D

Investigations and Analyses Report

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Appendix D1 Hydrology and Hydraulics

Hydrology and Hydraulics

Project:	Box Butte Watershed Plan - Environmental Assessment
Date:	Friday, May 10, 2024

D1.1 Introduction

This memorandum details the hydrologic and hydraulic analyses completed to support the Box Butte Creek Watershed Plan and Environmental Assessment (Plan-EA). This memorandum provides information on the following elements:

- Data collection
- Watershed characteristics and modeling approach
- Hydrologic and hydraulic modeling results
- Preliminary floodplain analysis

D1.2 Data Collection

Various documents and datasets were collected to support the hydrologic and hydraulic analyses and alternatives development. The data collection is summarized in Table D1-1.

Table D1-1. Data Collection Summary

Category	Data	Source	Notes
Reports and Studies	Damage Survey Reports	Upper Niobrara White Natural Resources District (UNWNRD)	Maps of observed roadway damages. Round 1: March 2019 Round 2: July 2019
Field Reconnaissance	Hydraulic Structure Data	HDR 2021a	Basic dimensions obtained for accessible structures at key locations based on field reconnaissance performed by HDR in May 2021. Documented via memo dated May 17, 2021.
Hydrology and Hydraulics	Statewide Land Use Mapping (2005)	University of Nebraska – Lincoln, Center for Advanced Land Management Information Technologies (CALMIT)	Used to develop loss parameters and roughness.
Hydrology and Hydraulics	National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Precipitation Data	NOAA 2020	Used for meteorologic inputs.

Category	Data	Source	Notes
Hydrology and Hydraulics	Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) Soils Data	NRCS 2020	Used to develop loss parameters.
Hydrology and Hydraulics	Hydrologic Unit Code (HUC) Dataset	Esri	HUC watershed boundaries for use in hydrologic calculations.
Hydrology and Hydraulics	Historical Precipitation Data	NOAA National Centers for Environmental Information (NCEI) Global Historical Climatology Network (GHCN)	Historical daily precipitation data at Alliance Municipal Airport (USW00024044) and Hemingford. Used to confirm hydrologic analysis and results.
Reference Data and Terrain	Aerial Imagery	Eagleview Pictometry	Review of basin characteristics and infrastructure locations.
Reference Data and Terrain	ArcGIS Aerial Imagery	Esri, Maxar, Earthstar Geographics, GIS User Community	Review of basin characteristics and infrastructure locations.
Reference Data and Terrain	U.S. Geological Survey (USGS) 1-meter NE Hat White Sioux 2016	USGS 3DEP LidarExplorer	Used for hydrologic and hydraulic analyses.
Reference Data and Terrain	Statewide Parcel Data	Nebraska Department of Natural Resources (NeDNR)	Correlating damage locations to parcel boundaries.
Floodplain Analysis	Two-dimensional (2D) hydraulic model (rain on grid with dss hydrology files)	NeDNR	Based on correspondence with NeDNR, the model is considered “draft” and will be used for future preliminary Flood Insurance Rate Map (FIRM) mapping. NeDNR indicated that this would be acceptable for this project for the purpose described in the subsequent sections.

D1.3 Watershed Characteristics and Modeling Approach

D1.3.1 Watershed Characteristics

The Box Butte Creek Watershed encompasses approximately 162,000 acres in northeast Box Butte County and west-central Sheridan County. The land is primarily agricultural and consists of grass/pasture and row crops.

D1.3.2 Modeling Approach

A HEC-HMS model was constructed to estimate rainfall runoff and flow frequency discharges. This approach used topographic mapping and land use characteristics allowing for delineation of subbasins and parameter development for defined stream channels, resulting in computation of peak discharges and runoff volumes at specific locations throughout the watershed.

The hydraulic analyses were performed using two different approaches; each is described in more detail in subsequent sections. HY-8 was used to evaluate the hydraulics at roadway damage locations and dam diversion to off-channel storage locations. HEC-RAS 2D was used to evaluate and compare inundation extents for the 100 year and 500 year at the same locations.

D1.4 Hydrologic and Hydraulic Modeling Results

Existing conditions hydrologic and hydraulic modeling was performed to calculate peak discharges for a range of precipitation events (such as 1-year, 5-year, 10-year, etc.) to establish a baseline condition to which the proposed alternatives could be compared. The modeling was performed at historical roadway damage locations identified by UNWNRD and at the dam diversion to off-channel storage locations.

D1.4.1 Hydrologic Modeling

The U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) software was used to perform hydrologic modeling. Version 4.8 was the current version when the hydrologic modeling began and was used throughout. The development of hydrologic modeling input parameters for the existing conditions model is addressed in the sections below.

Subbasin Delineation

Subbasins were initially delineated using the Hydrologic Unit Code (HUC) dataset and then refined as necessary based on the Light Detection and Ranging (LiDAR) terrain datasets obtained from the U.S. Geological Survey (USGS). Minimal terrain processing was required to convert the data from meters to feet. The HUC dataset was used to inform and confirm subbasin delineation.

Subbasin outlets were selected considering stream confluences, roadway embankments, and roadway culverts, with a target subbasin area of between 10 and 20 square miles. In some cases, there were select locations where subbasin delineation resulted in an area of less than 10 square miles because of stream reaches, upstream/downstream subbasins, and damage locations. The subbasins are shown in Figure D1-1.

Loss Method

The Soil Conservation Service (SCS) runoff curve number method was used as the loss method for all subbasins. This method considers land use (or land cover) and hydrologic soil groups (HSG) to determine the initial abstraction and rainfall excess from each subbasin. The 2005 Statewide Center for Advanced Land Management Information Technologies (CALMIT) data were used to assess land use characteristics. Land cover is shown in Figure D1-2. The CALMIT classifications were correlated to cover descriptions in TR-55 (NRCS 1986).

NRCS Soil Survey Geographic Database (SSURGO) soils data were used to determine the HSGs. The predominant HSG is A; however, all remaining soil groups (B, C, and D) are present in the basin. HSGs are shown in Figure D1-3. Using TR-55 tables, curve numbers were identified for each land use and soil combination. Composite curve numbers were then calculated for each subbasin. The subbasin curve numbers range from 52 to 84. Table D1-2 documents the curve numbers for each of the subbasins.

Figure D1-1. HMS Subbasins

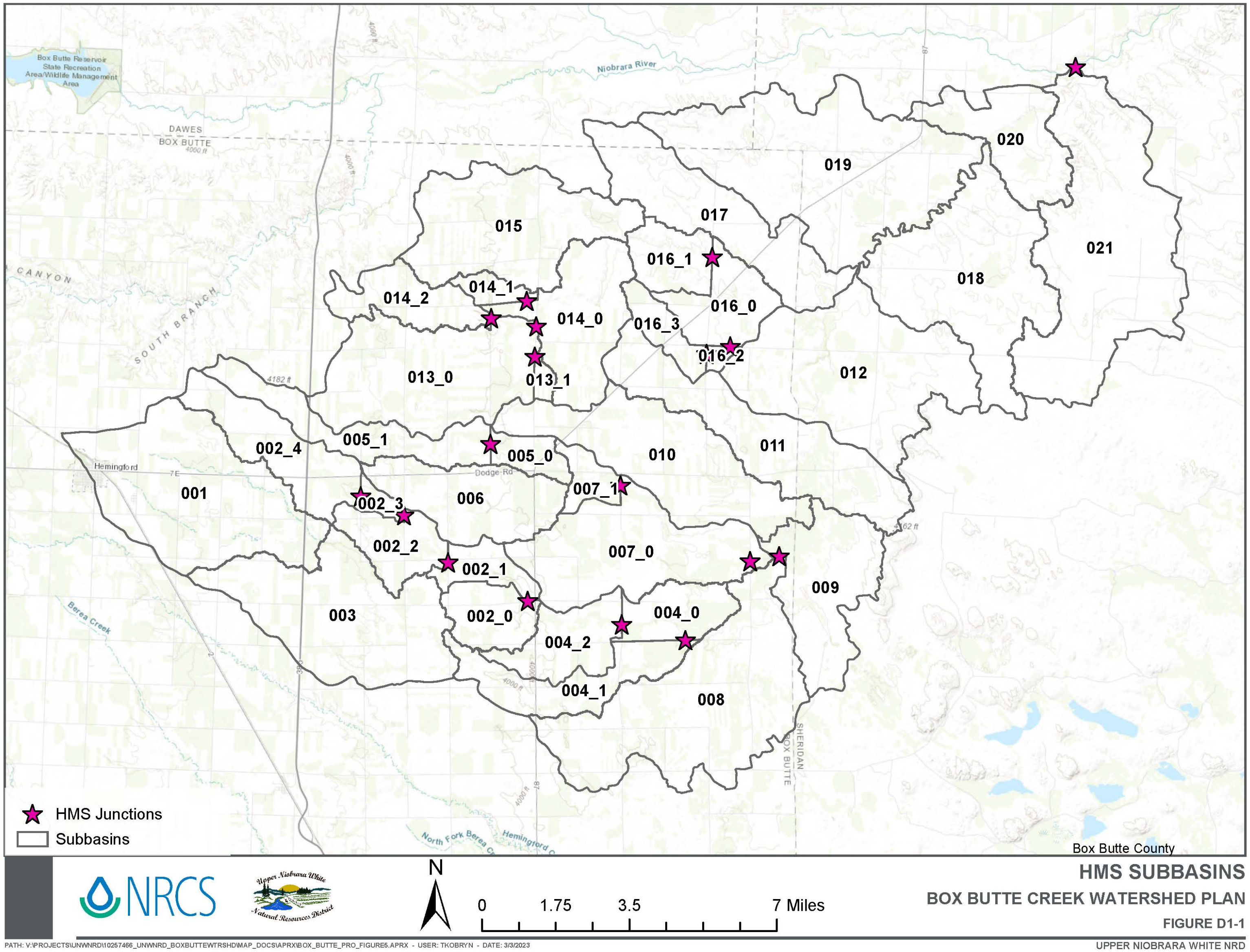

Figure D1-2. UNL CALMIT Land Cover

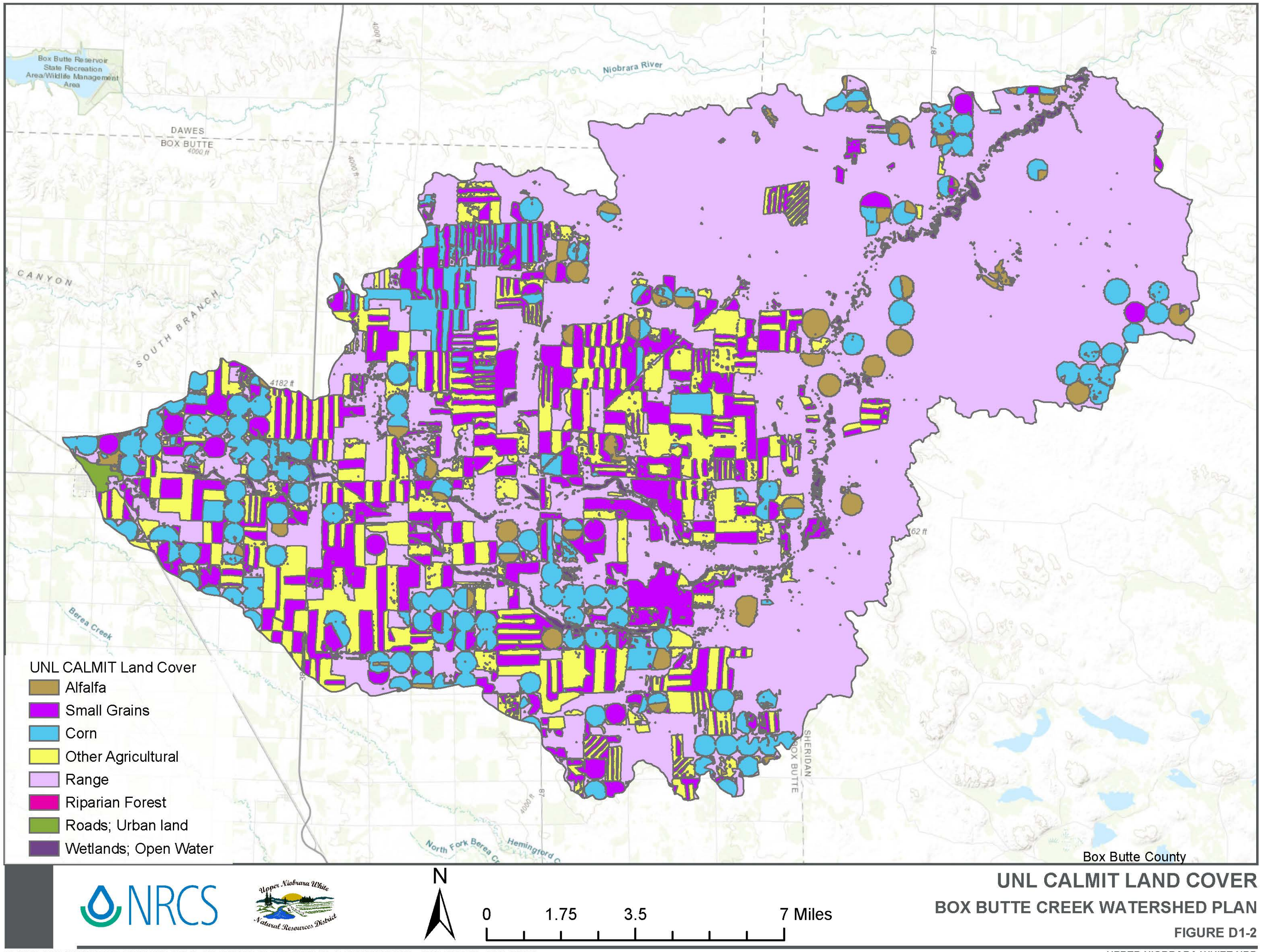

Figure D1-3. Hydraulic Soil Groups

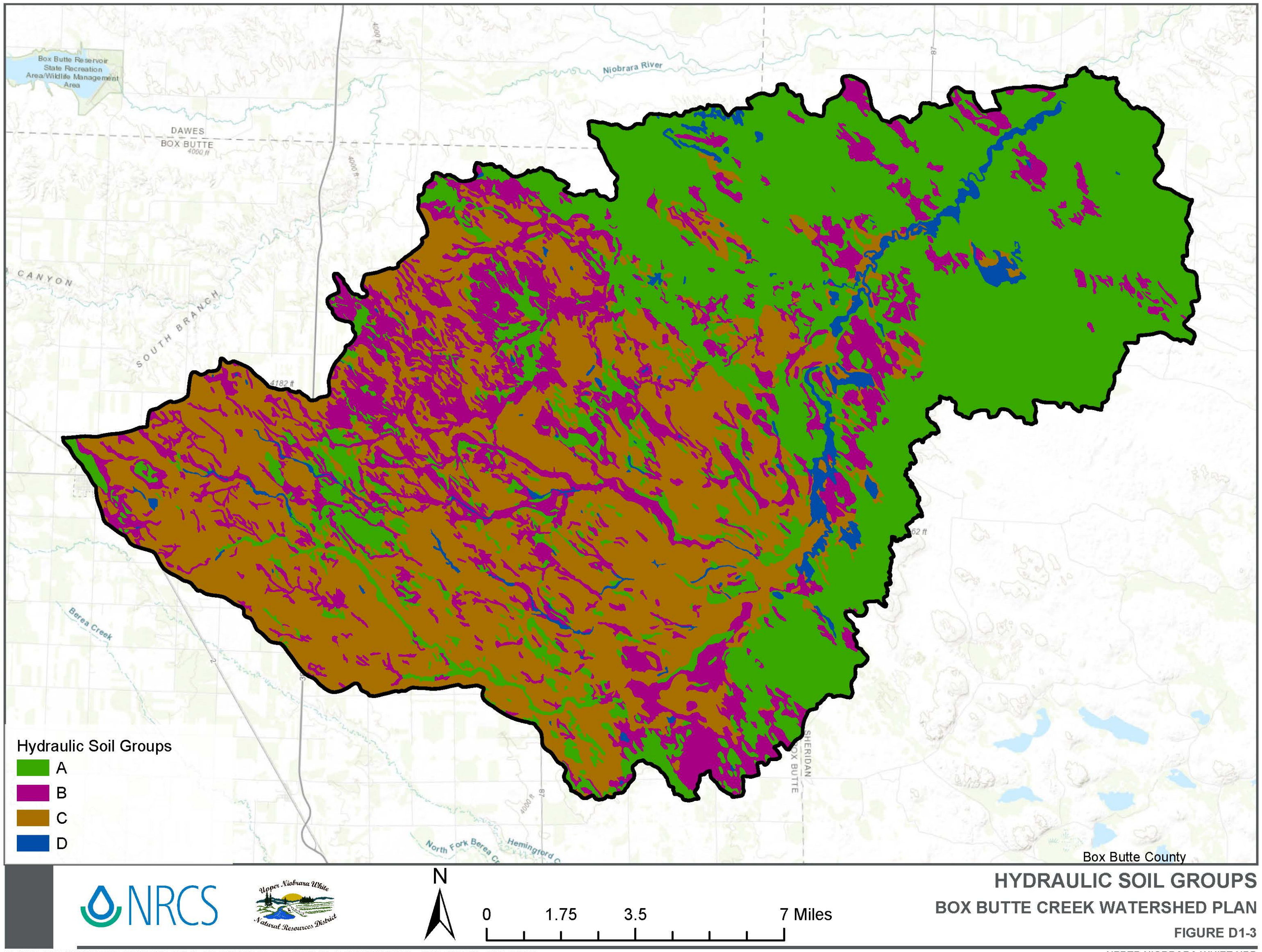

Table D1-2. Subbasin Information

Subbasin	Curve Number	Lag Time (min)	Area (mi^2)
001	82	233	14.8
002_0	83	98	3.0
002_1	80	101	2.0
002_2	78	124	3.3
002_3	73	73	0.6
002_4	80	185	5.7
003	82	230	13.1
004_0	80	141	3.1
004_1	79	246	5.0
004_2	82	138	4.0
005_0	82	84	1.6
005_1	79	239	5.2
006	78	182	6.7
007_0	79	251	10.5
007_1	79	84	1.5
008	70	333	16.8
009	57	301	7.7
010	81	270	11.2
011	72	281	10.6
012	61	379	15.2
013_0	76	266	11.7
013_1	80	55	0.4
014_0	74	188	7.0
014_1	73	97	1.0
014_2	80	145	3.8
015	71	237	11.1
016_0	64	180	3.9
016_1	55	120	2.9
016_2	79	43	0.3
016_3	70	126	1.9
017	54	422	9.4
018	53	392	14.3
019	57	559	19.2
020	57	243	5.8
021	52	467	19.3

Transform

Subbasin time of concentrations were calculated using equation 15-3b from Part 630 of the National Engineering Handbook (NRCS 2010). The contours were derived from the LiDAR terrain, specified at 1-foot intervals. The drainage area and curve numbers were determined as described previously. Subbasin lag times were calculated using the SCS lag equation. The calculated lag times are documented in Table D1-2.

Routing Reaches

The Muskingum-Cunge method was selected for reach routing. Input parameters were developed using the LiDAR terrain and geographic information system (GIS) methods. These included representative cross sections (8-point), channel slope, and basin outlet invert elevations. Manning's N (channel roughness factor) values were determined using aerial imagery and site photos.

Meteorologic Model

For application of precipitation data to the model, the centroid of the Box Butte Creek Watershed was calculated in ArcGIS. National Oceanic and Atmospheric Administration (NOAA) Atlas 14 precipitation data for this centroid were obtained via the NOAA point precipitation frequency website (NOAA 2017). The precipitation data are included in Table D1-3. A frequency storm distribution and a 24-hour storm duration were selected. It is noted that the frequency storm and SCS Type II distributions are similar, but the frequency storm incorporates additional location-specific depth-duration data.

Control Specifications

The hydrologic model runs simulate a 72-hour period with a 6-minute time interval. The 72-hour duration was used to ensure adequate duration to route runoff through the basin and to capture peak flows at areas of interest in the lower portion of the watershed.

Table D1-3. NOAA Atlas 14 Precipitation Data

NOAA Atlas 14, Volume 8, Version 2
Location name: Nebraska, USA*
Latitude: 42.3497°, Longitude: -102.8009°
Elevation: 3925.86 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.270 (0.209-0.345)	0.346 (0.268-0.442)	0.465 (0.359-0.595)	0.558 (0.429-0.716)	0.678 (0.503-0.876)	0.764 (0.558-0.997)	0.844 (0.602-1.12)	0.920 (0.636-1.24)	1.01 (0.678-1.39)	1.07 (0.711-1.50)
10-min	0.396 (0.307-0.505)	0.507 (0.393-0.648)	0.681 (0.526-0.871)	0.817 (0.629-1.05)	0.993 (0.736-1.28)	1.12 (0.818-1.46)	1.24 (0.881-1.64)	1.35 (0.931-1.81)	1.48 (0.993-2.03)	1.57 (1.04-2.19)
15-min	0.482 (0.374-0.616)	0.618 (0.479-0.790)	0.830 (0.642-1.06)	0.997 (0.767-1.28)	1.21 (0.898-1.56)	1.36 (0.997-1.78)	1.51 (1.08-2.00)	1.64 (1.14-2.21)	1.81 (1.21-2.47)	1.92 (1.27-2.67)
30-min	0.672 (0.521-0.858)	0.852 (0.660-1.09)	1.13 (0.873-1.45)	1.35 (1.04-1.73)	1.63 (1.21-2.10)	1.82 (1.33-2.38)	2.01 (1.43-2.66)	2.18 (1.50-2.93)	2.38 (1.60-3.26)	2.52 (1.67-3.51)
60-min	0.848 (0.657-1.08)	1.05 (0.810-1.34)	1.36 (1.05-1.74)	1.60 (1.23-2.06)	1.92 (1.43-2.49)	2.16 (1.58-2.82)	2.38 (1.70-3.16)	2.59 (1.79-3.49)	2.85 (1.92-3.91)	3.04 (2.01-4.23)
2-hr	1.02 (0.802-1.29)	1.24 (0.971-1.57)	1.58 (1.24-2.00)	1.86 (1.45-2.36)	2.22 (1.67-2.86)	2.49 (1.85-3.23)	2.75 (1.99-3.62)	3.00 (2.10-4.02)	3.32 (2.26-4.53)	3.55 (2.38-4.91)
3-hr	1.12 (0.882-1.40)	1.33 (1.05-1.67)	1.67 (1.31-2.09)	1.94 (1.52-2.45)	2.32 (1.76-2.97)	2.60 (1.95-3.37)	2.89 (2.10-3.79)	3.17 (2.24-4.23)	3.54 (2.42-4.81)	3.81 (2.57-5.25)
6-hr	1.29 (1.03-1.60)	1.49 (1.19-1.86)	1.83 (1.46-2.28)	2.12 (1.68-2.65)	2.53 (1.96-3.23)	2.86 (2.17-3.68)	3.19 (2.36-4.17)	3.54 (2.53-4.70)	4.00 (2.78-5.41)	4.37 (2.97-5.96)
12-hr	1.48 (1.20-1.82)	1.71 (1.38-2.10)	2.09 (1.68-2.56)	2.41 (1.93-2.98)	2.89 (2.26-3.65)	3.27 (2.51-4.17)	3.66 (2.74-4.75)	4.08 (2.96-5.38)	4.65 (3.27-6.25)	5.11 (3.51-6.90)
24-hr	1.69 (1.38-2.06)	1.96 (1.60-2.38)	2.42 (1.97-2.94)	2.81 (2.28-3.43)	3.37 (2.67-4.22)	3.82 (2.96-4.81)	4.27 (3.23-5.48)	4.75 (3.48-6.20)	5.41 (3.84-7.19)	5.92 (4.11-7.94)
2-day	1.93 (1.59-2.32)	2.27 (1.87-2.72)	2.81 (2.32-3.38)	3.28 (2.68-3.95)	3.92 (3.13-4.83)	4.42 (3.46-5.50)	4.93 (3.76-6.23)	5.44 (4.02-7.02)	6.14 (4.39-8.07)	6.67 (4.68-8.86)
3-day	2.12 (1.76-2.52)	2.47 (2.05-2.94)	3.05 (2.52-3.64)	3.53 (2.91-4.23)	4.20 (3.37-5.14)	4.72 (3.72-5.84)	5.25 (4.03-6.60)	5.79 (4.30-7.42)	6.50 (4.68-8.50)	7.05 (4.98-9.32)
4-day	2.28 (1.90-2.70)	2.63 (2.20-3.12)	3.22 (2.68-3.83)	3.71 (3.08-4.42)	4.40 (3.55-5.36)	4.93 (3.91-6.07)	5.47 (4.22-6.85)	6.02 (4.49-7.68)	6.75 (4.89-8.79)	7.31 (5.18-9.63)
7-day	2.67 (2.25-3.13)	3.04 (2.56-3.57)	3.65 (3.06-4.29)	4.16 (3.48-4.91)	4.88 (3.97-5.89)	5.44 (4.35-6.63)	6.00 (4.67-7.45)	6.58 (4.96-8.34)	7.36 (5.38-9.51)	7.96 (5.69-10.4)
10-day	3.02 (2.56-3.52)	3.42 (2.89-3.99)	4.07 (3.44-4.76)	4.63 (3.89-5.43)	5.40 (4.42-6.48)	6.00 (4.83-7.27)	6.60 (5.17-8.15)	7.23 (5.48-9.10)	8.06 (5.92-10.4)	8.70 (6.26-11.3)
20-day	4.03 (3.46-4.65)	4.58 (3.93-5.28)	5.46 (4.67-6.31)	6.19 (5.28-7.18)	7.20 (5.96-8.52)	7.96 (6.48-9.54)	8.73 (6.91-10.7)	9.50 (7.28-11.8)	10.5 (7.81-13.4)	11.3 (8.21-14.6)
30-day	4.91 (4.25-5.62)	5.59 (4.83-6.40)	6.67 (5.75-7.66)	7.55 (6.48-8.70)	8.74 (7.28-10.3)	9.63 (7.88-11.4)	10.5 (8.36-12.7)	11.4 (8.76-14.1)	12.5 (9.32-15.8)	13.3 (9.75-17.1)
45-day	6.05 (5.27-6.87)	6.88 (5.99-7.83)	8.20 (7.12-9.35)	9.25 (7.99-10.6)	10.6 (8.89-12.4)	11.6 (9.57-13.7)	12.6 (10.1-15.1)	13.5 (10.5-16.6)	14.7 (11.0-18.4)	15.5 (11.5-19.8)
60-day	7.04 (6.16-7.96)	8.00 (7.00-9.05)	9.49 (8.28-10.8)	10.7 (9.26-12.1)	12.2 (10.2-14.0)	13.3 (10.9-15.5)	14.3 (11.5-17.0)	15.2 (11.8-18.5)	16.4 (12.3-20.4)	17.1 (12.7-21.8)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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Source: NOAA 2017

D1.4.2 Hydraulic Modeling

Hydraulic modeling was performed at the roadway damage locations and at the dam diversion to off-channel storage alternative locations. At the roadway damage locations, the modeling was performed to estimate the capacity of existing culverts and the resulting roadway overtopping frequency discharge at a range of precipitation events (such as 1 year, 5 year, 10 year, etc). Hydraulic analyses were performed at various locations throughout the study area, which are shown in Figure D1-4. These locations were selected based on damages resulting from 2019 flooding, as documented by the Upper Niobrara White Natural Resources District (UNWNRD). Similarly, hydraulic analysis was performed at the dam diversion to off-channel storage alternative locations to estimate discharge capacity of the through pipe (in comparison to frequency discharges) at each diversion structure, which are shown in Figure D4-14.

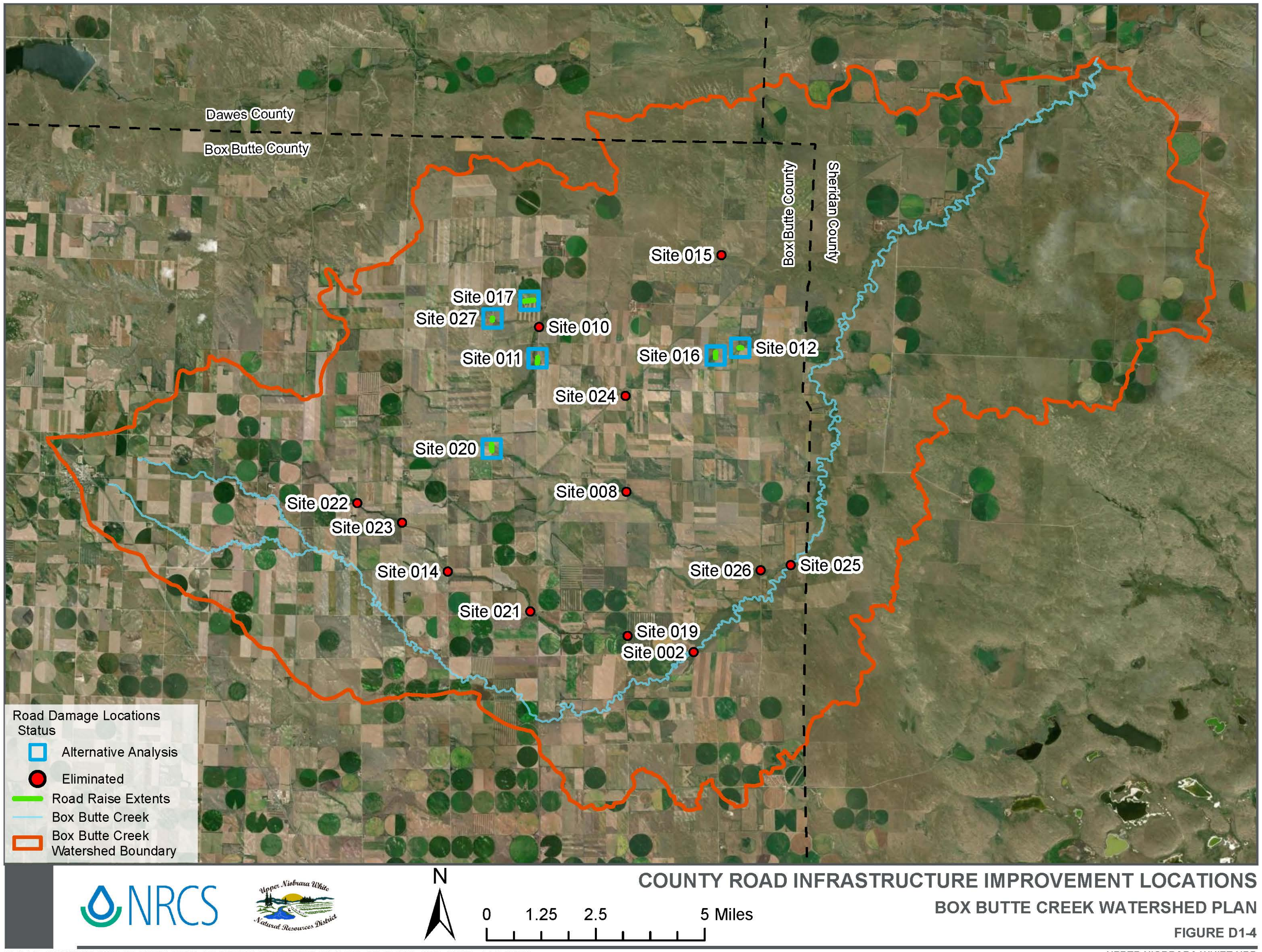
The analyses were conducted using the HY-8 Culvert Hydraulic Analysis Program administered by the Federal Highway Administration (FHWA 2019). HY-8 automates culvert hydraulic computations as well as the design methods described in Hydraulic Design Series (HDS) No. 5, Hydraulic Design of Highway Culverts (FHWA-HIF-12-026), and in Hydraulic Engineering Circular (HEC) No. 14, Hydraulic Design of Energy Dissipators for Culverts and Channels (FHWA-NHI-06-086). The program allows for culvert hydraulic computations and analysis of the following:

- Performance of culverts
- Multiple culvert barrels at a single crossing as well as multiple crossings
- Roadway overtopping at the crossing
- Report documentation in the form of performance tables, graphs, and key information regarding the input variables

Hydraulic model inputs include the following:

- Roadway Damage Locations
  - Culvert type and size (including number of barrels, length, invert, etc.)
  - Roadway information (including top of road elevation profile)
  - HMS (recurrence) peak discharge
  - Downstream (boundary) conditions (channel slope, roughness, definition)
- Dam Diversion to Off-channel Storage Locations
  - Culvert type and size (including number of barrels, length, invert, etc.)
  - Dam embankment configuration (crest height, crest length, embankment length)
  - HMS 1-year (recurrence) peak discharge
  - Downstream (boundary) conditions (channel slope, roughness, definition)

Figure D1-4. County Road Infrastructure Improvement Locations



Once the inputs are defined and the analysis is complete, the software provides the following outputs:

- Culvert discharge
- Roadway/Dam overtopping discharge (if applicable)
- Downstream (tailwater) elevation
- Upstream (headwater) elevation
- Velocity (culvert and channel)

D1.4.3 Results

Existing Condition Results

The analysis of the existing conditions was limited to only the road damage locations and concluded that the damage locations overtop at very frequent events (i.e., less than 1-year recurrence). All locations except for Site 16 overtop for the 1-year event, with overtopping depths ranging from approximately 2 to 10 inches. The length of roadway overtopped ranges from approximately 70 to 500 feet. At Site 16, roadway overtopping occurs at a frequency between the 1- and 5-year events.

The existing condition hydrologic and hydraulic analyses results are summarized by damage location in Table D1-4 and Table D1-5. It includes the 1-, 5-, 10-, and 100-year discharges; the existing structure information; the computed water surface elevation (WSEL); roadway overtopping depth; and roadway overtopping length.

Analysis of existing conditions was not conducted at the dam diversion to off-channel storage alternative locations using this approach. The approach for identifying existing and post-project conditions, specifically to estimate the inundation extents for the 100- and 500-year floodplain, is provided in Section D1.5.

Alternatives Analysis

The alternatives analyses were conducted at the road damage locations and at the dam diversion to off-channel storage alternative locations.

The analyses at the road damage locations consisted of modifying the existing condition hydraulic models with the goal of eliminating roadway overtopping for the 1-year event. This was accomplished by modifying (raising) the vertical profile of the roadway and assuming replacement of the existing culvert with a larger opening. In all cases, a 2-foot raise was assumed at the existing “sag” point in the roadway profile. LiDAR terrain was used to calculate the length of roadway impacted by the 2-foot raise.

At all damage locations, the existing culvert was assumed to be replaced with a new corrugated metal pipe (CMP) culvert. The culvert size was determined based on proposed roadway elevation (assuming the 2-foot raise), assumed minimum cover (top of road to top of pipe), and channel invert elevation. The channel invert elevation was estimated based on review of the LiDAR terrain. The final step was to identify the number of openings, which was determined by iterating the hydraulic model until the 1-year event could be discharged without roadway overtopping.

The culvert size and number of openings vary by location. The results of the alternatives analysis are summarized by damage location and included in Table D1-6 and Table D1-7.

In general, the proposed culverts range from 2 to 4 feet in diameter with 3 or 4 openings. The exception is at Site 27, where the existing roadway is situated nearly at grade with minimal or no fill over the adjacent floodplain. Based on a 2-foot grade raise and a 2-foot-diameter culvert, 14 openings would be required to pass the 1-year event without overtopping.

At the dam diversion to off-channel storage locations, the goal of the analysis was to estimate the discharge capacity of the through pipe (i.e. culvert) prior to overtopping of the dam crest, in comparison to the 1-year event. The following criteria were used to evaluate the hydraulics:

- Dam height: < 6 feet
- Minimum culvert size: 12 inches
- Minimum cover (dam crest to top of culvert): 1.5 ft

Table D1-8 provides a summary of the analyses at the dam diversion to off-channel storage alternative locations, including the pertinent information specific to each location.

Table D1-4. Existing Conditions Hydrologic and Hydraulic Results (1-year and 5-year)

Site	Modeled Structure	1-year Event Peak Discharge (cfs)	1-year Event WSEL (ft)	1-year Event Road Inundation Depth (ft)	1-year Event Impacted Road Length (ft)	5-year Event Peak Discharge (cfs)	5-year Event WSEL (ft)	5-year Event Road Inundation Depth (ft)	5-year Event Impacted Road Length (ft)
008	2-ft CMP	380	3925.85	0.47	183	917	3926.13	0.75	268
010	2-ft CMP	356	3941.44	0.45	536	909	3941.61	0.62	1017
011	2-ft CMP	41	3956.70	0.37	106	109	3956.93	0.60	219
012	2-ft CMP	34	3881.21	0.18	76	116	3881.57	0.54	139
016	2-ft CMP	26	3906.29			405	3907.52	0.42	345
017	2-ft CMP	26	3953.22	0.22	108	90	3953.44	0.44	216
020	2-ft CMP	146	4001.17	0.48	311	355	4001.40	0.71	486
025	2-ft CMP	1761	3857.15	0.48	67	4283	3857.68	1.01	268
027	2-ft CMP	174	3986.40	0.88	139	427	3986.85	1.33	178

Table D1-5. Existing Conditions Hydrologic and Hydraulic Results (10-year and 100-year)

Site	Modeled Structure	10-year Event Peak Discharge (cfs)	10-year Event WSEL (ft)	10-year Event Road Inundation Depth (ft)	10-year Event Impacted Road Length (ft)	100-year Event Peak Discharge (cfs)	100-year Event WSEL (ft)	100-year Event Road Inundation Depth (ft)	100-year Event Impacted Road Length (ft)
008	2-ft CMP	1249	3926.24	0.86	318	2786	3926.58	1.20	391
010	2-ft CMP	1258	3941.68	0.69	1063	2751	3941.90	0.91	1208
011	2-ft CMP	150	3957.01	0.68	269	311	3957.22	0.89	376
012	2-ft CMP	177	3881.73	0.70	177	462	3882.15	1.12	236
016	2-ft CMP	163	3907.53	0.43	345	433	3907.89	0.79	426
017	2-ft CMP	133	3953.50	0.50	456	327	3953.69	0.69	527
020	2-ft CMP	485	4001.51	0.82	511	1035	4001.83	1.14	585
025	2-ft CMP	6029	3857.92	1.25	294	12782	3859.17	2.50	417
027	2-ft CMP	582	3987.08	1.56	201	1214	3987.84	2.32	251

Table D1-6. Alternatives Analysis Hydrologic and Hydraulic Results (1-year and 5-year events)

Site	Proposed Culvert (dia., # pipes)	1-year Event Peak Discharge (cfs)	1-year Event WSEL (ft)	1-year Event Road Inundation Depth (ft)	1-year Event Impacted Road Length (ft)	5-year Event Peak Discharge (cfs)	5-year Event WSEL (ft)	5-year Event Road Inundation Depth (ft)	5-year Event Impacted Road Length (ft)
008	3-ft CMP (3)	93	3927.20			247	3927.57	0.19	541
008	4-ft CMP (3)	93	3926.64			247	3927.53	0.15	535
010	4-ft CMP (3)	186	3941.61			454	3943.07	0.08	2447
011	3-ft CMP (3)	41	3955.25			109	3956.76		
012	3-ft CMP (3)	34	3880.27			116	3882.10		
012	3-ft CMP (4)	34	3880.12			116	3881.64		
016	3-ft CMP (3)	26	3905.01			405	3906.87		
017	3-ft CMP (3)	26	3953.23			90	3955.05	0.05	1190
020	3-ft CMP (3)	146	4002.72	0.03	747	355	4002.90	0.21	771
020	3-ft CMP (4)	146	4001.97			355	4002.87	0.18	767
025	2-ft CMP (3)	127	3858.04			431	3859.05	0.38	273
027	2-ft CMP (14)	174	3987.45			427	3987.98	0.45	259

Table D1-7. Alternatives Analysis Hydrologic and Hydraulic Results (10-year and 100-year events)

Site	Proposed Culvert (dia., # pipes)	10-year Event Peak Discharge (cfs)	10-year Event WSEL (ft)	10-year Event Road Inundation Depth (ft)	10-year Event Impacted Road Length (ft)	100-year Event Peak Discharge (cfs)	100-year Event WSEL (ft)	100-year Event Road Inundation Depth (ft)	100-year Event Impacted Road Length (ft)
008	3-ft CMP (3)	342	3927.65	0.27	552	726	3927.90	0.52	579
008	4-ft CMP (3)	342	3927.62	0.24	548	726	3927.86	0.48	575
010	4-ft CMP (3)	617	3943.12	0.13	2456	1292	3943.37	0.38	2501
011	3-ft CMP (3)	150	3957.98			311	3958.51	0.18	698
012	3-ft CMP (3)	177	3883.12	0.09	331	462	3883.47	0.44	359
012	3-ft CMP (4)	117	3882.49			462	3883.39	0.36	353
016	3-ft CMP (3)	163	3908.66			433	3909.35	0.25	701
017	3-ft CMP (3)	133	3955.08	0.08	1198	327	3955.18	0.18	1224
020	3-ft CMP (3)	485	4002.97	0.28	781	1035	4003.22	0.53	813
020	3-ft CMP (4)	485	4002.95	0.26	778	1035	4003.20	0.51	811
025	2-ft CMP (3)	647	3859.23	0.56	369	1687	3859.85	1.18	502
027	2-ft CMP (14)	582	3987.50	0.64	267	1214	3988.73	1.21	287

Table D1-8. Dam Diversion to Off-channel Storage Alternative Location Hydraulic Results

Site	Contributing Drainage Area (sq. mi.)	Diversion Dam Height# (ft)	Diversion Dam Crest Length (ft)	Culvert Number of Barrels	Culvert Diameter (in)	Culvert Length (ft)	Summary of Discharges 1-year (cfs)	Summary of Discharges Culvert Flow* (cfs)	Summary of Discharges Overtopping Flow (cfs)
1	19.3	3.0	155	1	18	75	475	11.0	464.0
2	32.6	5.4	520	1	24	85	839	21.0	818.0
4a	25.1	2.5	315	1	12	40	537	3.4	533.6
5a	96.8	5.4	285	1	24	50	1401	27.6	1,373.4
6	15.6	3.8	290	1	24	50	349	21.7	327.3
7	8.6	5.4	150	1	24	70	366	22.6	343.4
8	14.8	3.9	565	1	24	50	344	18.8	325.2
9a	126.3	5.4	380	1	24	70	1465	21.9	1,443.1

#Dam crest to top of culvert
*Incipient dam diversion overtopping discharge

D1.5 Preliminary Floodplain Analysis

A Flood Insurance Rate Map (FIRM) is the official map that defines both the special flood hazard areas and the flood zones applicable to a community. The National Flood Insurance Program uses this map for floodplain management, mitigation, and insurance purposes. The flood map is the official source for determining flood risk in a community.

The 1 percent annual exceedance probability (AEP) floodplain (Zone A) for Box Butte County is shown on Flood Hazard Boundary Maps for Box Butte County, Nebraska (Unincorporated Areas), effective August 23, 1977. A Zone A identifies an approximately studied special flood hazard area for which no base flood elevations have been determined. Although base flood elevations are not provided, the community is still responsible for ensuring that new development in approximate Zone A areas is constructed using methods that will minimize flood damage.

Of the eight diversion to off-channel storage areas evaluated, all are located in a FEMA Zone A floodplain. Of the nine roadway improvement sites, five are located in a FEMA Zone A.

Table D1-9. Dam Diversion to Off-channel Storage Alternative Location FIRM Data

Site	FEMA Zone	FIRM Panel
1	A	3104160007A
2	A	3104160007A
4a	A	3104160008A
5a	A	3104160008A
6	A	3104160007A
7	A	3104160007A
8	A	3104160007A
9a	A	3104750021B

Table D1-10. Roadway Crossing Project Location FIRM Data

Site	FEMA Zone	FIRM Panel
8	A	3104160007A
10	A	3104160003A
11	A	3104160003A
12	–	3104160004A
16	–	3104160004A
17	–	3104160003A
20	A	3104160007A

Site	FEMA Zone	FIRM Panel
25	A	3104160008A
27	–	3104160003A

D1.5.1 Floodplain Analysis Approach

Because the FEMA maps were developed using approximate methods, detailed hydraulic analyses were not performed to generate the FEMA-generated FIRM mapping of the 1 percent and 0.2 percent AEP events (100- and 500-year events, respectively). Therefore, new hydraulic modeling was performed to identify the effects to the floodplain.

NeDNR provided a HEC-RAS model developed by Stantec Consulting Inc. to support the Box Butte County Study (dated November 2022). The model represents the 2D hydrology and hydraulic model developed for HUC 10 _1015000309 (Box Butte Creek) and was completed using HEC-RAS 6.2 2-D Unsteady Flow rain-on-grid option. The analysis includes the 10, 4, 2, 1, and 0.2 percent AEP events and 1 percent plus AEP event.

The rain-on-grid modeling technique allows the direct application of rainfall to a 2D mesh, combining hydrologic and hydraulic modeling. This method is implemented to simulate 2D unsteady flows in response to precipitation input using a finite volume method. This model is considered the best available data to support the floodplain analysis for this Plan-EA.

For existing conditions, the Box Butte County model geometry was modified to reflect a single 2-foot corrugated metal pipe at each of the nine roadway locations (Section D1-4). This was accomplished by adding a SA/2D connection along the top-of-road profile at each location and using the culvert editor to add the culvert. Invert elevations and lengths match those assumed in the HY-8 analysis (Section D1.4.2).

For proposed conditions, the existing conditions geometry was modified to increase the culvert capacities at each roadway crossing location and reflect a 2-foot road raise, consistent with Tables D1-6 and D1-7. This was accomplished by modifying the SA/2D connection at each roadway location. The dam diversions and off-channel storage areas were modeled in a copy of the terrain file itself through terrain modifications, which were then associated with the proposed conditions geometry.

D1.5.2 Results

Modeling results indicate that changes to the 1 and 0.2 percent AEP modeled floodplain will occur due to the construction of the off-channel storage structures in the floodplain.

Figure D1-5 and Figure D1-6 illustrate the extent of the existing and proposed modeled 1 and 0.2 percent AEP floodplains for Site 9. The modeled floodplain mapping for the remainder of the evaluated sites is included in Appendix C. While the modeled 1 and 0.2 percent AEP floodplain may differ from the FEMA-generated FIRM mapping, the impacts on regulated floodplains are anticipated to be moderate, permanent, direct, and adverse.

Impacts beyond those allowed by local, state, and federal permitting requirements will be mitigated through further design refinements within the existing project footprint. Impacts that cannot be mitigated to a level satisfactory for permitting requirements will require coordination with appropriate jurisdictions.

Figure D1-5. Roadway Damage Location: 1 Percent AEP Floodplain Map

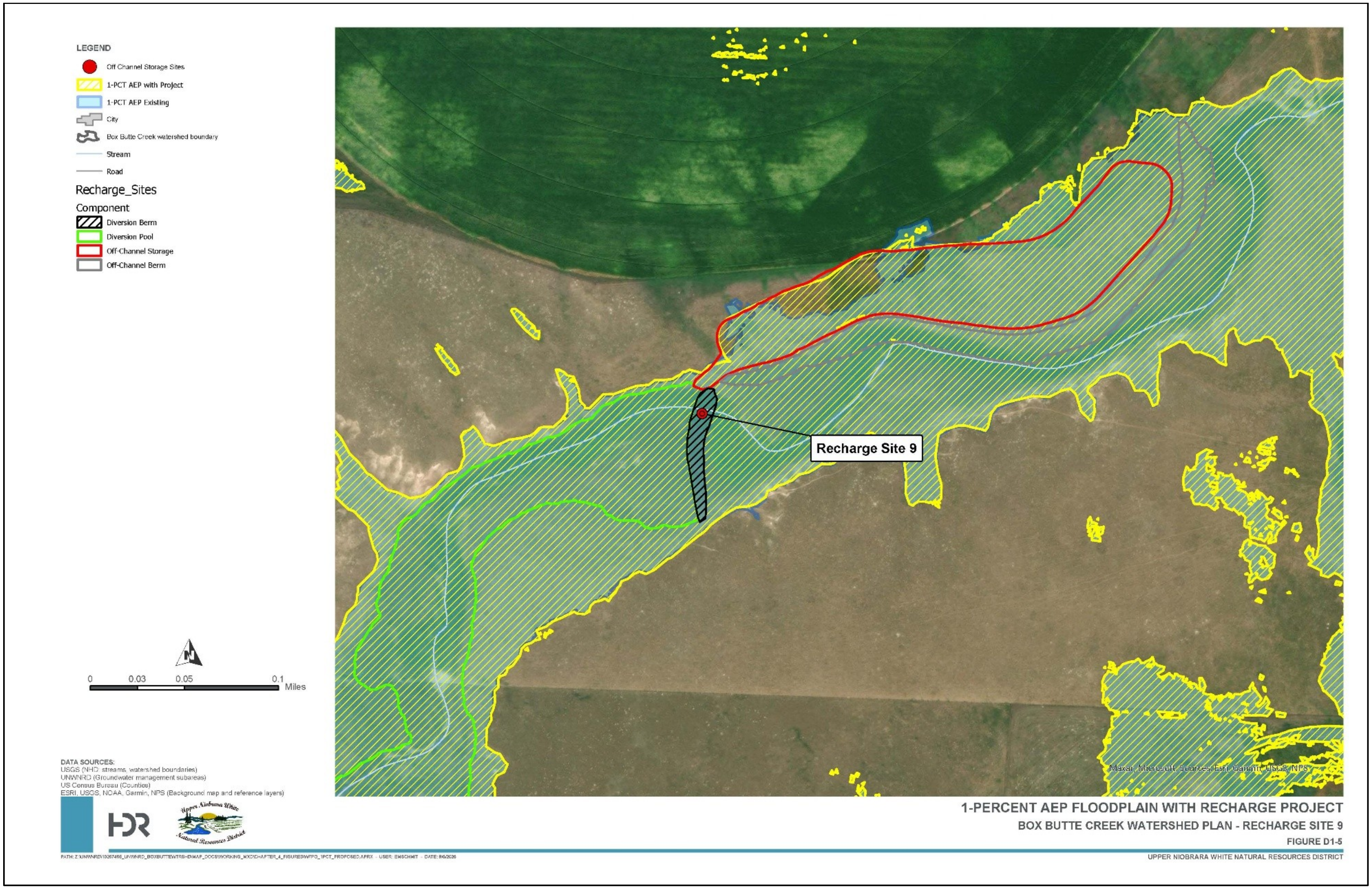
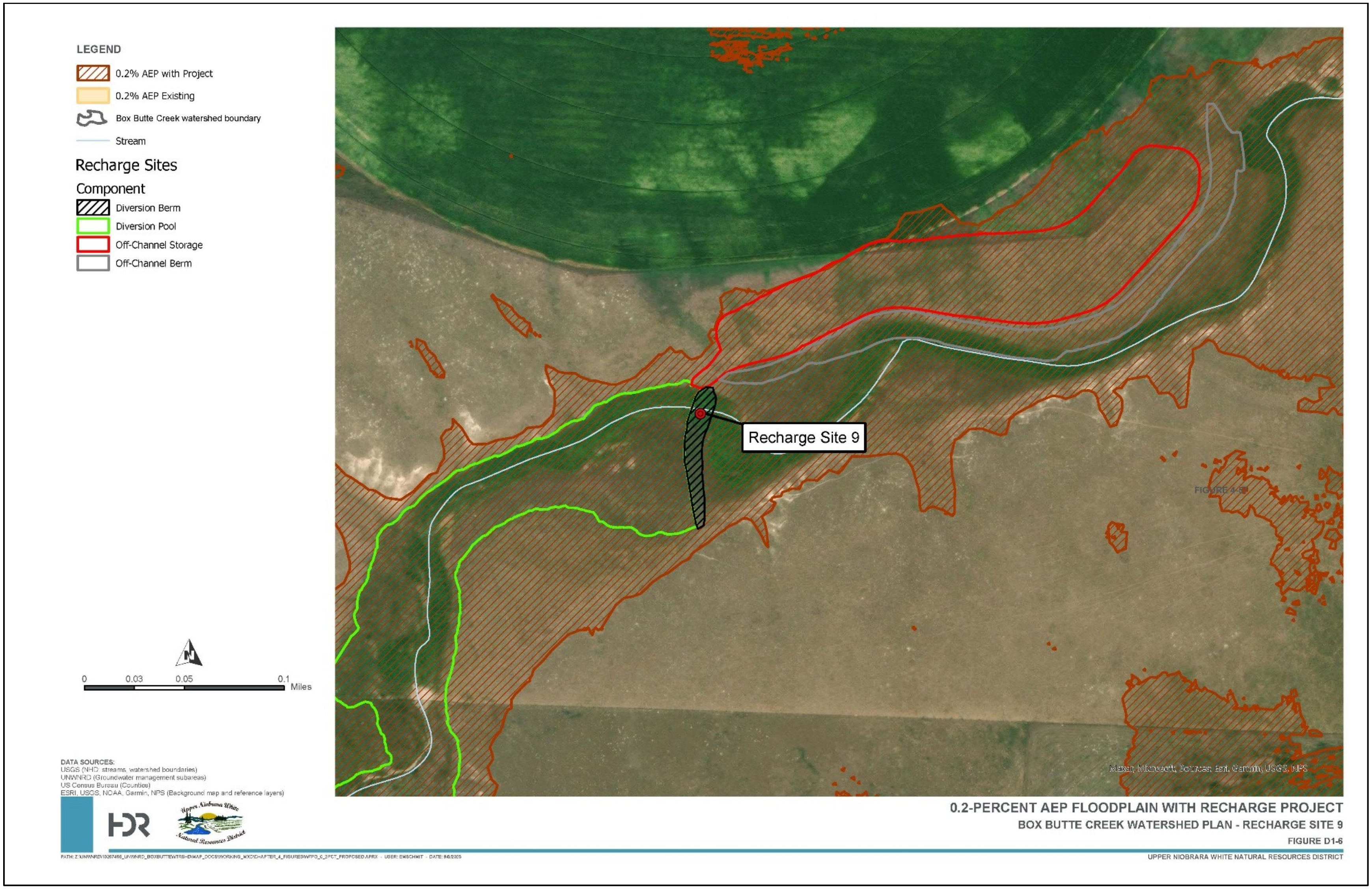


Figure D1-6. Roadway Damage Location: 0.2 Percent AEP Floodplain Map



D1.6 References

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Appendix D2 Aquatic Resources Avoidance, Minimization, and Mitigation

Aquatic Resources Avoidance, Minimization, and Mitigation

Project:	Box Butte Creek Watershed Plan - Environmental Assessment
Date:	Thursday, August 22, 2024

The purpose of this memorandum is to provide the detail needed to address Section 404 of the Clean Water Act (specifically the Section 404(b)(1) guidelines and 33 Code of Federal Regulations [CFR] 325 and 332) as well as Natural Resources Conservation Service (NRCS) policy and Executive Order 11990, Protection of Wetlands and the Food Security Act (FSA).

D2.1 Regulatory Context

This section provides the linkages between Section 404 of the Clean Water Act (specifically the Section 404(b)(1) guidelines and 33 CFR 325 and 332) and NRCS policies.

D2.1.1 Section 404 of the Clean Water Act

The Federal Water Pollution Control Act of 1972 is known today as the Clean Water Act. The U.S. Army Corps of Engineers (USACE) and the states administer the various sections of the Clean Water Act with the oversight of the U.S. Environmental Protection Agency (EPA). Section 404 of the Clean Water Act regulates the discharge of dredged or fill material into waters of the U.S., which is prohibited unless the action is exempted or is authorized by a permit issued by USACE or by the state.

In USACE's evaluation of permit applications to discharge dredged or fill material into waters of the U.S., including wetlands, USACE is required to analyze alternatives to the proposed project that achieve its purpose. USACE conducts this analysis pursuant to two main requirements: the Section 404(b)(1) guidelines (Guidelines)[1] and the National Environmental Policy Act (NEPA).[2] USACE also considers alternatives as part of its public interest review evaluation.[3]

USACE must evaluate alternatives that are practicable and reasonable. In accordance with the Guidelines at 40 CFR 230.10(a), a permit cannot be issued if a practicable alternative exists that would have fewer adverse impacts on the aquatic ecosystem (known as the least environmentally damaging practicable alternative [LEDPA]), provided that the LEDPA does not have other significant adverse environmental consequences on other natural ecosystem components. Reasonable alternatives must be considered to satisfy NEPA. However, there are no requirements with reasonable alternatives relative to USACE's permit decision similar to the Guidelines. Evaluations to address the Guidelines and NEPA normally satisfy the requirements of the public interest review.

1 40 CFR 230
2 33 CFR 325 Appendix B and 40 CFR 1508
3 33 CFR 320.4(a)(2)ii

The Guidelines include two rebuttable presumptions for projects with discharges into waters of the U.S. that involve special aquatic sites (defined at 40 CFR 240.40–45 and include wetlands, riffle pool complexes, and other specific aquatic resources) but that do not require access to or siting within the special aquatic site(s) to achieve their basic essence (that is, their basic project purpose). The first presumption states that alternatives that do not affect special aquatic sites are presumed to be available. The second presumption states that practicable alternatives located in non-special aquatic sites (for example, other waters, uplands) have fewer adverse impacts on the aquatic ecosystem. It is the applicant's responsibility to clearly demonstrate to USACE that both of these presumptions have been rebutted in order to pass the alternatives portion of the Guidelines.

D2.1.2 NRCS Policy

NRCS provides guidance for compliance with NEPA as well as executive orders. The National Watershed Program Manual[4] and National Watershed Program Handbook[5] provide the requirements for alternatives formulation. The alternatives formulation process is the basis for selecting combinations of measures to include as alternatives. Any alternative that does not meet the stated purpose and need does not get considered in detail for economic and environmental analysis.

In additional, Executive Order 11990 requires that federal agencies take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the beneficial functions of wetlands when “providing federally undertaken, financed, or assisted construction and improvements.” NRCS policy for implementing Executive Order 11990 can be found at 190-GM, Part 410, Subpart B, Section 410.26 and includes procedures for pre-conversion that involve an evaluation of potential avoidance, minimization, and mitigation measures.

Lastly, FSA requires that for wetlands that could be converted to a commodity crop, the Upper Niobrara White Natural Resources District (UNWNRD), landowners, and producers have been informed and are aware of the potential effect of the wetland conversion provisions and of the actions needed to avoid loss of program benefits.

D2.1.3 Regulatory and Policy Crosswalk

The Guidelines state that a practicable alternative is “available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall project purposes.”[6] Reasonable alternatives are based on consideration of the project purpose as well as technology, economics, and professional judgement.[7] The Guidelines may require more substantive effort to demonstrate compliance compared to NEPA,[8] and may involve limitations relative to how they can be applied to determine practicability. This is further underscored by the

[4] Title 390-501-M
[5] Title 390-600-H
[6] 40 CFR 230.3(l)
[7] Council on Environmental Quality, Forty Most Asked Questions #2A, https://www.energy.gov/nepa/articles/forty-most-asked-questions-concerning-ceqs-national-environmental-policy-act
[8] 40 CFR 230.10(a)(4)

rebuttable presumptions discussed previously, requiring it be clearly demonstrated by the applicant that the alternatives are not practicable compared to the applicant's proposed project.

The National Watershed Program Manual states that any alternative that does not meet the stated purpose and need for action does not need to be considered in detail. Alternatives that meet the need for action but do not achieve the purposes may be eliminated from detailed study. "[F]or alternatives that the agency eliminated from detailed study, briefly discuss the reasons for their elimination."[9] Alternatives that may appear reasonable but clearly become unreasonable because of cost, logistics, existing technology, or environmental reasons must be included and the reasons for elimination discussed. In addition, the Principles, Requirements, and Guidelines (PR&G) for federal investments in water resources evaluates the completeness, effectiveness, efficiency, and acceptability of each alternative.

D2.2 Avoidance Alternatives Analysis

This section provides an evaluation of the range of alternatives considered that would potentially avoid impacts on wetlands and aquatic resources for the purpose of compliance with the Guidelines and NRCS policy.

D2.2.1 Range of Alternatives and Screening

NRCS and cooperating agencies considered several alternatives during the scoping phase of this Plan-EA. The purpose of the project is to address agricultural water management through promotion of groundwater recharge and to provide flood prevention through flood damage reduction within the Box Butte Creek Watershed study area, which includes the village of Hemingford. The project is needed due to significant groundwater declines in the Box Butte Creek Watershed over the past 25 years. In addition, the Box Butte Creek Watershed has experienced four major flooding events with watershed-wide impacts in the last 10 years, as well as several intense rainfall events that have resulted in substantial flooding along Box Butte Creek and its tributaries.

The following sections summarize the screening for each project purpose.

Agricultural Water Management

A range of alternatives was identified to address the purpose of agricultural water management due to groundwater level declines, and each alternative was analyzed for its ability to meet the project purpose and to determine its reasonableness and practicability. Alternatives were also evaluated for completeness, effectiveness, efficiency, and acceptability. Table D2-1 provides the evaluation of the range of alternatives and disposition relative to evaluation within the Plan-EA. Detailed discussion of the results of screening follows.

9 40 CFR 1502.14(a)

Table D2-1. Agricultural Water Management

Alternatives	Description	Screening Methodology	Screening Results: Purpose and Need	Screening Results: Reasonableness (NEPA)	Screening Results: Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	Screening Results: PR & G	Disposition of Alternative
No Action / Future Without Federal Project	This alternative is the most likely course of action should the Sponsor not receive federal funding for the project. In this alternative, the Sponsor would continue to implement measures of their Integrated Management Plan to address groundwater resources.	NA	NA	NA	NA	NA	Carried forward for further study.
Off-Channel Storage (Passive)	Small detention areas in the uplands providing up to 1,000 acre-feet per year of overland flow (runoff from excess precipitation, snowmelt, or irrigation return flows).	Determine if off-channel storage can provide meaningful rates of recharge through the following approach: Initial Screening – Review the effectiveness of recharge for small detention areas to determine if meaningful recharge can be obtained. Pending results of initial screening, advance to Phases I and II: Phase I – Physical Passive Recharge Factors. Identify locations where passive recharge can occur based on the following factors: (1) depth to groundwater (topographic data and state-wide water table map data) (2) thickness of silt and clay in the unsaturated zone (test hole and NDNR well records). Locations identified will have between 10 and 120 feet available in the unsaturated zone (depth to groundwater) and have relatively little unsaturated zone thickness composed of silt and clay. Phase II – Identify Location of Recharge Need. Within the study area, identify the location of recharge need based on the following factors: (1) historic groundwater-level declines (since predevelopment) (2) net groundwater recharge deficit (as difference between deep drainage of water below plant root zone and the rate of groundwater pumping by high-capacity irrigation wells). Phase III – Surface Water Supply Availability. Based on results of Phase I and II, determine if diverted in-channel water supply would provide meaningful recharge (providing more than 1,000 acre-feet per year of overland flow [runoff from excess precipitation,	In areas where passive recharge factors and locations of recharge need are present, drainage areas are less than 1,000 acre-feet per year. Smaller drainage areas providing runoff of this magnitude would not provide meaningful recharge to address the project need.	NA	NA	NA	Eliminated from further study due to not meeting project purpose and need.

Alternatives	Description	Screening Methodology	Screening Results: Purpose and Need	Screening Results: Reasonableness (NEPA)	Screening Results: Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	Screening Results: PR & G	Disposition of Alternative
		snowmelt, or irrigation returns flows]). Locations identified will consider the distance of other nearby in-channel water detention structures/dams so as not to be limited in available supplies, or to unduly limit any functional benefits of such features downstream.					

Alternatives	Description	Screening Methodology	Screening Results: Purpose and Need	Screening Results: Reasonableness (NEPA)	Screening Results: Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	Screening Results: PR & G	Disposition of Alternative
Diversion to Off-Channel Storage (Passive)	Diversion from tributary or main channel stream flows to off-channel detention basins within floodplains or adjacent low-lying areas.	Determine if diversion to off-channel storage can provide meaningful rates of recharge through a three-phase approach. Phase I – Physical Passive Recharge Factors. Identify locations where passive recharge can occur based on the following factors: (1) depth to groundwater (topographic data and state-wide water table map data) (2) thickness of silt and clay in the unsaturated zone (test hole and NDNR well records). Locations identified will have between 10 and 120 feet available in the unsaturated zone (depth to groundwater) and have relatively little unsaturated zone thickness composed of silt and clay. Phase II – Identify Location of Recharge Need. Identify the location of recharge need within the study area based on the following factors: (1) historic groundwater-level declines (since predevelopment) (2) net groundwater recharge deficit (as difference between deep drainage of water below plant root zone and the rate of groundwater pumping by high-capacity irrigation wells). Phase III – Surface Water Supply Availability. Based on results of Phase I and II, determine if diverted in-channel water supply would provide meaningful recharge (providing more than 1,000 acre-feet per year of overland flow [runoff from excess precipitation, snowmelt, or irrigation returns flows]). Locations identified will consider the distance of other nearby in-channel water detention structures/dams so as not to be limited in available supplies, or to unduly limit any functional benefits of such features downstream.	In areas where passive recharge factors and locations of recharge need are present, locations for off-channel storage are available that would provide meaningful recharge.	Yes	Yes	Yes	Carried forward for further study.

Alternatives	Description	Screening Methodology	Screening Results: Purpose and Need	Screening Results: Reasonableness (NEPA)	Screening Results: Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	Screening Results: PR & G	Disposition of Alternative
In-Channel Storage (Passive Recharge)	In-channel detention structure to promote ponding, infiltration, and passive groundwater recharge.	Phase I and Phase II screening methods would be applied. Phase III – Surface Water Supply Availability. Based on results of Phase I and II, determine if diverted in-channel water supply would provide meaningful recharge (providing more than 1,000 acre-feet per year of overland flow [runoff from excess precipitation, snowmelt, or irrigation returns flows]). Locations identified will consider the distance of other nearby in-channel water detention structures/dams so as not to be limited in available supplies, or to unduly limit any functional benefits of such features downstream.	In areas where passive recharge factors and locations of recharge need are present, locations for in-channel storage are available that would provide meaningful recharge.	Yes	No. The drainage areas needed to support passive recharge would require an in-channel structure to meet NRCS standards (TR-60) for earth dams and reservoirs. These standards set minimum performance requirements for a variety of design parameters, including but not limited to dam height, storm event storage, and spillway types and capacities. These standards do not benefit the purpose of agricultural water management. Due to the cost to meet these standards, on-channel storage is not reasonable or practicable.	No. Due to the need to meet dam safety criteria without any additional benefit for the purpose of ground water recharge, this alternative does not address the problem of ground water declines nor achieve the desired opportunity efficiently.	Eliminated from further study due to unreasonable cost and inefficiency.

Alternatives	Description	Screening Methodology	Screening Results: Purpose and Need	Screening Results: Reasonableness (NEPA)	Screening Results: Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	Screening Results: PR & G	Disposition of Alternative
Injection Recharge	Collection of available surface water and injecting it directly to groundwater (below water table) in areas where geologic factors for passive recharge are limiting.	Determine if recharge via injection can provide meaningful rates of recharge through a three-phase approach. Phase I – Physical Factors for Siting Injection Sites. Identify locations where injection recharge can occur based on the following factors: (1) depth to groundwater (topographic data and state-wide water table map data) (2) inverse of Phase I screening for passive recharge. Locations identified will have between 30 and 120 feet available in the unsaturated zone (depth to groundwater). Phase II – Identify Location of Recharge Need. Identify the location of recharge need within the study area based on the following factors: (1) historic groundwater-level declines (since predevelopment) (2) net groundwater recharge deficit (as difference between deep drainage of water below plant root zone and the rate of groundwater pumping by high-capacity irrigation wells). Phase III – Surface Water Supply Availability. Based on results of Phase I and II, determine the available runoff potential to determine if the volume would provide meaningful recharge (providing more than 1,000 acre-feet per year of overland flow [runoff from excess precipitation, snowmelt, or irrigation returns flows]).	In areas where injection recharge has potential and locations of recharge need are present, including areas where surface water is available that would provide meaningful recharge.	Yes	Yes	No. The nature of this alternative requires infrastructure for both surface water storage and injection well components. Due to the added infrastructure, the efficiency of this alternative is greatly reduced as compared to passive recharge options. There are also acceptability constraints from state regulatory agencies due to regulatory requirements and water quality concerns due to injection of surface water into groundwater.	Eliminated from further study due to unreasonable inefficiency and acceptability constraints.

Agricultural Best Management Practices (Conservation Measures)	Full implementation of conservation measures on agricultural lands within the Box Butte Creek drainage basin. Non-irrigated measures may include conservation cropping systems, contour farming, diversion, grassed waterway or outlet, flat channel terrace, and level terrace. Irrigated measures may include irrigation land leveling, irrigation water management, and drainage field ditch.	From NRCS, estimate the percent of the watershed with conservation treatment measures employed and what measures are used. Qualitatively assess the potential for meaningful groundwater recharge of the various implemented measures. Qualitatively assess the potential for increasing the implementation of meaningful groundwater recharge measures.	Nebraska Soil and Water Conservation program was established in 1977 by the Department of Natural Resources (DNR) and administered by the NRD. This cost share program provides assistance to landowners who wish to install approved conservation measures. These measures aim to improve water quality and quantity and help control erosion and sedimentation. Practices eligible for the cost-share program are: • Critical Area Planting • Diversions • Dugouts for Livestock Water • Grade Stabilization Structures • Grassed Waterways • Irrigation Tailwater Recovery Pit • Irrigation Water Management • Planned Grazing Systems • Planting or Range Seeding • Repair of Practices – terraces, dams, diversions, etc. • Stream Bank Stabilization • Terrace Systems • Terrace Underground Outlets	NA	NA	NA	Eliminated from further study due to not meeting project purpose and need.

Alternatives	Description	Screening Methodology	Screening Results: Purpose and Need	Screening Results: Reasonableness (NEPA)	Screening Results: Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	Screening Results: PR & G	Disposition of Alternative
			• Water Impoundment Dams • Water and Sediment-Control Basins • Windbreaks/ Shelterbelts • Windbreak Renovation. There are 33 different types of NRCS practices in place within the study area. Of the 33 practices, 12 representing approximately 11% of the study area are assumed to result in some increase groundwater recharge. Of the 12, 4 practices (7.5% of the study area) would result in more than limited amounts of recharge. It is unreasonable to assume that broader implementation of these measures would meet the project purpose.				

*A Phase II designation will be implemented when an accumulative decline of spring static water levels equals or exceeds 3 feet below the spring 1990 static water level in a groundwater management subarea (Upper Niobrara White Natural Resources District, Ground Water Management Area and Integrated Management Area Rules and Regulations, November 2018).

Alternatives Eliminated from Detailed Study

Off-Channel Storage (Passive)

Small detention areas would be constructed in the uplands, providing up to 1,000 acre-feet per year of overland flow for runoff from excess precipitation, snowmelt, or irrigation return flows. This alternative was eliminated from further study due to not meeting the project purpose and need. In the areas where passive recharge factors and recharge need are present, the drainage areas are less than 1,000 acre-feet per year. Smaller drainage areas providing runoff of this magnitude would not provide meaningful recharge to address the project need.

On-Channel Storage (Passive Recharge)

This alternative would involve an on-channel detention structure to promote ponding, infiltration, and passive groundwater recharge. In areas where passive recharge factors and recharge needs are present, locations for on-channel storage are available that would provide meaningful recharge.

However, the drainage areas needed to support passive recharge would require an in-channel structure to meet NRCS standards (TR-60) for earth dams and reservoirs. These standards set minimum performance requirements for a variety of design parameters, including but not limited to dam height, storm event storage, and spillway types and capacities. These standards do not benefit the purpose of agricultural water management. Due to the cost to meet these standards, on-channel storage is not reasonable or practicable. In addition, due to the need to meet dam safety criteria without any additional benefit for the purpose of ground water recharge, this alternative does not address the problem of ground water declines or achieve the desired opportunity efficiently.

Injection Recharge

This alternative would include the collection and storage of surface water sources and, through the construction of an injection well, would pump the stored water directly into the groundwater aquifer. This alternative would be implemented in areas where passive recharge is not conducive due to limited geologic factors. This alternative would provide recharge opportunities in area of need where surface water is available that would provide meaningful recharge. However, UNWNRD and NRCS both expressed implementation concerns that include approvals needed from the Nebraska Department of Environment and Energy and/or NeDNR. While injection wells are used in Nebraska for remediation projects using treated water, this alternative would use untreated surface water. Because of these concerns, the Sponsor has elected not to pursue this alternative at this time but may choose to reevaluate it under a separate study.

Agricultural Best Management Practices (Conservation Measures)

This alternative would require the full implementation of conservation measures on agricultural lands within the Box Butte Creek drainage basin. Some non-irrigated measures may include conservation cropping systems, contour farming, diversion, grassed waterways or outlets, flat channel terraces, or level terraces. Irrigated measures may include irrigation land leveling, irrigation water management, or drainage field ditches. There are 33 different types of NRCS practices in place within the study area. Of the 33 practices, 12, which represent approximately 11 percent of the study area, are assumed to result in some increase in groundwater recharge. Of the 12, only 4 practices (7.5 percent of the study area) would result in more than limited amounts of recharge. It is unreasonable to assume that broader implementation of these measures could occur at the scale needed to provide suitable recharge in the areas where recharge is needed.

Alternatives Carried Forward for Detailed Study

Alternative 1 - No Action / Future Without Federal Project[10]

This alternative is the most likely course of action should the Sponsor not receive federal funding for the project. The Sponsor would continue to implement their Integrated Management Plan (UNWNRD 2011) to address groundwater management for agricultural use. Box Butte County would repair road damages on an as-needed basis.

Alternative 2 – Dam Diversion to Off-Channel Storage (Passive Recharge)

This alternative would involve an on-channel diversion structure to an off-channel storage basin (or catchment) to promote ponding, infiltration, and passive groundwater recharge. In areas where passive recharge factors and recharge needs are present, locations for diversion to off-channel storage would be available to provide meaningful recharge.

Locations for diversions to off-channel storage were determined through a multi-phase screening process. Refer to Appendix D4 for descriptions of the data sources used for the screening process.

Using topographic data and statewide water table map data during Phase I, locations were identified where passive recharge could occur based on the depth to groundwater as well as the thickness of silt and clay in the unsaturated zone using test hole and NeDNR well records. Any locations identified had between 10 and 120 feet available in the unsaturated zone (depth to groundwater) and had relatively little unsaturated zone thickness of silt and clay.

In Phase II, locations of recharge need were identified in the project area based on historic groundwater level declines (since predevelopment) and net groundwater recharge deficit (as the difference between deep drainage of water below the plant root zone and the rate of groundwater pumping by high-capacity irrigation wells).

Within areas where Phase I and Phase II locations overlap, locations were reviewed as part of a Phase III screening, which evaluated the surface area potential for any given site. A target of 750 acre-feet per year of overland flow (runoff from excess precipitation, snowmelt, or irrigation return flows) was considered to have the potential to provide meaningful recharge on a site-by-site basis. Locations were identified based on the distance of other nearby on-channel water detention structures/dams so as not to limit available supplies or unduly limit any functional benefits of such features downstream. Locations on sites with single property owners were also

[10] Note that Alternative 1 – No Action, includes both project purposes.

preferred for ease of potential acquisition and site design. As a result of this screening, a total of eight potential off-channel recharge sites were identified.

Design Considerations

Structural Design

Each diversion to off-channel storage (passive recharge) sites would include constructing a low earthen berm, which would be designed to divert portions of runoff to an off-channel storage basin (or catchment) and to have all other flows generated from runoff events overtop the structure at a controlled location. A culvert (low-flow outlet pipe) would be placed in the berm to allow for normal flows (< 1 year) to pass. These dam diversion structures would be designed to meet NeDNR criteria (NeDNR 2008) for either Minimal Hazard potential (a dam failure or misoperation would likely result in no economic loss beyond the cost of the structure itself and limited to the property owner) or Low Hazard potential (a dam failure or misoperation would result in no probable loss of human life and low economic loss). In addition, these dam diversion structures would meet NRCS Conservation Practice Standard 348 (Dam, Diversion).

Figure D2-1 and Figure D2-2 show the typical design profile and cross-section for the dam diversion structures. Table D2-2 summarizes the dimensions and anticipated storage area for each dam diversion.

Figure D2-1. Typical Dam Diversion Structure Profile

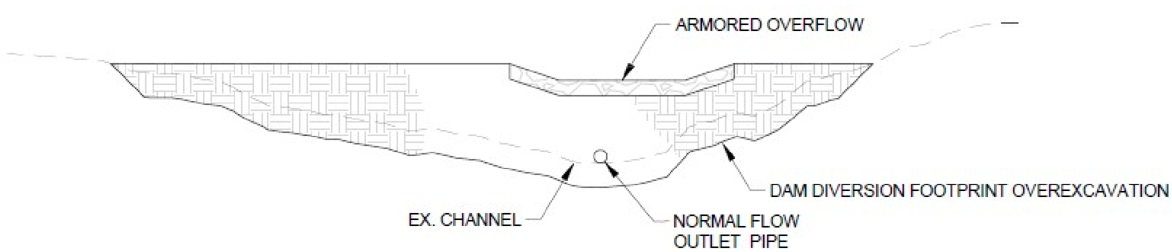
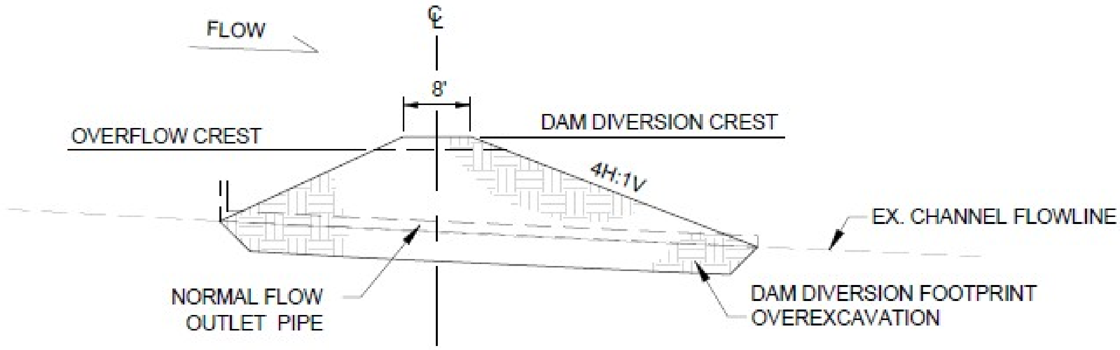


Figure D2-2. Typical Dam Diversion Section



The dam diversion structure would effectively convey water to an off-channel storage basin (catchment). These basins would be excavated in the floodplain adjacent to the diverted water source. The off-channel storage basin depth would be no deeper than the bottom elevation of the diverted water source. Side slopes would be a minimum of 3:1. Extension of the dam diversion structure would be placed around the off-channel storage basins, as site topography dictates, to contain the desired storage volume. The dam diversion extension elevation would be set at the elevation of the in-channel dam diversion structure. Borrow material for the dam diversion extension would obtained from the excavated material for the off-channel storage basins. Figure D2-3, Figure D2-4, and Figure D2-5 show the typical design of the off-channel storage basin and associated extension of the dam diversion structure. Table D2-2 provides the anticipated storage areas for the off-channel storage basins and the total length of the diversion dam structure (both in-channel and extensions).

Existing soil survey data (USDA NRCS 2025) was reviewed for the excavated areas of the off-channel storage basins for its use as borrow material for the dam diversion structures. For these structures (less than 6 feet high), the excavated material is suitable. Preliminary analysis suggests that geological conditions at the project site should not impose any impacts on future design. Geological and geotechnical investigations in accordance with NRCS policies will be completed during the project’s design phase to support these initial analyses, confirm material suitability for any structures installed, and confirm design determinations for appropriate armoring and scour protection.

Figure D2-3. Dam Diversion Extensions for Off-Channel Storage Basin Containment Profile

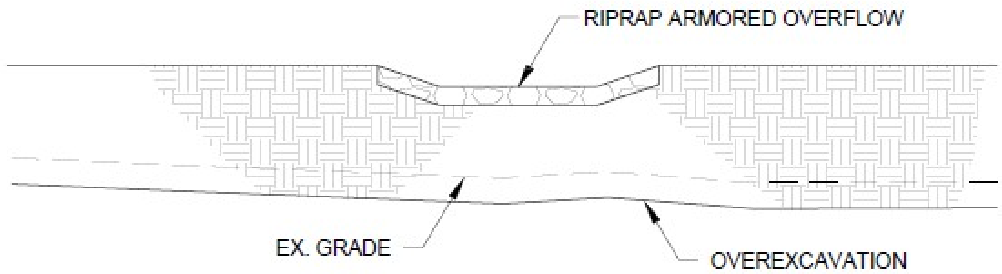


Figure D2-4. Typical Dam Diversion Extension Overflow Crest Section

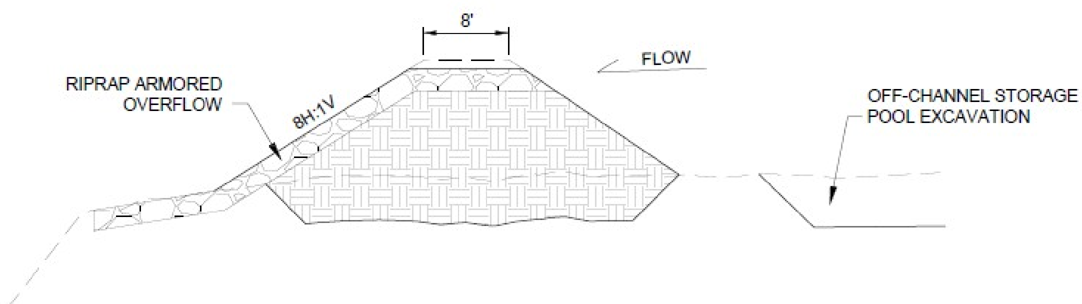


Figure D2-5. Typical Dam Diversion Extension and Off-Channel Storage Section

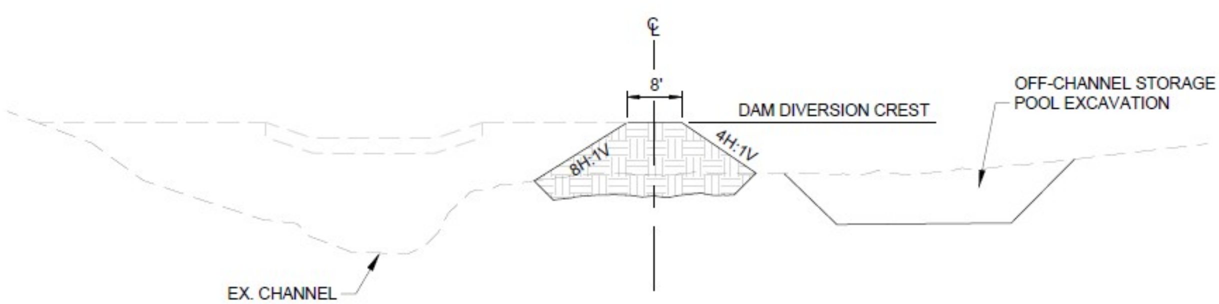


Table D2-2. Diversion to Off-Channel Storage (Passive Recharge) Site Detail

Site Identifier	Structure Length (feet)	Structure Height[1]	In-Channel Storage Volume (acre-feet)	Off-Channel Storage Basin Volume (acre-feet)	Annual Aquifer Recharge Rate (acre-feet/year)[2]	Applicable NRCS Standards
1	160	3.5	5.0	17.4	510	348
2	2,200	5.9	6.6	9.2	277	348
4a	2,625	3.0	0.6	25.0	34	348
5a	190	5.9	85.9	4.4	605	348
6	1,510	4.3	2.5	40.6	277	348
7	155	5.9	5.4	6.6	288	348
8	2,150	4.4	3.6	18.6	200	348
9a	2,165	5.9	25.0	21.9	274	348

[1] Determined from the bottom of the channel to the top of the structure.
[2] Adjusted for upstream flow capture, mounding height, and ranking of silt/clay thickness in the unsaturated zone.

Flood Damage Reduction

To address the purpose of flood damage reduction, a range of alternatives were identified, and each alternative was analyzed for its ability to meet the project purpose and to determine its reasonableness and practicability. Table D2-3 provides the evaluation of the range of alternatives and disposition relative to evaluation within the Plan-EA. Detailed discussion of the results of screening follows.

Table D2-3. Flood Damage Reduction

Alternatives	Description	Screening Methodology	Screening Results: Purpose and Need	Screening Results: Reasonableness (NEPA)	Screening Results: Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	Screening Results: PR & G	Screening Results: Disposition of Alternative
No Action / Future Without Federal Project	This alternative is the most likely course of action should the Sponsor not receive federal funding for the Project. In this alternative, Box Butte County would repair road damages on an as-needed basis.	NA	NA	NA	NA	NA	Carried forward for further study.
On-Channel Storage	Construction of flood retarding structures within the channel.	Based on location and extent of the problem areas, determine the amount of storage needed to reduce flood damages of the 1-year event.	Yes	No. The size of flood retarding structures needed to reduce flood damages for a 1-year event would require embankments greater than 6 feet in height. This would require each structure to meet high hazard criteria by NeDNR and would require principal and emergency spillways. These added costs, relative to the cost of flood damages, makes the cost of this alternative unreasonable when compared with other alternatives and the anticipated benefits.	No. This alternative is not practicable due to cost as improvements of this type would require each structure to meet high hazard criteria by NeDNR and would require principal and emergency spillways. These added costs are orders of magnitude higher than the cost of simple road raise and capacity improvements.	No. Due to the need to meet dam safety criteria, the cost of this alternative exceeds the benefits of county road damage reduction.	Eliminated from further study because it is not reasonable or logistically practicable.

Alternatives	Description	Screening Methodology	Screening Results: Purpose and Need	Screening Results: Reasonableness (NEPA)	Screening Results: Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	Screening Results: PR & G	Screening Results: Disposition of Alternative
Off-Channel Storage	Construction of small upland detention basins that would capture surface water runoff.	Based on location and extent of the problem areas, determine the amount of storage needed to reduce flood damages of the 1-year event.	Yes	No. The size of flood retarding structures needed to reduce flood damages for a 1-year event would require embankments greater than 6 feet in height. This would require each structure to meet high hazard criteria by NeDNR and would require principal and emergency spillways. These added costs, relative to the cost of flood damages, makes the cost of this alternative unreasonable when compared with other alternatives and the anticipated benefits.	No. Alternative is not practicable due to cost as improvements of this type would require each structure to meet high hazard criteria by NeDNR and would require principal and emergency spillways. These added costs are orders of magnitude higher than the cost of simple road raise and capacity improvements.	No. Due to the substantial infrastructure and investment, such as grading to achieve sufficient surface water storage of storm events to reduce the potential for roadway overtopping and/or earth dams and reservoirs (meeting associated dam design standards), this alternative does not efficiently address the problem of flood damage reduction or realize the opportunities at reasonable cost.	Eliminated from further study because it is not reasonable or practicable.
Channel/Infrastructure Improvements	Increase the capacity of the conveyance system through modification of the channel alignment and/or geometry and/or replace undersized drainage structures and/or improve other infrastructure (roadways) to provide protection from a defined damage storm. Based on hydraulic modeling, identify locations for channel improvements to safely convey a defined damage storm within the channel banks.	Evaluate the ability to eliminate roadway overtopping of the 1-year event through additional culverts and/or increased culvert size at potential road crossings that experience routine flooding. Road raises maintaining the existing county right-of-way limits will be considered.	Yes.	Yes.	Yes.	Yes.	Carried forward for further study.
Flood Protection Dikes/Levees	Implementation of specific flood projection barriers to provide flood damage reduction for specific areas of interest.	Based on location and extent of the problem areas, determine the amount of flood protection berms/levees reduce flood damages of the 1-year event.	Yes.	No. The general topography and perpendicular nature of the problem areas makes flood protection berms unreasonable or impracticable to implement.	No. Alternative is not practicable due to logistics. Sites are not conducive to dikes/levees due to general topography and perpendicular nature of the problem areas.	No. Due to the general topography and perpendicular nature of the problem areas, flood protection dikes/levees cannot be effectively implemented.	Eliminated from further study because it is not reasonable or practicable or effective.

Alternatives	Description	Screening Methodology	Screening Results: Purpose and Need	Screening Results: Reasonableness (NEPA)	Screening Results: Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	Screening Results: PR & G	Screening Results: Disposition of Alternative
Diversions	Redirecting excess flows upstream and constructing a diversion around problem areas to reduce flows to no-damage flows. Use existing drainages or drainage ditches to convey excess floodwaters.	Based on location and extent of the problem areas, determine the amount of flood protection berms/levees reduce flood damages of the 1-year event.	Yes.	No. Due to the general topography and perpendicular nature of the problem areas, diversion around the problem areas to reduce flows is not reasonable to implement.	No. Due to the general topography and perpendicular nature of the problem areas, diversion around the problem areas to reduce flows is not reasonable to implement.	No. Due to the general topography and perpendicular nature of the problem areas, diversion around the problem areas to reduce flows cannot be effectively implemented.	Eliminated from further study because it is not reasonable or practicable or effective.
Floodplain Connectivity	The intent of this alternative would be to use the historic floodplain for temporary flood storage of floodwaters. This alternative would consist of reconnecting the stream to the historic floodplain by constructing a series of grade check structures along the channel.	Based on location and extent of the problem areas, determine the amount of storage needed to reduce flood damages of the 1-year event.	Alternative would not meet project purpose and need. Due to the 1-year event causing the routine damage, the floodplain is already inundated at this event. No additional connection to the floodplain is feasible.	NA	NA	NA	Eliminated from further study.
Physical Nonstructural Measures	Use physical but nonstructural measures, such as relocation or acquisition of property prone to flood damage.	Qualitative evaluation of the potential to reduce flood damage	Yes.	No. The existing roadways cannot be relocated or acquired, so this alternative is not reasonable.	No. The existing roadways cannot be relocated or acquired, so this alternative is not logistically practicable.	No. The existing roadways cannot be relocated or acquired, so this alternative cannot be effectively implemented.	Eliminated from further study because it is not reasonable or practicable or effective.
Nonphysical, Nonstructural Measures	Land use regulation, zoning, flood insurance, floodplain mapping, damage communication, flood emergency preparedness plan.	Qualitative evaluation of the potential to reduce flood damage.	Non-physical, non-structural measures would not address the purpose or need of the project.	NA	NA	NA	Eliminated from further study.
Agricultural Best Management Practices (Conservation Measures) – Non-Structural	Full implementation of conservation measures on agricultural lands within the Box Butte Creek drainage basin. Non-irrigated measures may include conservation cropping systems, contour farming, diversion, grassed waterway or outlet, flat channel terrace, and level terrace. Irrigated measures may include irrigation land leveling, irrigation water management, and drainage field ditch.	From NRCS, estimate the percent of the watershed with conservation treatment measures employed and what measures are used. Based on literature values, reduce the peak flows by a percent reduction factor due to the use of conservation measures on the remaining lands to be treated.	The Nebraska Soil and Water Conservation program was established in 1977 by NeDNR and administered by the NRD. This cost-share program provides assistance to landowners who wish to install approved conservation measures. These measures aim to improve water quality and quantity and help control erosion and sedimentation. Practices eligible for the cost-share program are: • Critical Area Planting • Diversions • Dugouts for Livestock Water	NA	NA	NA	Eliminated from further study.

Alternatives	Description	Screening Methodology	Screening Results: Purpose and Need	Screening Results: Reasonableness (NEPA)	Screening Results: Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	Screening Results: PR & G	Screening Results: Disposition of Alternative
			• Grade Stabilization Structures • Grassed Waterways • Irrigation Tailwater Recovery Pit • Irrigation Water Management • Planned Grazing Systems • Planting or Range Seeding • Repair of Practices – terraces, dams, diversions, etc. • Stream Bank Stabilization • Terrace Systems • Terrace Underground Outlets • Water Impoundment Dams • Water and Sediment-Control Basins • Windbreaks/ Shelterbelts • Windbreak Renovation. There are 33 different types of NRCS practices in place within the study area. Of the 33 types, 12 represent approximately 11% of the study area and are assumed to result in some decrease in runoff. However, it is unreasonable to assume that broader implementation of these measures within subwatersheds where flood damages are occurring would reduce the flows to the extent that the roadways would not overtop at the 1-year event.				

*A Phase II designation will be implemented when an accumulative decline of spring static water levels equals or exceeds 3 feet below the spring 1990 static water level in a groundwater management subarea (Upper Niobrara White Natural Resources District, Ground Water Management Area and Integrated Management Area Rules and Regulations, November 2018).

Alternatives Eliminated from Detailed Study

On-Channel Storage

This alternative would involve constructing flood retarding structures within the channel upstream of county road damage to contain the 1-year flood event. The drainage areas at the location of flood damage would require an in-channel structure to meet NRCS standards (TR-60) for earth dams and reservoirs. TR-60 defines the minimum performance requirements for a variety of dam purposes. The costs to meet the performance requirements, relative to the cost of flood damages, would make the cost of this alternative unreasonable when compared with other alternatives and the anticipated benefits.

Off-Channel Storage

This alternative would involve constructing upland detention basins that would capture surface water runoff. Due to the size of the drainage areas associated with the flood damage reduction locations, the number of small upland basins would be extensive. The cost to acquire, design, construct, and maintain these structures would be substantial. These costs, relative to the cost of flood damages, makes the cost of this alternative unreasonable when compared with other alternatives and the anticipated benefits.

Flood Protection Dike/Levee

This alternative would include construction of an earthen berm and/or other flood projection barrier to provide flood damage reduction for specific areas of interest. The berm type, size, and location would be based on hydraulic modeling to identify locations to redirect flows away from flood-prone structures. Due to the general topography and perpendicular nature of the problem areas, flood protection berms are not reasonable or practicable to implement.

Diversions

This alternative would include redirecting excess flows upstream and constructing a diversion around problem areas to reduce flows to no-damage flows. Existing drainages or drainage ditches may be used to convey excess flood waters. Due to the general topography and perpendicular nature of the problem areas, diversion around the problem areas to reduce flows is not reasonable or logistically practicably to implement.

Floodplain Connectivity

This alternative would use the historic floodplain for temporary storage of floodwaters. It would consist of reconnecting the stream to the historic floodplain by constructing a series of Grade Stabilization Structures (NRCS Conservation Practice Standard 410) along the channel. Due to the 1-year event causing the routine damage, the floodplain is already inundated at this event. No additional connection to the floodplain is feasible; therefore, this alternative is not reasonable or logistically practicable to implement.

Physical Non-structural Measures

This alternative consists of physical, non-structural measures to remove properties prone to flood damage. Measures would consist of relocation and/or buyout/acquisition of property susceptible to flood damage at the 1-year event. Because the problem areas are county roads, relocation and/or buyout/acquisition is not a feasible solution. The transportation network cannot be altered in a way that would permanently change the transportation network and the access to properties it provides. The roadway cannot simply be acquired to eliminate the damage to the facility. Therefore, it is not reasonable or logistically practicable to implement physical, non-structural measures.

Non-physical, Non-structural Measures

This alternative would involve implementing non-physical, non-structural measures, such as flood warning systems, land use regulation, zoning, flood insurance, floodplain mapping, damage communication, and flood emergency preparedness planning. Ultimately, these measures would not prevent flood damage from occurring.

Agricultural Best Management Practices (Conservation Measures)

This alternative would require the full implementation of conservation measures on agricultural lands within the Box Butte Creek drainage basin. Non-irrigated measures may include conservation cropping systems, contour farming, diversion, grassed waterways or outlets, flat channel terraces, and level terraces. Irrigated measures may include irrigation land leveling, irrigation water management, and drainage field ditches. It is unreasonable to assume broader implementation of these measures within subwatersheds where flood damages are occurring would reduce the flows to the extent that the roadways would not overtop at the 1-year event.

Alternatives Carried Forward for Detailed Study

Alternative 1 - No Action / Future Without Federal Project[11]

This alternative is the most likely course of action should the Sponsor not receive federal funding for the project. The Sponsor would continue to implement their Integrated Management Plan (UNWNRD 2011) to address groundwater management for agricultural use. Box Butte County would repair road damages on an as-needed basis.

Alternative 3 - Channel/Infrastructure Improvements

The Channel/Infrastructure Improvements alternative was evaluated for multiple locations throughout the study area where routine county road damage was identified by the Box Butte County Highway Department. A hydrologic and hydraulic analysis was performed at each location. This analysis determined the magnitude of the runoff events that contribute to potential road damage. As part of this study, it was determined to focus on reducing flood damages to the smaller, more frequent events. This would allow the county road improvements to occur within existing county right-of-way, thus minimizing implementation costs. A total of nine sites were evaluated.

Road improvements for each site consist of raising the roadbed by a maximum of 2 feet and increasing the capacity of the conveyance of flow under the roadway by adding and/or enlarging

[11] Note that Alternative 1 – No Action, includes both project purposes.

the culverts under the roadway. Figure D2-6 shows the typical design for the county road improvements, and Table D2-4 summarizes each site.

Figure D2-6. Typical County Road Improvement Design Cross-Section

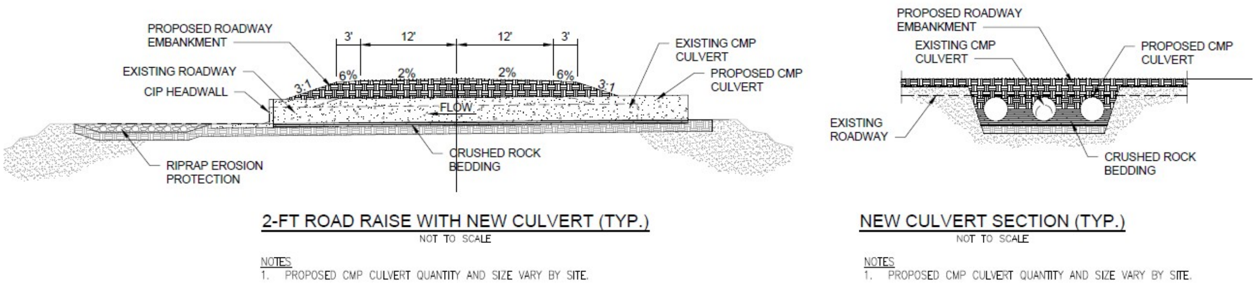


Table D2-4. Flood Damage Reduction Site Details

Site Identifier	Conveyance Improvement	Road Raise Length (ft)
8	3 x 36” CMPs	515
10	3 x 48” CMPs	2450
11	3 x 36” CMPs	655
12	3 x 36” CMPs	325
16	3 x 36” CMPs	660
17	3 x 36” CMPs	1175
20	4 x 36” CMPs	745
25	3 x 24” CMPs	370
27	14 x 24” CMPs	235

D2.3 Wetlands and Aquatic Resource Impact Minimization

This section describes the anticipated impacts to wetlands and aquatic resources.

D2.3.1 Wetland and Aquatic Resource Impacts

Table D2-5 describes the wetland and aquatic resource impacts.

Table D2-5. Dam Diversion to Off-Channel Storage Resource Impacts

Site	Permanent Impact (acres)	Temporary Impact (acres)[1]
1	**0.00**	**0.04**
Riverine Wetland	0.00	0.04
2	**0.07**	**3.92**
Freshwater Pond	0.00	0.72
Freshwater Emergent Wetland	0.00	0.65
Riverine Wetland	0.00	1.27
PEMA Wetland	0.07	1.10
Open Water	0.00	0.18

Site	Permanent Impact (acres)	Temporary Impact (acres)[1]
4a	**0.03**	**2.85**
Freshwater Emergent Wetland	0.00	0.29
Riverine Wetland	**0.03**	**2.56**
5a	**0.07**	**24.24**
Freshwater Pond	0.00	4.60
Freshwater Emergent Wetland	0.00	5.84
Riverive Wetland	0.00	0.08
PEMA Wetland	0.02	12.40
PUB Wetland	0.05	1.32
6	**0.08**	**6.75**
Freshwater Emergent Wetland	0.00	1.59
Riverine Wetland	0.00	3.71
PEMA Wetland	0.08	1.45
7	**0.00**	**0.004**
Riverine Wetland	0.00	0.004
8	**0.07**	**10.12**
Freshwater Emergent Wetland	0.00	3.88
Riverine Wetland	0.00	2.04
PEMA Wetland	0.07	4.05
Open Water	0.00	0.15
9a	**0.51**	**6.64**
Freshwater Pond	0.00	0.08
Freshwater Emergent Wetland	0.00	0.13
PEMA Wetland	0.51	6.43
TOTAL	**0.83**	**54.56**

Source: HDR, 2022
[1] Those temporary impacts outside the originally delineated area were calculated using National Wetland Inventory features.

Table D2-6. Channel/Infrastructure Improvements Resource Impacts

Site	Permanent Impact (acres)[1]
8	**0.06**
Freshwater Emergent Wetland	0.01
PEMA Wetland	0.05
10	**0.00**
11	**0.01**
PEMA Wetland	0.01
12	**0.01**
Riverine Wetland	0.01
16	**0.00**

Site	Permanent Impact (acres)[1]
17	**0.20**
PEMA Wetland	0.20
20	**0.01**
Riverine Wetland	0.01
25	**0.06**
PEMA Wetland	0.06
27	**0.01**
Riverine Wetland	0.01
TOTAL	**0.36**

Source: HDR, 2022
[1] Those impacts outside the originally delineated area were calculated using National Wetland Inventory features.

D2.3.2 Minimization

Impacts on existing natural resources and cultural resources/historic properties due to the installation of this project were identified in Chapter 5. All adverse impacts were avoided and minimized to the maximum extent practicable.

D2.4 Mitigation

Construction would have temporary, minor, adverse impacts on streams due to construction, vehicle traffic, and excavation. Minor permanent fill would be required where proposed berms intersect wetlands. There are no temporary or permanent stream impacts anticipated. Wetland mitigation would be determined during the Clean Water Act 404 permitting process. All temporarily affected resources would be restored after the project.

During construction, site mitigation measures would include erosion and sediment control, dust control, and other practices identified during the design process. Best management practices during construction would be implemented to minimize the mobilization of the sediment into stream systems, including silt fencing, bank stabilization, construction entrances, sediment storage, matting, and grassing/vegetative cover.

Impacts on existing natural resources and cultural resources/historic properties due to the installation of this project were identified in Chapter 5. All adverse impacts were avoided and minimized to the maximum extent practicable. Remaining adverse impacts, while still minor in nature, would be mitigated. In-field surveys, paired with other existing data, were utilized to determine the mitigation needs. Mitigation quantities for each resource would be based on input from NRCS resource specialists and USACE regulatory requirements. Land required for mitigation would be located at or near the project site and would be acquired by the Sponsor for the duration of the project life. All necessary mitigation plans would be developed as part of the design phase, prior to construction.

The project would be permitted with a Clean Water Act Section 404, Individual Permit. This project complies with the Food Security Act by not making wetland areas easier to farm than they currently are nor does it convert any wetlands to farmland. This project complies with EO 11990 by adequately replacing impacted wetlands with new wetlands.

Appendix D3 Economics

Economics

Project:	Appendix D. Economics
Date:	Friday, May 10, 2024

D3.1 Introduction

The Box Butte Creek Watershed comprises the area drained by Box Butte Creek from its headwaters in north-central Box Butte County as it proceeds easterly to the confluence with the Niobrara River in west-central Sheridan County (Figure 1-1). The total study area is approximately 162,000 acres (253 square miles).

Groundwater level declines and recharge deficits have been observed in Box Butte Creek Watershed (HDR 2019), primarily due to irrigation pumping demands that are larger than aquifer water replenishment through recharge. Therefore, the Upper Niobrara White Natural Resources District (UNWNRD) has initiated restrictions on the use of groundwater for irrigated agriculture. Figure 1-2 represents groundwater level changes over 10 years, from 2007 to 2017, showing a decline of approximately 2 to 17 feet over the area. Since the 1970s, groundwater levels have declined in excess of 45 feet in the study area (U.S. Geological Survey [USGS] 2021), while recharge deficits of 1 to 3 inches are prevalent (University of Nebraska-Lincoln [UNL] 2021). Due to the declines and deficits, UNWNRD has initiated restrictions on the use of groundwater for irrigated agriculture within Box Butte Creek Watershed.

Box Butte Creek typically has base flow in the early spring and summer, but that flow may be intermittent in late summer to early fall based on precipitation and corresponding irrigation. However, substantial flooding along the creek and its tributaries has occurred with increasing frequency. This flooding has resulted from four major flooding events with watershed-wide impacts in the last 10 years, including major flood events in both 2018 and 2019, and from several other events with isolated damages and intense rainfall.

The Box Butte Creek Watershed Plan and Environmental Assessment (Plan-EA) is prepared under the authority of the Watershed Protection and Flood Prevention Act of 1954 (Public Law 83-566). The Plan-EA has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code [U.S.C.] 43221 et seq.). This Plan-EA will address two of the eight purposes listed in Title 390, National Watershed Program Manual, Part 500, Subpart A, 500.3, Agricultural Water Management and Flood Prevention (Flood Damage Reduction).

D3.2 Federal Guidelines of National Economic Efficiency Analysis of Flood Mitigation and Groundwater Recharge Measures

A National Economic Efficiency (NEE) benefit-cost analysis (BCA) has been performed to evaluate benefits of the Action Alternatives. The evaluation includes an identification of damages sustained under the Future Without Federal Investment (FWOFI) Alternative and estimates the benefits associated with each Action Alternative. This analysis relies on federal water resource project and U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) guidelines for the evaluation of NEE benefits and costs. These guidelines rely primarily on the Principles, Requirements, and Guidelines (PR&G) (CEQ, 2014); the NRCS Natural Resources Economics Handbook (NRCS 1998); and the National Watershed Program Manual (NRCS 2014b).

With the passage of the 2007 Water Resources Development Act, federal agencies were directed to update the original Principles and Guidelines (P&G) from 1983. This update resulted in the creation of the PR&G. The revised purpose of the PR&G is to allow for:

> *"… maximizing public benefits (of all types) relative to costs, the use of quantified and unquantified information in the tradeoff analysis, flexibility in decision-making to promote localized solutions, ability to rely on the best available science and objectivity, and advance transparency for Federal investments in water resources."*

Further expanding the guidance on benefits, the PR&G states:

> *"Public benefits encompass environmental, economic, and social goals; include monetary and non-monetary effects; and allow for the consideration of both quantified and unquantified measures."*

The PR&G guides projects to be evaluated from an ecosystem services perspective. In order to receive federal investment, water projects must strive to:

> *"…protect and restore the functions of ecosystems and mitigate any unavoidable damage to these natural systems."*

The updated PR&G gives equal standing to economic, social, and environmental impacts when selecting an alternative. This includes both monetized and non-monetized valuation methods. This allows the analysis to fully articulate the impacts the project provides. The equal standing also allows the project to best meet the Federal Objective of maximizing public benefits and costs while ensuring the protection of ecosystem services.

D3.3 Ecosystem Services Evaluated

The resource concerns discussed above include all categories of ecosystem services present within Box Butte Creek Watershed. The ecosystem services evaluated for groundwater recharge include the groundwater available for irrigation, terrestrial and aquatic wildlife, and culture and heritage services. The ecosystem services evaluated for flood damage reduction include agricultural production, water quality, and culture and heritage services. Public scoping comments, planning documents, watershed plans from surrounding areas, and discussions with the project sponsor and federal agencies further suggest the project's primary benefits will result from groundwater recharge and flood damage reduction in Box Butte Creek Watershed.

Figure D3-1 and Figure D3-2 illustrate how the groundwater recharge and flood damage reduction actions would create social benefits within Box Butte Creek Watershed. The illustration, when used as part of the NEE BCA, describes changes in ecosystem composition all the way through to effects on social outcomes and human well-being. This would change the ecological structure of the watersheds through the construction of water harvesting basins, which includes a diversion structure and berms for some locations, to obtain enough storage for groundwater recharge. Roadway improvements would increase the public's ability for safe travel on existing infrastructure and replace undersized drainage structures to provide protection from a defined damage storm.

The described changes would provide groundwater recharge within the Box Butte Creek Watershed, thereby increasing the value of groundwater availability for irrigation services. The Channel/Infrastructure Alternative would reduce the damages to public roadways and increase the value of water quality, flood damage reauction, and dependable infrastructure.

Figure D3-1. Ecosystem Services for Groundwater Recharge

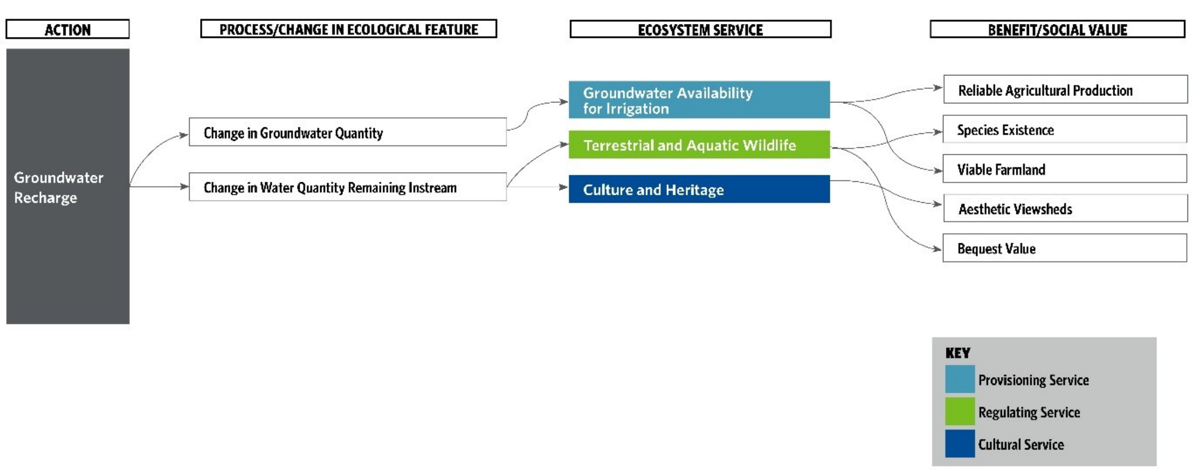
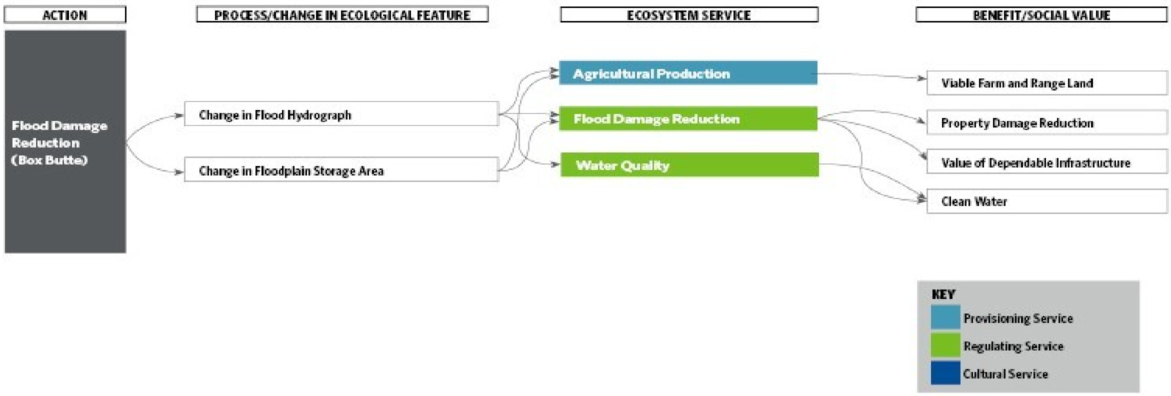


Figure D3-2. Ecosystem Services for Flood Damage Reduction



D3.3.1 Prioritizing Services

Services were prioritized based on their expected contribution to groundwater recharge and flood damage reduction. As a result, ecosystem services shown in Figure D3-1 and Figure D3-2 were prioritized for analysis. While the primary benefits are from changes to regulating services, the project may result in smaller, secondary changes to other ecosystem services.

D3.3.2 Ability to Characterize, Quantify, and Monetize Services

The passive groundwater recharge rates expected to occur at each of the 8 on-channel storage (recharge) sites that are inclusive within Alternative 2 – Dam Diversion to Off-Channel Storage, were analyzed using a step-wise procedure. This step-wise procedure involves using a steady-state analytical equation for groundwater mounding height bounded on the upper end by the water supplies (from runoff) available to each site. The analytical equation is used in an iterative fashion to limit the recharge rate when the calculated mounding height is above the land surface. Further reductions in recharge rates follow, including multiplication by defined fractions based on the combined influence of silt and clay in the unsaturated zone (potentially limiting deep percolation to the water table) and evapotranspiration, in addition to reductions to account for all sites being in operation (i.e., reductions at sites affected by operation of upstream sites).

The resulting groundwater recharge rates are presented in terms of depth and volume per year in Table D3-1. In addition, Table D3-1 provides values for the storage volume for full (top of the berm) conditions, the average annual surface (field) runoff volume at each site, the calculated radius of influence, and the remaining depth to groundwater after the steady-state adjustment to the water table (i.e., mounding) has occurred.

Table D3-1. Groundwater Recharge Rates by Site

Site Number	Storage Volume at Top of Berm (acre-feet)	Average Annual (2007–2015) Runoff Rate (acre-feet/year)	Radius of Influence (feet)	Remaining Depth to Ground-water (feet)	Recharge Rate (ft/d)	Recharge Rate (acre-feet/year)
1	23.34	1,600	1,807	0.0	0.190	531
2	26.68	2,705	990	2.4	0.193	468
4a	18.07	1,022	533	46	0.006	35
5a	4.18	7,184	984	0.1	0.435	604
6	56.55	953	407	52	0.003	30
7	14.75	706	1,039	31	0.175	353
8	49.85	893	780	42	0.063	446
9a	56.24	8,747	188	0.0	0.042	328

Hydraulic modeling was performed to estimate the discharge capacity of existing roadway culverts and the resulting roadway overtopping frequency discharge on 12 site locations that experience routine flooding. These locations were selected based on damages resulting from 2019 flooding, as documented by UNWNRD and Box Butte County.

Table D3-2. Length of Damaged Roadway from the 1-yr Event

Site	Length (ft)
8a	183
8b	183
10	536
11	106
12a	76
12b	76
16	0
17	108
20a	311
20b	311
25	67
27	139

D3.3.3 Metrics to Evaluate Services

Provisioning and regulating services are evaluated by quantifying and monetizing changes to the amount of groundwater recharge (groundwater availability for irrigation), and flood damage reduction. The monetized values are in Section D3.4.4 of this appendix.

D3.4 National Economic Efficiency Benefit-Cost Analysis Data and Methodology

For the completion of the NEE, a BCA was conducted for UNWNRD in support of a Watershed and Flood Prevention Operations (WFPO) project. This analysis compares a set of alternatives to assist in the selection of an alternative. The project will provide resilience to the community by reducing roadway damage from flooding while increasing local aquifer recharge. The benefits and costs of each alternative are estimated and compared to the FWOFI. The benefit categories analyzed within this BCA include increased aquifer recharge and the roadway damage from floods that is avoided.

The NEE analysis compares benefits derived from a comparison of the Action Alternatives against the FWOFI. The Action Alternatives consist of 20 increments located within Box Butte Creek. The Action Alternatives consist of the project types provided in Table D3-3.

Table D3-3. Box Butte Project Types

Project Alternatives	Increments of Project Alternatives in Box Butte Watershed	Description of Increment	Number of Increments
Groundwater Recharge	On-Channel Storage (Passive Recharge)	In-channel detention structures to promote ponding, infiltration, and passive groundwater recharge.	8
Flood Damage Reduction	Channel/Infrastructure Improvements	Increase the capacity of the conveyance system through modification of the channel alignment; and/or geometry; and/or replace undersized drainage structures; and/or improve other infrastructure (roadways) to provide protection from a defined damage storm.	12

D3.4.1 Incremental Analysis

NRCS and the PR&G do not treat the economic analysis as an all or nothing evaluation. In other words, even though the sum of the benefits of all the measures inclusive of each alternative might provide positive net benefits, the NEE plan must be formulated to maximize the benefits compared to costs for each alternative. To do this in the context of the NEE framework, the PR&G suggests an incremental analysis be completed. NRCS and PR&G have a requirement for incremental analysis (1962 Senate Document 97) which states that:

> *"Net benefits are maximized when the scope of development is extended to the point where the benefits added by the last increment of scale (i.e., an increment of a unit, an individual purpose in a multiple-purpose plan, or a unit in a comprehensive plan) are equal to the costs of adding that increment of scale. The increment to be considered in that way are the smallest increments on which there is a practical choice of omission from the plan."*

As such, an incremental analysis was completed for the project where benefits and costs were evaluated for each project site. The net benefits were computed and then the sites were sorted on net benefits to identify the components of the project.

D3.4.2 Future Without Federal Investment Alternative

Under the FWOFI, NRCS would not complete any of the improvements in the Action Alternatives. The FWOFI represents the project area as it currently stands. Without federal funding, the Sponsor is most likely to select the FWOFI. Though no costs are associated with this alternative, flood damages will continue to occur.

D3.4.3 Action Alternatives

The Action Alternative is implementation of Alternative 2 – Dam Diversion to Off-Channel Storage, and/or Alternative 3 – Channel/Infrastructure Improvements, or a combination of the two. Under the Action Alternative, NRCS funding will result in the implementation of projects within the Box Butte Creek Watershed. These projects aim to improve and restore groundwater levels and/or reduce flood damages. The present value of benefits and costs are computed with a 2.75 percent discount rate over 100 years. Construction of each alternative will occur over the first year of analysis. Project benefits will accrue following 1 year of construction, that is benefits begin in year 2 of the analysis and extend for 99 years until the end of the period of analysis. All benefits and costs are evaluated at the watershed level.

D3.4.4 Benefits Analysis

Economic benefits and impacts are calculated based on the expected effects of the Action Alternative and the specific project components. The project's Action Alternatives include implementation of up to 8 projects associated with Alternative 2 and 12 projects associated with Alternative 3. The potential benefits considered in the analysis include groundwater recharge benefits and the flood damage to rural roads that is avoided.

All economic benefits calculated assumed that the improvements are expected to be fully developed by 2025. The following sections describe the development of these benefit categories.

Groundwater Recharge Benefits

Groundwater level declines and recharge deficits have been observed in Box Butte Creek Watershed (HDR 2019). These declines are primarily due to irrigation pumping demands that are greater than replenishment of water to aquifers through current recharge. The study area has declining groundwater levels and UNWNRD has initiated restrictions on the use of groundwater for irrigated agriculture. The expansion of irrigated acreage has been curtailed in the study area, and allocations have been enacted on pumping from high-capacity irrigation wells.

Under the project, a selection of the Action Alternatives would improve groundwater levels through passive groundwater recharge. The projects include on-channel detention structures, which promote ponding, infiltration, and passive groundwater recharge. The quantity in acre-feet (AF) per year of groundwater recharge was estimated for each site.

The value of groundwater recharge can be estimated in a range of ways, including direct approaches, such as income capitalization; value of net irrigated agricultural production; or alternatively, through benefits transfer (BT). For the direct approaches, the quantity of groundwater recharge would need to be converted into quantity of agricultural source water, thus allowing for the estimation of impact to cash rents and/or production of irrigated agriculture in the watershed. Conversely, the BT approach allows the application of similar or equivalent values for willingness-to-pay (WTP) of water to the study area. In the BT approach, a literature search identifies WTP for water that can be transferred to the study site. These values can be either market based (values from transactions such as the sales of water from reservoirs) or non-market based (developed using WTP surveys or hedonic methods).

Since direct estimation of agricultural water supplies was going to be difficult for the Box Butte Creek Watershed, a literature search was conducted to identify any possible WTP values. These could be used to estimate the value of groundwater recharge in a BT study. In the literature search, the study "The Extent and Value of Agricultural, Municipal, and Industrial Water Use in the Niobrara Basin" (Schultz 2010) was identified. This study reviewed both historical market transactions in the Niobrara Basin and performed a hedonic study to develop WTP measures for water supplies. The results were broken down by Natural Resource District (NRD) and included UNWNRD. The study found that market values historically ranged between a low value of $24.71 per AF to a high of $169.76 per AF with a median value of $63.58 per AF. The hedonic study determined a value of $53 per AF of water used for agricultural water.[12] The value of the hedonic study results was used to estimate recharge benefits in the Box Butte Creek Watershed. This value was updated to 2024 dollars resulting in a benefit of $75.03. The high and low market values were later used to test sensitivity to the findings.

The results of the groundwater recharge benefits analysis are shown in Table D3-4.

Table D3-4. Average Annual Groundwater Recharge Benefits of Alternative 2 – Dam Diversion to Off-Channel Storage, NWPM 506.11 (FY 2024 $'s, 100-yr Period of Analysis, 2.75% Discount Rate)

Project Alternative	Site Number	FWOFI		Action	
		Quantity of Groundwater Recharge AF/Yr	Average Annual Value of Recharge Benefits $/yr	Quantity of Groundwater Recharge AF/Yr	Average Annual Value of Recharge Benefits $/yr
Alternative 2 – Dam Diversion to Off-Channel Storage	1	-	-	510	$38,520
	2	-	-	277	$20,922
	4a	-	-	34	$2,568
	5a	-	-	605	$45,696
	6	-	-	277	$20,922
	7	-	-	288	$21,602
	8	-	-	200	$15,106
	9a	-	-	274	$20,695

[12] Table 6.8 Capitalized (Annualized) and Total Irrigation Values (2000-2008), Page 58, "The Extent and Value of Agricultural, Municipal, and Industrial Water Use in the Niobrara Basin" (Schultz, 2010).

Avoided Flood Damages

Alternative 3 – Conveyance/Infrastructure Improvements, feature the replacement of deficient culverts and raising the road profiles to meet increased hydraulic standards. The improvements are expected to avoid future maintenance costs that would result from frequent floods overtopping the rural roads.

In the FWOFI, road overtopping would continue to result in maintenance costs (replacing and grading the existing gravel road) and, in extreme cases, road closures and travel delays for users. Road repair costs were estimated using lengths of roads (linear feet) inundated under the 1-, 5-, 10-, and 100-yr return periods for the FWOFI and Action Alternatives.

Road damage repair costs were estimated using a value per cubic foot of gravel and labor costs for grading. The estimated repair cost per linear foot of gravel road is $50. This value was applied to the linear feet of road damaged for each return period. The damages were then converted to expected annual amounts. The difference between damages under the FWOFI and the Action Alternative are the flood damage reduction benefits. Road replacement damages were calculated based on the linear feet of inundation. The same amount of inundation is flowing over the roadway in each scenario; therefore, raising the roadway causes that water to be spread out over a longer surface area, resulting in an increase in estimated damages. While the length of roadway inundated is greater in the proposed condition, the depth and velocity should be less, resulting in less damages. The results are shown in Table D3-5.

Table D3-5. Average Annual Flood Damage Reduction Benefits of Alternative 3- Conveyance/Infrastructure Improvements, NWPM 506.11 (FY 2024 $'s, 100-yr Period of Analysis, 2.75% Discount Rate)

Project Alternative	Site Number	Expected Annual Flood Damages		Flood Damage Reduction Benefit[1]
		FWOFI	Action	
Alternative 3 – Conveyance/Infrastructure Improvements	8a	$12,866	$17,174	-$4,309
	8b	$12,866	$17,001	-$4,136
	10	$43,991	$77,138	-$33,147
	11	$9,809	$2,012	$7,797
	12a	$6,432	$2,682	$3,750
	12b	$6,432	$1,017	$5,415
	16	$11,081	$2,020	$9,060
	17	$11,146	$37,553	-$26,407
	20a	$22,209	$40,070	-$17,861
	20b	$22,209	$24,297	-$2,088
	25	$10,390	$9,721	$668
	27	$8,835	$8,264	$571

D3.4.5 Estimated Costs

Project capital, operations, maintenance, and replacement costs (O&M) are estimated in 2024 dollars for each alternative (see Table D3-6). Costs for each project measure are included as separate items. The present value costs are compared to present value benefits for each measure. O&M costs for each alternative are assumed to be 0.5 percent of the capital cost and are estimated to include the cost of an eventual replacement of the project measure. The O&M cost estimate is also assumed to account for the difference between FWOFI and Action Alternative O&M expenditures. Average annual and amortized values are computed with a 2.75 percent discount rate over 100 years.

Table D3-6. Average Annual Costs of Action Alternatives, NWPM 506.11 (FY 2024 $'s, 100-yr Period of Analysis, 2.75% Discount Rate)

Project Alternative	Site Number	Installation Cost	Amortization of Installation Cost	Operations, Maintenance, and Replacement Cost	Total Average Annual Cost
Alternative 2 – Dam Diversion to Off-Channel Storage	1	$1,110,431	$32,707	$380	$33,087
	2	$755,190	$22,243	$810	$23,053
	4a	$1,343,803	$39,581	$1,120	$40,701
	5a	$669,610	$19,723	$650	$20,373
	6	$2,051,860	$60,436	$800	$61,236
	7	$584,599	$17,219	$750	$17,969
	8	$1,043,413	$30,733	$1,090	$31,823
	9a	$1,828,062	$53,844	$900	$54,744
Alternative 3 – Conveyance/ Infrastructure Improvements	8a	$77,244	$2,275	$3,350	$5,625
	8b	$112,996	$3,328	$4,900	$8,228
	10	$274,242	$8,078	$11,880	$19,958
	11	$88,876	$2,618	$3,850	$6,468
	12a	$61,201	$1,803	$2,650	$4,453
	12b	$71,670	$2,111	$3,110	$5,221
	16	$89,386	$2,633	$3,870	$6,503
	17	$132,263	$3,896	$5,730	$9,626
	20a	$96,244	$2,835	$4,170	$7,005
	20b	$106,692	$3,143	$4,620	$7,763
	25	$59,528	$1,753	$2,580	$4,333
	27	$143,705	$4,233	$6,230	$10,463

D3.5 Results of the NEE Benefit-Cost and Incremental Analysis

The NEE analysis results compare the benefits added by each project action. These serve as the best estimates to the economic value the preferred alternative would provide. Results are presented following NRCS guidelines (NWPM Part 506, NRCS 2014b). Table D3-7 summarizes the average annual NEE benefits and costs for the with-project actions in the Box Butte project area.

Table D3-7 also includes the results of the incremental analysis. The incrementally justifiable column depicts which actions are also economically favorable for the preferred alternative. Six of the proposed actions across the two alternatives are incrementally justified for funding with the PL 83-566. These actions are projects 1, 5, and 7 for the groundwater recharge alternative, and projects 11, 12b, and 16 for the flood damage reduction alternative.

Table D3-7. Comparison of NEE Benefits and Costs. Box Butte, Nebraska (FY 2024 $s, 2.75% Discount Factor).

Project Alternative	Project	Total Damage Reduction Benefit, Average Annual	Total Cost, Average Annual	NEE Metrics		
				BCR	Net Benefits	Incrementally Justifiable
Alternative 2 – Dam Diversion to Off-Channel Storage	1	$38,520	$33,087	1.16	$5,433	Yes
	2	$20,922	$23,053	0.91	-$2,132	No
	4a	$2,568	$40,701	0.06	-$38,133	No
	5	$45,696	$20,373	2.24	$25,323	Yes
	6	$20,922	$61,236	0.34	-$40,314	No
	7	$21,602	$17,969	1.20	$3,633	Yes
	8	$15,106	$31,823	0.47	-$16,717	No
	9a	$20,695	$54,744	0.38	-$34,049	No
	Total	**$186,030**	**$282,985**	**0.66**	**-$96,955**	
Alternative 3 – Conveyance/Infrastructure Improvements	8a	-$4,309	$5,625	-0.77	-$9,934	No
	8b	-$4,136	$8,228	-0.50	-$12,364	No
	10	-$33,147	$19,958	-1.66	-$53,105	No
	11	$7,797	$6,468	1.21	$1,329	Yes
	12a	$3,750	$4,453	0.84	-$703	No
	12b	$5,415	$5,221	1.04	$194	Yes
	16	$9,060	$6,503	1.39	$2,558	Yes
	17	-$26,407	$9,626	-2.74	-$36,033	No
	20a	-$17,861	$7,005	-2.55	-$24,866	No
	20b	-$2,088	$7,763	-0.27	-$9,850	No
	25	$668	$4,333	0.15	-$3,665	No
	27	$571	$10,463	0.05	-$9,892	No
	Total	**-$60,686**	**$95,644**	**-0.63**	**-$156,330**	

D3.6 Economic References

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Appendix D4 Groundwater Recharge

Groundwater Recharge

Project:	Box Butte Watershed Plan - Environmental Assessment
Date:	Monday, May 13, 2024

D4.1 Introduction

This memorandum describes the data sources and the analysis approach and methods used to quantify potential passive groundwater recharge rates in support of the Box Butte Creek Watershed Plan and Environmental Assessment (Plan-EA). More specifically, the recharge rate quantities are used as the basis for determining economic benefits described in Appendix D, Attachment 3. The locations of the analyzed passive recharge sites were previously determined through the multi-phase screening process under the diversion to off-channel storage (passive recharge) alternative, as described in Chapter 4 of the Plan-EA. As a result of the screening process, a total of eight potential diversion to off-channel passive recharge sites (i.e., recharge sites) were identified. Figure 4-5 of the Plan-EA and Figure D4-1 of this memorandum show the locations of these sites within the study area.

This memorandum provides information on the following elements: data sources, site characteristics and water supplies (runoff), passive groundwater recharge analysis methods and results, and limitations of this analysis.

D4.2 Data Sources

The data sources used for this analysis involve those related to defining the recharge structures and inundation areas and the water supplies (from runoff) available to each site. Water supplies provide the capacity and maximum volume of water for passive recharge to occur. In addition, site geometry and hydraulic property data are used in the groundwater recharge analysis.

D4.2.1 Upper Niobrara-White Model Output

The Upper Niobrara-White (UNW) Model was developed by the Upper Niobrara White Natural Resources District (UNWNRD) and the Nebraska Department of Natural Resources (NeDNR) to evaluate water management scenarios and estimate basin water supply and hydrologically connected areas as part of the integrated management planning process (NeDNR 2014). A component of this model is referred to as the CROPSIM process that partitions precipitation into water budget components, including surface runoff (overland flow), and calculates groundwater pumping at the grid-cell level (1x1-mile dimensions). The CROPSIM process is a soil-water balance model developed by Derrel Martin at the University of Nebraska (Martin et al. 1984; Martin 2000) that has been integrated with the UNW groundwater model that was calibrated through adjustment of CROPSIM parameters and aquifer properties to create simulated flows that captured the magnitude and dynamics of measured historic conditions (NeDNR 2014).

The water supplies available to each potential recharge site were derived from the 2007 through 2015 annual average rates of surface (field) runoff from the UNW CROPSIM process. Data were supplied directly from The Flatwater Group (the consulting firm responsible for performing computations with the CROPSIM process). For more details on the surface (field) runoff dataset, refer to NeDNR (2014) and HDR (2019).

The total thickness of materials beneath each recharge site, including saturated and unsaturated aquifer material making up the total thickness of the High Plains aquifer and younger materials, was assigned an approximate value of 320 feet (HDR 2019). This value was obtained from spot checking layer thicknesses of the UNW Model within the Box Butte Creek Watershed and was corroborated against the thicknesses obtained from several test hole logs in central Box Butte Creek Watershed, with values ranging from 286 feet to 357 feet (see the University of Nebraska–Lincoln Conservation and Survey Division test hole database [University of Nebraska–Lincoln 2021]).

Additionally, the hydraulic conductivity (effective) of the entire thickness of aquifer material (High Plains aquifer and younger) was assigned an approximate value of 3 feet per day. This was obtained from the most widespread value assigned to the calibrated UNW Model within the Box Butte Creek Watershed.

D4.2.2 Topographic Dataset

The groundwater recharge analysis required the use of a topographic dataset to serve two purposes:

1. Delineating drainage basins associated with recharge sites for use in determining the expected availability of water supplies as surface (field) runoff from the UNW Model output
2. Defining the geometry of recharge storage structures (earthen berms) and inundation area/volumes associated with the capacity of storage water ponded

The topographic dataset used is from the U.S. Geological Survey (USGS) 1-meter resolution digital elevation models (DEM) derived from Light Detection and Ranging (LiDAR) methods.

Inundation areas at each site were used to approximate the area of recharge and the radius of the recharge area (or distance from center of recharge area), required input parameters for calculation of water-table mounding height, and the expected groundwater recharge rates at each site.

D4.2.3 Depth to Groundwater (Unsaturated Zone Thickness)

The groundwater recharge analysis relied on a rate adjustment that is dependent on the thickness of the unsaturated zone (i.e., depth to groundwater) as determined and mapped in the *Groundwater Recharge Potential Analysis* report (HDR 2019). The depth to groundwater dataset was generated by differencing land surface topography and water table elevations, as performed as part of the study by HDR (2019). The influence of depth to groundwater on recharge rates is generally assumed to be the most (i.e., reducing recharge rates) where depth to groundwater is the largest because there is the potential for losses as water migrates downward (e.g., increasing soil moisture in the unsaturated zone, perching on low-permeability lenses, lateral migration in the unsaturated zone). For this analysis, this assumption was not explicitly used as it relates to this dataset; instead, this variable was used to constrain recharge rates that sites could accept if the calculated mounding height of the water table were to intersect the land surface. This is related to the concept of "rejected recharge," because recharge rates are also limited once saturated conditions are reached.

The sources of information used to calculate depth to groundwater (although not performed in this analysis) include the following:

1. LiDAR-derived 1x1-meter county-wide DEMs obtained from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) that were resampled to a 10-foot resolution

2. Statewide 50-foot water table contours of Nebraska representing spring 1995 conditions

Recharge sites were screened to exclude areas with depth to groundwater less than 10 feet and exceeding 120 feet during alternative screening. This was based on use of an aggregated version of the original data layer at the 1x1-mile scale. See HDR (2019) for complete details on the methodology used to develop the dataset of unsaturated zone thickness (depth to groundwater) across the entire UNWNRD.

D4.2.4 Thickness of Silt and Clay in the Unsaturated Zone

The groundwater recharge analysis relied on a rate adjustment based on a classification (ranking) index derived from the thickness of fine-grained (silt- and clay-rich) sediment and/or other low-permeability lithologic units in the unsaturated zone (i.e., above the water table) as determined and mapped in the *Groundwater Recharge Potential Analysis* report (HDR 2019). The ranking index describes the relative likelihood for deep percolating water in the unsaturated zone, after infiltration into the soil and movement beyond influence of plant roots, to reach the water table and become groundwater recharge. The basic premise is that silt- and clay-rich sediment (or siltstone and other low-permeability materials, such as shale, lignite, bentonite, marl, caliche, or agate) causes an increase in the duration of transmission (or percolation) of infiltrated water to reach the water table relative to sand or more coarsely textured sediment or more permeable lithologic units (such as sandstone or fracture limestone).

The 100x100-foot resolution silt and clay thickness layer was joined spatially (with ArcMap) to calculate the average silt and clay thickness within each 1x1-mile cell of the UNW Model grid. This dataset was grouped into three classes and ranked in decreasing order of silt and clay thickness, whereby the thickest silt and clay class was given a value of 1 and the thinnest silt and clay class was given a value of 3; the higher the score, the higher the likelihood that percolating water will reach the water table and recharge the underlying aquifer. A ranking index value of 3 is applied to the class where silt and clay thickness is less than 6.3 feet, while an index value of 2 is applied to the class with a thickness of between 6.3 feet and 35.1 feet. The class assigned a ranking index of 1 has a silt and clay thickness in the unsaturated zone of between 35.2 feet and 168.2 feet in the study area.

For the groundwater recharge analysis performed for this analysis, a ranking index value of 3 was excluded during alternative screening, so each site falls within classes ranked as either a 1 or 2, with thickness of silt and clay in the unsaturated zone of less than 35.1 feet based on the dataset used. See HDR (2019) for more complete details on the methodology used to develop the dataset of silt and clay thickness in the unsaturated zone across much of UNWNRD.

D4.3 Site Characteristics and Water Supplies (Runoff)

Recharge site characteristics and water supply were calculated using multiple software packages and tools, including ArcGIS, HEC-RAS, and Excel. Methods and results relating to water supplies and inundation volumes and extents are described in this section.

D4.3.1 Subbasin Delineation

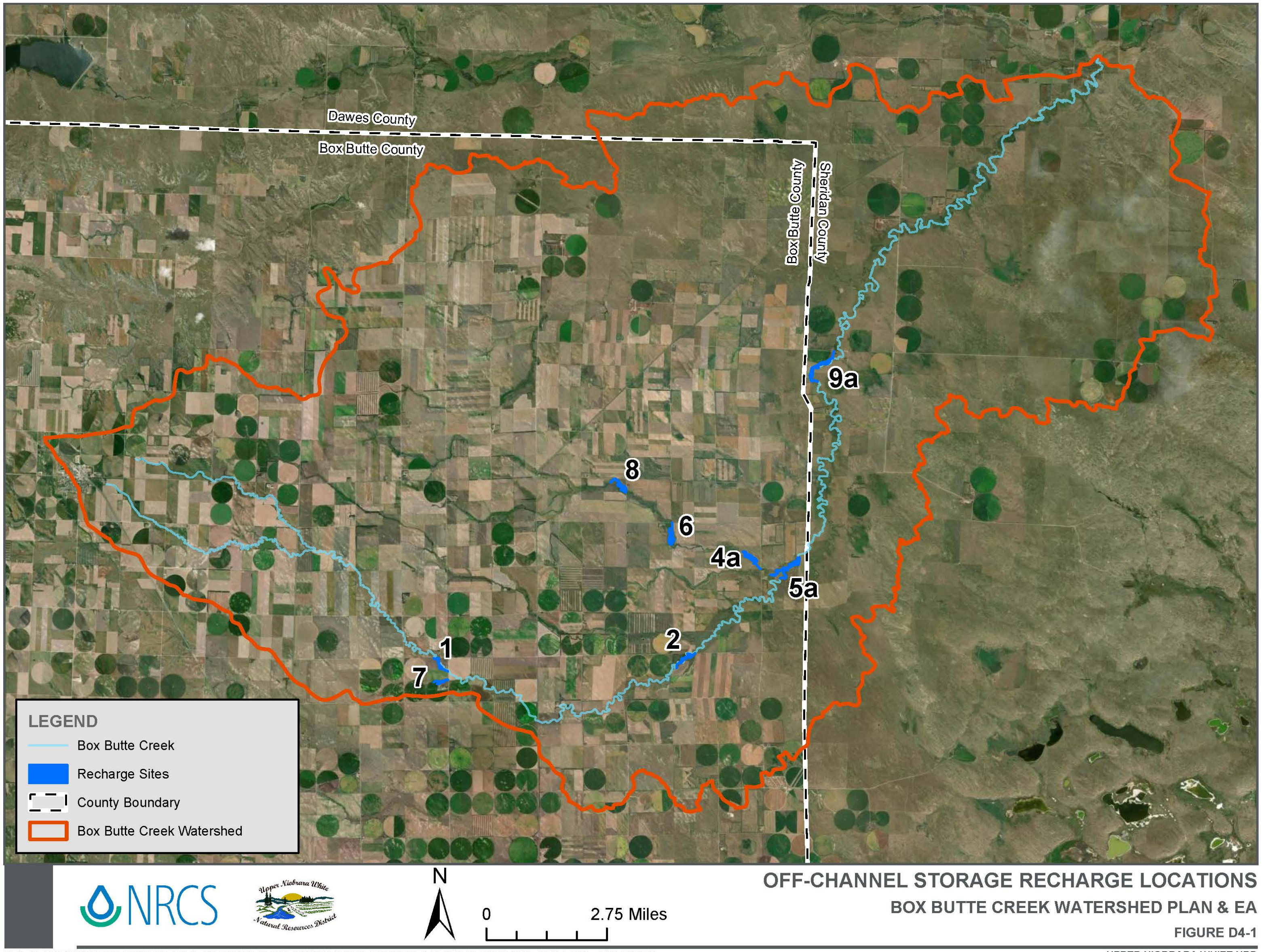
Subbasins were initially developed using the U.S. Environmental Protection Agency (EPA) hydrologic unit code (HUC) dataset and then refined, as necessary, based on the LiDAR topographic datasets obtained from USGS. Minimal terrain processing was required and used only to convert the data from meters to feet. The EPA HUC dataset was used to inform and confirm subbasin delineation.

Subbasins were delineated with the berms at the recharge sites as the outlets to which all the surface water flowing out of the subbasin watersheds would flow. The subbasins associated with all 11 recharge sites are shown in Figure D4-1.

D4.3.2 Storage Volume and Inundation Extents

The discussion in the Plan-EA (Section 4.3.1) outlines the process of determining the diversion structure berm locations and elevations, and the associated off-channel storage and total storage volumes. These berm centerlines were imported into HEC-RAS 6.1 where the terrain modification tool was used to incorporate the berms into the terrain. Then, the terrain was exported from HEC-RAS and bought into ArcGIS where the surface volume tool was used to calculate the volume behind each berm. Inundation extents were derived by querying the terrain area behind a berm where the elevation was at or below the berm elevation. These rasters were converted to shapefiles that were then used to calculate areas. The recharge site storage volumes are shown in Table D4-1.

Figure D4-1. Recharge Sites



3 PATH: Z:\PROJECTS\UNWNRD\10257466_UNWNRD_BOXBUTTEWTRSHD\MAP_DOCS\APRX\UNWNRD_BOX_BUTTE_RECHARGE_SITES_UPDATED_20240418.APRX - USER: JREMUS - DATE: 10/28/2024

D4.3.3 Average Annual Runoff

The UNW Model gridded output (2007 through 2015 average annual runoff) was clipped to each recharge site subbasin. The clipped gridded output was brought into Excel where a grid's area (acres) and runoff (inches) were used to determine a runoff volume (acre-feet) supplied to each recharge site. The recharge site storage volumes are shown in Table D4-1.

Table D4-1. Recharge Site Drainage Basin Area, Maximum Storage Volume and Inundation Area, and Water Supply Availability as Average Annual Surface (Field) Runoff

Site Number	Drainage Area (acres)	Total Storage Volume (acre-feet)	Inundation Area (acres)	Average Annual (2007–2015) Runoff Rate (acre-feet/year)
1	12,349	22.39	5.71	1,600
2	20,846	15.80	7.26	2,705
4a	11,057	25.57	12.27	1,022
5	62,080	90.26	34.97	7,184
6	10,153	43.02	11.32	953
7	5,444	12.04	4.23	706
8	9,358	22.24	8.11	893
9	82,502	46.91	19.15	8,747

D4.4 Passive Groundwater Recharge Analysis Methods

D4.4.1 Description of Procedure

The passive groundwater recharge rates expected to occur at each of the eight storage (recharge) sites are analyzed using a step-wise procedure. This step-wise procedure involves using a steady-state analytical equation for groundwater mounding height bounded on the upper end by the water supplies (from runoff) available to each site. The analytical equation is used in an iterative fashion to limit the recharge rate when the calculated mounding height is above the land surface. Further reductions in recharge rates follow, including multiplication by defined fractions based on the combined influence of silt and clay in the unsaturated zone (potentially limiting deep percolation to the water table) and evapotranspiration, in addition to reductions to account for all sites being in operation (i.e., reductions at sites affected by operation of upstream sites).

D4.4.2 Required Steps to Implement Procedure

The required steps for calculating passive groundwater recharge rates at each recharge site are as follows:

1. Determine site characteristics, dimensions, and water supply availability, including representative values for the following:

    - Depth to groundwater (or water table)

- Dimensions of the inundation area (long and short dimensions)
- Hydraulic conductivity of aquifer materials (saturated)
- Thickness of aquifer (fillable) materials above an impermeable base
- Average annual water supplies (runoff)

2. Input initial values for the recharge rate in units of length/time and multiply by the inundation area to calculate a volumetric recharge rate. Then limit the recharge volumetric rate to not exceed the maximum value defined by the average annual water supply to the site. This step is where the analytical equation from Allen (1980) is first used (described in Section D4.4.3 below).

3. Input initial values for the radius of influence and update it iteratively until the value equals that which is defined by the Sichardt empirical equation (Kyrieleis and Sichardt 1930; Powers et al. 2007), divided by 0.4 because the Sichardt equation itself yields relatively small values of the radius of influence that represents 40 percent of the maximum mound draw up (Yihdego 2018). It should be noted that the radius of influence could not be found to equal that from the Sichardt equation in all cases where the recharge rates were calculated to be relatively small. In these cases, the radius of influence was set equal to the radius of the recharge area (i.e., measured short dimension of the maximum inundation area).

4. Check that the mounding height remains less than, or equal to, the depth to groundwater, and if it exceeds depth to groundwater, then iterate by changing values of the recharge rate (Step 2) and the radius of influence (Step 3), and continue iterating until the recharge rate is maximized without the calculated water table mound exceeding the land surface elevation. For practical purposes, iterations are stopped when the mound height is within 3 feet of the depth to groundwater.

5. Reduce the recharge rates by multiplying by defined fractions to account for the approximate combined influence of silt and clay in the unsaturated zone (potentially limiting deep percolation) and evapotranspiration. Sites falling within areas ranked as values of 3 or 2 based on their silt and clay thickness (see Section 2) are multiplied by fractions of 0.8 and 0.5 (20 percent and 50 percent reductions), respectively. Here it is assumed that, at a minimum, 20 percent of the water supplies captured and ponded at each recharge site will be lost to evapotranspiration or to soil moisture that does not directly influence the water table through recharge.

6. Reduce recharge rates further for sites affected by lost water supplies assumed to have been captured during operation of upstream recharge sites. For purposes of determining economic benefits of recharge water (as described in Appendix D, Attachment 3), it has been assumed that all sites are operational and, therefore, potentially limiting recharge rates of the affected downstream sites.

D4.4.3 Analytical Equation for Groundwater Mounding

The analytical solution used to calculate steady-state (time-independent) mounding height underneath a recharge area is from Allen (1980). The solution is of a similar form to that developed by Hantush (1962), describing an exact solution for the steady-state drawdown around a discharging well with a finite radius of influence. The equation used for the groundwater recharge analysis is that from Allen (1980), reproduced as follows:

$$H^2 = D^2 + \frac{Q}{\pi K}\left(ln\frac{L}{R} + \frac{1}{2}\right)$$

where:

H = mounded water table height above the impermeable base at the center of the recharge system (feet)
D = initial saturated thickness of aquifer material (feet)
Q = volumetric quantity of water recharged (ft^3 per day)
K = saturated hydraulic conductivity of aquifer material (feet per day)
L = radius of influence (or distance to lateral hydraulic control) (feet)
R = radius of the recharge area (inundated by ponded water)

The rise of the water table mound relative to the initial water table was then calculated by subtracting the depth to groundwater from the calculated mound height, H, as the basis for comparison against the land surface.

The initial saturated thickness of aquifer material, D, was set equal to 320 feet minus the site-dependent depth to groundwater, and the saturated hydraulic conductivity for each site was set equal to 3 feet per day (as described in Section 2). The radius of the recharge area, R, was set equal to a representative short dimension of each recharge site performed by measuring inundation features using ArcMap (projected in the North American Datum of 1983 [NAD83] Nebraska State Plane coordinate system).

Assumptions in using the Allen (1980) analytical solution for mounding height at the center of the recharge sites are as follows:

- Recharge flow rates are steady, and the solution has reached a steady-state equilibrium (i.e., average annual recharge rates prevail for an extended period).
- Recharge occurs uniformly over a circular area without any evapotranspiration.
- Mounding effects (i.e., rise of the water table relative to initial condition) has a finite radius of influence.
- Darcy's Law assumptions apply, meaning the water is of constant standard temperature (density and viscosity), usually assumed to be 20°C, the flow is laminar, and inertial forces can be neglected.

- Water is incompressible.
- Porous medium is incompressible (and non-expanding).
- Capillary effects and lateral flow in the capillary and unsaturated zones can be neglected.
- Mound height is small relative to the initial saturated thickness.
- Dupuit assumptions adequately describe the flow of groundwater, meaning that flow is near enough to horizontal such that the slope of the free surface can be assumed to express the hydraulic gradient everywhere in a vertical section through the saturated zone, and that the flow rate entering the aquifer vertically as recharge, Q, equals the rate of horizontal flow through a cylindrical surface across the saturated zone.

Several reasons exist as to why the resulting recharge might not match the estimates derived from this analysis. However, reasonable approximation methods have been used, and recharge rates have been constrained to be relatively conservative (lowered) by implementation of several steps in the procedure.

D4.5 Results

The resulting groundwater recharge rates are presented in terms of depth and volume per year in Table D4-2. In addition, Table D4-2 provides values for the storage volume for full (top of the berm) conditions, the average annual surface (field) runoff volume at each site, the calculated radius of influence, and the remaining depth to groundwater after the steady-state adjustment to the water table (i.e., mounding) has occurred.

Table D4-2. Groundwater Recharge Rate by Site

Site Number	Total Storage Volume (acre-feet)	Average Annual (2007–2015) Runoff Rate Adjusted for Upstream Site Capture (acre-feet/year)	Radius of Influence (feet)	Remaining Depth to Ground-water (feet)	Recharge Rate (ft/d)	Recharge Rate (acre-feet/year)
1	22.39	1,600	1,718	3.7	0.245	510
2	15.80	1,110	213	36.7	0.105	277
4a	25.57	69	533	45.8	0.008	34
5	90.26	4,013	985	0.0	0.047	605
6	43.02	553	407	45.8	0.067	277
7	12.04	706	760	42.2	0.187	288
8	22.24	893	292	68.5	0.068	200
9	46.91	4,338	188	0.7	0.039	274

Only two recharge sites are located in areas ranked 3 for silt and clay thickness in the unsaturated zone (i.e., expected to have the thinnest silt and clay thickness), including Sites 5 and 9a, which resulted in only a 20 percent reduction in recharge rates, while the other six sites are ranked 2 for silt and clay thickness, which results in those sites having a 50 percent reduction in recharge rates. Five of the eight sites have reduced recharge rates caused by assumed capture of water supplies at upstream sites, including Sites 2, 4a, 5, 6, and 9a.

D4.6 Limitations

The field runoff rates calculated from the CROPSIM process (of the UNW Model) are accumulated from the grid-cell level (1x1-mile dimensions) and do not explicitly account for re-use pits, natural depressions, or other losses that may occur during conveyance or transmission to the collection point (i.e., potential recharge sites). These will tend to reduce the available water supplies that can be captured for recharge projects. The approach to performing the approximate accounting of recharge rate reductions owing to the combined influence of silt and clay in the unsaturated zone (potentially limiting deep percolation) and evapotranspiration is considered a first-order approximation.

While the use of the mounding calculations affords the ability to scrutinize the functionality of each site, especially as viewed in the relative sense, the analytical equation and procedure used to establish estimates of groundwater recharge rates are considered to be approximate in an absolute sense with various assumptions that may not all be met and with input parameters that may vary from values that could be determined through field site characterization. Recharge rates are meant to indicate the flux of water across the water table, so the assumption that the water can freely infiltrate into the ground, and traverse (percolate) downward and reach the water table, is neglected in the use of the analytical mounding equation.

The silt and clay thickness in the unsaturated zone dataset was generated to be accurate at a mapping scale of approximately 1 to 2 miles, which is appropriate for this analysis. During selection of registered well logs to review, only 9.5 percent of the available wells within the HDR (2019) study area were analyzed. More specific site information on the unsaturated zone material types/lithology is warranted at potential recharge sites to help with site-specific feasibility or design-level work.

The findings in this technical memorandum are intended to allow analysis of groundwater recharge relying on readily available public information/data. As with any scientific investigation, the findings depend on the available data and on information provided and published from other sources. While HDR has used its best efforts in preparing this technical memorandum, it is assumed that third-party or client data are accurate, complete, reliable, and current. The analysis presented herein does not constitute a detailed evaluation of actual site conditions, because no measurements were obtained at the evaluated passive recharge sites. The results presented in this report are interpretations and must be used with caution. Use of this work product by others is at their own risk, and the user assumes liability for further use.

D4.7 References

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Appendix D5 Special Status Species Review

Special Status Species Review

To:	Project file
Project:	Box Butte Watershed Plan - Environmental Assessment
Date:	Thursday, August 22, 2024

D5.1 Introduction

This memorandum provides the analysis of the effects of the No Action and Action alternatives on fish and aquatic resources, terrestrial resources, and endangered and threatened species for the Box Butte Subwatershed.

For purposes of habitat assessment, the following information was used to assess habitat within the Box Butte Subwatershed study area, and for assessment of specific project areas within the geographic areas of interest:

- The study area falls within the Shortgrass Prairie and Sandhills Ecoregions defined by the Nebraska Game and Parks Commission (NGPC) (see **Error! Not a valid bookmark self-reference.**). The Shortgrass Prairie Ecoregion, located in western Nebraska, supports dry mixedgrass prairie, shortgrass prairie, sandsage prairie, sand prairie, pine woodlands, badlands, and other vegetation types. Threadleaf sedge western mixedgrass prairie is the predominant vegetation type in the ecoregion. Shortgrass prairies, mixedgrass prairies, and sandsage prairies are dominated by various grasses, sedges, and forbs. Open canopies of tall cottonwoods (*Populus deltoides*) and shorter peachleaf willows (*Salix amygdaloides*) dominate riparian woodlands in many stream valleys of the ecoregion. Subcanopies often consist of green ash (*Fraxinus pennsylvanica*), box-elder (*Acer negundo*), Russian-olive (*Elaeagnus angustifolia*), and junipers (*Juniperus sp.*) (Schneider et al. 2011). In the Sandhills Ecoregion, two principal plant community types are found: dune prairie and valley wetlands. Dune prairies consist of a mixture of sand-adapted grasses. Blowouts, which are wind-excavated depressions in dune tops, are uncommon today because of improved range management that limits the effects of wind on erosion and decreases the frequency of fire. Wet meadows occur in the valleys and support sedges (*Carex sp.*), spikerushes (*Eleocharis sp.*), prairie cordgrass (*Spartina pectinata*), and switchgrass (*Panicum virgatum*) (Schneider et al. 2011).

- The Upper Niobrara River biologically unique landscape (BUL) occupies the Niobrara River channel and a two-mile wide buffer on each side of the river from eastern Cherry County westward to the Nebraska/Wyoming border. In the far west, the landscape has a gently sloping valley with few trees. Rocky outcrops are also common along the valley bluffs and mixedgrass prairie occurs on most of the bluffs. Where the river enters the Sandhills in western Cherry County, the valley is several hundred feet deep. Ponderosa pine woodlands occupy portions of the bluff, and cottonwood dominated woodlands occupy portion of the floodplain. Portions of the valley bottom are cropland. Extreme northern portions of the study area fall within this BUL (Schneider et al. 2011).

Potential presence of species of interest were identified from Lists of Species of Greatest Conservation Need from the Nebraska Natural Legacy Project (Schneider et al. 2018). Tier 1 species were reviewed for this analysis. Tier 1 species are those that are globally or nationally most at-risk of extinction. Tier 1 species are higher priority, and more research and conservation efforts are focused on these species.

Identification of federally and state-listed endangered and threatened species was developed based on coordination with Nebraska Game and Parks Commission (NGPC) and use of their Conservation and Environmental Review Tool (CERT) and the United States Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) website. This coordination and review identified 12 federally and state-listed endangered, threatened, or candidate species that have the potential to occur in the study area.

D5.2 Fish and Aquatic Species

Table D5-1 provides a list of the fish and aquatic species (mollusks) that are included on the Tier 1 species list within the Shortgrass Prairie and Sandhills Ecoregions.

Table D5-1. Box Butte Subwatershed Effect Determination and Conservation Measures for Tier 1 Fish and Aquatic Species

Common Name	Scientific Name	Habitat	Determination of Effects and Conservation Measures
Blacknose shiner	*Notropis heterolepis*	headwater streams, spring fed, clear water, pools, quiet waters	The project is located outside the NGPC-estimated range of blacknose shiner, with an apparent absence of headwater and spring-fed aquatic habitat. Therefore, no effect anticipated.
Finescale dace	*Chrosomus neogaeus*	headwaters of clear, cool, high-quality streams	While the project is located within the NGPC-estimated range of finescale dace, the dominance of agricultural fields makes possibility of occurrence unlikely. The sites encountered in the project consist of turbid, low velocity, seasonally intermittent agricultural ditches with a higher thermal range than the preferred cool, headwater stream habitat of this species. Therefore, no effect anticipated.
Flathead chub	*Platygobio gracilis*	large, turbid rivers with relatively fast currents over gravel or sand substrates	The project is located outside the NGPC-estimated range of flathead chub, with an apparent absence of large, turbid river habitat. Therefore, no effect anticipated.
Northern redbelly dace	*Chrosomus eos*	headwater streams, spring fed, clear water, sandhill streams, beaver ponds, undercut	While the project is located within the NGPC-estimated range of northern redbelly dace, the dominance of agricultural fields makes possibility of occurrence unlikely. The sites encountered in the project consist of turbid,

Common Name	Scientific Name	Habitat	Determination of Effects and Conservation Measures
		banks, meandering streams, small pools	low velocity, seasonally intermittent agricultural ditches with a higher thermal range than the preferred cool, headwater stream habitat of this species. Therefore, no effect anticipated.
Plains minnow	*Hybognathus placitus*	permanent streams and backwaters with sandy substrate and moderate current	The project is located outside the NGPC-estimated range of plains minnow; therefore, no effect anticipated.
Plains topminnow	*Fundulus sciadicus*	vegetative backwaters and headwaters, shallow parts of rivers and streams	The project is located within the NGPC-estimated range of plains topminnow. One site possesses vegetated shoreline and substrate; therefore, it is recommended that conservation measures are implemented to avoid impacts to this species.
Topeka shiner	*Notropis topeka*	cold/cool clear water streams with gravel, low gradient	The project is located outside the NGPC-estimated range of Topeka shiner; therefore, no effect anticipated.
Western silvery minnow	*Hybognathus argyritis*	backwaters, pools, and slow-moving waters in medium to large rivers	The project is located outside the NGPC-estimated range of western silvery minor; therefore, no effect anticipated.
Niobrara ambersnail	*Oxyloma haydeni*	moist soil by stream	The project is located outside the NGPC-estimated range of Niobrara ambersnail; therefore, no effect anticipated.
Oxbow snail	*Galba cockerelli*	oxbows and backwaters	The project is located outside the NGPC-estimated range of oxbow snail; therefore, no effect anticipated.
Plain pocketbook	*Lampsilis cardium*	small creeks to medium rivers in mud, sand, or gravel	The project is located outside the NGPC-estimated range of plain pocketbook, therefore, no effect anticipated.
Ornate fairy shrimp	*Eubranchipus ornatus*	clear, cool water with neutral to low pH, in well vegetated ephemeral pools	The project is located outside the NGPC-estimated range of ornate fairy shrimp; therefore, no effect anticipated.
Potassium-loving fairy shrimp	*Branchinecta potassa*	shallow to ephemeral, alkaline lakes with specific range of potassium levels	While the project is located within the NGPC-estimated range of Potassium-loving fairy shrimp, the dominance of agricultural fields makes possibility of occurrence unlikely. The sites encountered in the project consist of turbid, low velocity, seasonally intermittent agricultural ditches that lack the alkaline lake habitat of this species. Therefore, the project may affect but is unlikely to adversely affect Potassium-loving fairy shrimp.

Source: Schneider et al. 2018.
[1]Also addressed as part of Endangered and Threatened Species

D5.3 Terrestrial Wildlife

Table D5-2 provides a list of the terrestrial species (insects, mammals, and reptiles) that are included on the Tier 1 species list within the Shortgrass Prairie and Sandhills Ecoregions.

Table D5-2. Bux Butte Subwatershed Effect Determination and Conservation Measures for Tier 1 Terrestrial Species

Common Name	Scientific Name	Habitat	Determination of Effect and Conservation Measures
American burying beetle	*Nicrophorus americanus*	grassland prairie, forest edge, scrubland and mesic areas	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.
Colorado rita dotted-blue	*Euphilotes rita coloradensis*	sparse grasslands with rocky, gravelly soils of ridges, outcrops and bluffs	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.
Fox mayfly	*Cercobrachys fox*	medium size rivers	The project includes creeks but no medium-sized rivers. Therefore, no effects are anticipated.
Ghost tiger beetle	*Cicindela lepida*	sparsely vegetated areas with open, sandy soils	The project area east of Nebraska Highway 87 intersect the NGPC-estimated range of the species. Project elements in these areas may encounter sparsely vegetated areas with open, sandy soils. Therefore, the species may be affected by the project. No conservation measures have been developed for this species.
Hourglass drone fly	*Eristalis brousii*	specific habitat requirements unknown	The project is located within the NGPC-estimated range of the species. Since specific habitat requirements are unknown, the species may be affected by the project. No conservation measures have been developed for this species.
Iowa skipper	*Atrytone arogos iowa*	tall-grass prairie, mixed-grass prairie along the Niobrara, native prairie with standing grass stems	The project is located within the NGPC-estimated range of the species. While a majority of the surrounding land use consists of agriculture, there may be areas along waterways or field edges that provide sufficient prairie habitat for the species. No conservation measures have been developed for this species.

Common Name	Scientific Name	Habitat	Determination of Effect and Conservation Measures
Kohler's fritillary	*Boloria selene sabulocollis*	sandhills and stream valley wet meadows with violets	While the project is located within the NGPC-estimated range of the species, it is on the western edge of the Sandhills range and does not intersect characteristic Sandhills stream valleys with wet meadows. Therefore, no effects are anticipated.
Lakota mayfly	*Apobaetis lakota*	medium size rivers, specific habitat requirements not known	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.
Long-nosed mayfly	*Sparbarus nasutus*	oxbows and backwaters	The northern portion of the project is located within the NPGC-estimated range of the species. The project area does not include waterways sufficient in size to include oxbows and backwaters within their floodplains suitable for the species. Therefore, no effects are anticipated.
Monarch butterfly	*Danaus plexippus*	uses broad range of habitats but requires select species of milkweeds as larval host plants	The project is located within the NGPC-estimated range of the species. The project area includes habitat capable of supporting milkweed populations. Therefore, the project may affect monarch butterfly. No conservation measures have been developed for the species.
Mottled duskywing	*Erynnis martialis*	hilly areas with prairie openings, host plant is New Jersey tea (*Ceanothus*)	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.
Nebraska fritillary	*Boloria selene nebraskensis*	wet meadows with violets	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.
Nine-spotted ladybird beetle	*Coccinella novemnotata*	predator on aphids found in variety of habitats	The project is located within the NGPC-estimated range of the species. The project area includes habitat capable of supporting aphid populations. Therefore, the project may affect the species. No conservation measures have been developed for the species.

Common Name	Scientific Name	Habitat	Determination of Effect and Conservation Measures
Ottoe skipper	*Hesperia ottoe*	tall-grass prairie, rolling/hilly prairie, mixed-grass prairie - feed on bluestems	The project is located within the NGPC-estimated range of the species. The project area includes habitat capable of supporting skipper populations. Therefore, the project may affect the species. No conservation measures have been developed for the species.
Pawnee stonefly	*Perlesta xube*	shaded to open canopied, sand-bottomed streams	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.
Regal fritillary	*Speyeria idalia*	tall-grass and mixed-grass prairie with violets, wet meadows	The project is located within the NGPC-estimated range of the species. No prairie or wet meadow habitat with large violet populations were identified during the wetland delineation. Therefore, no effects are anticipated on the species, and no conservation measures are anticipated.
Sandy tiger beetle	*Cicindela limbata limbata*	blowouts in Sandhills, open sand substrate	While the project is located within the NGPC-estimated range of the species, it is located on the periphery of the Sandhills in an agriculturally dominated area. Therefore, no effects are anticipated on the species, and no conservation measures are anticipated.
Smoky-eyed brown	*Lethe eurydice fumosa*	sedge meadows in Sandhills and along streams and wetlands	While the project is located within the NGPC-estimated range of the species, it is located on the periphery of the Sandhills in an agriculturally dominated area. Therefore, no effects are anticipated on the species, and no conservation measures are anticipated.
Southern plains bumble bee	*Bombus fraternus*	prairie grasslands	The project area includes prairie grassland habitat. Therefore, the project may affect the species. No conservation measures have been developed for the species.
Suckley’s cuckoo bumble bee	*Bombus suckleyi*	grasslands, wetlands, woodland openings	The project is on the eastern extent of the NGPC-estimated range of the species. The project area includes grasslands, wetlands, and

Common Name	Scientific Name	Habitat	Determination of Effect and Conservation Measures
			wooded areas. Therefore, the project may affect the species. No conservation measures have been developed for the species.
Tawny crescent	*Phyciodes batesii*	canyon type habitat - close to water, between stream and dry pine wooded areas with grassland openings	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.
Two-lined stonefly	*Perlesta golconda*	medium rivers with sand bottoms	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.
Two-spotted skipper	*Euphyes bimacula illinois*	Along streams and wetlands, marshes, and wet road ditches, generally associated with wetlands, wet meadows in Sandhills	The project is located within the NGPC-estimated range of the species. The project area includes habitat capable of supporting skipper populations. Therefore, the project may affect the species. No conservation measures have been developed for the species.
Western bumble bee	*Bombus occidentalis ccidentalis*	grasslands, wetlands, woodland openings	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.
Whitney underwing	*Catocala whitneyi*	tall-grass and mixed-grass prairie; larvae feed on lead plant (*Amorpha*)	The project is located on the immediately western extent of the NGPC-estimated species range. Portions of the project area contain grassland capable of supporting lead plant populations. Therefore, the project may affect the species. No conservation measures have been developed for the species.
Winnebago mayfly	*Cercobrachys winnebago*	medium size rivers, specific habitat requirements not known	The project includes creeks but no medium-sized rivers. Therefore, no effects are anticipated on the species, and no conservation measures are anticipated.
Bailey's eastern woodrat	*Neotoma floridana baileyi*	pines and bluffs, woodlands and rocks	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.
Cheyenne northern pocket gopher	*Thomomys talpoides cheyennensis*	hard rocky soils, short-grass prairies	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.

Common Name	Scientific Name	Habitat	Determination of Effect and Conservation Measures
Eastern red bat	*Lasiurus borealis*	deciduous and pine woodlands, usually associated with water source	The project is located within the NGPC-estimated range for the species. The project area contains waterways supporting riparian corridors potentially suitable for the species. Conservation measures for northern long-eared bat (tree clearing timing restrictions) would be used to minimize impacts on the species.
Hoary bat	*Lasiurus cinereus*	deciduous and pine woodlands, usually associated with water source in arid landscapes	The project is located within the NGPC-estimated range for the species. The project area contains waterways supporting riparian corridors potentially suitable for the species. Conservation measures for northern long-eared bat (tree clearing timing restrictions) would be used to minimize impacts on the species.
Northern long-eared bat	*Myotis septentrionalis*	interior of deciduous and coniferous woodlands	The project is located within the NGPC-estimated range for the species. The project area contains waterways supporting riparian corridors potentially suitable for the species. Tree removal would occur between November 1 and March 31 to mitigate effects on the species.
Pierre northern pocket gopher	*Thomomys talpoides pierreicolus*	short-grass, hard soils	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.
Plains spotted skunk	*Spilogale putorius interrupta*	grasslands and old field habitat close to old structures and wooded areas	The project contains grasslands and wooded areas suitable for the species. Therefore, the project may affect the species. No conservation measures have been developed for plains spotted skink.
Rocky Mountain bighorn sheep	*Ovis canadensis*	rocky buttes of Pine Ridge and Wildcat Hills	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.
Silver-haired bat	*Lasionycteris noctivagans*	deciduous and pine woodlands, usually associated with water source	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.

Common Name	Scientific Name	Habitat	Determination of Effect and Conservation Measures
Swift fox	*Vulpes velox*	short-grass prairie, western mixed-grass prairie	The project is located within the NGPC-estimated range for the species. The project area includes habitat potentially suitable for the species. Surveys for potential den sites may be conducted up to a year prior to construction to mitigate impacting the species.
Tricolored bat	*Perimyotis subflavus*	deciduous woodlands	The project is located within the NGPC-estimated range for the species. The project area contains waterways supporting riparian corridors potentially suitable for the species. Conservation measures for northern long-eared bat (tree clearing timing restrictions) would be used to minimize impacts on the species.
Blanding's turtle	*Emydoidea blandingii*	requires proximity to water; Sandhills fens, Sandhills freshwater marsh, northern cordgrass wet prairie, small tributaries, Sandhills prairies (upland habitat), marshes and oxbows in eastern portion of state	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.
Glossy snake	*Arizona elegans*	arid mixed to shortgrass prairies with sandy soil and sparse vegetation	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.
Sagebrush lizard	*Sceloporus graciosus*	open, rocky, short-grass prairie, usually associated with sagebrush, higher elevations	The project is located outside the NGPC-estimated range of the species. Therefore, no effects are anticipated.

Source: Schneider et al. 2018.
[1]Also addressed as part of Endangered and Threatened Species

D5.4 Special Status Species

Table D5-3 provides the list of Endangered and Threatened Species for Box Butte Subwatershed and resultant effects analysis for Box Butte Watershed Diversion to Off-Channel Storage (Passive) Alternative. Unless otherwise noted, there are no effects resulting from the No-Action/Future Without Federal Investment Project Alternative. The Analysis has been further refined to include the geographical areas of interest for each alternative.

Table D5-3. Box Butte Subwatershed Endangered and Threatened Species Review

Common Name	Species Name	Listing	Habitat	Determination of Effect and Conservation Measures
Black-footed ferret	*Mustela nigripes*	FE; SE	prairie dog towns or complexes 1,000 acres or more in size.	No prairie dog towns present in the project area. Therefore, no effect anticipated.
Blacknose shiner	*Notropis heterolepis*	SE	headwater streams, spring fed, clear water, pools, quiet waters	The project is located outside the NGPC-estimated range of blacknose shiner, with an apparent absence of headwater, spring-fed aquatic habitat. Therefore, no effect anticipated.
Blowout penstemon	*Penstemon haydenii*	FE; SE	blowouts in Sandhills, open sand substrate	The project is located outside the NGPC-estimated range of the species, and it is located on the periphery of the Sandhills in an agriculturally dominated area. Therefore, no effects are anticipated on the species, and no conservation measures are anticipated.
Eastern black rail	*Laterallus jamaicensis jamaicensis*	FT, ST	dense vegetative cover, freshwater marsh habitats, sedge meadows	Emergent wetland habitat is present in the project area; however, no documented occurrences of the species in close proximity. Therefore, the project may affect but is unlikely to adversely affect eastern black rail.
Eskimo curlew	*Numenius borealis*	FE; SE	wet meadows, burned over prairies, newly plowed fields.	Agricultural land present may provide suitable habitat for the species. Therefore, the project may affect but is unlikely to adversely affect Eskimo curlew.

Common Name	Species Name	Listing	Habitat	Determination of Effect and Conservation Measures
Finescale dace	*Phoxinus neogaeus*	ST	headwaters of clear, cool, high-quality streams	While the project is located within the NGPC-estimated range of Finescale dace, the dominance of agricultural fields makes possibility of occurrence unlikely. The sites encountered in the project consist of turbid, low velocity, seasonally intermittent agricultural ditches with a higher thermal range than the preferred cool, headwater stream habitat of this species. Therefore, no effect anticipated.
Gray wolf	*Canis lupus*	FE; SE	wide range of habitats including prairie, mountains, temperate forests, wetlands, tundra, and taiga.	No documented occurrences of the species within proximity to the project in the last 30 years. Therefore, no effect anticipated.
Monarch Butterfly	*Danaus plexippus*	Proposed Threatened	field, roadside area, open area, wet area, or urban garden; milkweed and flowering plants are needed for monarch habitat	The project is located within the NGPC-estimated range of the species. The project area includes habitat capable of supporting milkweed populations. Therefore, the project may affect monarch. No conservation measures have been developed for the species.
Northern long-eared bat	*Myotis septentrionalis*	FE; SE	roost singly or in colonies underneath bark or in cavities, crevices or hollows of live and dead trees and/or snags (typically ≥ 3 inches dbh); overwinter in hibernacula that include caves and abandoned mines, abandoned railroad tunnels, storm sewer entrances, dry wells, and aqueducts	The project is located within the NGPC-estimated range for the species. The project area contains waterways supporting riparian corridors potentially suitable for the species. Tree removal would occur between November 1 and March 31 to mitigate effects on the species.

Common Name	Species Name	Listing	Habitat	Determination of Effect and Conservation Measures
Northern redbelly dace	*Phoxinus eos*	ST	headwaters of clear, cool, high-quality streams	While the project is located within the NGPC-estimated range of Northern redbelly dace, the dominance of agricultural fields makes possibility of occurrence unlikely. The sites encountered in the project consist of turbid, low velocity, seasonally intermittent agricultural ditches with a higher thermal range than the preferred cool, headwater stream habitat of this species. Therefore, no effect anticipated.
Pallid sturgeon	*Scaphirhynchus albus*	FE; SE	large, deep, swift moving, rivers	The project is located outside the NGPC-estimated range of pallid sturgeon, with an apparent absence of large, deep, swift-moving river habitat. Therefore, no effect anticipated.
Piping plover	*Charadrius meoldus*	FT; ST	unvegetated or sparsely vegetated sandbars in river channels and sandpits	The project is located outside the NGPC-estimated range of piping plover, with an apparent absence of unvegetated or sparsely vegetated sandbars in river channels and sandpits habitat. Therefore, no effect anticipated.
Rufa red knot	*Calidris canutus rufa*	FT; ST	open mud flats and/or mud and sandy shorelines free of vegetation	Project is approximately 9 miles southwest of the Niobrara River. Visual site distance between the project and the river is inhibited. No effect anticipated.

Common Name	Species Name	Listing	Habitat	Determination of Effect and Conservation Measures
Swift fox	*Vulpes velox*	SE	short-grass prairie, western mixed-grass prairie	The project is located within the NGPC-estimated range for the species. The project area includes habitat potentially suitable for the species. Surveys for potential den sites may be conducted up to a year prior to construction to mitigate impacting the species. Therefore, the project may affect but is not likely to adversely affect swift fox.
Tricolored bat	*Perimyotis subflavus*	Proposed Endangered	similar habitat needs as northern long-eared bat.	While no woodland areas are present within the project area, there are areas of dense tree habitat associated with wind breaks and drainages that may provide suitable habitat for the species. Tree removal would occur between November 1 and March 31 to mitigate effects on the species.

D5.5 Determination of Effects and Conservation Measures

The following fish and aquatic, terrestrial, and special status specials have the potential to occur in the geographical area:

- Plains topminnow
- Potassium-loving fairy shrimp
- Ghost tiger beetle
- Hourglass drone fly
- Iowa skipper
- Monarch
- Nine-spotted ladybird beetle
- Ottoe skipper
- Regal fritillary
- Southern plains bumble bee
- Suckley’s cuckoo bumble bee
- Two-spotted skipper
- Whitney underwing
- Eastern red bat
- Hoary bat
- Northern long-eared bat
- Plains spotted skunk
- Swift fox
- Tricolored bat
- Eastern black rail
- Eskimo curlew

The project is also located within the NGPC-estimated range of the plains topminnow. The project contains an area with favorable slow-to-moderate velocity, vegetated shoreline and substrate, and pool-habitat suitable for the species. The following conservation measures are proposed to mitigate effects on the species:

- Some chemicals that are approved for overwater use may not be acceptable for use in streams with these fish. Guidance documents will be made available.
- Work or projects conducted in stream or river channels may not be allowed during the spawning periods of these fish.
- Bank stabilization may be limited.
- Grazing (as part of a management plan developed with the assistance of a state agency) along streams where these fish occur may be limited or controlled.
- Upland erosion or soil disturbances will need to be designed to avoid and minimize sedimentation of streams where these fish occur.
- Aquatic organism passage will need to be considered for in-stream structures (e.g., culverts, dams, weirs).

With the implementation of the above conservation measures, the project may affect but is unlikely to adversely affect the species.

The project contains turbid, low velocity, seasonally intermittent agricultural ditches that are unlikely to support the potassium-loving shrimp. With the absence of ephemeral alkaline lakes, the project may affect but is unlikely to adversely affect the species.

The project contains marginal habitat for the ghost tiger beetle, hourglass drone fly, Iowa skipper, monarch, nine-spotted ladybird beetle, ottoe skipper, regal fritillary, southern plains bumble bee, Suckley's cuckoo bumble bee, two-spotted skipper, and whitney underwing. There are currently no conservation measures proposed for these species. The project impact footprint would be reduced to the maximum extent possible prior to construction. Best Management Practices would be employed during construction to limit habitat disturbance, including enforcing erosion control methods and limiting mowing and tillage. Following construction, all temporarily impacted areas would be returned to their pre-project conditions. Therefore, the project may affect but is unlikely to adversely affect the ghost tiger beetle, hourglass drone fly, Iowa skipper, monarch, nine-spotted ladybird beetle, ottoe skipper, regal fritillary, southern plains bumble bee, Suckley's cuckoo bumble bee, two-spotted skipper, and whitney underwing.

There is woodland habitat present within the project area that may provide suitable habitat for eastern red bat, hoary bat, northern long-eared bat, and tri-colored bat. The project would be modified, to the extent practicable, to avoid tree removal in excess of what is required to implement the project safely. Tree removal would be limited to that specified in project plains, and contractors would understand clearing limits and how they are marked in the field. Tree removal would occur between November 1 through March 31 to mitigate effects on the species. With the implementation of conservation measures, the project may affect but is unlikely to adversely affect eastern red bat, hoary bat, northern long-eared bat, and tri-colored bat.

There are rolling hills of pasture within the project area that may provide suitable habitat for swift fox. Surveys for potential den sites would be conducted up to a year prior to construction to mitigate impacts. With the implementation of conservation measures, the project may affect but is unlikely to adversely affect swift fox.

There is wetland habitat present within the project area that may provide suitable habitat for eastern black rail. However, there are no documented occurrences in proximity of the project. Upon project completion, impacted wetland areas would be stabilized and revegetated appropriately. Therefore, the project may affect but is unlikely to adversely affect eastern black rail.

Agricultural land present in both geographical areas may provide suitable habitat for the Eskimo curlew. There are currently no conservation measures proposed for the species. Due to the mobile nature of the species, the curlew would avoid areas of construction and disturbance. Upon project completion, the species would reintegrate into previously disturbed areas. Therefore, the project may affect but is unlikely to adversely affect Eskimo curlew.

Conservation Planning Report

Project Information

Report Generation Date:	6/3/2024 12:33:46 PM
Project Title:	Box Butte Watershed - CERT Chapter 3 Analysis
User Project Number(s):	
System Project ID:	NE-CERT-012466
Project Type:	Conservation Planning Report (not an environmental review)
Project Activities:	None Selected
Project Size:	162,458.95 acres
County(s):	Box Butte; Dawes; Sheridan
Watershed(s):	Niobrara
Watershed(s) HUC 8:	Upper Niobrara
Watershed(s) HUC 12:	101500031009; Headwaters Box Butte Creek; Headwaters Hemingford Creek; Katen Cemetery +
Biologically Unique Landscape(s):	Upper Niobrara River
Township/Range and/or Section(s):	026N046W; 026N047W; 026N048W; 026N049W; 027N045W; 027N046W; 027N047W; 027N048W; 027N049W; 028N045W; 028N046W; 028N047W; 028N048W; 028N049W; 029N045W; 029N046W; 029N047W
Latitude/Longitude:	42.349569 / -102.812942

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Prepared By:	
Submitted On Behalf Of:	

Project Description

This is the CERT report that was used to analyze listed species within the boundaries of the watershed.

Introduction

This conservation planning report compiles information and maps pertaining to at-risk species, natural communities, protected areas, and other features within the vicinity of an area of interest delineated by the user. For more information about the data provided in this report, contact the appropriate staff (botanist, zoologist, or data manager) of the Nebraska Natural Heritage Program:

http://outdoornebraska.gov/naturalheritageprogram/

Most of the information on at-risk species and natural communities in this report is based on records managed within the Nebraska Natural Heritage database. Please be aware that although the Nebraska Natural Heritage database is the most up-to-date and comprehensive database available on the occurrences of rare species and natural communities, many areas have not been inventoried or reported on to the Natural Heritage Program. Similarly, the record of one rare species at a location does not imply that other species have been surveyed at that site or reported to the Natural Heritage Program. As such, the data should be interpreted with abundant caution, and an “absence of evidence is not evidence of absence” philosophy followed.

Please note that this report does not satisfy requirements of the Nongame and Endangered Species Conservation Act or the Endangered Species Act for an evaluation of the potential impacts to threatened and endangered species of a proposed project. To have an environmental review of this project conducted, re-submit it through the CERT and select the specific project type and associated activities related to this project. The resulting evaluation will determine if conservation conditions need to be implemented for the project in order to avoid adverse impacts on listed species, or if further consultation with the NGPC and/or USFWS is necessary.

To cite this report please use the following citation:

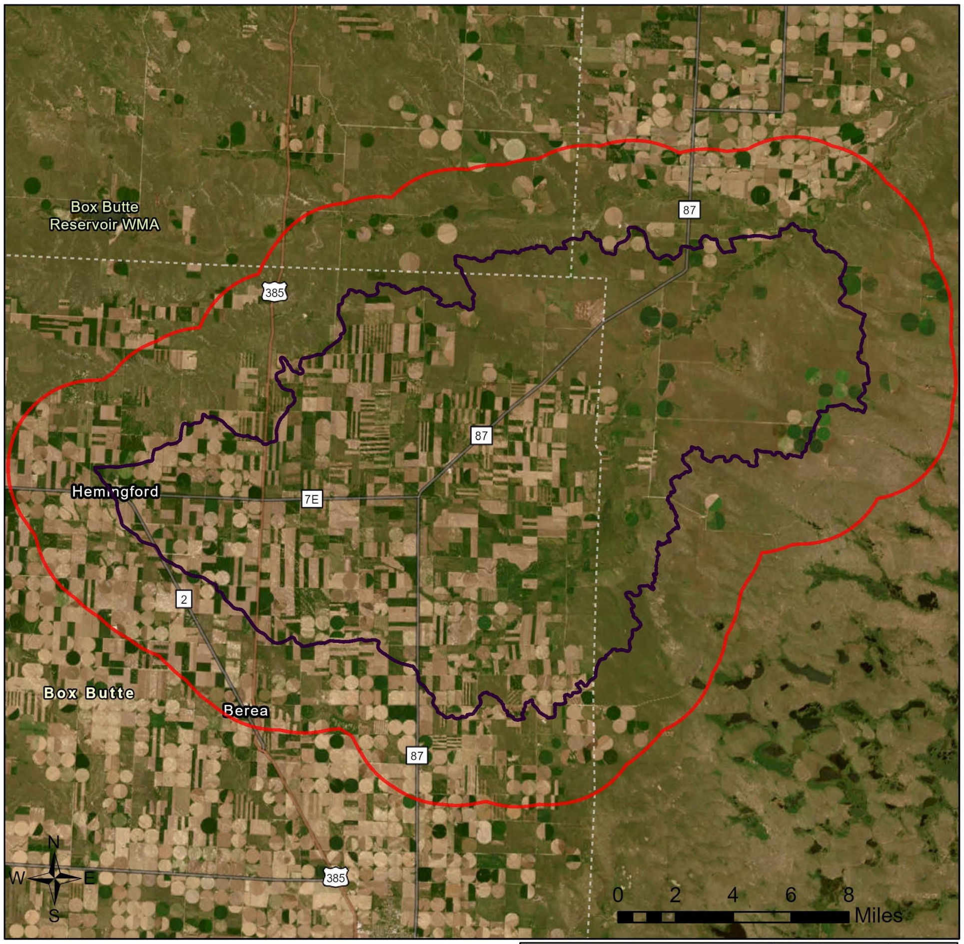
Nebraska Game and Parks Commission. <year report was generated>. Conservation Planning Report. [report generated by the Nebraska Conservation and Environmental Review Tool]. Report generated <Month, Day, and Year from report’s ‘Report Generation Date’ >. URL: https://cert.outdoornebraska.gov.

To cite species or natural community data shown in a table, please use the following citation:

Nebraska Natural Heritage Program of the Nebraska Game and Parks Commission. <year report was generated>. <Title of Table>. [table]. *In:* Nebraska Game and Parks Commission. <Report Title>. [report generated by the Nebraska Conservation and Environmental Review Tool]. Report generated <Month, Day, and Year from report’s ‘Report Generation Date’ >. URL: https://cert.outdoornebraska.gov.

Box Butte Watershed - CERT Chapter 3 Analysis

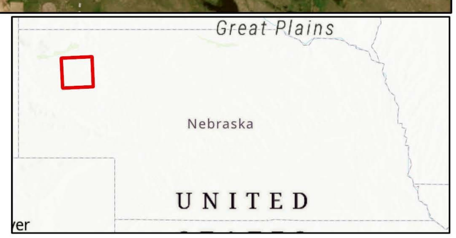
Aerial Image Basemap With Locator Map



3-mile Information Buffer Boundary

Project Review Boundary

Project Boundary



Project Size (acres): 162,458.95

Lat/Long (DD): 42.3496 / -102.8129

County(s): Box Butte; Dawes; Sheridan

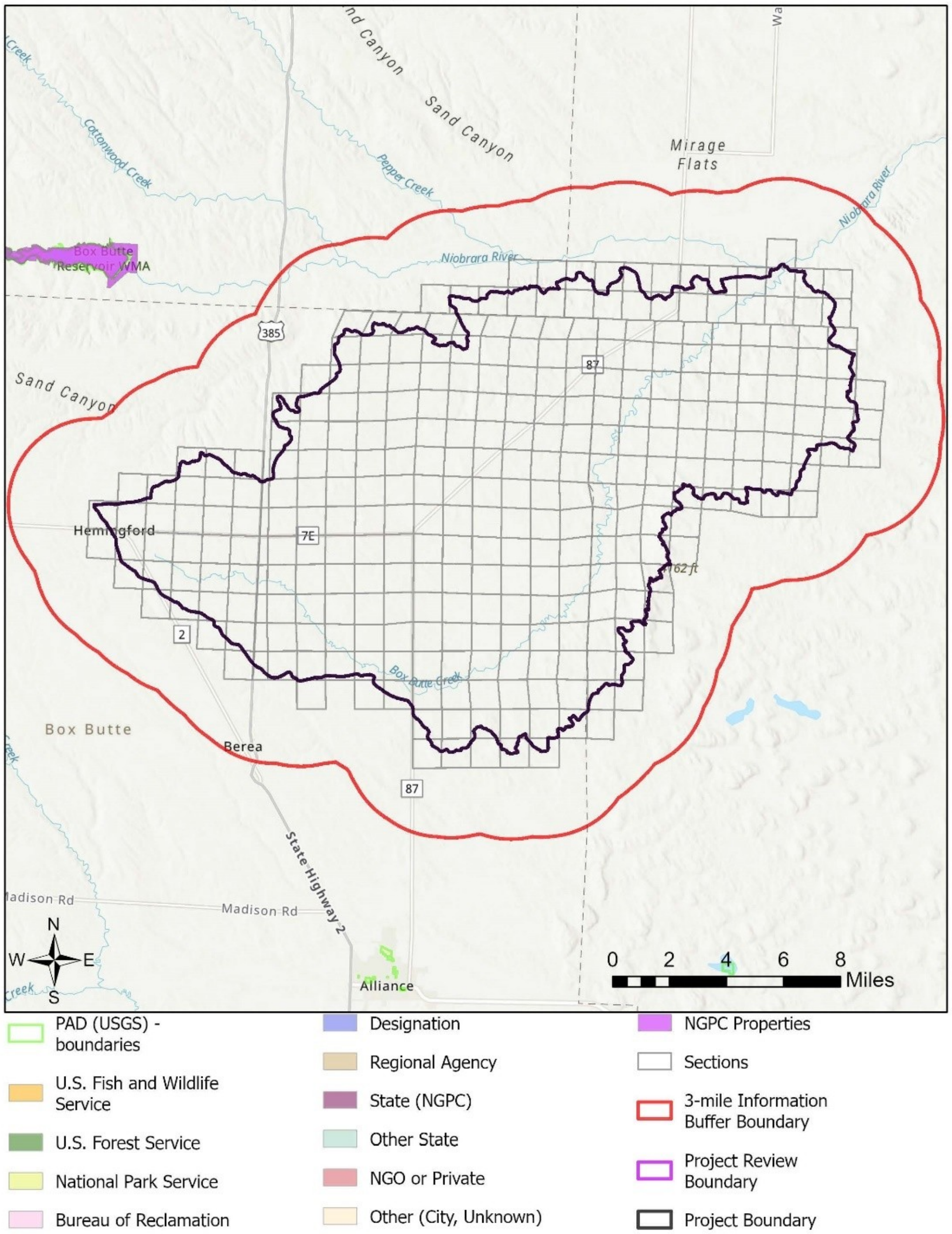
BUL(s): Upper Niobrara River

Township/Range/Section(s): T26R46WS05; T26R46WS06; T26R46WS07; T26R46WS08; T26R46WS18 +

Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS
Earthstar Geographics
Esri, USGS

Box Butte Watershed - CERT Chapter 3 Analysis

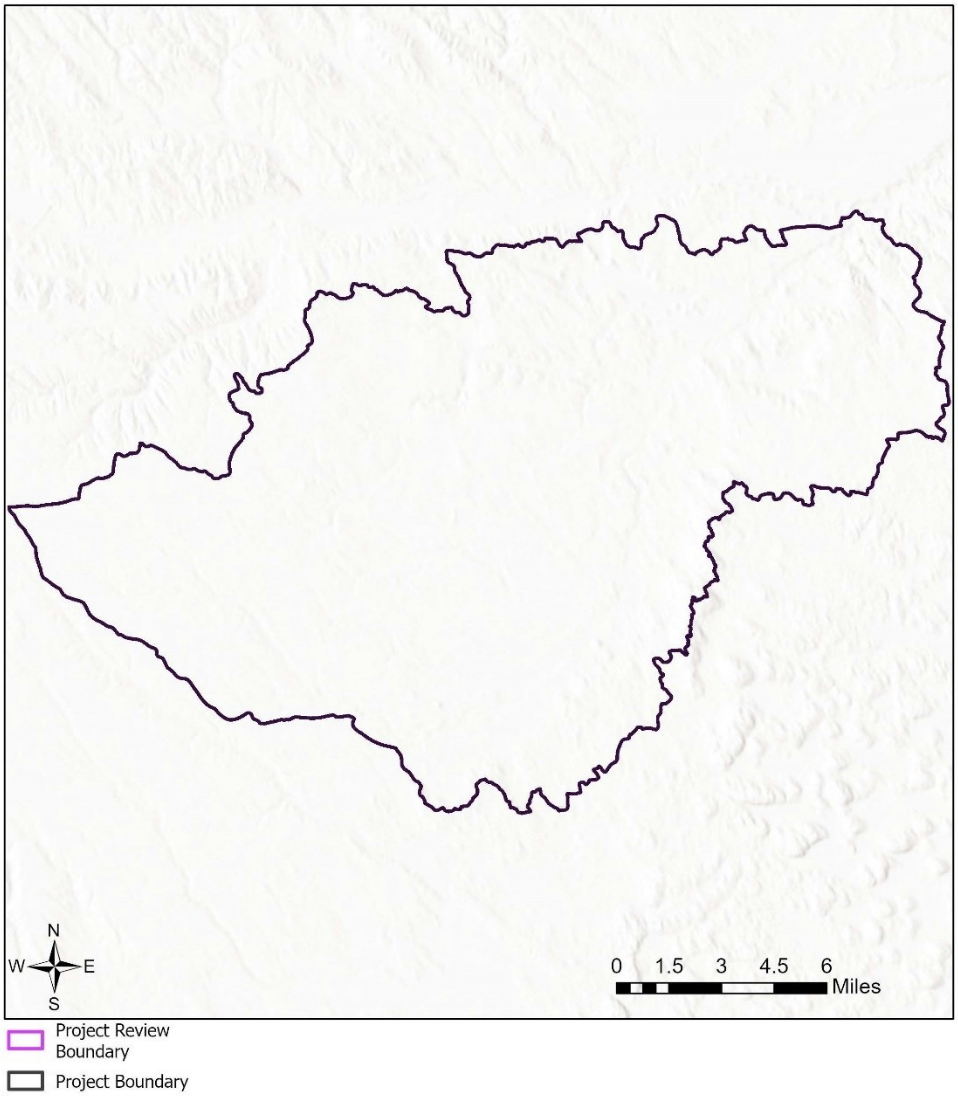
Topographic Basemap With Sections and Protected Areas



Esri, CGIAR, USGS
Nebraska Game & Parks Commission, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, USFWS

Box Butte Watershed - CERT Chapter 3 Analysis

Web Map As Submitted By User



Esri, CGIAR, USGS

Table 1
Protected Areas in Immediate Vicinity of Project (project review area)

This table has no results.

Table 2
Documented Occurrences in Immediate Vicinity of Project (project review area): Natural communities and selected special areas

Name	Other Information	SRank	GRank
Upper Niobrara River Biologically Unique Landscape	Link to BUL document		
Large Intact Block of Habitat for At-risk Species			

Table 3
Regional Documented Occurrences of Species within 1 Mile of Project Review Area: Tier 1 and 2 at-risk species and additional S1-S3 plants

Scientific Name	Common Name	USFWS	State	SGCN	SRank	GRank	Taxonomic Group
Aquila chrysaetos	Golden Eagle			Tier 2	S3	G5	Vertebrate Animal - Birds
Asio flammeus	Short-eared Owl			Tier 1	S2	G5	Vertebrate Animal - Birds
Athene cunicularia	Burrowing Owl			Tier 1	S2	G4	Vertebrate Animal - Birds
Atrytonopsis hianna	Dusted Skipper			Tier 2	S3	G4G5	Invertebrate Animal - Butterflies and Skippers
Buteo regalis	Ferruginous Hawk			Tier 1	S2	G4	Vertebrate Animal - Birds
Chrosomus neogaeus	Finescale Dace		T	Tier 1	S2	G5	Vertebrate Animal - Fishes
Coryphantha missouriensis	Missouri Pincushion Cactus				S3S4	G5	Vascular Plant - Dicots
Dalea cylindriceps	Large-spike Prairie-clover			Tier 1	S2	G3	Vascular Plant - Dicots
Fundulus sciadicus	Plains Topminnow			Tier 1	S3	G4	Vertebrate Animal - Fishes
Haliaeetus leucocephalus	Bald Eagle			Tier 2	S3	G5	Vertebrate Animal - Birds
Hybognathus argyritis	Western Silvery Minnow			Tier 1	S2	G4	Vertebrate Animal - Fishes
Lepus townsendii	White-tailed Jackrabbit		NC	Tier 2	S3	G5	Vertebrate Animal - Mammals
Margariscus nachtriebi	Pearl Dace			Tier 2	S2	G5	Vertebrate Animal - Fishes
Megathymus streckeri	Strecker's Giant Skipper			Tier 2	S3	G5	Invertebrate Animal - Butterflies and Skippers
Microsteris gracilis var. humilior	Dwarf-phlox			Tier 2	S1	G5T5	Vascular Plant - Dicots
Numenius americanus	Long-billed Curlew			Tier 1	S3	G5	Vertebrate Animal - Birds

Table 3
Regional Documented Occurrences of Species within 1 Mile of Project Review Area:
Tier 1 and 2 at-risk species and additional S1-S3 plants

Scientific Name	Common Name	USFWS	State	SGCN	SRank	GRank	Taxonomic Group
Rhinichthys obtusus	Western Blacknose Dace			Tier 2	S2	G5	Vertebrate Animal - Fishes
Sorex merriami	Merriam's Shrew			Tier 2	S1	G4	Vertebrate Animal - Mammals
Vulpes velox	Swift Fox		E	Tier 1	S2	G3	Vertebrate Animal - Mammals

Table 4
Potential Occurrences in Immediate Vicinity of Project (project review area):
Special status species (Tier 1 at-risk species and Bald and Golden Eagle), based on models or range maps

Scientific Name	Common Name	Data Type	USFWS	State	SGCN	SRank	GRank	Taxonomic Group
Aquila chrysaetos	Golden Eagle	Model			Tier 2	S3	G5	
Argynnis idalia	Regal Fritillary	Range			Tier 1	S3	G3?	
Asio flammeus	Short-eared Owl	Range			Tier 1	S2	G5	
Athene cunicularia	Burrowing Owl	Range			Tier 1	S2	G4	
Atrytone arogos iowa	Iowa Skipper	Range			Tier 1	S1	G2G3T2T3	
Boloria myrina sabulocollis	Kohler's Fritillary	Range			Tier 1	S1S2	G5?T3	
Bombus suckleyi	Suckley's Cuckoo Bumble Bee	Range			Tier 1	SNR	G2G3	
Brachycercus nasutus	Long-nosed Mayfly	Range			Tier 1	S1	G3G4	
Branchinecta potassa	Potassium-loving Fairy Shrimp	Range			Tier 1	S2	G2	
Buteo regalis	Ferruginous Hawk	Range			Tier 1	S2	G4	
Calcarius ornatus	Chestnut-collared Longspur	Range			Tier 1	S3	G5	
Catocala nuptialis	Married Underwing	Range			Tier 1	SNR	G3	
Catocala whitneyi	Whitney Underwing	Range			Tier 1	S1	G2G3	
Chrosomus eos	Northern Redbelly Dace	Model		T	Tier 1	S2	G5	
Chrosomus neogaeus	Finescale Dace	Model		T	Tier 1	S2	G5	
Cicindela limbata limbata	Sandy Tiger Beetle	Range			Tier 1	S4	G5T3T4	
Coccinella novemnotata	Nine-spotted Ladybird Beetle	Range			Tier 1	S1	G5	

Table 4
Potential Occurrences in Immediate Vicinity of Project (project review area):
Special status species (Tier 1 at-risk species and Bald and Golden Eagle), based on models or range maps

Scientific Name	Common Name	Data Type	USFWS	State	SGCN	SRank	GRank	Taxonomic Group
Dalea cylindriceps	Large-spike Prairie-clover	Range			Tier 1	S2	G3	
Danaus plexippus	Monarch	Range			Tier 1	S2	G4	
Ellipsoptera lepida	Ghost Tiger Beetle	Range			Tier 1	S2	G3	
Eristalis brousii	Hourglass Drone Fly	Range			Tier 1	S1	G4	
Euphyes bimacula illinois	Two-spotted Skipper	Range			Tier 1	S3	G4T1T2	
Fundulus sciadicus	Plains Topminnow	Range			Tier 1	S3	G4	
Haliaeetus leucocephalus	Bald Eagle	Range			Tier 2	S3	G5	
Hesperia ottoe	Ottoe Skipper	Range			Tier 1	S2	G3	
Hybognathus argyritis	Western Silvery Minnow	Range			Tier 1	S2	G4	
Lanius ludovicianus	Loggerhead Shrike	Range			Tier 1	S3	G4	
Lasiurus borealis	Eastern Red Bat	Range			Tier 1	S3	G3G4	
Lasiurus cinereus	Hoary Bat	Range			Tier 1	S3	G3G4	
Lethe eurydice fumosus	Smoky-eyed Brown	Range			Tier 1	S3	G5T3T4	
Myotis septentrionalis	Northern Long-eared Myotis	Range	E	E	Tier 1	S1S2	G2G3	
Numenius americanus	Long-billed Curlew	Range			Tier 1	S3	G5	
Perimyotis subflavus	Tricolored Bat	Range			Tier 1	S3	G3G4	
Vulpes velox	Swift Fox	Range		E	Tier 1	S2	G3	

IPaC **U.S. Fish & Wildlife Service**

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Project information

NAME

Box Butte Watershed - IPaC Chapter 3 Analysis

LOCATION

Box Butte , Dawes , and Sheridan counties, Nebraska

DESCRIPTION

Some(This is the IPaC report that was used to analyze listed species within the boundaries of the watershed.)

Local office

Nebraska Ecological Services Field Office

(308) 382-6468
(308) 384-8835

MAILING ADDRESS
9325 B South Alda Rd., Ste B
Wood River, NE 68883-9565

PHYSICAL ADDRESS
9325 South Alda Rd., Ste B
Wood River, NE 68883-9565

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Log in to IPaC.
2. Go to your My Projects list.
3. Click PROJECT HOME for this project.
4. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).
2. 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.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Northern Long-eared Bat Myotis septentrionalis Wherever found This species only needs to be considered if the following condition applies: • This species only needs to be considered if the project includes wind turbine operations. No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9045	**Endangered**
Tricolored Bat Perimyotis subflavus Wherever found This species only needs to be considered if the following condition applies: • This species only needs to be considered if the project includes wind turbine operations. No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/10515	**Proposed Endangered**

Birds

NAME	STATUS
Piping Plover Charadrius melodus There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/6039	**Threatened**

Fishes

NAME	STATUS
Pallid Sturgeon Scaphirhynchus albus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7162	**Endangered**

Insects

NAME	STATUS

Monarch Butterfly Danaus plexippus Wherever found **No critical habitat has been designated for this species.** https://ecos.fws.gov/ecp/species/9743	**Candidate**

Flowering Plants

NAME	STATUS
Blowout Penstemon Penstemon haydenii Wherever found **No critical habitat has been designated for this species.** https://ecos.fws.gov/ecp/species/6172	**Endangered**

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

There are no critical habitats at this location.

You are still required to determine if your project(s) may have effects on all above listed species.

Bald & Golden Eagles

Bald and golden eagles are protected under the Bald and Golden Eagle Protection Act[1] and the Migratory Bird Treaty Act[2].

Any person or organization who plans or conducts activities that may result in impacts to bald or golden eagles, or their habitats[3], should follow appropriate regulations and consider implementing appropriate conservation measures, as described in the links below. Specifically, please review the "Supplemental Information on Migratory Birds and Eagles".

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds

- Nationwide conservation measures for birds
  https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC
  https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

There are likely bald eagles present in your project area. For additional information on bald eagles, refer to Bald Eagle Nesting and Sensitivity to Human Activity

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the PROBABILITY OF PRESENCE SUMMARY below to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Bald Eagle Haliaeetus leucocephalus This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Oct 15 to Jul 31
Golden Eagle Aquila chrysaetos This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1680	Breeds Jan 1 to Aug 31

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read "Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

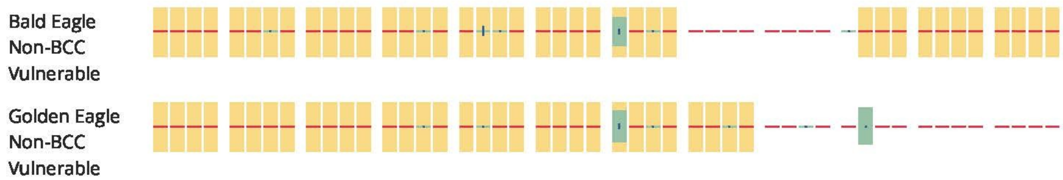
To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

■ probability of presence ■ breeding season | survey effort – no data

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC



What does IPaC use to generate the potential presence of bald and golden eagles in my specified location?

The potential for eagle presence 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). To see a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs of bald and golden eagles 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 Rapid Avian Information Locator (RAIL) Tool.

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. Please contact your local Fish and Wildlife Service Field Office if you have questions.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats[3] should follow appropriate regulations and consider implementing appropriate conservation measures, as described in the links below. Specifically, please review the "Supplemental Information on Migratory Birds and Eagles".

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the PROBABILITY OF PRESENCE SUMMARY below to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Bald Eagle Haliaeetus leucocephalus This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	**Breeds Oct 15 to Jul 31**

Black Tern Chlidonias niger surinamenisis — Breeds May 15 to Aug 20

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3093

Bobolink Dolichonyx oryzivorus — Breeds May 20 to Jul 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Chimney Swift Chaetura pelagica — Breeds Mar 15 to Aug 25

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Golden Eagle Aquila chrysaetos — Breeds Jan 1 to Aug 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1680

Grasshopper Sparrow Ammodramus savannarum perpallidus — Breeds Jun 1 to Aug 20

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/8329

Lark Bunting Calamospiza melanocorys — Breeds May 10 to Aug 15

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Lesser Yellowlegs Tringa flavipes — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9679

Long-billed Curlew Numenius americanus — Breeds Apr 1 to Jul 31

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/5511

Northern Harrier Circus hudsonius — Breeds Apr 1 to Sep 15
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/8350

Pectoral Sandpiper Calidris melanotos — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Red-headed Woodpecker Melanerpes erythrocephalus — Breeds May 10 to Sep 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Western Grebe aechmophorus occidentalis — Breeds Jun 1 to Aug 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/6743

Willet Tringa semipalmata — Breeds Apr 20 to Aug 5
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read "Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted

Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

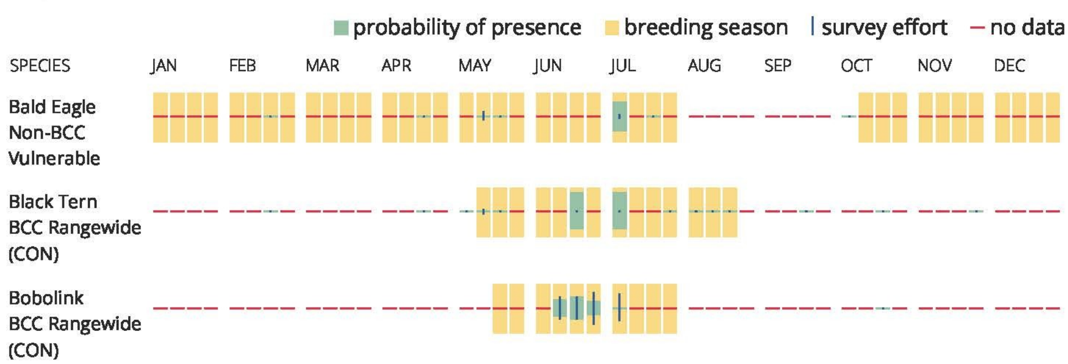
Breeding Season ( )
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

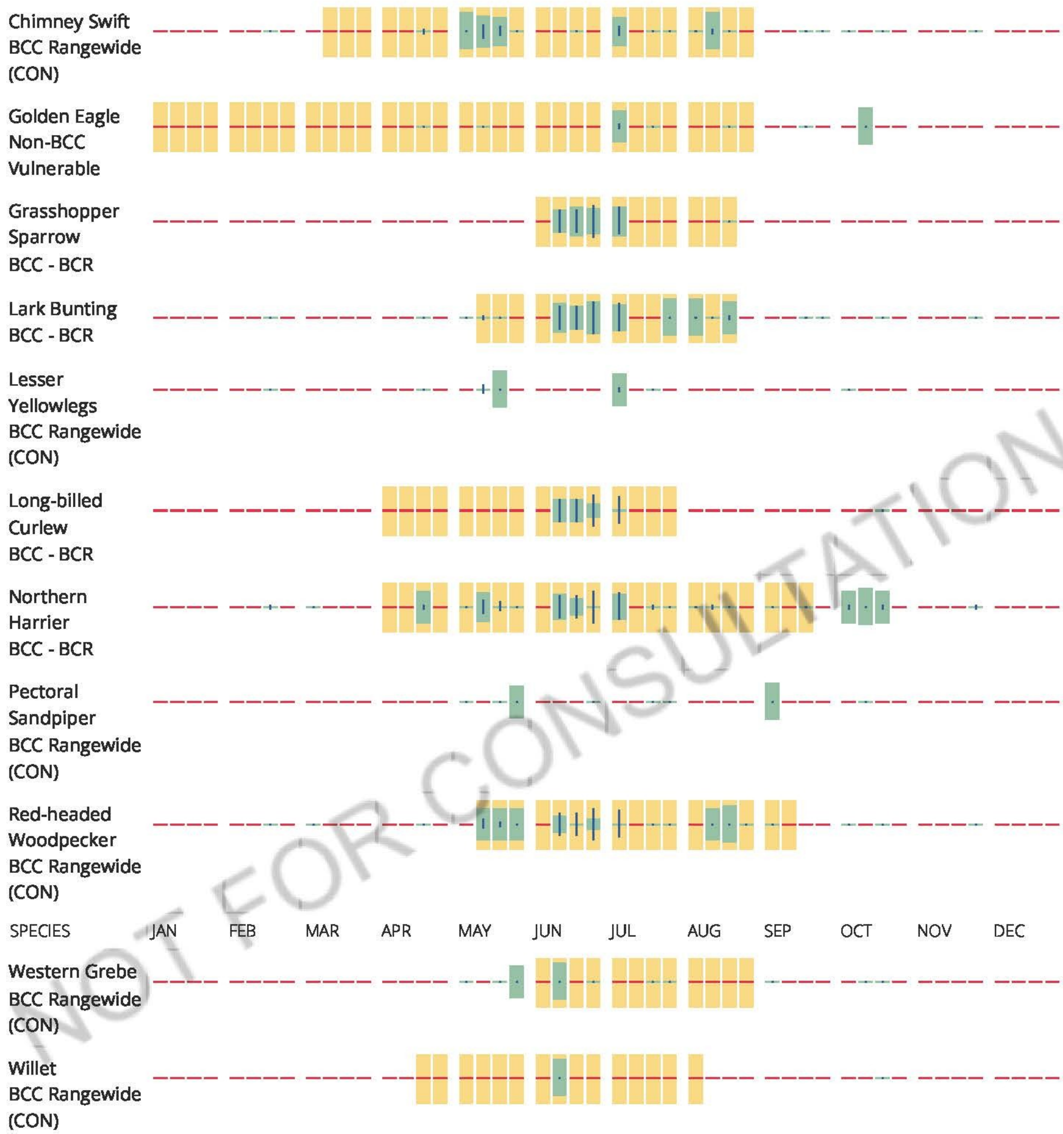
Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.





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 list of migratory birds that potentially occur 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 Rapid Avian Information Locator (RAIL) 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 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 or migrating in my 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 query your location using the RAIL Tool and look at the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. 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.

Facilities

National Wildlife Refuge lands

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 at this location.

Fish hatcheries

There are no fish hatcheries at this location.

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

This location overlaps the following wetlands:

The area of this project is too large for IPaC to load all NWI wetlands in the area. The list below may be incomplete. Please contact the local U.S. Fish and Wildlife Service office or visit the NWI map for a full list.

FRESHWATER EMERGENT WETLAND

- PEM1A
- PEM1/ABFh

PEM1/SSC

FRESHWATER POND

PABFh
PABF
PABKx
PABFx

A full description for each wetland code can be found at the National Wetlands Inventory website

NOTE: This initial screening does **not** replace an on-site delineation to determine whether wetlands occur. Additional information on the NWI data is provided below.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.