armoring, or another bank protection should be installed to protect the needed improvements from erosion hazards. The riprap was sized based on average velocities, water depth during the design storm, channel slope, riprap properties, and safety factors. Five different methods were evaluated based on the proposed channel geometry and flow characteristics during the 100-year event and Table 12 shows the riprap sizing recommendations that have been developed based on the results of this evaluation. Riprap calculations including a summary comparing the various methods are included in Appendix B. A typical cross section showing the proposed riprap channel armoring is provided in Figure 20.

Table 12
Summary of Proposed Flood Riprap Criteria Alternative 4

Reach	D50 (in)	Thickness (in)
1 (Berm)	12	18
2 (Berm)	12 - 17	18 - 26
3 (Channel Improvement)	18 - 27	18 - 50
DS Side of Ford	18	24

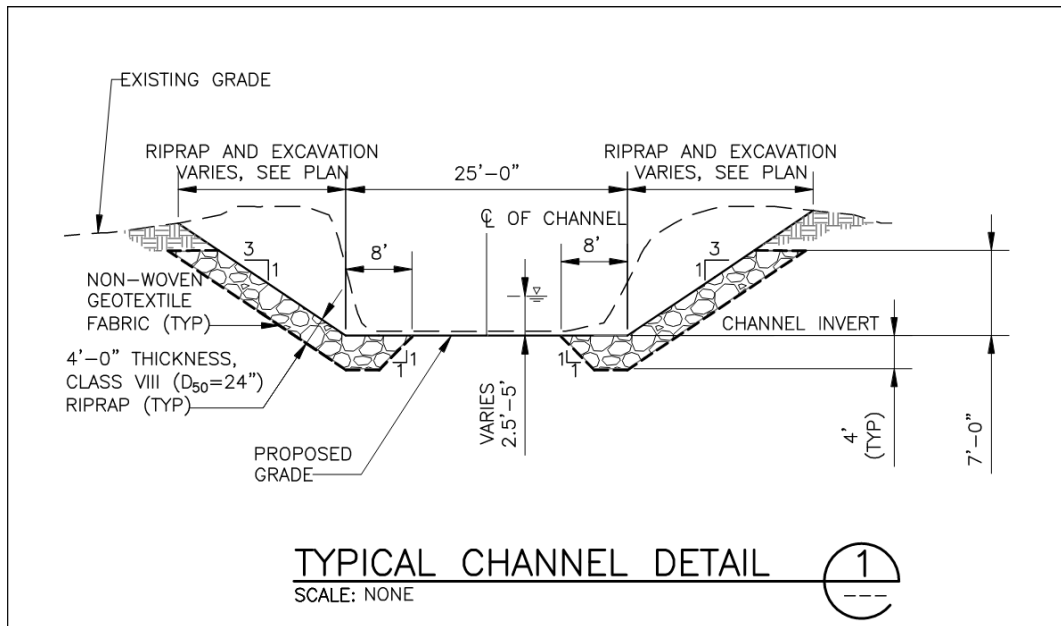


Figure 20. Typical Riprap Channel Armoring Detail

4.5.1 Estimated Construction Cost – ALTERNATIVE 4

The estimated construction cost for the potential Alternative 4 improvements is summarized in Table 13.

Table 13
Conceptual Construction Costs for Alternative 4 Improvements

Item	Quantity	Unit	Unit Cost	Cost
Mobilization/Demobilization (10%)	1	LS	\$ 348,700	\$ 348,700
Survey	1	LS	\$ 69,800	\$ 69,800
SWPPP	1	LS	\$ 40,000	\$ 40,000
Berm/Channels Excavation	22,100	CY	\$ 7	\$ 154,700
Berm/Road Construction	11,500	CY	\$ 14	\$ 161,000
Disposal of Excavated Berm Material	10,600	CY	\$ 3	\$ 31,800
Rip Rap Excavation	29,000	CY	\$ 7	\$ 203,000
Ford Excavation and Construction	1,300	CY	\$ 22	\$ 28,600
Concrete Ford	300	CY	\$ 1,100	\$ 330,000
Ford Base	200	CY	\$ 65	\$ 13,000
Ford Riprap	200	CY	\$ 80	\$ 16,000
Road Repair Fill and Construction	800	CY	\$ 30	\$ 24,000
Road Repair Base	400	CY	\$ 65	\$ 26,000
Rip Rap	29,100	CY	\$ 80	\$ 2,328,000
Rip Rap Geotextile	34,400	SY	\$ 3	\$ 103,200
Berm Natural Seeding	135,000	SF	\$ 0.2	\$ 27,000
Subtotal				\$ 3,904,800
Contingency (30%)				\$ 1,071,440
Total Project Cost (rounded to nearest \$1,000)				\$ 5,077,000

4.6 ALTERNATIVE 5 – DO NOTHING

The “Do Nothing” or “No Action” alternative consists of the Sponsor and the Skull Valley Band of Goshute Indian Tribe choosing to leave Skull Valley drainage “as-is” with no future improvements for flood control. Under this alternative there would still be the potential for significant shallow flooding in the developed areas shown in the existing conditions floodplain maps in Appendix A and described below.

The flooding from Indian Hickman and Foothills drainage areas goes in the southwest direction where it spreads out and becomes shallow sheet flow spread out over the entire reservation except where previous countermeasures were constructed to direct flow away. On the foothills drainage path there is an undersized culvert south of the pond that overtops. It eventually reaches the old irrigation pond and buildings as it continues to spread out until it reaches SR-196 where all eleven UDOT culverts are undersized and overtop. It is important to note that as this is an alluvial fan, and every flow event has the potential of creating a new drainage path.

4.7 RECOMMENDED ALTERNATIVE

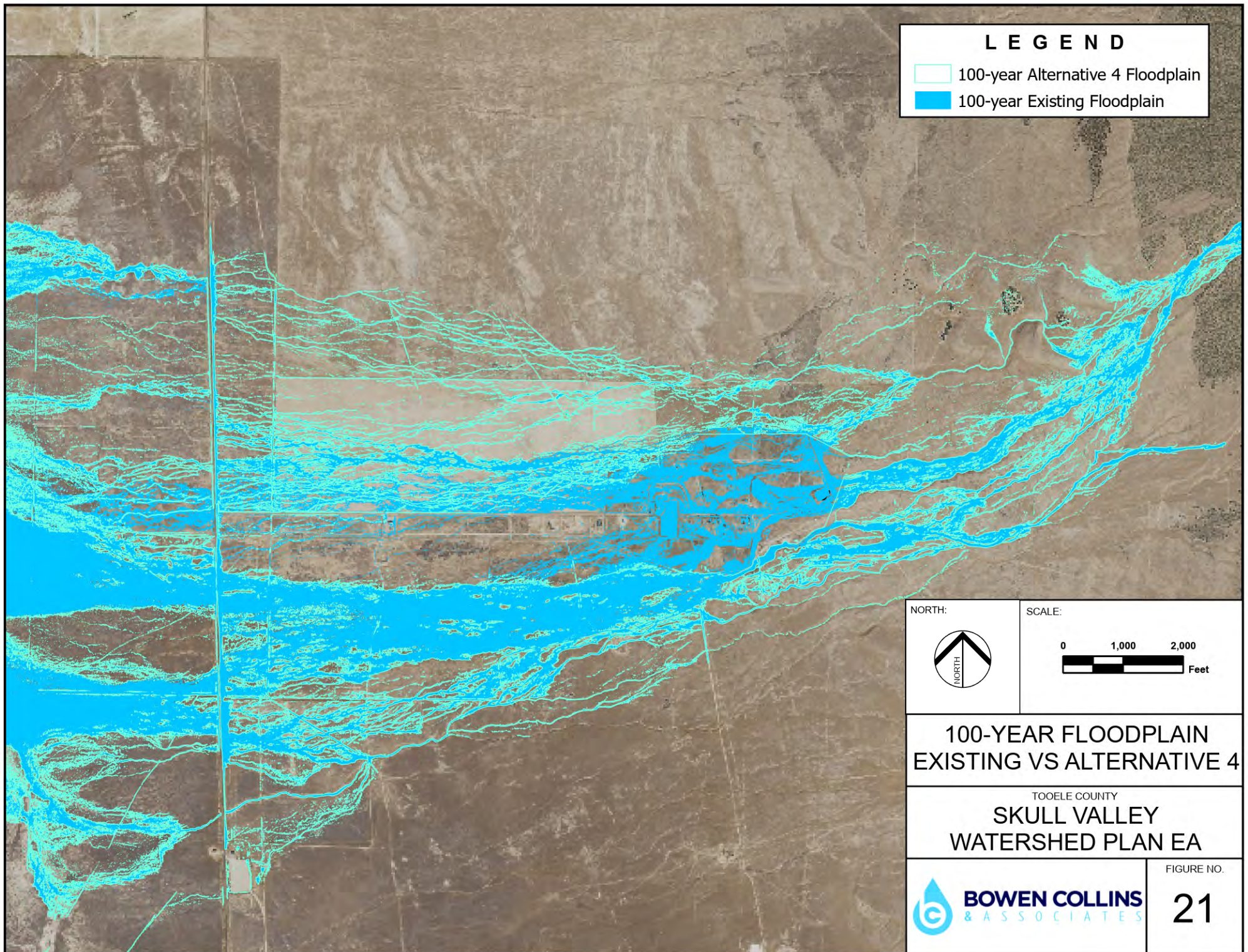
Based upon this analysis, it is recommended that Alternative 4 – Berm and Channel Improvements with riprap and concrete ford be implemented.

- Alternative 4 improvements will protect the developed areas of Reservation land from damages incurred by a 100-year design storm. Currently all storms show that flood water can reach the reservation and can thus risk damage to residents and structures.
- The proposed Alternative 4 improvements are anticipated to have minimal disruption to existing utilities.
- Alternative 4 costs the least amount compared to all other alternatives.
- Alternative 4 would have the least maintenance costs when compared to the other alternatives.
- Alternative 4 provides more safety as it reduces the amount of water that may get on Reservation dirt roads.
- Work and coordination with UDOT is required as runoff from the 100-year design flood currently overtops the highway. The recommended alternative has some potential to slightly increase flood discharges and associated flood hazards a SR-196.

4.7.1 Floodplain Mapping – Recommended Alternative

The improvements associated with Alternative 4 will mitigate potential flood hazards associated with the 100-year design storm for existing structures on the developed portion of Reservation land. Preliminary floodplain mapping for the Alternative 4 proposed condition was performed for only the 100-year event by placing tall walls in the model to simulate the berms and is shown in Appendix A and Figure 19.

Figure 21 below shows a comparison between the 100-year existing and Alternative 4 floodplains. The results show that the berm diversions and a channel would direct water away from Reservation land and protect existing structures. The results illustrated on Figure 21 also show that the exterior 100-year floodplain limits for existing and is not affected by Alternative 4 improvements and all impacts are on reservation property.



SECTION 5 - PIPELINE AND IRRIGATION POND

5.1 BACKGROUND

As discussed in Section 3, the reservation had an irrigation pond and pipeline that was used for fire suppression via an outlet and connected to three fire hydrants which was damaged after the 2013 and 2014 flood events. Figure 22 below shows the irrigation pond in 2014 after the outlet works were damaged and before it was drained due to concerns of flooding nearby homes. During the 2014 event, the concrete inlet structure and road to the pipeline near the mouth of the Indian Hickman watershed was destroyed. Figure 23 and Figure 24 shows damaged pipeline and an old manhole found in the field in 2019.

In 2015, the NRCS installed 5,750 ft of waterline along the south of the tribal community that connected an existing well to refurbished water tank. The refurbished water tank was designed to replace the old irrigation pond and supply water storage for fire suppression and waste management. Since 2015, no analysis or work has been done on restoring the irrigation pond or pipeline.

5.2 PIPELINE AND IRRIGATION POND DESIGN

In recent discussions with NRCS personnel, the concept of replacing the pipeline and restoring the irrigation pond was discussed. It was decided to make these elements potential improvements as part of this study. As BC&A began the process of looking into this concept, no existing data could be located to accurately define the location of the pipeline between the canyon mouth and the pond, how water was released from the pond, engineering plans for the pond and pipeline, and how the pond water was used. A review of historic aerial photographs of the area indicated that the pond was constructed between 1980 and 1986.



Figure 22. Irrigation Pond after Pond Outlet was Plugged by Flood Runoff in 2014



Figure 23. Destroyed Pipeline Example 1



Figure 24. Destroyed Pipeline and Manhole Example 2

Several assumptions were made with regard to developing a concept design for improvements to replace the damaged irrigation pipeline and to repair the irrigation pond due to the lack of data and information on the existing facilities. Figure 25 below shows the approximate locations and improvements for the irrigation pond and pipeline.

Replacement Pipeline

The basis for the replacement pipeline design was to approximately follow the alignment of the new road and to begin and end at the same locations. Based on field reconnaissance, the damaged pipeline extended about 13,800 ft upstream of the irrigation pond to the mouth of the Indian Hickman Canyon. The pipe appeared to be 8-inch diameter PVC and it had at least two manholes cleanout structures and one air vent. NRCS personnel estimated that the spring that fed the inlet structure produced approximately 100 gpm (0.25 cfs) and the 8-inch pipe had more than enough capacity. The 13,800 ft pipeline was designed with a minimum slope to allow for a capacity of 100 gpm shown in Table 14. It was assumed that the new pipe would be installed to maintain a minimum cover of 5 feet, maintain a slope in the downward direction, and have air vent manholes every half mile to prevent the pipe from experiencing pressurized conditions.

Table 14
Summary of Recommended Pipeline Hydraulic Design Criteria

Reach	Length (ft)	Flow Rate (cfs)	Manning's "n" Roughness Value	Pipe Diameter (ft)	Estimated Flood Depth (ft)	Min Pipe Slope (%)	Max Flow Capacity (cfs)	Average Velocity (fps)
1	13,800	0.25	0.015	0.67	0.14	.40	.70	7.0

Irrigation Pond Restoration

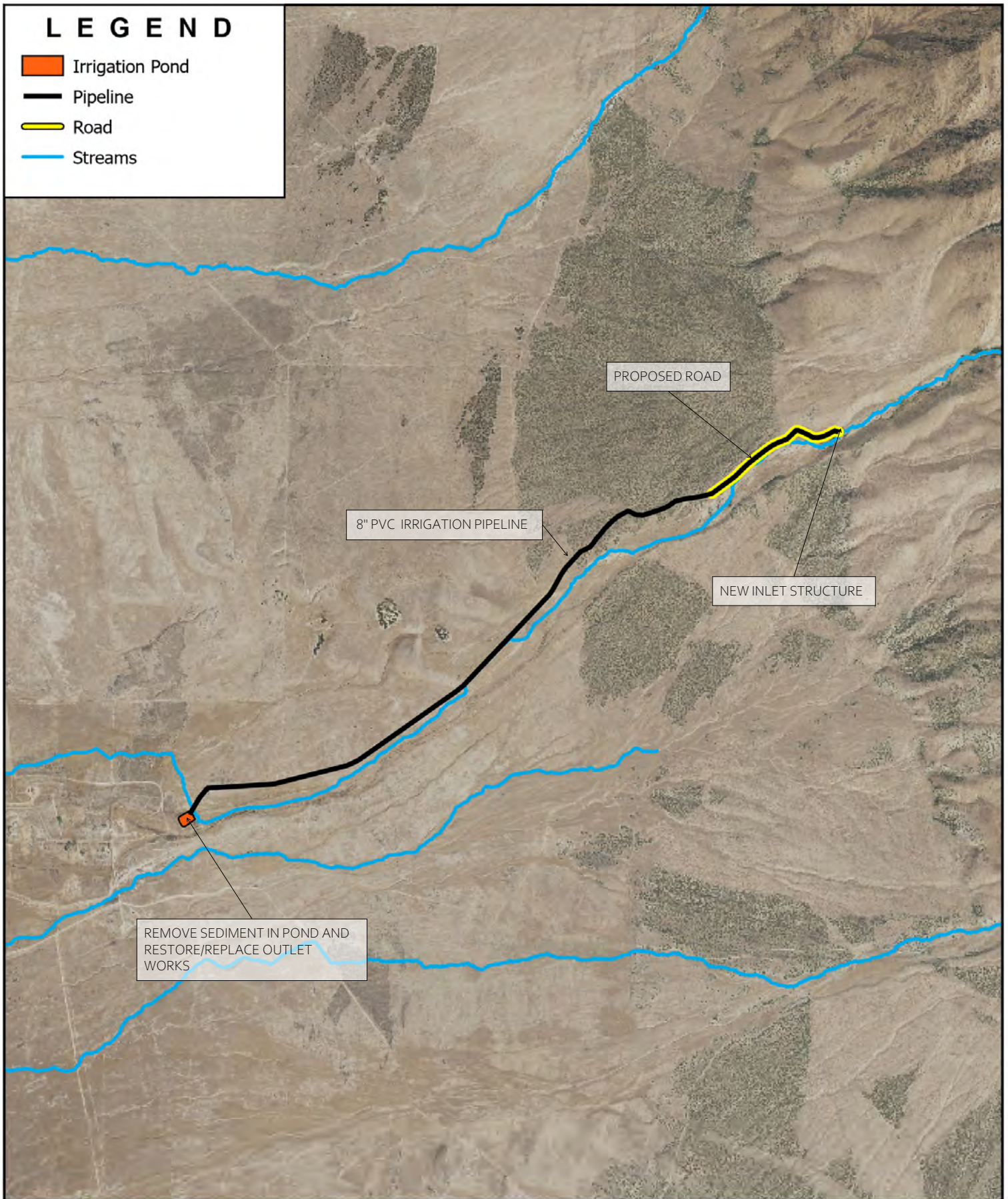
There was no information made available regarding the design of the existing irrigation pond and its associated inlet and outlet works. Assuming that leaders of the Skull Valley Band of Goshute Indian Tribe want the pond and pipeline returned to service, it was assumed that work at the pond would include removing sediment, repairing or replacing the outlet works, and repairing and replacing the inlet works. If these improvements are not needed or desired by the local Band leaders, it is requested that those leaders provide this information. The assumptions for the design of the irrigation pond are shown in Table 15.

Table 15
Summary of Recommended Irrigation Pond Sizing

Downstream Height (ft)	Depth (ft)	Side Slope	Top Surface Area (ac)	Bottom Surface Area (ac)	Size (ac-ft)
12	8	5:1	1	0.37	5.5

LEGEND

-  Irrigation Pond
-  Pipeline
-  Road
-  Streams



BOWEN COLLINS
& ASSOCIATES

IRRIGATION POND AND PIPELINE POTENTIAL IMPROVEMENTS

TOOELE COUNTY
SKULL VALLEY WATERSHED PLAN EA

NORTH:



SCALE:



FIGURE NO.

25

Access Road Restoration

Approximately 2,000 ft of the existing access road just downstream of the inlet structure was washed out during the recent flood events. This access road will need to be reconstructed to access the new inlet near the same location as the destroyed one. The pipeline will be in the road. It was assumed that existing material near the apex of the alluvial fan can be used to reconstruct the 15 ft wide road and provide protection along the road embankment.

5.3 ESTIMATED CONSTRUCTION COST – IRRIGATION POND AND PIPELINE

The estimated construction cost for potential irrigation pond and pipeline improvements to restore the pond to service are shown in Table 16

Table 16
Conceptual Construction Costs for Irrigation Pond and Pipeline Improvements

Item	Quantity	Unit	Unit Cost	Cost
Mobilization/Demobilization (10%)	1	LS	\$ 197,300	\$ 197,300
Survey	1	LS	\$ 39,500	\$ 39,500
Pipeline Road Excavation	4,300	CY	\$ 7	\$ 30,100
Pipeline Road Fill	3,400	CY	\$ 14	\$ 47,600
Disposal of Excavated Pipeline Material	900	CY	\$ 3	\$ 2,700
Inlet Rip Rap Excavation	1,400	CY	\$ 7	\$ 9,800
Irrigation Pond Excavation	9,000	CY	\$ 15	\$ 135,000
Irrigation Pond Berm Fill and Construction	5,000	CY	\$ 22	\$ 110,000
Irrigation Outlet Repair	1	LS	\$ 20,000	\$ 20,000
8" Untreated Base Course	3,600	CY	\$ 65	\$ 234,000
Rip Rap (Inlet Structure)	1,400	CY	\$ 80	\$ 112,000
Rip Rap Geotextile (Inlet Structure)	1,100	SY	\$ 3	\$ 3,300
8" PVC Irrigation Line	13,800	LF	\$ 85	\$ 1,173,000
Air Vent Manholes	5	EA	\$ 5,000	\$ 25,000
Inlet Structure Concrete	1	LS	\$ 60,800	\$ 60,800
Meter Manhole	1	LS	\$ 9,000	\$ 9,000
Subtotal				\$ 2,209,100
Contingency (30%)				\$ 662,730
Total Project Cost (rounded to nearest \$1,000)				\$ 2,872,000

SECTION 6 - SUMMARY OF RECOMMENDATIONS

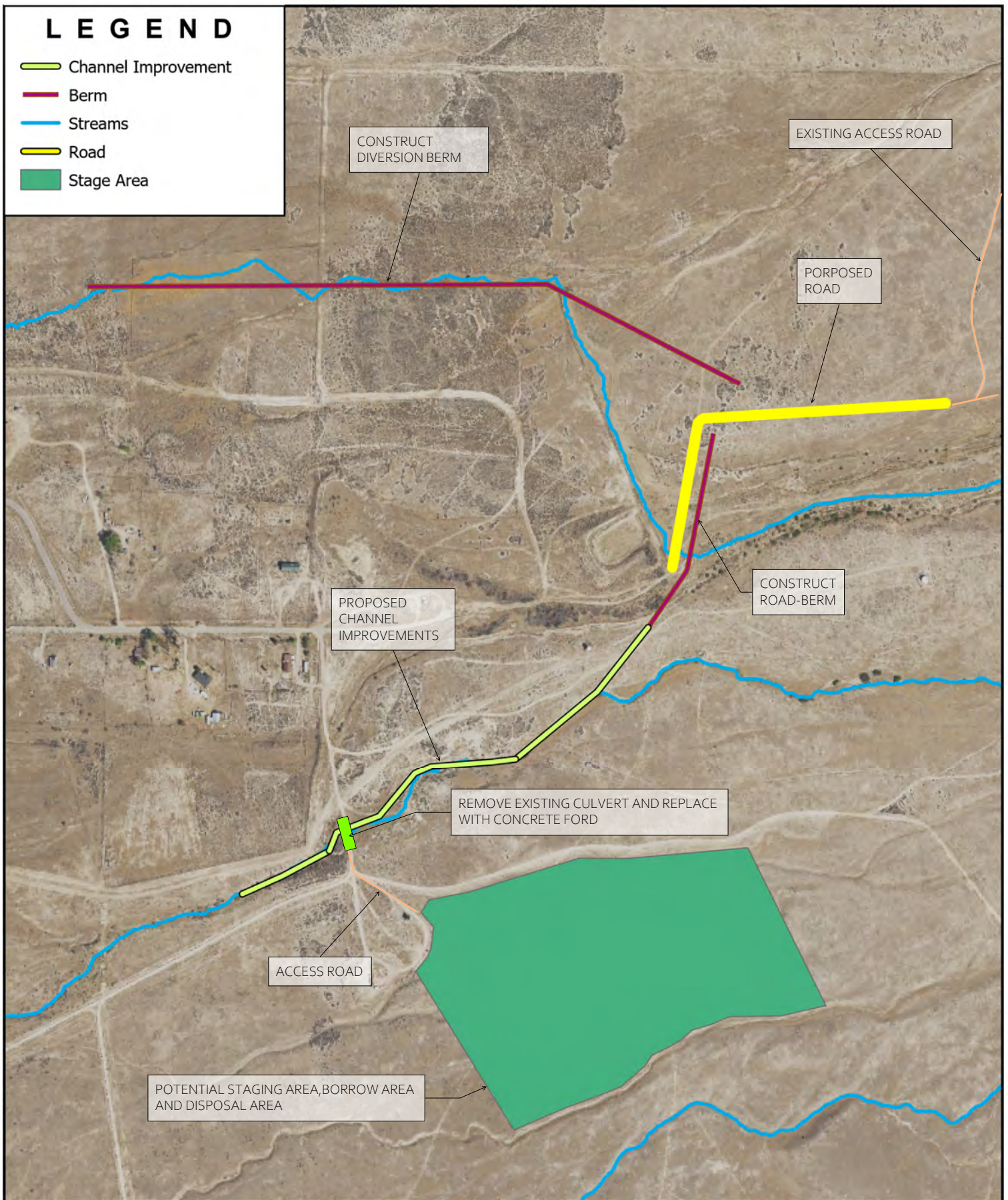
Along with the flood mitigation recommendation discussed in the previous sections, a number of other repairs and improvements were initially recommended within the Indian Creek Watershed as discussed in Section 5 (pipeline and irrigation pond). After multiple discussions with personnel from the NRCS, Tooele County, representatives from the Skull Valley Band of Goshute Indian Tribe, field reconnaissance and the engineering evaluation discussed above, it was determined that the pipeline and irrigation improvements discussed in Section 5 would not be included as a recommendation. A summary of the final recommendations is provided in Table 17 and shown in Figure 26. 30% design drawings for the alternatives are shown in Appendix C. See previous sections for more detailed information for each alternative.

Table 17
Summary of Recommendations

Project Element	Recommendations
Alternative 4	Construct berms, channel, and concrete ford to redirect flooding around reservation
Construction Staging Area	For planning purposes, identify approximately a 6-acre parcel near the project improvements that can be used by a construction contractor for staging. This will allow the needed environmental clearances to be performed.
Potential Borrow Area	It may be possible to utilize fill from an onsite borrow area to construct needed earthen embankments. For planning purposes, include about a 10-acre parcel for borrow purposes. This will allow the needed environmental clearances to be performed.
Potential Disposal Area	During construction it is likely that there will be some items like excess fill or organic material from clearing and grubbing that may need to be disposed somewhere. For planning purposes, include about a 6-acre parcel that can be used to disposal of excess soil and plant materials from construction activities. This will allow the needed environmental clearances to be performed.

LEGEND

-  Channel Improvement
-  Berm
-  Streams
-  Road
-  Stage Area



BOWEN COLLINS
& ASSOCIATES

RECOMMENDED IMPROVEMENTS

TOOELE COUNTY
SKULL VALLEY WATERSHED PLAN EA

NORTH:



SCALE:



FIGURE NO.

26

SECTION 7 - PROPERTY RIGHTS AND ACQUISITION

All of the proposed work associated with improvements identified in this report are located on Skull Valley Band of Goshute Indian Tribe land. Other than obtaining plan approval, there should be no need to purchase any right-of-way or easements for improvements. If easements or maintenance access agreements are needed to enable the Sponsor to access the improvements for inspection or repair, it was assumed that the Skull Valley Band of Goshute Indian Tribe will grant such permissions at no cost to the Sponsor or the Project.

SECTION 8 - PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COSTS

A summary of the conceptual level construction costs for the recommended improvements is summarized in Table 18 for a total of \$5,077,000. This conceptual opinion of probable construction costs is based on the design concepts identified in this report, information from recent bids on similar projects, information obtained from suppliers, and estimating guidelines. Note that the cost estimates include a 30-percent contingency for budgeting to account for unknown factors that may be present at the time of bid including variability in material pricing and bidding climate.

Table 18
Preliminary Conceptual Cost Estimate

Preliminary Opinion of Probable Construction Cost				 BOWEN COLLINS & ASSOCIATES	
<i>Project:</i> Skull Valley Watershed				<i>Date:</i>	6/1/2022
<i>Desc.:</i> Berm and Channel				<i>Prepared by:</i>	CJ/CN
No.	Item	Quantity	Units	Unit Cost	Cost
1	Mobilization/Demobilization (10%)	1	LS	\$ 348,700	\$ 348,700
2	Survey	1	LS	\$ 69,800	\$ 69,800
3	SWPPP	1	LS	\$ 40,000	\$ 40,000
4	Berm/Channel Excavation	22,100	CY	\$ 7	\$ 154,700
5	Berm/Road/Diversion Fill/Construction	11,500	CY	\$ 14	\$ 161,000
6	Disposal of Excavated Berm Material	10,600	CY	\$ 3	\$ 31,800
7	Berm/Channel Rip Rap Excavation	29,000	CY	\$ 7	\$ 203,000
8	Berm/Channel Rip Rap	29,100	CY	\$ 80	\$ 2,328,000
9	Berm/Channel Geotextil	34,400	SY	\$ 3	\$ 103,200
10	Berm Natural Seeding	135,000	SF	\$ 0.20	\$ 27,000
11	Ford Excavation and Construction	1,300	CY	\$ 22	\$ 28,600
12	Concrete Ford	300	CY	\$ 1,100	\$ 330,000
13	Ford Base	200	CY	\$ 65	\$ 13,000
14	Ford Riprap	200	CY	\$ 80	\$ 16,000
15	Road Repair Fill and Construction	800	CY	\$ 30	\$ 24,000
16	Road Repair Base	400	CY	\$ 65	\$ 26,000
Subtotal					\$3,904,800
Contingency				30%	\$1,171,440
Total Project Cost (rounded to nearest \$1,000)					\$5,077,000
This opinion of probable construction is based on experience with past projects of similar construction. It is understood that Bowen Collins & Associates has no control over economical factors or unknown conditions that may have a significant impact on actual project costs. Bowen Collins & Associates does not guarantee its cost estimates and accepts no liability for problems created by the difference in actual costs and this opinion of probable construction cost.					

SECTION 9 - STATEMENT OF LIMITATIONS

This document represents Bowen Collins & Associates' professional judgement based on the information available at the time of its completion, and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the engineering profession currently practicing under similar conditions. No warranty, express or implied, is made.

SECTION 10 - REFERENCES

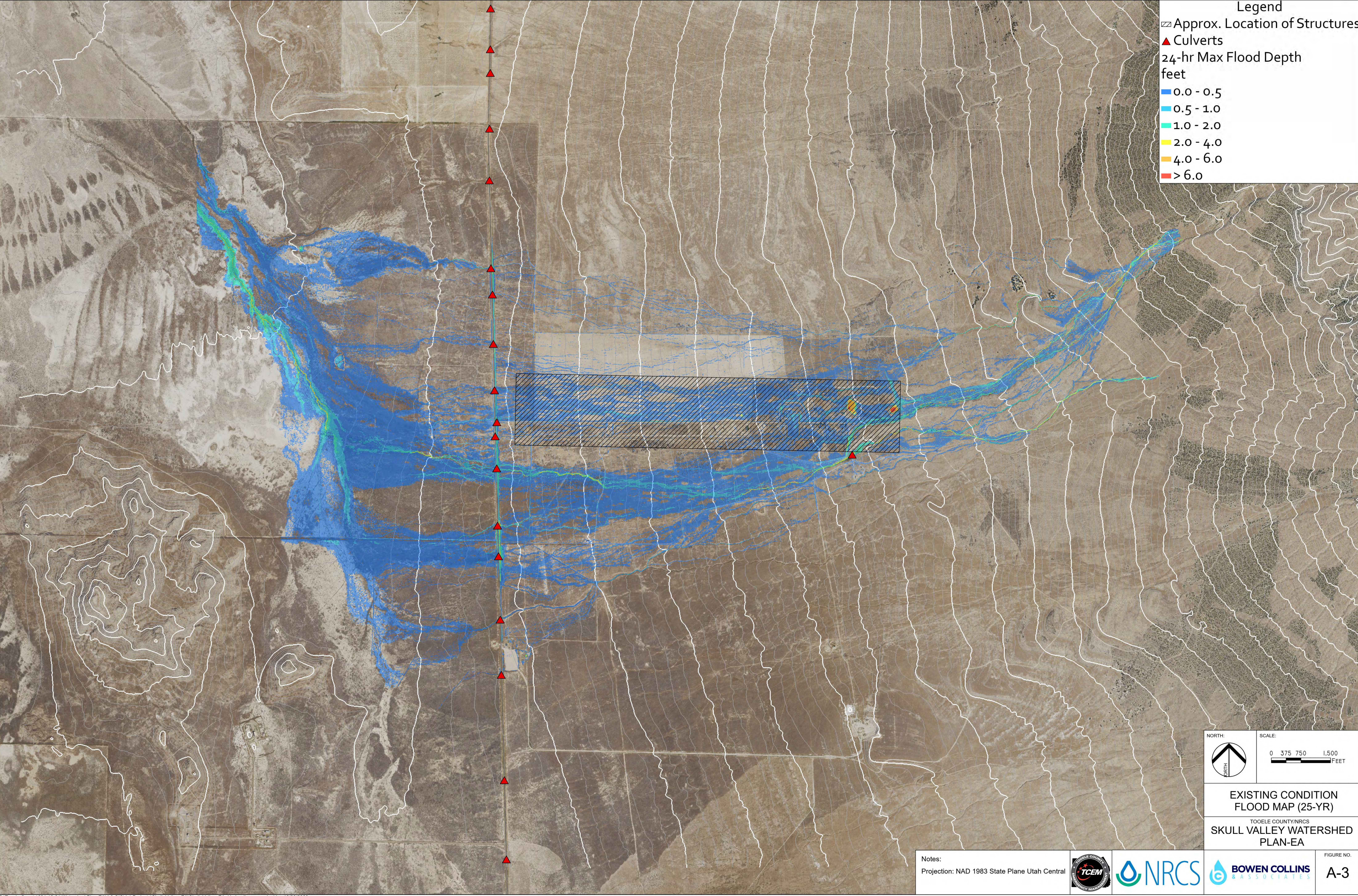
- Bowen Collins and Associates, August 2020, Skull Valley Watershed Plan-EA Hydrology Technical Memorandum.
- Natural Resources Conservation Service, May 2010, National Engineering Handbook, Part 630, Hydrology.
- Natural Resources Conservation Service, Pre/Post Fire Hydrology – Patch Springs, September 23, 2013.
- US Army Corps of Engineers, Skull Valley Band of Goshute Floodplain Management Plan, March 2018.
- US Army Corps of Engineers, Hydrology Study, Skull Valley Hydrologic Model, 2019, Unpublished.
- US Army Corps of Engineers, Hydraulic Study, Skull Valley Hydraulic Model, November 2019, Unpublished.
- VanDine, D. F. 1996. Debris Flow Control Structures for Forest Engineering. Res. R., B.C. Min. For., Victoria, B.C., Work. Pap. 09/1996

APPENDIX A

FLOODPLAIN MAPPING







Legend

Approx. Location of Structures

Culverts

24-hr Max Flood Depth
feet

0.0 - 0.5

0.5 - 1.0

1.0 - 2.0

2.0 - 4.0

4.0 - 6.0

> 6.0

NORTH:

SCALE:
0 375 750 1,500
FEET

EXISTING CONDITION
FLOOD MAP (25-YR)

TOOELE COUNTY/NRCS
SKULL VALLEY WATERSHED
PLAN-EA

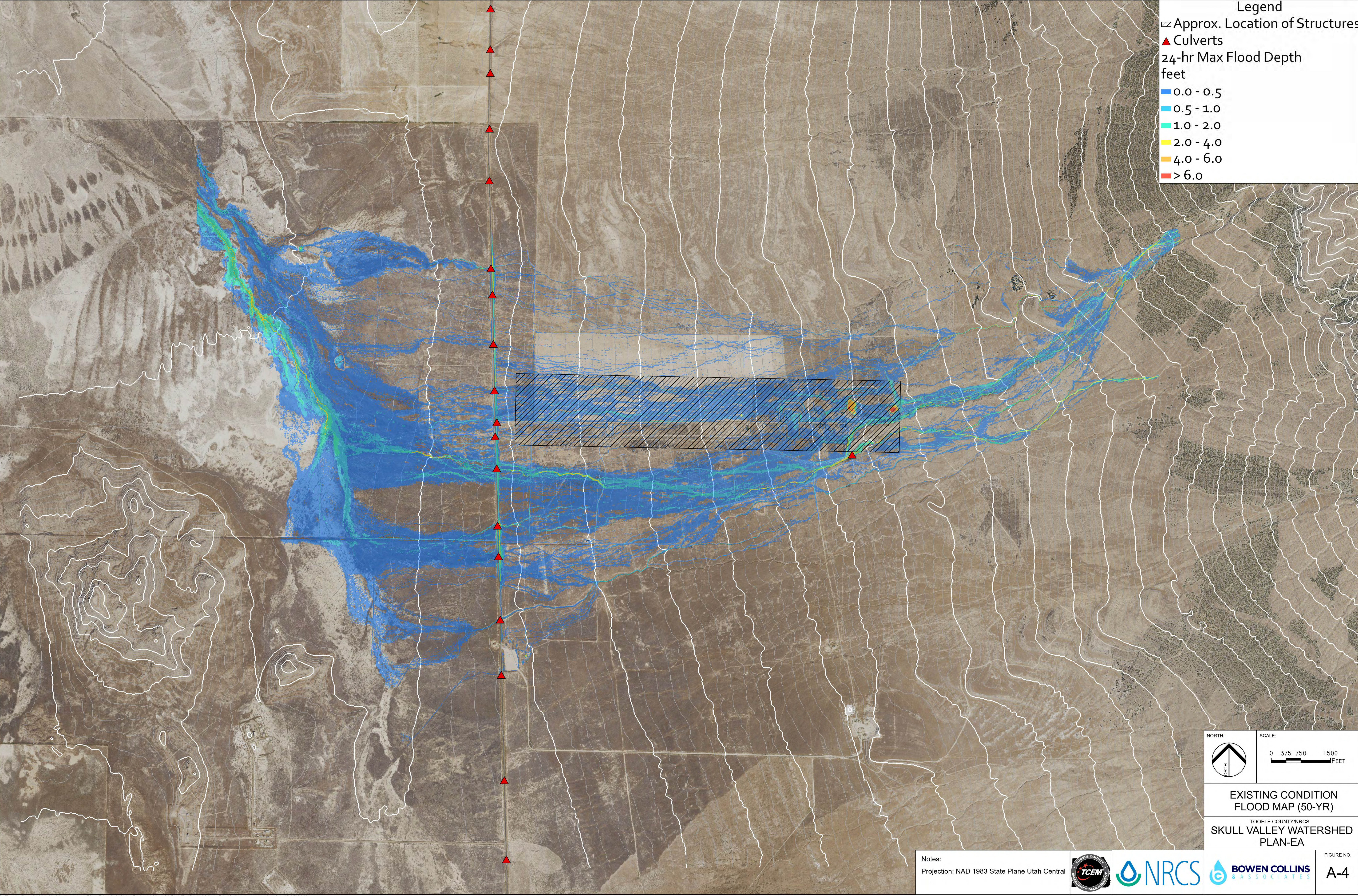
Notes:

Projection: NAD 1983 State Plane Utah Central



FIGURE NO.

A-3



Legend

Approx. Location of Structures

Culverts

24-hr Max Flood Depth
feet

0.0 - 0.5

0.5 - 1.0

1.0 - 2.0

2.0 - 4.0

4.0 - 6.0

> 6.0

NORTH:

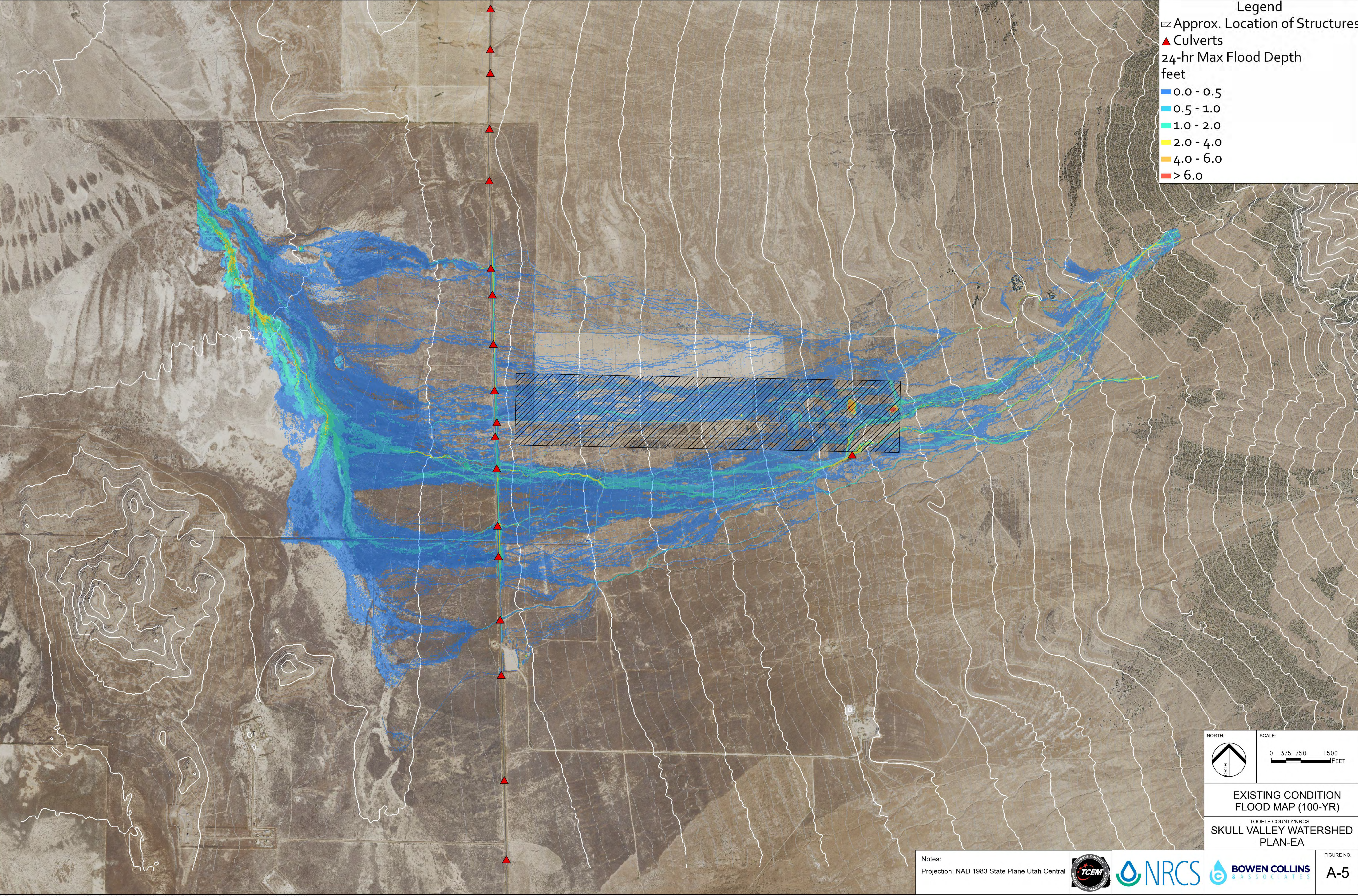
SCALE:
0 375 750 1,500
FEET

EXISTING CONDITION
FLOOD MAP (50-YR)

TOOELE COUNTY/NRCS
SKULL VALLEY WATERSHED
PLAN-EA

Notes:
Projection: NAD 1983 State Plane Utah Central

FIGURE NO.
A-4



Legend

- ▨ Approx. Location of Structures
- ▲ Culverts
- 24-hr Max Flood Depth
feet
- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- > 6.0

NORTH:

SCALE:

0 375 750 1,500
FEET

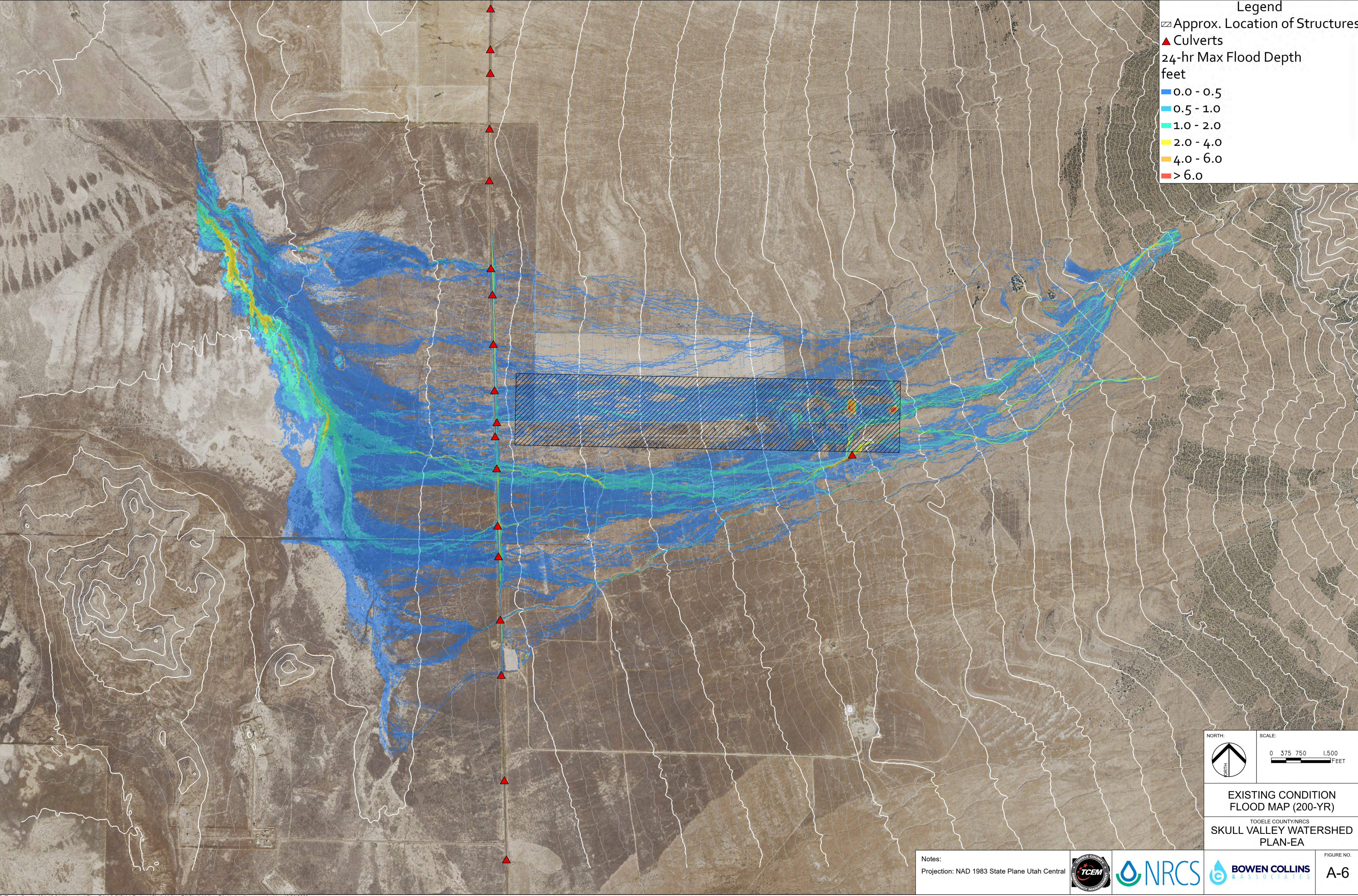
EXISTING CONDITION
FLOOD MAP (100-YR)

TOOELE COUNTY/NRCS
SKULL VALLEY WATERSHED
PLAN-EA

Notes:
Projection: NAD 1983 State Plane Utah Central



FIGURE NO.
A-5



Legend

▨ Approx. Location of Structures

▲ Culverts

24-hr Max Flood Depth
feet

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- > 6.0

NORTH:

SCALE:

0 375 750 1,500
FEET

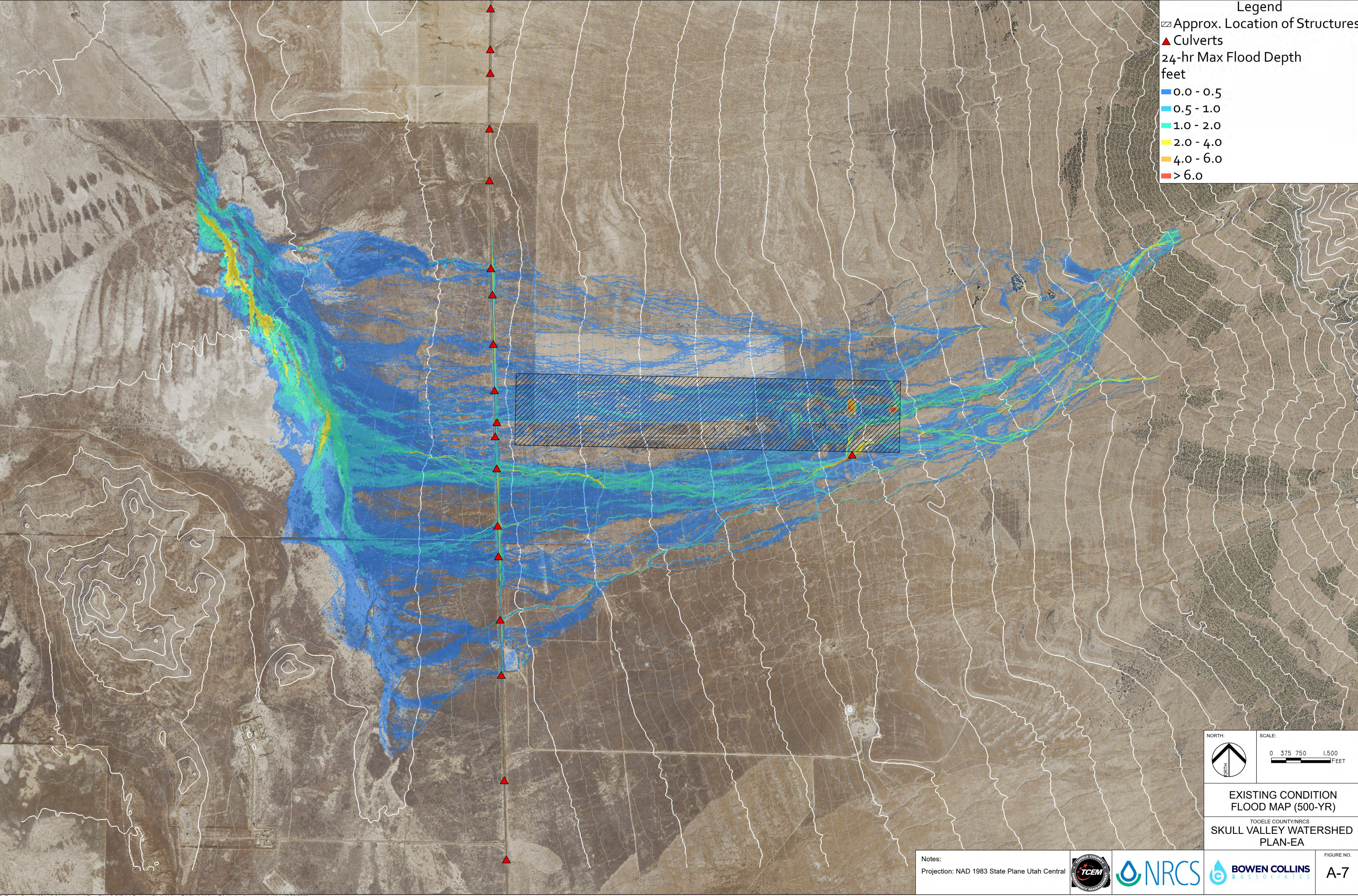
EXISTING CONDITION
FLOOD MAP (200-YR)

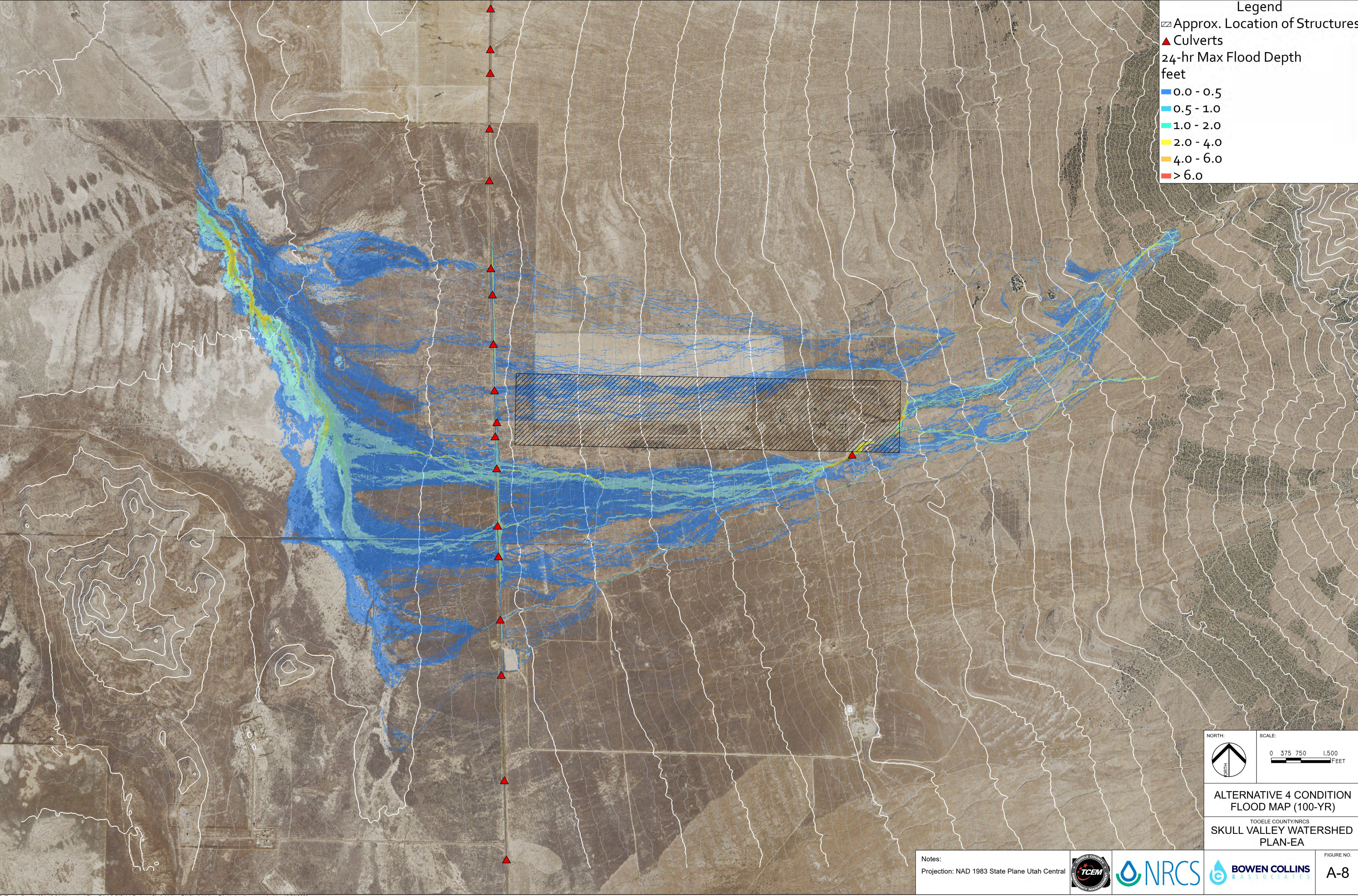
TOOELE COUNTY/NRCS
SKULL VALLEY WATERSHED
PLAN-EA

Notes:
Projection: NAD 1983 State Plane Utah Central



FIGURE NO.
A-6





Legend

▨ Approx. Location of Structures

▲ Culverts

24-hr Max Flood Depth
feet

- 0.0 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- > 6.0

NORTH:

SCALE:

0 375 750 1,500
FEET

ALTERNATIVE 4 CONDITION
FLOOD MAP (100-YR)

TOOELE COUNTY/NRCS
SKULL VALLEY WATERSHED
PLAN-EA

Notes:
Projection: NAD 1983 State Plane Utah Central



FIGURE NO.
A-8

APPENDIX B CALCULATIONS

A copy of Appendix B can be requested from the Project contacts listed on the fly sheet of the Plan-EA

APPENDIX C
30% DESIGN DRAWINGS

The concept design was updated after completion of this Memorandum and is not included here.

**Skull Valley Watershed EA
Project Loss of Life Analysis**

TECHNICAL MEMORANDUM

TO: NRCS

COPIES: Norm Evenstad – NRCS
Derek Hamilton - NRCS
Aimee Rohner – NRCS
Bucky Whitehouse - TCEM

FROM: Cameron Jenkins, PE CFM
Bowen, Collins & Associates
154 East 14075 South
Draper, Utah 84020

DATE: November 11, 2022

SUBJECT: Skull Valley Watershed EA Project Loss of Life Analysis

JOB NO.: 631-19-01

INTRODUCTION

Bowen Collins & Associates was asked by the NRCS to provide additional data and analysis for the 50-year and 100-year flood events as part of the Skull Valley Watershed EA project. During large rain events, the Indian Hickman and Foothill watersheds causes flooding in the Indian Reservation and overtopping along SR-196 due to insufficient culvert capacity along SR-196. As part of the Skull Valley Watershed EA project, multiple alternatives were analyzed and Alternative 4 was selected to help redirect flooding away from the structures on the Indian reservation. The selected alternative design and costs were based on the 100-year flood event; however, the NRCS may be able to save on costs and only design for the 50-year flood event if there is no loss of life for the 100-year event. This memo discusses the loss of life criteria, potential for loss of life during the 100-year flood event, and the 50-year flood event compared to the 100-year flood event with Alternative 4 as requested by the NRCS. Figures showing the 100-year depth x velocity and the 100-year vs 50-year depth Alternative 4 comparison and are provided as attachments to this memo.

LOSS OF LIFE CRITERIA

During a flood event, the main concerns are the damage and hazards it creates to buildings, pedestrians, and vehicles. In discussions with the NRCS on what should be used for the Loss of Life criteria, the NRCS said they did not have any specific guidance but provided the recommendation to use other public agencies guidance such as USBR or FEMA.

In 1988 the USBR and more recently in 2010/2011 Engineers Australia, developed hazard mapping guidelines for vehicle and pedestrian stability limits during a flood event based on depth x velocity. Figures 1 through 3 show example graphs from the USBR study and Figures 3 and 4 show graphs from the Engineers Australia study which also shows the experimental data used to help develop the graphs and final recommendations. The final recommendation from Engineers Australia for hazard mapping and used for our analysis is presented in Table 4 and Table 5 below. The tables were converted from SI to English units as our study was done in English units. The USBR and Engineers Australia documents are provided as attachments to this memo.

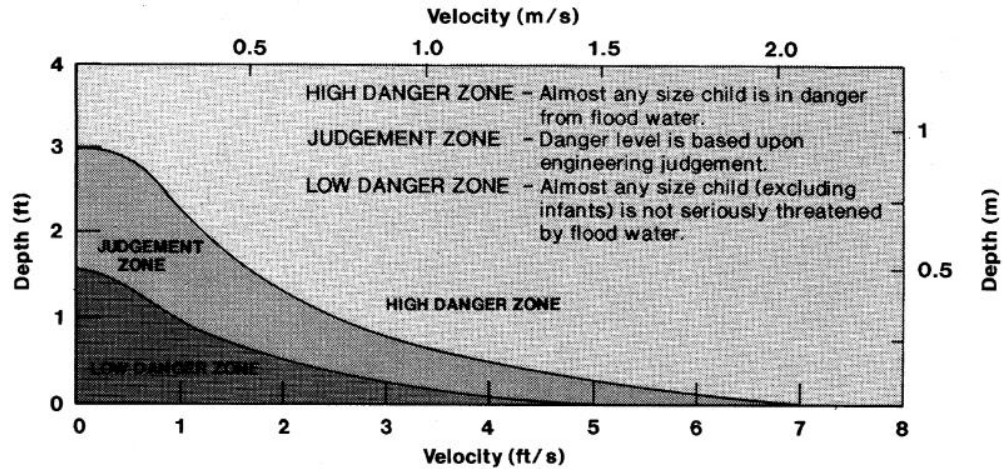


Figure 1 USBR 1988 Hazard Danger for Children

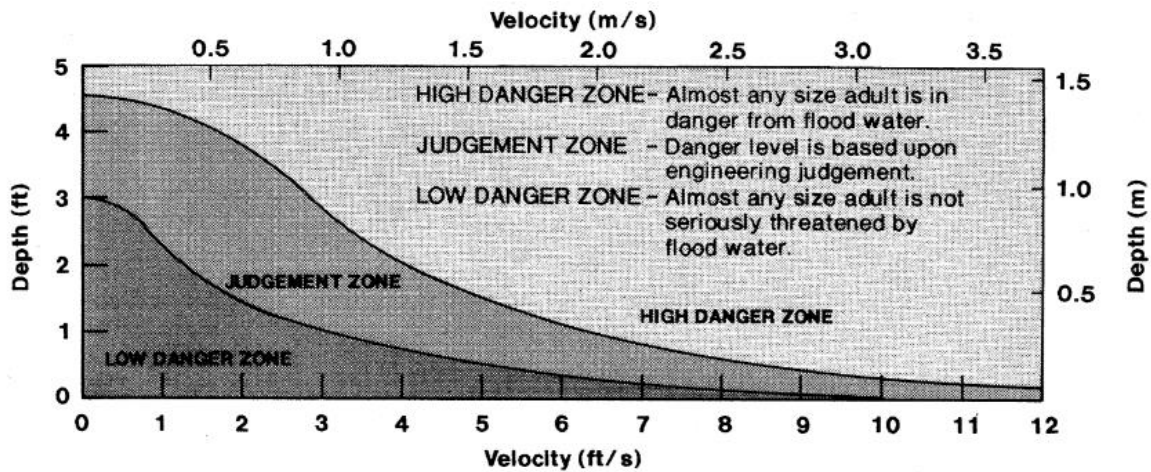


Figure 2 USBR 1988 Hazard Danger for Adults

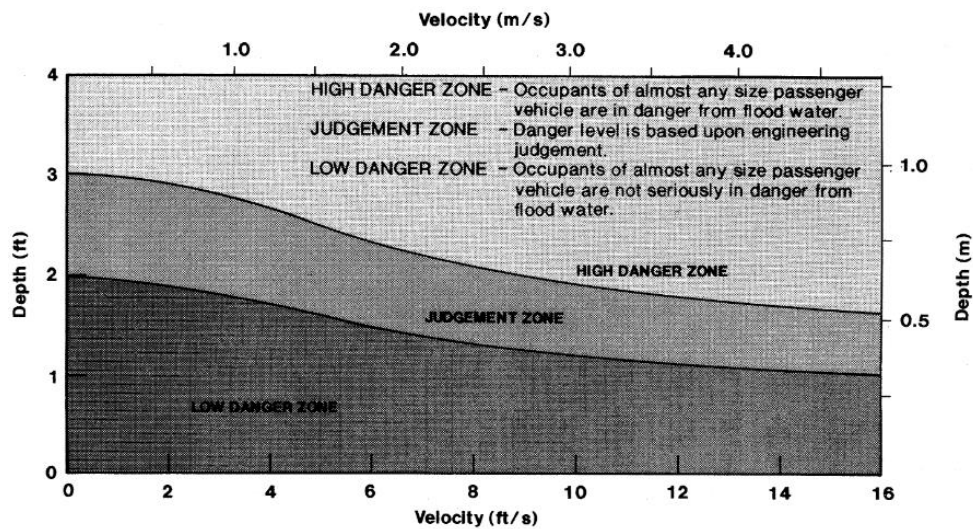


Figure 3 USBR 1988 Hazard Danger for Cars

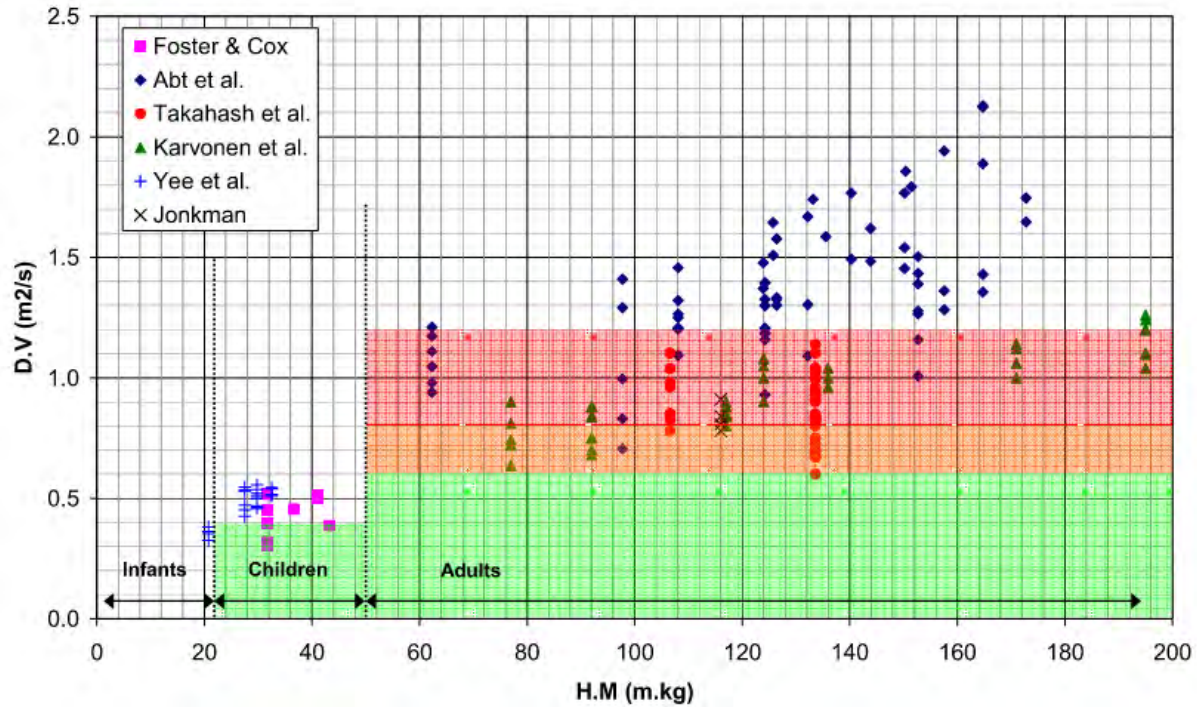


Figure 4 Engineers Australia 2010 Hazard Danger Zones based on Height and Mass Compared to Available Experimental Data

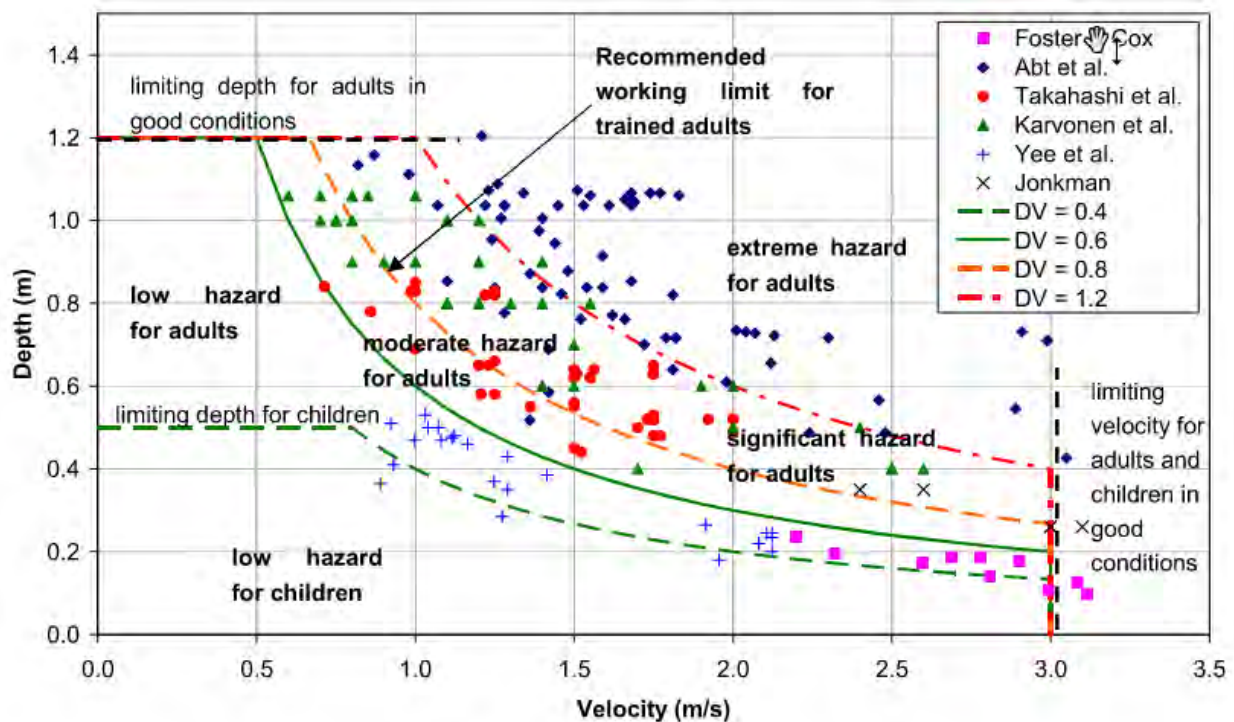


Figure 5 Engineers Australia 2010 Hazard Danger Zones for People Compared to Available Experimental Data

Table 4
Criteria for Station Vehicle Stability (Adapted from Engineers Australia 2011)

Class of Vehicle	Length (ft)	Curb Weight (lbs)	Ground Clearance (ft)	Limiting Still Water Depth (ft) ¹	Limiting High Velocity Depth (ft) ²	Limiting Velocity (ft/s) ³	Hazard (ft ² /s)
Small passenger	< 14.1	< 2750	< 0.4	1.0	0.3	9.8	0 - 3.2
Large passenger	> 14.1	> 2750	> 0.4	1.3	0.5	9.8	3.2 - 4.8
Large 4WD	> 14.8	> 4400	> 0.7	1.6	0.7	9.8	4.8 - 6.5

1) At velocity = 0ft/s; 2) at velocity 9.8; 3) at low depth

Table 5
Flow Hazard Regimes for People (Adapted from Engineers Australia 2010)

Hazard (ft ² /s)	Infants, small children (HM1 ≤ 180) and frail/older persons	Children (HM = 180 to 360)	Adults (HM > 360)
0	Safe	Safe	Safe
0 - 4.3	Extreme Hazard; Dangerous to all	Low Hazard	Low Hazard
4.3 - 6.5		Significant Hazard; Dangerous to most	
6.5 - 8.6		Extreme Hazard; Dangerous to all	Moderate Hazard; Dangerous to some
8.6 - 12.9			Significant Hazard; Dangerous to most
> 12.9			Extreme Hazard; Dangerous to all

1) HM = Height (ft)*weight (lbs.)

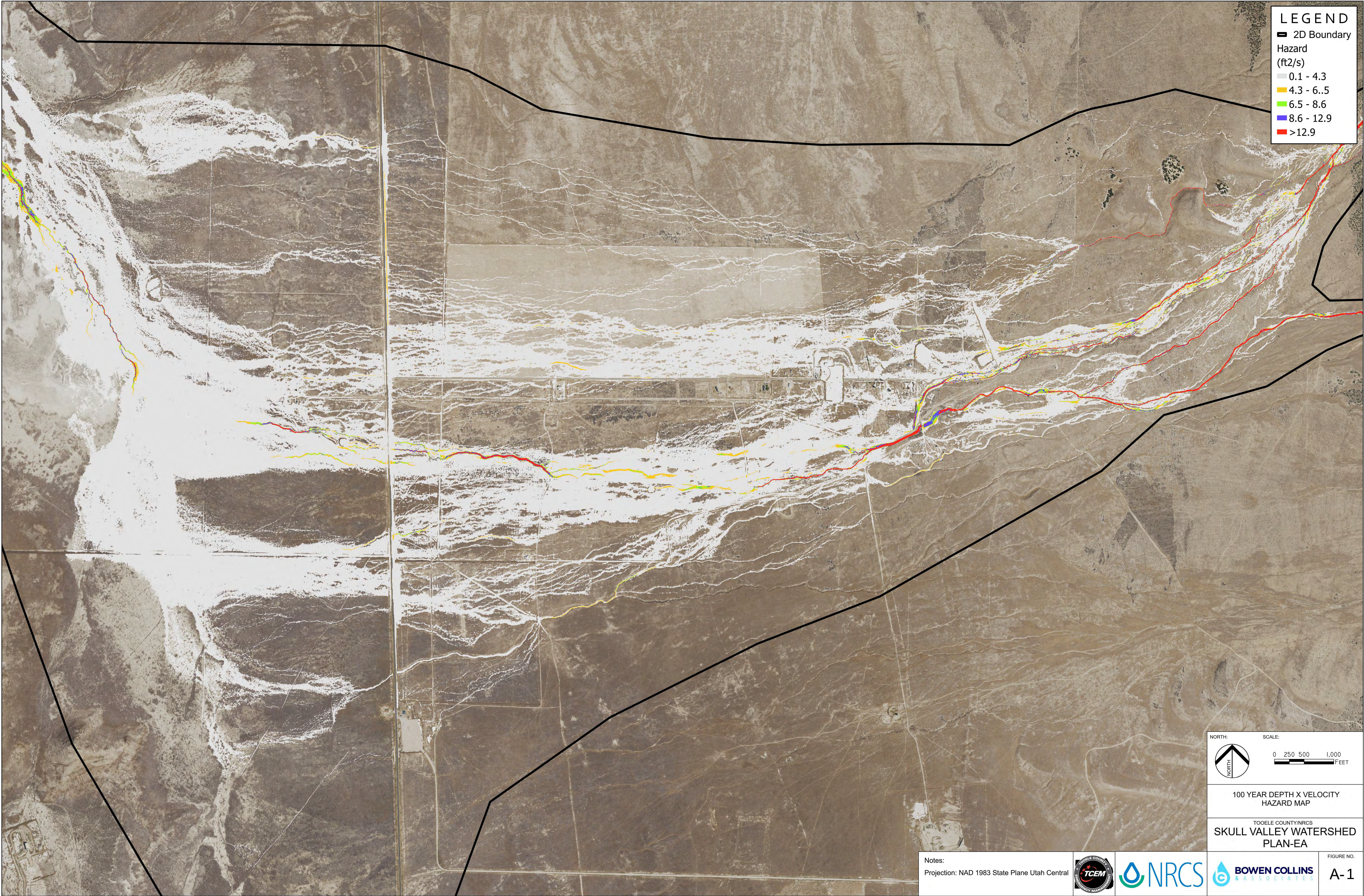
100-YEAR FLOOD EVENT HAZARD ASSESSMENT

The Hazard for the 100-year flood event is provided in Figure A-1. Based on the hazard results and information in Table 4 and 5, the depth x velocity results indicates that it would be extremely hazardous for only small passenger cars and small children in most locations, but there are a few dirt roads through the project site that would also be extremely hazardous to all people. Based on this information, it appears that there is a possibility of loss of life for the 100-year event and the NRCS will have to design for the 100-year event.

50-YEAR FLOOD EVENT ALTERNATIVE 4 COMPARISON

Although not required since there is a chance for loss of life for the 100-year flood event, the 50-year flood event was also looked at to see how the design might change for the smaller event. The model results for the 50-year scenario including the floodplain, depth of flooding, and velocity for both existing conditions and the proposed alternative 4, are very similar to the 100-year. The existing conditions model results identify shallow flooding over the entire project area over the multiple braided systems which flow to the west and overtop SR-196 at five different locations.

The Alternative 4 analysis shows similar model results, but with water being directed by the proposed berms and channels around the buildings to keep them safe from flooding. Figure A2 shows a depth difference (100-year minus 50-year) for the Alternative 4 scenario. This figure shows that in most areas there is less than a 0.25 ft depth difference between the 50-year and 100-year floodplain. There are a handful of areas where the flood depth is between 0.25 feet and 1 foot, but these areas are relatively small. Based on these results, the design and cost changes for Alternative 4 if designed for the 50-year event would be minimal.



LEGEND

2D Boundary

Hazard
(ft2/s)

- 0.1 - 4.3
- 4.3 - 6.5
- 6.5 - 8.6
- 8.6 - 12.9
- >12.9

NORTH: 

SCALE: 0 250 500 1,000 FEET

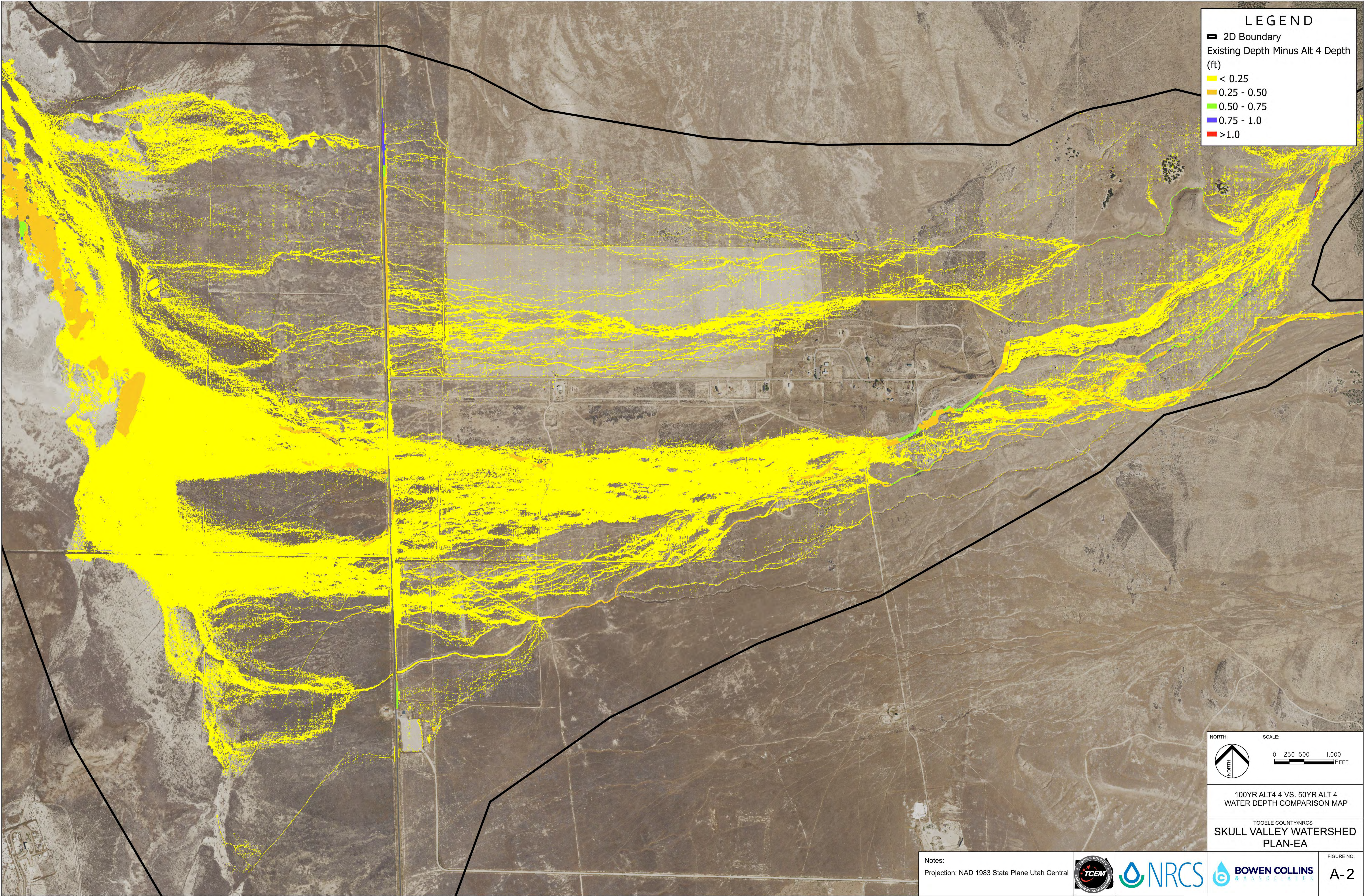
100 YEAR DEPTH X VELOCITY
HAZARD MAP

TOOELE COUNTY/NRCS
**SKULL VALLEY WATERSHED
PLAN-EA**

Notes:
Projection: NAD 1983 State Plane Utah Central



FIGURE NO.
A-1



LEGEND

2D Boundary

Existing Depth Minus Alt 4 Depth (ft)

- < 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.0
- >1.0

NORTH: 

SCALE: 0 250 500 1,000 FEET

100YR ALT4 4 VS. 50YR ALT 4
WATER DEPTH COMPARISON MAP

TOOELE COUNTY/NRCS
**SKULL VALLEY WATERSHED
PLAN-EA**

Notes:
Projection: NAD 1983 State Plane Utah Central



FIGURE NO.
A-2

Cultural Resource Assessment

COVER PAGE

Must Accompany All Project Reports
Submitted to the Utah SHPO



Report Title: *A Cultural Resource Assessment for the Skull Valley Watershed EA, Tooele County, Utah*

UDSH Project Number: U21HY0765

Org. Project Number: BCA27

Report Date: October 12, 2021

County(ies): Tooele

Report Author(s): Sheri Murray Ellis

Principal Investigator: Sheri Murray Ellis

Record Search Date(s): October 17, 2020

Field Supervisor(s): Sheri Murray Ellis

Intensive Acres Surveyed (<15m intervals): 132 ac.

Recon Acres Surveyed (<15m intervals): 0 ac.

USGS 7.5' Series Map Reference(s): Deseret Peak West, UT

Sites Reported	Count	Smithsonian Trinomials
Revisits (no updated site forms)	0	
Updates (updated site forms attached)	1	42TO2265
New recordings (site forms attached)	4	42TO7511 – 42TO7514
Total Count of Archaeological Sites in APE	5	42TO2265, 42TO7511 – 42TO7514
Historic Structures (structures forms Attached)	0	
Total National Register Eligible Sites	1	42TO2265

*Please list all site numbers per category. Number strings are acceptable (e.g. "42TO1-13; 42TO15"). Cells should expand to accommodate extensive lists.

Checklist of Required Items for Submittal to SHPO

- ☒ "Born Digital" Report in a PDF/A format
 - ☒ SHPO Cover Sheet
 - ☒ File Name is the UDSH Project Number with no hyphens or landowner suffixes
- ☒ "Born Digital" Site forms in PDF/A format
 - ☒ UASF with embedded maps and photos
 - ☒ File name is Smithsonian Trinomial without leading zeros (e.g. 42TO13 not 42TO00013)
 - ☒ Photo requirements (including size and quality)
- ☒ Archaeological Site Tabular Data
 - ☒ Single spreadsheet for each project
 - ☒ Follows UTSHPO template (info here: <https://goo.gl/7SLMqi>)
- ☒ GIS data
 - ☒ Zipped polygon shapefile or geodatabase of survey (if different from APE) or other activity area with required field names and variable intensity denoted
 - ☒ Zipped polygon shapefile or geodatabase of site boundaries with a the required field name

A Cultural Resource Assessment for the Skull Valley Watershed EA, Tooele County, Utah

Prepared for

Bowen Collins & Associates

Prepared by

Sheri Murray Ellis, MS, RPA
Owner/Consultant



Certus Environmental Solutions, LLC
Salt Lake City, Utah
801.230.7260

**PLPCO Permit No. 176
Utah Antiquities Project No. U21HY0765**

Certus Project Number: BCA27

October 12, 2021

PROJECT ABSTRACT SHEET

Report Title: *A Cultural Resource Assessment for the Skull Valley Watershed EA, Tooele County, Utah*

State Project No.: U21HY0765

Project Description: Tooele County (the County), in cooperation with the Natural Resources Conservation Service (NRCS), is preparing a new Watershed Plan and Environmental Assessment (Plan-EA) for the Skull Valley Watershed. The Plan-EA focusses on identifying needed mitigation measures for flood and debris flows impacting property of the Skull Valley Reservation as a result of recent wildfires. The NRCS has provided funding for the Plan-EA and may provide funding for the future mitigation projects. Issuance of this funding constitutes an undertaking per the National Historic Preservation Act and its implementing regulations at 36 CFR 800. As such, impacts to historic properties must be considered and resolved as part of project implementation. The County contracted with Bowen Collins & Associates (BCA) to assist in fulfilling the regulatory requirements for the Plan-EA. In turn, BCA contracted with Certus Environmental Solutions (Certus) to prepare a cultural resource assessment pursuant to 36 CFR 800. The results of that assessment are presented herein.

Survey Area: The survey area for cultural resources consists of a series of interconnected linear corridors and irregularly shaped polygons located in and around the Skull Valley Reservation housing area and extending northeasterly into along Indian Hickman Canyon. In total, the area encompasses 132 acres, including paved roadways and the “Hickman’s Creek” channel. The NRCS and any other involved state or federal regulatory agencies will determined the final area of potential effects (APE) as part of their permitting or funding authorizations.

Agencies: Tooele County; Natural Resources Conservation Service

Location: Skull Valley Reservation; Sec. 6 in T. 5S, R. 7W; Secs. 9–12 & 16 in T. 5S, R. 8W

Land Ownership: Tribal

Date(s) of Fieldwork: October 28, 2020

Methods: Intensive-level archaeological survey

Acres Surveyed: 132 acres

Total # of Cultural Resource Sites in Survey Area: 5 (42TO2265, 42TO7511 – 42TO7514)

Resources Recommended Eligible for the NRHP: 1 (42TO2265)

Resources Recommended Ineligible for the NRHP: 4 (42TO7511 – 42TO7514)

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PROJECT PURPOSE AND DESCRIPTION

Tooele County (the County), in cooperation with the Natural Resources Conservation Service (NRCS), is preparing a new Watershed Plan and Environmental Assessment (Plan-EA) for the Skull Valley Watershed. The Plan-EA focusses on identifying needed mitigation measures for flood and debris flows impacting property of the Skull Valley Reservation as a result of recent wildfires. See **Figure 1** for the general location of the study area. The NRCS has provided funding for the Plan-EA and may provide funding for the future mitigation projects. Issuance of this funding constitutes an undertaking per the National Historic Preservation Act and its implementing regulations at 36 CFR 800. As such, impacts to historic properties must be considered and resolved as part of project implementation. The County contracted with Bowen Collins & Associates (BCA) to assist in fulfilling the regulatory requirements for the Plan-EA. In turn, BCA contracted with Certus Environmental Solutions (Certus) to prepare a cultural resource assessment pursuant to 36 CFR 800. The results of that assessment are presented herein.

Fieldwork, which was carried out October 28, 2020 by the author, consisted of an intensive-level survey for archaeological resources. No buildings are located in the specific cultural resource survey area. Work was carried out by the author under Utah State Antiquities Report No. U21HY0765.

PERSONNEL QUALIFICATIONS

Sheri Murray Ellis, holder of State of Utah Public Lands Policy Coordination Office Permit No. 176, conducted fieldwork for the project and served as the principal investigator. Ms. Ellis meets all standards for professional qualifications for both archaeology and architectural history and for both prehistoric and historic period resources. Ms. Ellis holds an M.S. in American Studies (a multi-disciplinary degree that includes archaeology and history). Ms. Ellis has 30 years of professional experience in cultural resource assessments in Utah and the western United States.

CULTURAL RESOURCES SURVEY AREA

The survey area for cultural resources consists of a series of interconnected linear corridors and irregularly shaped polygons located in and around the Skull Valley Reservation housing area and extending northeasterly into along Indian Hickman Canyon. In total, the area encompasses 132 acres, including paved roadways and the “Hickman’s Creek” channel. (see **Figure 2 and 3**). The NRCS and any other involved state or federal regulatory agencies will determined the final area of potential effects (APE) as part of their permitting or funding authorizations.

The survey area is located in Section 6 of Township 5 South, Range 7 West and Sections 1, 9-12, and 16 of Township 5 South, Range 8 West of the Salt Lake Base and Meridian. The area can be found on USGS 7.5 minute topographic quadrangle Deseret Peak West, Utah (see **Figure 2**). All lands in the survey area are part of the Skull Valley Reservation (i.e., tribal lands).

ENVIRONMENTAL SETTING

The survey area is located along the eastern margin of the Skull Valley, within the boundaries of the Skull Valley Reservation. The area sits on an alluvial fan emanating from the Stansbury Mountains. Indian Hickman Canyon is located at the east end of the survey area, and a now-seasonal creek flowing therefrom extends southwesterly through the survey area and past the core housing and administrative area of the reservation. Ground elevation in the survey area ranges from approximately 5710 feet above

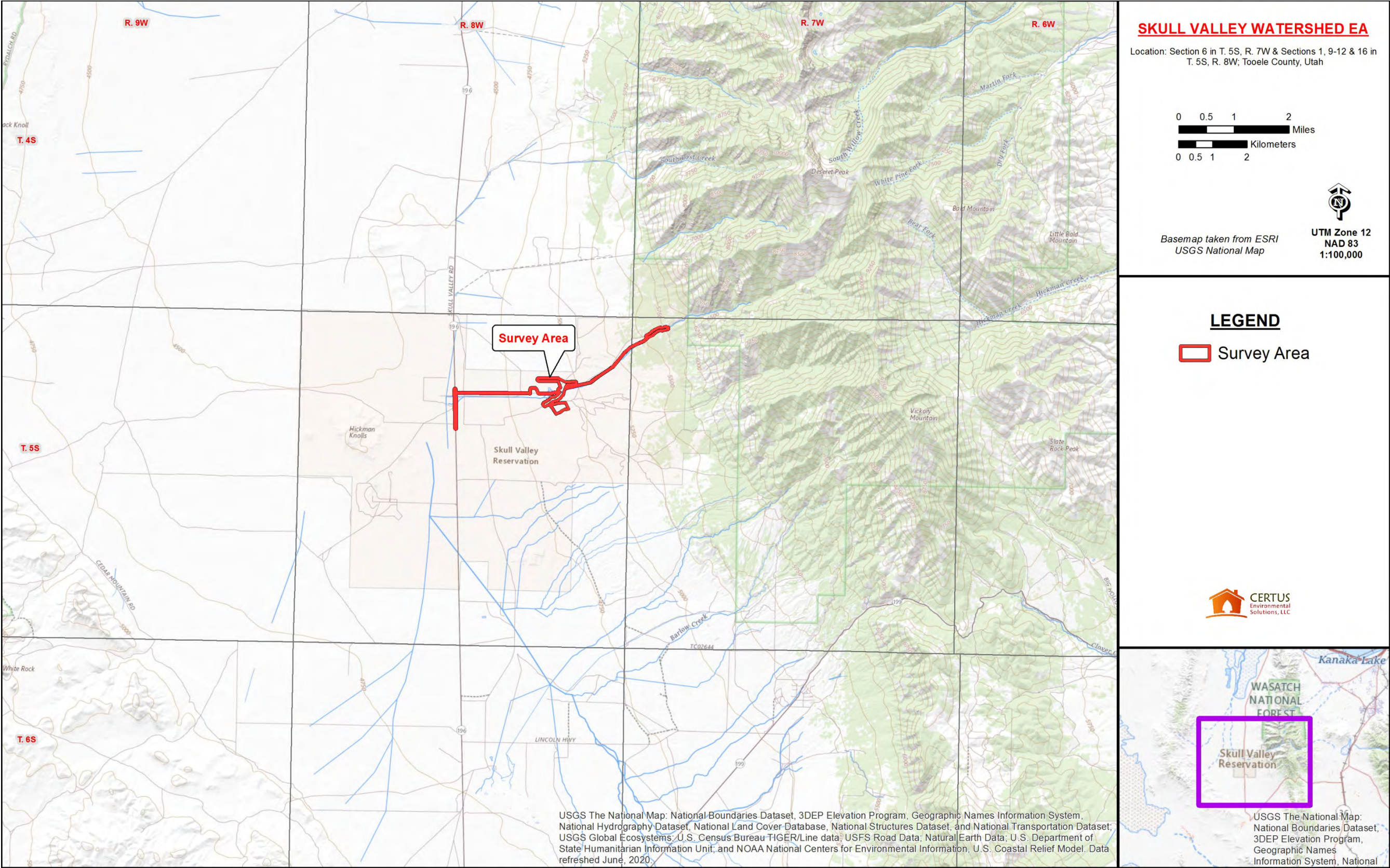


Figure 1. General location of the project

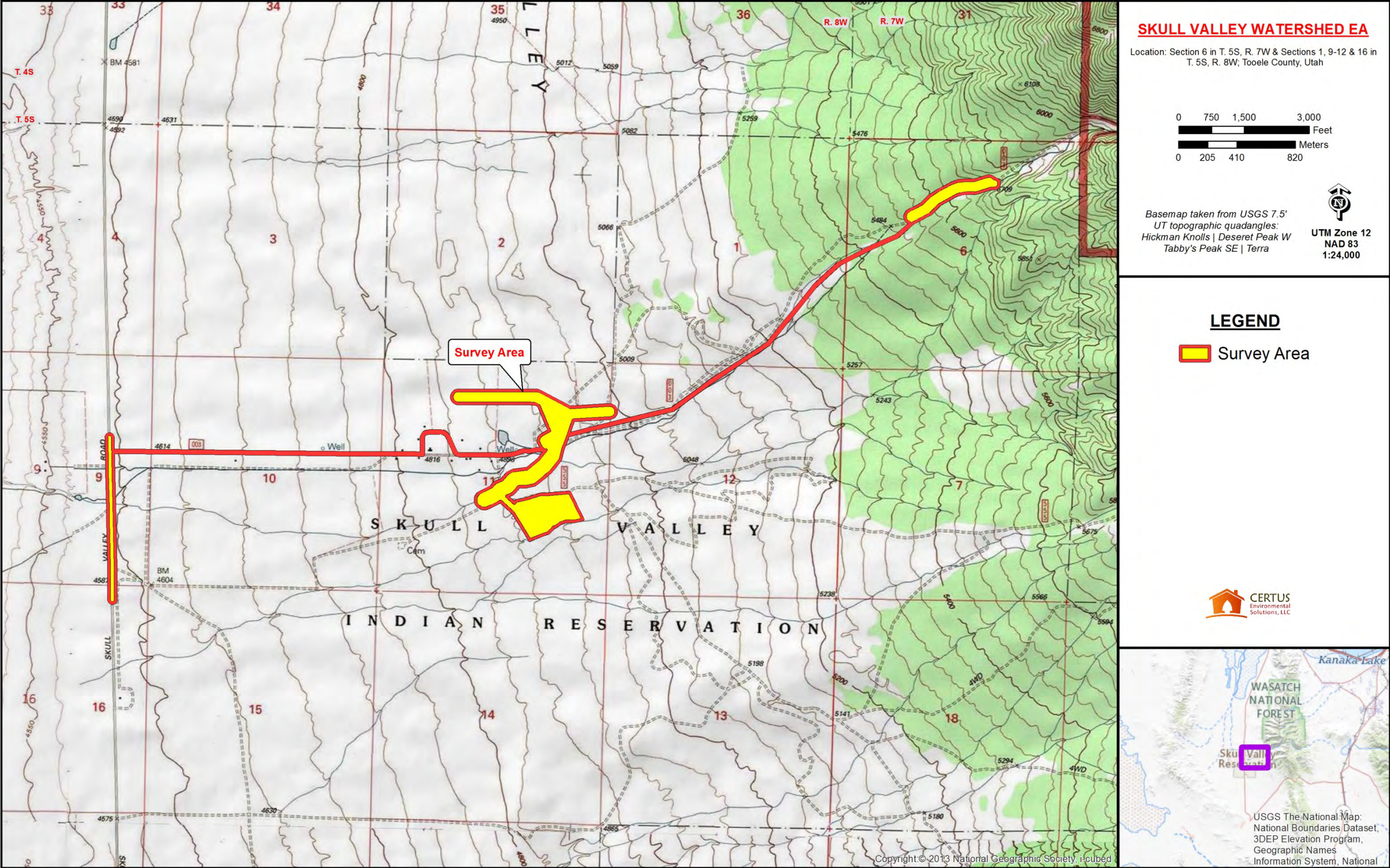


Figure 2. Location of cultural resources survey area; Topographic Map

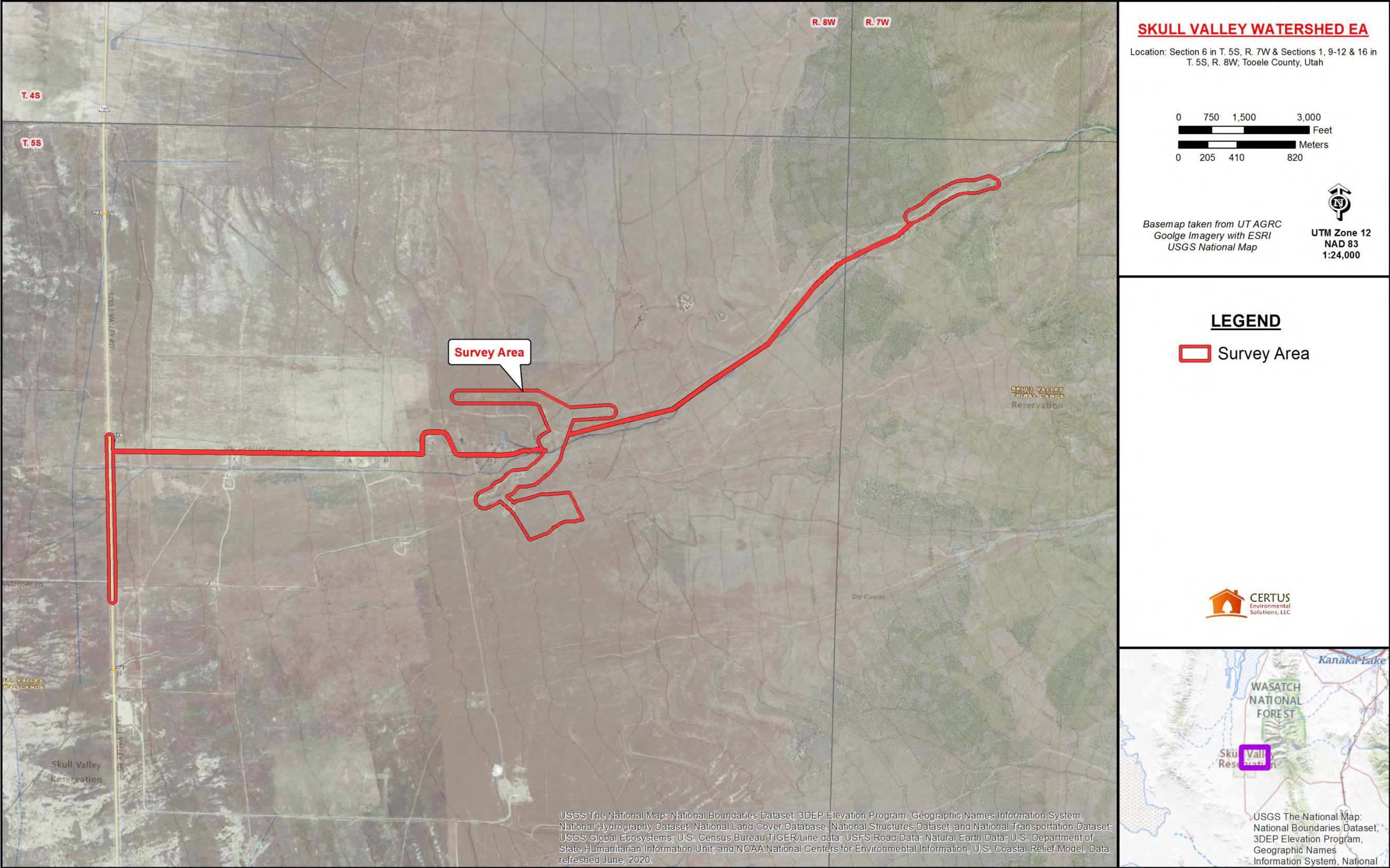


Figure 3. Location of cultural resources survey area; Aerial Map

modern sea level at the east end to 4580 feet above modern sea level at the west end along SR-196. The survey area includes portions of SR-196 and the road leading into the reservation housing area (Skull Valley Indian Reservation Road) as well as lands east and south of the housing area.

Select lands in the survey area exhibit pronounced evidence of both sediment scouring and deposition from flood events following a 2013 wildfire. Heavy flooding occurred in both 2013 and 2014 as a result of precipitation falling on the burn scar. More recently flooding and debris flows have occurred since then but were not as severe. As a general rule, the flood flow followed the braided drainage channel coming from Indian Hickman Canyon but also over-topped the banks of that channel and widened and further braided it. When flood waters and debris reached flatter terrain, it spread out over a broader area, leaving behind one or more inches of sediment in some locations.

Vegetation in the survey area comprises sagebrush community species, including low sagebrush, occasional cacti, and fine bunch grasses. Ground cover ranged from barren to roughly 90-percent across the area. In addition to the ground surface disturbance from the aforementioned floods, extensive disturbance was observed in the form of two-track roads, trails, livestock grazing, and excavations for landfill uses. Several emergency flood control berms were also constructed in the area around the time of the 2013-2014 floods. A general photographic overview of the survey area east of the housing and administrative area is shown in **Figure 4**.



Figure 4. General overview of the project area; looking southeast

FIELD METHODS

Certus applied intensive-level survey methods accepted by the NRCS, Utah State Historic Preservation Officer (SHPO), and other agencies in Utah to identify cultural resources that could be affected by the undertaking. Sheri Murray Ellis of Certus inventoried the survey area by walking parallel transects spaced no more than 15 meters (50 feet) apart. This equated multiple parallel transects across the survey area.

Navigation within the survey area was accomplished using a handheld GPS unit capable of decimeter accuracy, aerial maps, and visual landmarks.

The National Park Service (NPS) defines five cultural resource types that can be listed on the NRHP: buildings, sites, districts, structures, and objects (NPS 2002). For the purpose of this project, the following criteria set forth by the Utah SHPO were used to define resources as an archaeological site:

- At least 10 artifacts of a single class (e.g., 10 sherds) within a 10-meter diameter area, except when all pieces appear to originate from a single source (e.g., one ceramic pot or one glass bottle)
- At least 15 artifacts that include at least 2 classes of artifact types (e.g., sherds, nails, glass) within a 10-meter area
- One or more archaeological features in temporal association with any number of artifacts
- Two or more temporally associated archaeological features without artifacts

The SHPO defines isolated finds (a.k.a., isolated artifacts, isolated occurrences, or isolates) as those cultural resources that fall “below stated site thresholds” as defined above.

RESOURCE EVALUATION METHODS

Certus employs regulatory standard methods for evaluating the historical significance of cultural resources encountered during the field inventory. To that end, Certus evaluates all identified cultural resources for their eligibility for listing on the National Register of Historic Places (National Register). The evaluation considers the four criteria of the National Register as listed in 36 CFR 60.4 and followed the guidelines issued by the National Park Service (NPS) in Bulletin 15, *How to Apply the National Register Criteria for Evaluation* (NPS 2002). The National Register criteria state that a resource may be considered eligible for listing on the National Register if it:

- **Criterion A** – is associated with events that have made a significant contribution to the broad patterns of our history; OR
- **Criterion B** – is associated with the lives of persons significant in our past; OR
- **Criterion C** – embodies the distinctive characteristics of a type, period, or method of construction, or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components may lack individual distinction; OR
- **Criterion D** – has yielded, or may be likely to yield, information important in prehistory or history.

Resources considered potentially eligible for the National Register pursuant to one of the above criteria are also to be assessed for integrity of location, design, setting, materials, workmanship, feeling, and association. To be eligible for listing on the National Register, the resource must possess integrity of those elements directly related to the criterion or criteria under which it would be determined eligible.

FILE SEARCH AND ARCHIVAL REVIEW

Certus conducted a file search and archival of information regarding past cultural resource surveys, known cultural resource sites, and potential cultural resource sites in the survey area. This research was conducted October 17, 2020. The background research included detailed review of the following sources:

- Utah Division of State History (UDSH) Sego and HUB databases;
- Historical topographic maps available through the Utah Geological Survey (UGS) and U.S. Geological Survey (USGS);
- Historical air photos available through the UGS and USGS;
- Historical General Land Office (GLO) maps;
- URARA rock art data (provided through Sego database); and
- Utah Statewide historic contexts

Certus also conducted a brief review of Sanborn maps, grazing, mining, water rights, and Master Title Plat records but did not identify any information of significance related to the current survey area.

Sego and HUB File Search

According to Sego records, 10 prior regulatory-based cultural resource assessments have taken place within 1/2 mile of the current survey area. These surveys occurred between 1979 and 2018. Several encompassed portions of the current survey area, though not in any meaningful way. Certus re-surveyed all previously inventoried portions of the current survey area as part of the present undertaking as a matter of logistical simplicity.

The Sego and HUB file search indicates that 11 archaeological sites have been documented previously in the 1/2 mile file search area (see **Table 1**). Two sites (42TO215 and 42TO2265) are mapped in Sego as being located at least partially in the current survey area. Certus revisited both mapped site locations and determined that the Sego plot for site 42TO215 is incorrect, and that site should be plotted approximately 75 meters north of its current plot. That correct location is well outside the current survey area. See the **Findings** section below for more discussion of site 42TO2265.

Table 1. Known sites in the file search area

Site #	Description	National Register Eligibility	In Current Survey Area?
42TO215	Rubble mound with possible obsidian debitage	Undetermined	No ¹
42TO2265	Skull Valley Highway/SR-196	Eligible	Yes
42TO5937	Prehistoric lithic scatter	Ineligible	No
42TO5942	Late prehistoric camp	Ineligible	No
42TO7262	Historical artifact scatter	Ineligible	No
42TO7263	Historical rock alignment and artifact scatter	Eligible	No
42TO7264	Historical (GLO) road segments	Eligible	No
42TO7265	Historical artifact scatter with depression features	Eligible	No
42TO7266	Historical artifact scatter	Ineligible	No
42TO7267	Historical cemetery	Ineligible	No
42TO7268	Historical artifact scatter	Ineligible	No

¹ Mapped in Sego as located in survey area but this represents a location error in Sego

UDSH records do not identify any URARA rock art sites in the file search area though rock art sites are present in the broader Skull Valley area.

Archival Review

The earliest GLO maps available online through the BLM for the relevant township and ranges date to 1871. Maps are also available for 1903 but do not provide detailed illustration of the project area. The 1871 maps depict a wagon road or trail entering Indian Hickman Canyon from the southwest. This road is shown in one map as being located north of Hickman's Creek and south of it in another. Several other roads branch off of it. A sheep corral is depicted as being located near the road and creek in the map for Range 8 West, and a trail and agricultural field are shown as being located in the vicinity of the current Skull Valley Reservation housing and administrative area. This area on the 1871 map is labeled as "Indian Settlement." Two roads are depicted immediate west of the "Indian Settlement." One runs northwest to southeast and is labeled "Road from Barlow Creek to Palmer Rancho"(sic), and the other T's off of that road and extends to the southwest. It is labeled as "Road from Deep Creek." None of these features were specifically located during fieldwork for the current undertaking due to extensive ground disturbance and the creation of myriad unimproved roads criss-crossing the general area.

No historical topographic maps of reasonable scale were found online for the project area. The earliest of reasonable scale dates to 1985.

Several historical air photos were found online for the general project area, though their scale is largely insufficient to identify individual structures and smaller man-made features on the landscape. Images from 1953 and 1972 provide the best resolution of the area. These images depict the current housing area access road extending east from SR-196 as well as SR-196 itself. They also show several agricultural fields that have subsequently been developed for the housing and administrative area of the reservation. Several buildings are also visible along the reservation access road but are outside the current survey area. Beyond these resources is a web of faint unimproved/2-track roads across the broader landscape surrounding the current location of the housing and administrative area of the reservation.

FINDINGS

Certus identified 13 isolated occurrences (isolated finds or isolates) and five cultural resource sites in the survey area. The sites include a previously documented segment of the Skull Valley Highway/SR-196 (42TO2265), three historical trash dumps (42TO7511, 42TO7512, and 42TO7513), and the reservation access road (42TO7514). The locations of the isolates and sites are shown in **Figure 5**, and descriptions and National Register eligibility evaluations are provided below.

Isolated Occurrences

As noted, Certus identified 13 isolated occurrences in the survey area for the flood protection projects. All of these isolates are located east of the reservation housing and administrative area and north of the Hickman's Creek wash. Most of the artifacts appear to have been washed into this area by stormwater runoff, and may have collected near the east side of an earthen berm built during the modern period to protect reservation infrastructure from flood damage. The locations of the isolated occurrences are shown in **Figures 5 and 6**, and they are described in **Table 2**, below. None of the isolated occurrences documented here meet the standards of eligibility for listing on the National Register and should be considered ineligible for the purposes of the current undertaking.

Redacted (16 U.S.C. §470hh)

Redacted (16 U.S.C. §470hh)

Figure 6. Survey results, isolated occurrences detail

Table 1. Isolated occurrences in the survey area

Isolate #	UTMs	Description	Photo
I001	Redacted (16 U.S.C. 9472hh) [Redacted]	Key-wind 1-lb coffee tin lid	
I002	Redacted (16 U.S.C. 9472hh) [Redacted]	2 cans— 1 crushed multi-serving sanitary food tin and 1 perforated hole-in-cap can fragment; 1 coffee pot fragment; and 1 metal coffee cup	
I003	Redacted (16 U.S.C. 9472hh) [Redacted]	1 galvanized paint-type can	
I004	Redacted (16 U.S.C. 9472hh) [Redacted]	1 crushed rectangular sanitary type meat tin	
I005	Redacted (16 U.S.C. 9472hh) [Redacted]	1 sanitary type potted meat tin, round	

Table 1. Isolated occurrences in the survey area

Isolate #	UTMs	Description	Photo
I006	Redacted (16 U.S.C. 947(h)) [Redacted]	Dutch oven base plate	
I007	Redacted (16 U.S.C. 947(h)) [Redacted]	1 sanitary type lard pail, crushed	
I008	Redacted (16 U.S.C. 947(h)) [Redacted]	Collection of a car frame and seat springs	
I009	Redacted (16 U.S.C. 947(h)) [Redacted]	1 crushed metal bowl or pan	
I010	Redacted (16 U.S.C. 947(h)) [Redacted]	1 shell button	

Table 1. Isolated occurrences in the survey area

Isolate #	UTMs	Description	Photo
IO11	Redacted (16 U.S.C. 8612hh) [Redacted]	1 crushed metal coffee pot	
IO12	Redacted (16 U.S.C. 8612hh) [Redacted]	1 crushed metal bowl or pan	
IO13	Redacted (16 U.S.C. 8612hh) [Redacted]	Possible historic period campfire ring	

Archaeological Sites

As stated previously, Certus identified five archaeological sites in the survey area for the flood protection projects. These include two historical roads and three historical trash scatters/dumps. The locations of the sites are shown in **Figure 5**, and descriptions and National Register eligibility evaluations are provided below. It should be noted that random “trash” is strewn throughout much of the survey area south of the reservation housing and administrative complex. The vast majority of this debris dates to the modern era, though a few potentially older artifacts were observed among larger concentrations of modern items. Given the extensive nature of this intermixing and predominance of modern trash, Certus did not document such occurrences as sites. Rather, only those collections of artifacts dominated by historical items were defined as sites and documented for the purposes of the current undertaking.

Site 42TO2265, Skull Valley Highway/SR-196

Site 42TO265 is the Skull Valley Highway, also known as SR-196. The site is located in the extreme western part of the current survey area. This segment of the site was documented previously, most recently in 2018. Certus did not observe any changes to the segment in the current survey area when

compared to the 2018 site record and did not, therefore, prepare an update to that record. The Skull Valley Highway road reportedly was constructed in 1951 to provide access to Dugway Proving Ground (Fowler 2018), located south of the Skull Valley Reservation. The road is actively used and maintained as a modern highway. The road comprises a raised road bed between 3 and 5 feet tall depending on terrain and has a roughly 20-foot wide paved surface. No historical roadway features, such as culverts or guardrails, are present along the segment in the current survey area, though modern culvert pipes were noted.

NATIONAL REGISTER EVALUATION FOR SITE 42TO2265

Site 42TO2265—the Skull Valley Highway/SR-196—has been documented at least four times prior to the present undertaking with the most recent documentation occurring in 2018. The overall site was determined eligible for the National Register under Criterion A as a result of each documentation effort. The basis for this determination lies in the road’s direct association to the introduction of “large-scale transportation unique to the Skull Valley” (Fowler 2018). The site was determined ineligible for the National Register under Criteria B, C, and D as a result of the prior documentation. Certus has not identified any additional information that would dispute the existing determination of the site’s significance under Criterion A and recommends this determination be retained. As such, this site would qualify as a historic property for the purpose of 36 CFR 800, and effects from the proposed undertaking must be considered.

Site 42TO7511, Historical Trash Scatter

Site 42TO7511 is a historical trash scatter newly documented as part of the present undertaking. The site is located on the edge of a small wash southeast of the housing and administrative complex of the Skull Valley Reservation. It measures roughly 85 meters long by 30 meters wide at its maximum dimensions and covers an area of approximately 1,347 square meters.

The site comprises artifacts only—no features were observed—and appears to represent multiple events of domestic refuse disposal. Between 200 and 300 artifacts were present at the time of documentation. Most of these artifacts are shards of broken bottle and container glass in colorless, amber, blue, lime green, and aqua colors. Other items include rubber tires and hose fragments; sanitary cans and can fragments; bi-metal flat-top beer cans with fully removable pull tabs; a frying pan; a thermos; a toleware pot lid; a fork; sherds of undecorated earthenware ceramic vessels; flower pot sherds; three medicine bottles with plastic screw cap closures; broken colorless glass jugs; an aluminum hubcap; a rubber shoe sole; a bed frame and springs; a battery core; the button from a pair of jeans; and miscellaneous other items. Several of the artifacts in the assemblage exhibited temporally diagnostic maker’s marks or other such marks. Among these were a 1950s 7Up bottle with an applied color label, a ceramic sherd bearing a late-1920s Knowles, Taylor & Knowles backstamp, a 1915-1978 Obea-Nester Glass Company mark, and a post-1954 Owens-Illinois Glass Company mark. Collectively, these marks and the other artifacts suggest a late-1950s to late-1960s date of discard with at least some curation of older items prior to disposal. Given this date range, the site is most likely affiliated with residents of the nearby Skull Valley Reservation housing area.

NATIONAL REGISTER EVALUATION FOR SITE 42TO7511

Site 42TO7511 is a late-historic period scatter of mostly domestic refuse that is most likely associated with the residents of the Skull Valley Reservation. The site appears to retain integrity of location, materials, setting, feeling, and association. Integrity of design and workmanship does not apply to this site.

Certus **recommends site 42TO7511 ineligible** for the National Register under all criteria for the reasons set forth below. As an ineligible resource, site 42TO7511 would not qualify as a historic property for the purpose of 36 CFR 800.

This site is associated with commonplace domestic refuse discard in the remote environment of the Skull Valley Reservation. The site is most likely associated with the residents of the reservation during the late-historic period. Site 42TO7511 is not known to be associated with any important events or patterns of history within the reservation context. As such, the site would be ineligible for the National Register under Criterion A.

This site is not known to be associated meaningfully with any person or persons of importance in history. The size of the site and number of artifacts suggests contributions of refuse from multiple individuals or households that remain unknown at this time. Additionally, it seems highly unlikely that a site of this nature would be associated with an individual or individuals for the reasons such persons may be considered historically important. Therefore, site 42TO7511 would be ineligible for the National Register under Criterion B.

This site is not representative of a type, style, or method/manner of construction. It is not the work of a master and does not possess high artistic value. Further, it does not appear to be part of a larger cultural entity, such as a historic district or historical landscape, to which it may contribute. As such, the site would be ineligible for the National Register under Criterion C.

This site has not yielded information important to improving our understanding of history and does not appear to have the potential to do so with further investigation. There appears to be little, if any, “cultural depth” at the site, and the assemblage is such that only limited interpretations of research topics like general access to goods and differential consumer access based on economics or ethnicity can be made. Therefore, the site would be ineligible for the National Register under Criterion D.

Site 42TO7512, Historical Trash Dump

Site 42TO7512 is a historical trash dump newly documented as part of the present undertaking. The site is located in a shallow, ephemeral drainage channel southeast of the housing and administrative complex of the Skull Valley Reservation. It measures roughly 19 meters long by 5 meters wide at its maximum dimensions and covers an area of approximately 82 square meters.

The site comprises artifacts only—no features were observed—and appears to represent a single event of domestic refuse disposal. An estimated 40 artifacts were present at the time of documentation. The assemblage included fragments of light sun-colored amethyst glass from a machine-made brandy finish bottle; colorless glass shards from a vase, a condiment jar, and a Kerr canning jar; two complete colorless glass jars; three shards of thick crockery with brown interior glaze; sanitary cans with key-wind, pry-out, and screw cap openings; the housing from a car headlight; a spoked wire wheel or frame; and barbed wire. The majority of artifacts in the assemblage are temporally non-diagnostic or only diagnostic to the broad post-1900 period; however, two bottle/jar maker’s marks were noted that help provide a more refined date range for the site. These include a Hazel-Atlas mark generally dating from 1923 to ca. 1982. This artifact also displays a relatively rough and offset Owen’s rings, which suggests it dates to the earlier part of the date range during which this maker’s mark was used. The other mark was found on a colorless glass jar base. It comprises embossed markings that read: KERR GLASS MFG CO/SAND SPRINGS OKLA/ PAT JUN 9 1903 / 5.” This particular marking was used between 1903 and the 1920s. Collectively, these marks and the other artifacts suggest a 1920s or early-1930s date of discard for

the artifacts. Given this date range, the site is most likely affiliated with residents of the Skull Valley Reservation, which was established in 1912.

NATIONAL REGISTER EVALUATION FOR SITE 42TO7512

Site 42TO7512 is small scatter of domestic refuse that is most likely associated with an early resident of the Skull Valley Reservation. The site appears to retain integrity of location, materials, setting, and feeling. Its integrity of association is somewhat lacking in that the source of the site cannot be specifically identified. Integrity of design and workmanship does not apply to this site.

Certus **recommends site 42TO7512 ineligible** for the National Register under all criteria for the reasons set forth below. As an ineligible resource, site 42TO7512 would not qualify as a historic property for the purpose of 36 CFR 800.

This site is associated with commonplace domestic refuse discard in the remote environment of the Skull Valley Reservation. While there is no specific evidence to indicate the source of the site, it is most likely associated with a resident of the reservation during the first decade or two after the reservation was established. Site 42TO7512 is not known to be associated with any important events or patterns of history within the reservation context. As such, the site would be ineligible for the National Register under Criterion A.

This site is not known to be associated meaningfully with any person or persons of importance in history. The size of the site and number of artifacts suggests contributions of refuse from a single individual or household that remains unknown at this time. Additionally, it seems highly unlikely that a site of this nature would be associated with an individual for the reasons such a person may be considered historically important. Therefore, site 42TO7512 would be ineligible for the National Register under Criterion B.

This site is not representative of a type, style, or method/manner of construction. It is not the work of a master and does not possess high artistic value. Further, it does not appear to be part of a larger cultural entity, such as a historic district or historical landscape, to which it may contribute. As such, site 42TO7512 would be ineligible for the National Register under Criterion C.

This site has not yielded information important to improving our understanding of history and does not appear to have the potential to do so with further investigation. There appears to be little, if any, “cultural depth” at the site, and the assemblage is such that only limited interpretations of research topics like general access to goods and differential consumer access based on economics or ethnicity can be made. Therefore, site 42TO7512 would be ineligible for the National Register under Criterion D.

Site 42TO7513, Historical Trash Dump

Site 42TO7513 is a historical trash dump newly documented as part of the present undertaking. The site is located in and adjacent to a shallow, ephemeral drainage channel southeast of the housing and administrative complex of the Skull Valley Reservation. It measures roughly 47 meters long by 32 meters wide at its maximum dimensions and covers an area of approximately 927 square meters. Modern trash was intermixed with the historical debris.

The site comprises artifacts only—no features were observed—and appears to represent one or a few events of domestic refuse disposal. An estimated 50 to 70 artifacts were present at the time of

documentation. The assemblage included five galvanized metal tubs; parts of a stove; three sanitary cans; a galvanized jug-style cooler or gas can; bed springs; wire mesh fencing; a toleware kettle; part of a frying pan; buckets; parts of folding chairs; shards of colorless glass; miscellaneous indeterminate metal fragments; and three sherds of an undecorated white earthenware ceramic vessel, one of which includes a partial maker's backstamp. Most of the artifacts are temporally non-diagnostic beyond a mid-1900s time period; however, the partial maker's backstamp on the ceramic plate sherd appears to be a mark used by the Royal Stetson China Company during the 1950s, and the stove appears to be a ca. 1950s model of wood-burning stove manufactured by the Brown Stove Works of Tennessee. The dates suggested by these two items are consistent with the general nature of the other artifacts at the site and indicate a deposition date range during or after 1950s. Given this date range, the site is most likely affiliated with residents of the nearby Skull Valley Reservation housing area.

NATIONAL REGISTER EVALUATION FOR SITE 42TO7513

Site 42TO7513 is a late-historic period scatter of mostly domestic refuse that is most likely associated with the residents of the Skull Valley Reservation. The site appears to retain integrity of location, materials, setting, feeling, and association. Integrity of design and workmanship does not apply to this site.

Certus **recommends site 42TO7513 ineligible** for the National Register under all criteria for the reasons set forth below. As an ineligible resource, site 42TO7513 would not qualify as a historic property for the purpose of 36 CFR 800.

This site is associated with commonplace domestic refuse discard in the remote environment of the Skull Valley Reservation. The site is most likely associated with one or more residents of the reservation during the late-historic period. Site 42TO7513 is not known to be associated with any important events or patterns of history within the reservation context. As such, the site would be ineligible for the National Register under Criterion A.

This site is not known to be associated meaningfully with any person or persons of importance in history. The size of the site and number of artifacts suggests contributions of refuse from one or a few individuals or households that remain unknown at this time. Additionally, it seems highly unlikely that a site of this nature would be associated with an individual or individuals for the reasons such persons may be considered historically important. Therefore, site 42TO7513 would be ineligible for the National Register under Criterion B.

This site is not representative of a type, style, or method/manner of construction. It is not the work of a master and does not possess high artistic value. Further, it does not appear to be part of a larger cultural entity, such as a historic district or historical landscape, to which it may contribute. As such, the site would be ineligible for the National Register under Criterion C.

This site has not yielded information important to improving our understanding of history and does not appear to have the potential to do so with further investigation. There appears to be little, if any, "cultural depth" at the site, and the assemblage is such that only limited interpretations of research topics like general access to goods and differential consumer access based on economics or ethnicity can be made. Therefore, the site would be ineligible for the National Register under Criterion D.

Site 42TO7514, Skull Valley Indian Reservation Access Road

Site 42TO7514 is the access road into the Skull Valley Reservation housing and administrative area from SR-196. This road is labeled on maps as Skull Valley Road. Certus documented the entire road (2,740 meters long) as part of the current undertaking. The majority of the road remains in active use and repair. A short section near the east end of the road has been abandoned in-place and is no longer used. It appears to have been abandoned sometime in 2004.

The road was present by at least 1953, which is the time period of the earliest available aerial images of the area. Early topographic and General Land Office maps do not depict the road. The road, or at least a predecessor thereof, could date as early as 1912, which is when the Skull Valley Reservation was established; it appears the road served the sole purpose of providing access into the reservation's core housing area and was not used to access other destinations.

Along the actively used section, the road comprises a typical asphalt-paved corridor with a roughly 24-foot wide paved surface. The travel surface rests atop a low earthen berm/roadway prism that stands no more than 2 feet tall. The road is similarly surfaced along the abandoned segment but is being slowly overgrown with vegetation. No historical roadway features, such as culverts or guardrails, are present along the road.

NATIONAL REGISTER EVALUATION FOR SITE 42TO7514

Site 42TO7514 is a historical road providing access into the Skull Valley Reservation housing and administrative area. The site appears to retain integrity of location, materials, design, and workmanship, setting, feeling, and association, though integrity of design has been diminished slightly by the abandonment of a portion of the road and its subsequent deterioration.

Certus **recommends site 42TO7514 ineligible** for the National Register under all criteria for the reasons set forth below. As an ineligible resource, site 42TO7514 would not qualify as a historic property for the purpose of 36 CFR 800.

This site is associated with transportation access into the reservation housing and administrative area. This, itself, is a utilitarian function born of necessity after the location of the reservation was established for reasons independent of the road. That is, the road appears to be a response to establishing the reservation at this location and did not determine the reservation's location, layout, or function. Site 42TO7514 is not known to be associated with any important events or patterns of history within the reservation or transportation contexts. As such, the site would be ineligible for the National Register under Criterion A.

This site is not known to be associated meaningfully with any person or persons of importance in history. Rather, it appears to be associated most likely with a state or municipal transportation agency, which would not qualify as historically important persons. Therefore, site 42TO7514 would be ineligible for the National Register under Criterion B.

This site is not representative of a type, style, or method/manner of construction. It is not the work of a master and does not possess high artistic value. Further, it does not appear to be part of a larger cultural entity, such as a historic district or historical landscape, to which it may contribute. As such, the site would be ineligible for the National Register under Criterion C.

This site has not yielded information important to improving our understanding of history and does not appear to have the potential to do so with further investigation. Therefore, the site would be ineligible for the National Register under Criterion D.

POTENTIAL FOR BURIED CULTURAL RESOURCES

The potential for encountering intact buried cultural resources in the study area should be considered low to moderate. While sediment accumulation from flood events has occurred in the area, so has extensive scouring and earth moving to protect against flood damage. Prehistoric sites are known to be present in the area, especially toward the eastern end of the project area in the foothills of the Stansbury Mountains, but the narrowness of the current project corridor in that area and its location in areas scoured by flood waters reduces the potential that intact buried sites would be found during project construction. Additionally, historical uses of the area have been of sufficiently short duration that cultural deposits likely have not accumulated in the area.

SUMMARY

Certus conducted a cultural resources inventory for the proposed flood protection projects on the Skull Valley Reservation. The inventory resulted in the identification of five cultural resources sites, including two historical roads (42TO2265 and 42TO7514) and three historical trash scatters/dumps (42TO7511, 42TO7512, and 42TO7513). Of these five sites, one (42TO2265) has been determined eligible for the National Register as a result of prior evaluations under 36 CFR 800. The remaining sites were newly documented as part of the current undertaking and are recommended ineligible for the National Register under all criteria.

Site 42TO2265 is the Skull Valley Highway/SR-196. The current undertaking could result in installation of new culverts or replacement of existing culverts along a portion of the road. None of the existing culverts along the potentially affected segment are individually significant, and none contribute to the overall eligibility of the road site. The fundamental path of the road and its overall design would not be altered by the proposed flood protection improvements. As such, Certus recommends a finding of No Adverse Effect for this undertaking.

REFERENCES CITED

Fowler, B. 2018. Utah Archaeology Site Form for site 42TO2265. On file at the Utah State Historic Preservation Office, Salt Lake City.

National Park Service (NPS). 2002. *How to Apply the National Register Criteria for Evaluation*. National Register Bulletin 15. Utah Centennial County History Series. Accessed online on January 9, 2014 at: <http://www.nps.gov/history/nr/publications/bulletins/nrb15/>

Utah State Historic Preservation Office (SHPO). 2020. *Archaeological Compliance Guide*. Utah Division of State History, Salt Lake City.

Addendum Cultural Resource Assessment

COVER PAGE

**Must Accompany All Project Reports
Submitted to the Utah SHPO**



Report Title: *An Addendum Cultural Resource Assessment for the Skull Valley Watershed EA, Tooele County, Utah*
UDSH Project Number: U22HY0435 **Org. Project Number:** BCA27
Report Date: June 25, 2022 **County(ies):** Tooele
Report Author(s): Sheri Murray Ellis **Principal Investigator:** Sheri Murray Ellis
Record Search Date(s): October 17, 2020 **Field Supervisor(s):** Sheri Murray Ellis
Intensive Acres Surveyed (<15m intervals): 0.4 ac. **Recon Acres Surveyed (<15m intervals):** 0 ac.
USGS 7.5' Series Map Reference(s): Deseret Peak West, UT

Sites Reported	Count	Smithsonian Trinomials
Revisits (no updated site forms)	0	
Updates (updated site forms attached)	0	
New recordings (site forms attached)	0	
Total Count of Archaeological Sites in APE	0	
Historic Structures (structures forms Attached)	0	
Total National Register Eligible Sites	0	

*Please list all site numbers per category. Number strings are acceptable (e.g. "42TO1-13; 42TO15"). Cells should expand to accommodate extensive lists.

Checklist of Required Items for Submittal to SHPO

- ☒ "Born Digital" Report in a PDF/A format
 - ☒ SHPO Cover Sheet
 - ☒ File Name is the UDSH Project Number with no hyphens or landowner suffixes
- ☐ "Born Digital" Site forms in PDF/A format
 - ☐ UASF with embedded maps and photos
 - ☐ File name is Smithsonian Trinomial without leading zeros (e.g. 42TO13 not 42TO00013)
 - ☐ Photo requirements (including size and quality)
- ☐ Archaeological Site Tabular Data
 - ☐ Single spreadsheet for each project
 - ☐ Follows UTSHPPO template (info here: <https://goo.gl/7SLMqj>)
- ☒ GIS data
 - ☒ Zipped polygon shapefile or geodatabase of survey (if different from APE) or other activity area with required field names and variable intensity denoted
 - ☐ Zipped polygon shapefile or geodatabase of site boundaries with a the required field name

PROJECT ABSTRACT SHEET

Report Title: *An Addendum Cultural Resource Assessment for the Skull Valley Watershed EA, Tooele County, Utah*

State Project No.: U22HY0435

Project Description: Tooele County (the County), in cooperation with the Natural Resources Conservation Service (NRCS), is preparing a new Watershed Plan and Environmental Assessment (Plan-EA) for the Skull Valley Watershed. The Plan-EA focusses on identifying needed mitigation measures for flood and debris flows impacting property of the Skull Valley Reservation as a result of recent wildfires. The NRCS has provided funding for the Plan-EA and may provide funding for the future mitigation projects. Issuance of this funding constitutes an undertaking per the National Historic Preservation Act and its implementing regulations at 36 CFR 800. As such, impacts to historic properties must be considered and resolved as part of project implementation. The County contracted with Bowen Collins & Associates (BCA) to assist in fulfilling the regulatory requirements for the Plan-EA. In turn, BCA contracted with Certus Environmental Solutions (Certus) to prepare a cultural resource assessment pursuant to 36 CFR 800. Certus conducted a cultural resource inventory for the project in 2020 under report number U21HY0765. Subsequent to that survey, the project area was expanded slightly, and anticipated impacts were identified in four small areas outside the original survey area. Certus conducted an addendum assessment for these areas. The results of that addendum assessment are presented herein.

Survey Area: The survey area for cultural resources consists of four small irregularly shaped polygons located on the fringes of the original (U21HY0765) survey area. These four locations total approximately 0.4 acres. The NRCS and any other involved state or federal regulatory agencies will determine the final area of potential effects (APE) as part of their permitting or funding authorizations.

Agencies: Tooele County; Natural Resources Conservation Service

Location: Skull Valley Reservation; Sec. 11 in T. 5S, R. 8W

Land Ownership: Tribal

Date(s) of Fieldwork: October 28, 2020

Methods: Intensive-level archaeological survey

Acres Surveyed: 0.4 acres

Total # of Cultural Resource Sites in Survey Area: 0

Resources Recommended Eligible for the NRHP: 0

Resources Recommended Ineligible for the NRHP: 0

Archaeological Resources Survey Report

ADMINISTRATIVE INFORMATION

Project Name: Skull Valley Watershed EA Addendum Survey		Date of Report: June 25, 2022
Project Sponsor: Tooele County		Division of State History Project #: U22HY0435
Lead Agency for Section 106/UCA 9-8-404: Natural Resources Conservation Service		Certus Project #: BCA27
Author(s): Sheri Murray Ellis	Certus Environmental Solutions, LLC 655 7 th Avenue Salt Lake City, UT 84103	
Methods: Certus employed standard intensive-level archaeological survey techniques using transects spaced no more than 15 meters (50 feet) apart.		
Description of the Undertaking: Tooele County (the County), in cooperation with the Natural Resources Conservation Service (NRCS), is preparing a new Watershed Plan and Environmental Assessment (Plan-EA) for the Skull Valley Watershed. The Plan-EA focusses on identifying needed mitigation measures for flood and debris flows impacting property of the Skull Valley Reservation as a result of recent wildfires. The NRCS has provided funding for the Plan-EA and may provide funding for the future mitigation projects. Issuance of this funding constitutes an undertaking per the National Historic Preservation Act and its implementing regulations at 36 CFR 800. As such, impacts to historic properties must be considered and resolved as part of project implementation. The County contracted with Bowen Collins & Associates (BCA) to assist in fulfilling the regulatory requirements for the Plan-EA. In turn, BCA contracted with Certus Environmental Solutions (Certus) to prepare a cultural resource assessment pursuant to 36 CFR 800. Certus conducted a cultural resource inventory for the project in 2020 under report number U21HY0765. Subsequent to that survey, the project area was expanded slightly, and anticipated impacts were identified in four small areas outside the original survey area. Certus conducted an addendum assessment for these areas. The results of that addendum assessment are presented herein.		
Describe the Project Area, Area of Potential Effects, and Survey Area: The survey area is located along the eastern margin of the Skull Valley, within the boundaries of the Skull Valley Reservation. The area sits on an alluvial fan emanating from the Stansbury Mountains. Indian Hickman Canyon is located at the east end of the survey area, and a now-seasonal creek flowing therefrom extends southwesterly through the survey area and past the core housing and administrative area of the reservation. Vegetation in the survey area comprises sagebrush community species, including low sagebrush, occasional cacti, and fine bunch grasses. Ground cover ranged from barren to roughly 90-percent across the area. In addition to the ground surface disturbance from post-wildfire floods, extensive disturbance was observed in the form of two-track roads, trails, livestock grazing, and excavations for landfill uses. Several emergency flood control berms were also constructed in the general area around the time of the 2013-2014 floods.		
The survey area for cultural resources consists of four small irregularly shaped polygons located on the fringes of the original (U21HY0765) survey area (see Figures 1 and 2 , attached). These four locations total approximately 0.4 acres. The NRCS and any other involved state or federal regulatory agencies will determined the final area of potential effects (APE) as part of their permitting or funding authorizations. The survey area is located in Township 5 South, Range 8 West, Section 11 of the Salt Lake Base and Meridian. This area is found on USGS 7.5 minute topographic quadrangle Deseret Peak West, Utah (see Figure 2 , attached). Lands on which the undertaking addressed herein would occur are part of the Skull Valley Reservation.		

FILE SEARCH

Location of Records Search: Utah Division of State History Sego and HUB online systems	Date: October 17, 2020
Summary of File Search: Certus conducted a file search and archival of information regarding past cultural resource surveys, known cultural resource sites, and potential cultural resource sites in the survey area. This research was conducted October 17, 2020. According to Sego records, 10 prior regulatory-based cultural resource assessments have taken place within 1/2 mile of the current survey area. These surveys occurred between 1979 and 2018. None encompassed any portion of the current survey area. The Sego and HUB file search indicates that 11 archaeological sites have been documented previously in the 1/2 mile file search area. None of the sites are located in the current survey areas.	

RESULTS

Date of Survey: October 28, 2020	Surveyor: Sheri Murray Ellis P.I. Permit #: 176
Results: No cultural resources were identified in any of the addendum survey polygons.	

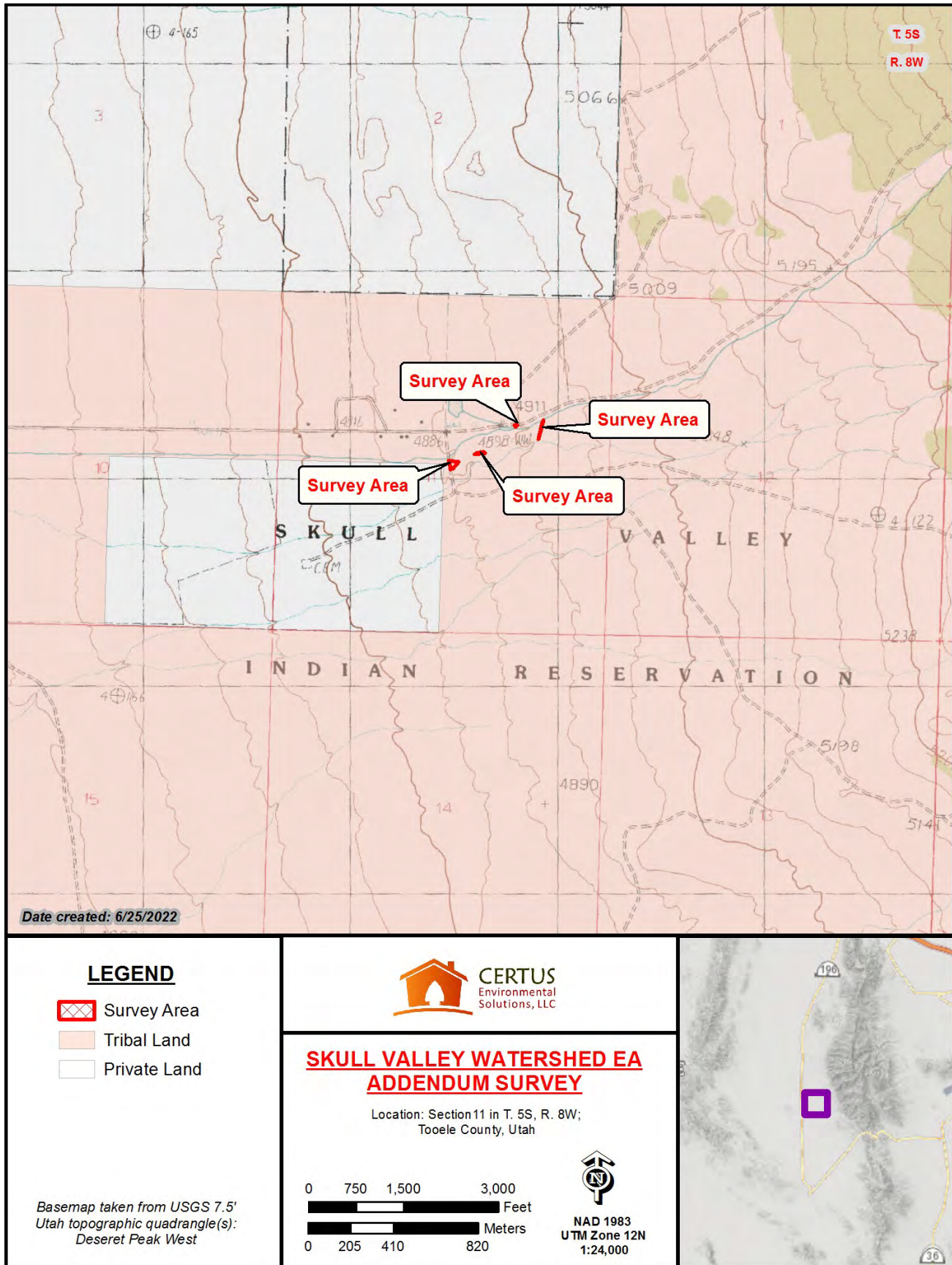


Figure 1. Location of survey area; topographic map



Figure 2. Location of survey area; aerial map