CUTLER HYDROELECTRIC PROJECT
FERC NO. 2420

INITIAL STUDY REPORT
VOLUME I

PACIFICORP

FEBRUARY 2021

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CUTLER HYDROELECTRIC PROJECT
FERC NO. 2420

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EXPLANATION OF TERMS

TERM	EXPLANATION
A	
Acre (ac)	A measure of land area equal to 43,560 square feet.
Acre-feet (af)	The amount of water it takes to cover one acre to a depth of one foot; equal to 43,560 cubic feet or 1,233.5 cubic meters.
Aquatic Life	Any plants or animals that live at least part of their life cycle in water.
B	
Baseline	A set of existing environmental conditions upon which comparisons are made during the NEPA process.
Bear Lake	Water released from Bear Lake into the Bear River is used for power generation as it passes downstream through PacifiCorp's five hydroelectric plants in Idaho and Utah.
Benthic	Associated with lake or river bottom or substrate.
Benthic Macroinvertebrates	Animals without backbones that are visible and live on, under, and around rocks and sediment on the bottoms of lakes, rivers, and streams.
Bud Phelps Wildlife Management Area (WMA)	The Bud Phelps WMA, located adjacent to the Project Boundary at the south end of Cutler Reservoir, includes 150 acres of wetland, marsh, and associated habitats just south of Cutler Reservoir, managed by the Utah Division of Wildlife Resources.
C	
CFR	Code of Federal Regulations
Clean Water Act (CWA)	The Federal Water Pollution Control Act of 1972 and subsequent amendments in 1977, 1981, and 1987 (commonly referred to as the Clean Water Act [CWA]). The CWA established a regulatory system for navigable waters in the United States, whether on public or private land. The CWA set national policy to eliminate discharge of water pollutants into navigable waters, to regulate discharge of toxic pollutants, and to prohibit discharge of pollutants from point source without permits. Most importantly, it authorized the Environmental Protection Agency (EPA) to set water quality criteria for states to use to establish water quality standards.
Commission	Federal Energy Regulatory Commission also referenced as FERC.
Critical Energy Infrastructure Information (CEII)	Project-related documents related to the design and safety of dams and appurtenant facilities that are restricted from public viewing in accordance with FERC regulations (18 CFR 388.113) to protect national security and public safety.
Cubic Feet (cf)	The volume of a cube with equal sides one foot in length.
Cubic Feet per Second (cfs)	A measurement of water flow representing one cubic foot of water moving past a given point in one second; equal to 0.0283 cubic meters per second and 0.646 million gallons per day (mgd).
Cultural Resources	Includes items, structures, etc. of historical, archaeological, or architectural significance.
Cutler Dam	Refers to the Cutler Dam structure; includes the dam, flowline,

	penstocks, surge tank, and powerhouse.
Cutler Hydroelectric Project	Federal Energy Regulatory Commission (FERC) Project No. 2420, located on the Bear River in Box Elder and Cache counties, Utah includes all the lands, waters and structures enclosed within the FERC Project Boundary.
Cutler Reservoir	Cutler Reservoir spreads out from the canyon, Cutler Dam, upstream into flat land consisting of pasture, meadows, meandering river channels, marshes, wetland, agricultural land, and forest.
D	
Dam	A structure constructed across a water body typically used to increase the hydraulic head at hydroelectric generating units. A dam typically reduces the velocity of water in a particular river segment and increases the depth of water by forming an impoundment behind the dam. It also generally serves as a water control structure.
Dissolved Oxygen (DO)	Perhaps the most commonly employed measure of water quality. Low DO levels adversely affect fish and other aquatic life. The total absence of DO leads to the development of an anaerobic condition and the eventual development of odor, loss of aquatic organisms, and aesthetic problems.
Drawdown	The distance the water surface of a reservoir is lowered from a given elevation as the result of releasing water. Also the reduction in flow downstream of a dam.
E	
Eutrophic	Waters with a high concentration of nutrients, greatly fluctuating DO, and a high level of primary production.
F	
°F	Degrees Fahrenheit
Federal Energy Regulatory Commission	FERC; The governing federal agency responsible for overseeing the licensing, relicensing, and operation of non-federal hydroelectric projects in the United States.
Flow	The volume of water passing a given point over a given amount of time.
G	
GIS	Geographic Information System
H	
Habitat	The locality or external environment in which a plant or animal normally lives and grows.
I	
Impoundment	The body of water created by a dam.
Integrated Licensing Process (ILP)	The ILP is the default process by which a hydroelectric project obtains a new license to operate from the FERC.
Interested Parties	Individuals who have expressed an interest in the relicensing proceeding; similar to a stakeholder.
L	

License	FERC authorization to construct a new project or continue operating an existing project. The license contains the operating conditions for a term of 30 to 50 years.
License Application	Application for a new license that is submitted to the FERC no less than 2 years in advance of expiration of an existing license.
Licensee	PacifiCorp, a subsidiary of Berkshire Hathaway Energy.
M	
Megawatt (MW)	A unit of electrical power equal to one million watts or 1,000 kW.
Megawatt-hour (MWh)	A unit of electrical energy equal to 1 MW of power used for one hour.
Model Boundary	The study area for the hydraulic modeling effort included all facilities within the PacifiCorp Project Boundary, as well as 1.5 miles of the Bear River downstream of the PacifiCorp Project Boundary near the Cutler powerhouse.
N	
National Environmental Policy Act (NEPA)	A law passed by the U.S. Congress in 1969 to establish methods and standards for the review of development projects requiring federal action such as permitting or licensing.
Non-Governmental Organization (NGO)	Local, regional, and national organizations such as conservation, sportsman's, or commerce groups.
P	
Power Factor	The ratio of actual power to apparent power. Power factor is the cosine of the phase angle difference between the current and voltage of a given phase. Unity power factor exists when voltage and current are in phase.
Powerhouse	The building that typically houses electric generating equipment.
Pre-Application Document (PAD)	A document required by FERC when relicensing a project that brings together all existing, relevant, and reasonably available information about the project and its effects on resources; includes a well-defined process plan that sets the schedule for developing the license application and a list of preliminary studies and issues.
Project	All the components of a hydropower development (i.e., dam, powerhouse, transmission junctions, reservoir, rights-of-way, lands). Project: the impoundment and any associated dam, powerhouse, reservoir, intake, water conveyance facility, and any other structures, rights, lands, and waters (the complete unit of development), as well as property rights in lands and waters as necessary for construction, operation, and maintenance of a project. For the purposes of this document, Project is defined as the Cutler Hydroelectric Project (FERC Project No. 2420), located on the Bear River in Box Elder and Cache counties, Utah.
Project Area	The geographic area comprised of the lands and waters within the Project Boundary and those lands immediately adjacent to the Project Boundary. For the purposes of this document, the Project Area is the area which

	contains all Project features (encompassing the Project Boundary as defined below), and which extends out for the purposes of characterization and analysis from the edge of the Project Boundary plus a 0.5-mile buffer.
Project Boundary	The boundary defined in the project's license issued by FERC outlining the geographic area needed for project operations and maintenance. Project Boundary: includes all structures (e.g., dams, powerplants or other structure used for generation of electricity), lands and waters included in a license or exemption. The Project Boundary must enclose only those lands necessary for operation and maintenance of the project and for other project purposes, such as recreation, shoreline control, or protection of environmental resources, as designated in the project license. Project boundaries are used to designate the geographic extent of the hydropower project that FERC determines a licensee must own or control on behalf of its licensed hydropower project. For the purposes of this document, the Project Boundary is defined as all lands and waters within the existing FERC Project Boundary for the Cutler Hydroelectric Project No. 2420, as denoted on the Project's Exhibit G.
Project Vicinity	Refers to a larger geographic area near a project, such as a county; used for characterization or analysis of specific resources. For the purposes of this document, Project Vicinity is defined by resource in relevant sections of the document.
R	
Relicensing	The administrative proceeding in which FERC, in consultation with other federal and state agencies, decides whether and on what terms to issue a new license for an existing hydroelectric project at the expiration of the original license.
Relicensing Participants	Individuals who actively participate in the relicensing proceedings.
Reservoir	A man-made lake into which water flows and is stored for future use.
Resident Fish	Fish that do not migrate out to a larger body of water such as a larger river, lake, or the ocean, but instead remain in the freshwater tributary where they hatched.
Resource Agency	A federal, state, or interstate agency with responsibilities in the areas of flood control, navigation, irrigation, recreation, fish or wildlife, water resource management, cultural, or other relevant resources of the state in which a project is or will be located.
Riparian	Of, relating to, or situated or dwelling on the bank of a river or other body of water. Frequently refers to the shrub- and tree-dominated habitats that are commonly found adjacent to these bodies of water.
S	
Salt Creek Waterfowl Management Area	The management area is managed by the UDWR and is located at the mouth of the Bear River Valley, north of the Bear River Migratory Bird Refuge and approximately 16 miles southwest of Cutler

	Reservoir.
Scoping Document 1 (SD1)	A document prepared by FERC as part of NEPA environmental review that initially identifies issues pertinent to the FERC's review of a project. The FERC circulates the SD1 and holds a public meeting to obtain the public's comment.
Scoping Document 2 (SD2)	A revision of the SD1 that considers public comment on that document.
Scoping Process	The process of identifying issues, potential impacts, and reasonable alternatives associated with the operation of a hydroelectric project. "Scoping" is a process required when any federal agency is taking an action that might affect the quality of the human environment, pursuant to the National Environmental Policy Act (NEPA) of 1969. In the case of hydroelectric projects, FERC′s issuance of an operating license qualifies as a federal action.
Secchi Depth	Average depth that a standard sized black and white disk disappears and reappears when viewed from the lake surface as the disk is lowered; an indicator of water clarity.
Spillway	A passage for releasing surplus water from a reservoir or canal.
Stakeholder	Any individual or organization (government or non-governmental) with an interest in a hydroelectric project; similar to an interested party.
Stratification	A physical process that results in the formation of distinct layers of water within a lake or reservoir (i.e., epilimnion, metalimnion, and hypolimnion) separated by temperature.
Study Plan	The aggregate of all study descriptions.
T	
Tailrace	The channel located between a hydroelectric powerhouse and the river where discharged water passing through the turbines enters the river immediately below the powerhouse.
Tailwater	The waters immediately downstream of a dam; for hydroelectric dams, also referred to as the tailrace.
Turbidity	A measure of the extent to which light passing through water is reduced due to suspended materials. Measured as NTU or FTU.
W	
Watershed	An entire drainage basin including all living and nonliving components of the basin.
Wetlands	Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the terrestrial surface or the land is covered by shallow water. Wetlands must have the following three attributes: 1) at least periodically, the land supports predominantly hydrophytes; 2) the substrate is predominantly undrained hydric soil; 3) the substrate is on soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

ACRONYMS

µg/l	microgram per liter
µm	one millionth of a meter (micrometer)
mg/L	milligrams per liter
1D	1 dimensional
2D	2 dimensional

A

AFO	Animal Feeding Operation
Al	aluminum
ANOVA	analysis of variance
APE	Area of Potential Effects
ATV	all-terrain vehicle
AWQMS	Ambient Water Quality Monitoring System

B

BBS	Breeding Bird Survey
BLM	Bureau of Land Management
BMI	Benthic Macroinvertebrate Index
BOD	Biological Oxygen Demand
BRCC	Bear River Canal Company
BYU	Brigham Young University

C

C	Celsius
$CaCO_3$	calcium carbonate
CAFO	Concentrated (or Confined) Animal Feeding Operation
CBC	Christmas Bird Count
CEC	Cation exchange capacity
CEII	Critical Energy Infrastructure Information
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
COVID-19	Coronavirus Disease 2019
CRA	Cultural Resources Assessment

D

DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
District	Cutler Hydroelectric Power Plant Historic District
DLA	Draft License Application
DO	Dissolved Oxygen
DTP	Dissolved Total Phosphorus

E

EC	Eligible/Contributing
ESA	Endangered Species Act
ERI	Ecosystems Research Institute

F

F	Fahrenheit
FAA	Federal Aviation Administration
Fe	Iron
FERC	Federal Energy Regulatory Commission
FTU	Fomazin Turbidity Unit

G

GIS	geographic information system
GLO	General Land Office
GPS	global positioning system

H

HPMP	Historic Properties Management Plan

I

ID	identification
IF	isolated features
ILP	Integrated Licensing Process
ILS	intensive-level survey
IO	isolated occurrences
IPaC	Information Planning and Conservation
ISR	Initial Study Report

J

JHU	Johns Hopkins University

K

K	thousand
kg	kilogram
kHz	kilohertz

L

LBM	Little Bear Marsh
LiDAR	Light Detection and Ranging
LRM	Logan River Marsh

M

MBTA	Migratory Bird Treaty Act
mg/kg	milligram per kilogram

ml	milliliter
mm	millimeter
msl	Mean Sea Level

N

NAIP	National Agricultural Imagery Program
NC	non-contributing
NEPA	National Environmental Policy Act
NGO	Non-Governmental Organization
NGVD	National Geodetic Vertical Datum
NH3	Ammonia
NLCD	National Land Cover Database
NO_2	Nitrite
NO_3	Nitrate
NOAA Fisheries	National Marine Fisheries Service (also NMFS)
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NTU	Nephelometric Turbidity Unit
NWI	National Wetland Inventory

O

OHWL	Ordinary High-Water Line
OP	orthophosphate

P

P	Phosphorus
PAD	Pre-Application Document
PCB	polychlorinated biphenyl
PM&E	Protection, Mitigation, and Enhancement
ppb	parts per billion
Project	Cutler Hydroelectric Project
PSP	Proposed Study Plan

Q

QA/QC	Quality Assurance/Quality Control
QR	Quick Response Code Scan

R

RCRA	Resource Conservation and Recovery Act
Reclamation	U.S. Bureau of Reclamation
RLS	Reconnaissance-level Survey
RMP	Resource Management Plan
RR	railroad

RSP	Revised Study Plan

S

SCM	Spring Creek Marsh
SD1	Scoping Document 1
SD2	Scoping Document 2
SDM	Sewage Discharge Marsh
SHPO	State Historic Preservation Office
SPD	Study Plan Determination
SRP	soluble reactive phosphorus
SWCA	SWCA Environmental Consultants

T

TDP	total dissolved phosphorus
TDS	Total Dissolved Solids
TIN	triangular irregular network
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TP	Total phosphorus
TSS	Total Suspended Solids

U

UDEQ	Utah Division of Environmental Quality
UDSH	Utah Division of State History
UDWR	Utah Division of Wildlife Resources
UDWRi	Utah Division of Water Rights
UDWQ	Utah Division of Water Quality
UHSF	Utah Historic Site Form
UP&L	Utah Power and Light
URN	Utah Reference Network
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USU	Utah State University
USUAL	Utah State University Analytical Lab

V

VEP	Vegetation Enhancement Program

W

WMA	Wildlife Management Area
WSE	Water Surface Elevation
WSoC	Wildlife Species of Concern
WWTP	Wastewater Treatment Plant

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CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

1.0 OVERVIEW

PacifiCorp (Licensee) files this Initial Study Report (ISR) with the Federal Energy Regulatory Commission (FERC or Commission) as part of the relicensing of the Cutler Hydroelectric Project (FERC No. 2420) (Project).

The current Project license expires March 31, 2024, and PacifiCorp is using FERC's Integrated Licensing Process (ILP) regulations (18 Code of Federal Regulations [CFR] § 5.15) to acquire a new license for the Project. PacifiCorp filed a Preliminary Application Document (PAD) and Notice of Intent (NOI) for the Project on March 29, 2019.

PacifiCorp initiated early contact with stakeholders, as described in the PAD (Section 2.0 and 3.5) and the Revised Study Plan (RSP) (Section 1.1). On February 13, 2019, PacifiCorp held an open house to inform the public about the Project and upcoming opportunities to participate in the relicensing process.[1] On June 25, 2019, PacifiCorp hosted an additional workshop (in parallel with the FERC relicensing process) to create opportunities for stakeholders to identify questions and potential issues that would be appropriate for the relicensing process and provide comments on the Proposed Study Plan (PSP) annotated outlines.[2] On June 26 and 27, 2019, FERC hosted two Scoping Meetings (a morning and afternoon session)[3,4] and a Cutler Project site visit. These workshops, meetings, and site visit helped develop a common understanding of the issues to be addressed during the relicensing. Stakeholders provided input on draft PSP annotated outlines that were developed in response to the previous workshops and other stakeholder input. Stakeholders were invited to provide comments on the PAD, Scoping Document 1 (SD1), and to

[1] Cutler Relicensing Public Workshop – Meeting Summary (February 13, 2019)
[2] Cutler Relicensing Stakeholder Workshop – Meeting Summary (June 25, 2019)
[3] Transcript of the AM Scoping Meeting. Available on FERC eLibrary (Accession Number: 20190815-4001)
[4] Transcript of the PM Scoping Meeting. Available on FERC eLibrary (Accession Number: 20190815-4002)

propose any additional studies by the required July 29, 2019 ILP deadline for the Cutler Project relicensing.

PacifiCorp invited federal and state agencies, non-governmental organizations (NGOs), Native American tribes and tribal organizations, adjoining landowners, elected officials, and other stakeholders to participate in the public meeting, workshops, scoping meeting, and site visit. During these meetings and through FERC eLibrary submission, stakeholders and PacifiCorp identified the need to conduct the studies contained in the PSP. The PSP that was filed on September 11, 2019 pursuant to 18 CFR § 5.12 detailed the study objectives, study area, methods, and schedule for each study. On September 13, 2019, FERC issued Scoping Document 2 (SD2).

On October 8, 2019, PacifiCorp hosted the required Study Plan Meeting in Logan, Utah pursuant to 18 CFR § 5.11(e). Stakeholders, along with FERC, were invited to discuss study plan requests and comments submitted by July 29, 2019 on SD1, the study plans filed in the PSP, as well as PacifiCorp's responses to comments.

Additionally, from October 28 through November 30, 2019, PacifiCorp hosted a number of supplemental stakeholder-specific meetings with the Bear River Canal Company (BRCC), Utah Department of Agriculture and Food (UDAF), Utah Division of Water Quality (UDWQ), Logan City, Bear Lake Watch, and the Bridgerland Audubon Society (BAS). PacifiCorp and these respective stakeholders discussed concerns and requests, ultimately agreeing on multiple study requests and revisions to the PSP. PacifiCorp filed response-to-comment letters and associated meeting summaries on December 10, 2019.[5]

On January 10, 2020, PacifiCorp submitted the RSP pursuant to 18 CFR § 5.12 and 5.13.[6] On February 7, 2020, FERC issued the Study Plan Determination (SPD) pursuant to 18 CFR § 5.13(c) (Appendix A). FERC approved the RSP, with minor revisions, in its SPD. The determination was based on criteria set in § 5.9(b) of FERC's regulations. The FERC SPD identified the studies to be completed as part of the relicensing.

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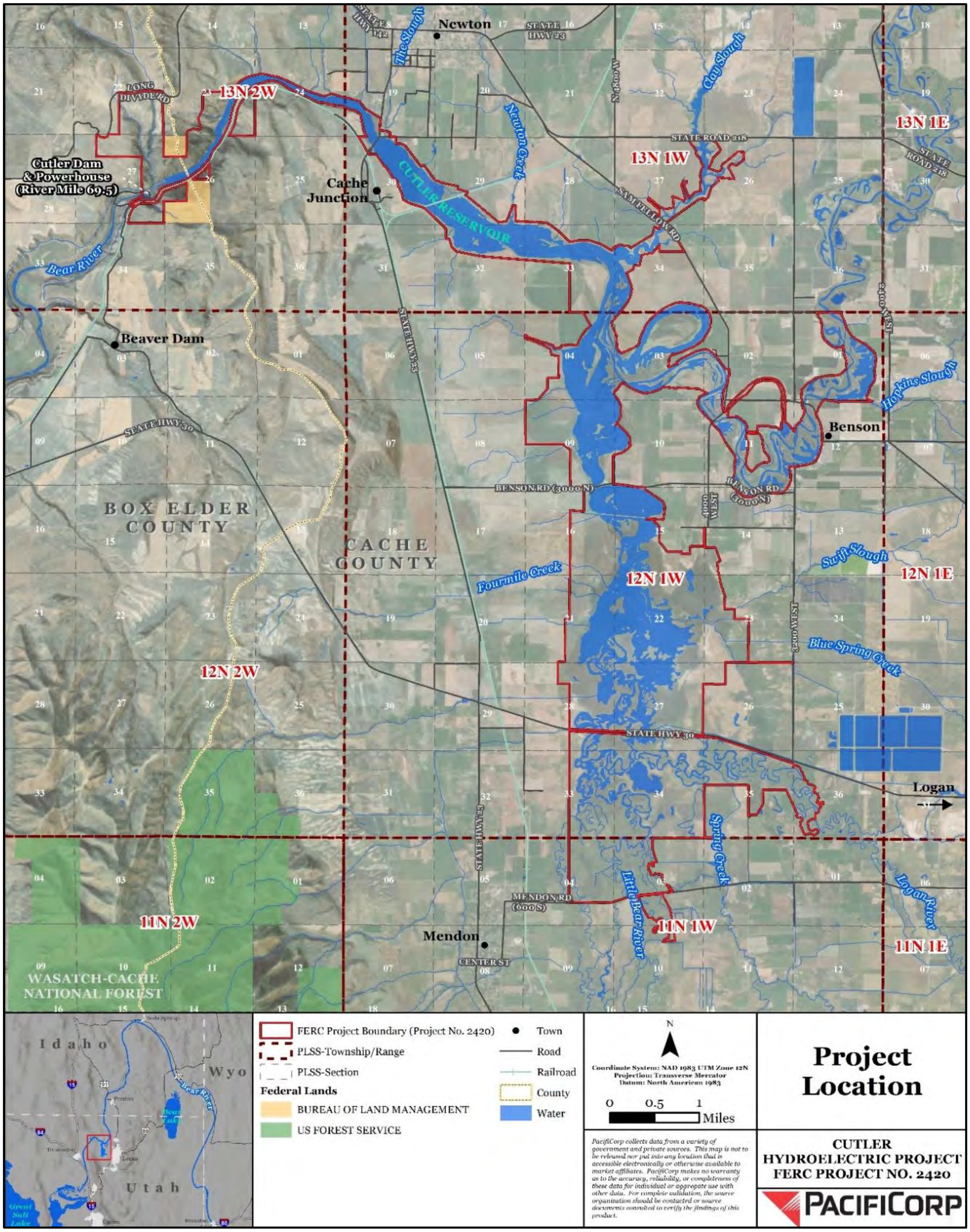
[5] PacifiCorp Response to Comments Letters and Meeting Summaries of Stakeholder Meetings
[6] PacifiCorp Revised Study Plan filed January 10, 2020

This ISR is being submitted in accordance with FERC's ILP regulations and describes PacifiCorp's overall progress in implementing the FERC-approved RSP and SPD, including an explanation of variances, if any, from the SPD. Volume I of this ISR includes results of the natural and cultural resources studies identified in the RSP that were completed in late 2019 and 2020 (first-year studies). Confidential results of the first year of cultural resources surveys are included in a separate volume of this ISR (Volume II) and are being filed as "Privileged" to protect sensitive archaeological data and other culturally important information in accordance with FERC regulations. Information related to protecting sensitive archaeological data and other culturally important information is also restricted under Section 106 of the National Historic Preservation Act (NHPA).

1.1 PROJECT LOCATION AND AREA

The Project is located on the Bear River in Cache Valley, Utah, between the Wasatch and the Wellsville Mountains (Figure 1-1). While the Cutler Dam is located in Box Elder County, most of the reservoir and adjacent Project land lies within Cache County. The reservoir is formed at the confluence of the Bear, Logan, Spring Creek, and Little Bear Rivers. In addition to the Cutler Project, PacifiCorp owns and operates four (4) other hydroelectric developments on the Bear River; all of which are located further north and upriver in Idaho. Additionally, there are seven (7) other hydroelectric developments located on the Logan River, Blacksmith Fork, Mink Creek and Paris Creek, which are all Bear River tributaries. PacifiCorp owns the hydroelectric development on Paris Creek, but not the other six developments.

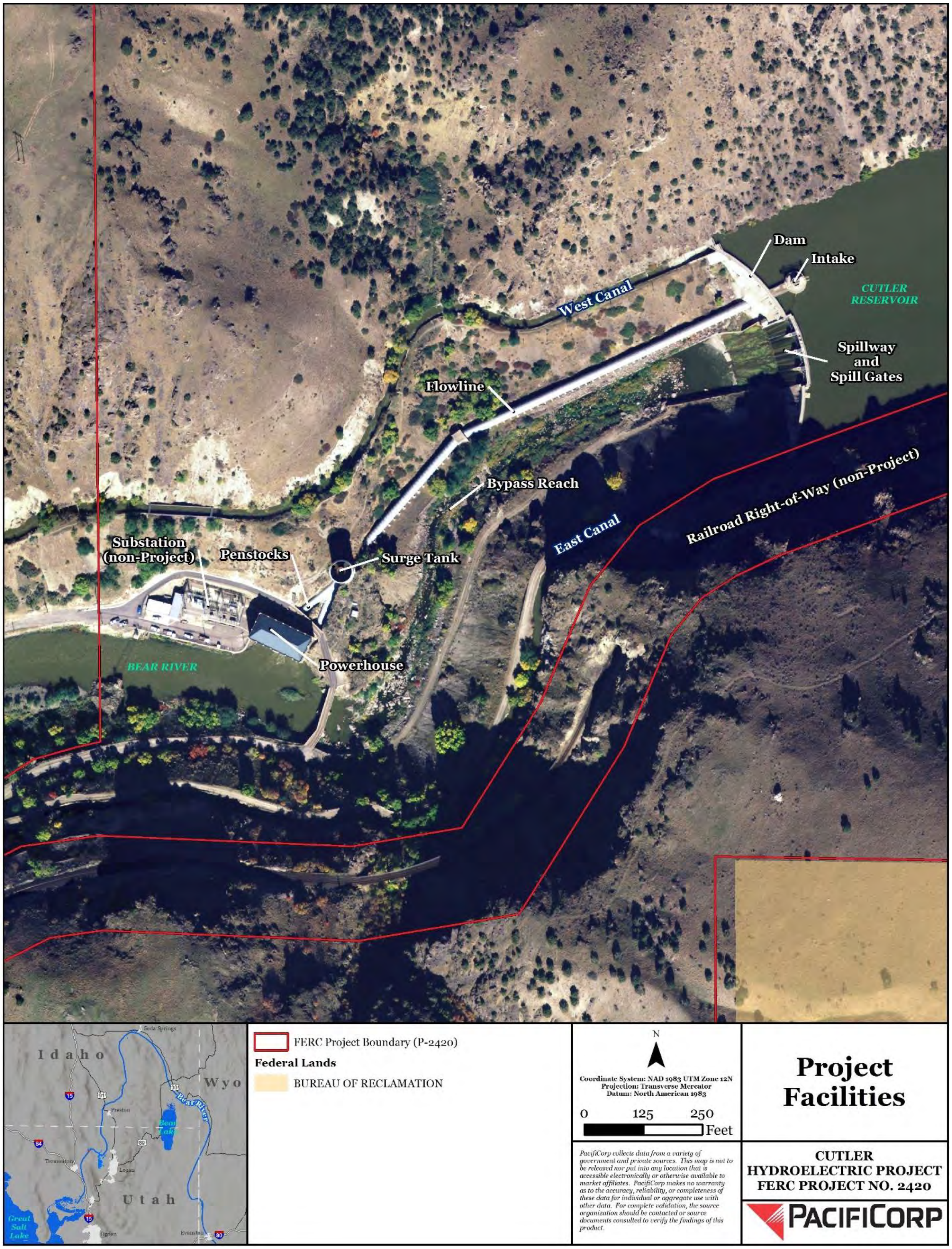


Source: PacifiCorp 2018

FIGURE 1-1 CUTLER HYDROELECTRIC PROJECT LOCATION

1.2 PROJECT DESCRIPTION

The Project facilities consist of a reservoir with a surface area of approximately 5,459 acres, with storage of approximately 13,200 acre-feet, a concrete gravity arch dam with a crest length of 545 feet, including two non-Project irrigation canal intakes at the top of the abutments, a gated-overflow spillway, an intake tower, a 1,157-foot-long steel flowline, an 81-foot-high Johnson Differential surge tank, two steel penstocks that bifurcate from the surge tank into the powerhouse, a brick powerhouse, two generating units with a total installed capacity of 30 megawatts (MW), two Francis turbines, and other appurtenant facilities (Figure 1-2).



Source: PacifiCorp 2018

FIGURE 1-2 CUTLER PROJECT FACILITY DETAILS

1.3 PROPOSED PROJECT OPERATIONS

PacifiCorp's current Project operations and elevation[7] ranges are outlined below in Table 1-1.

TABLE 1-1 CONDENSED RESERVOIR ELEVATION OPERATING RANGE TABLE

TIME PERIOD	OPERATING RANGE (ELEVATION IN FEET)	TOLERANCE (FEET)	TARGET PERCENTAGE
Mar. 1 – Dec. 1	4,407.5 – 4,406.5	+0.25, -0.25	95%
Dec. 2 – Feb. 28	4,407.5 – 4,406.0	+0.25, -0.50	90%

Source: PacifiCorp 2002 License Amendment

For the new license term, PacifiCorp proposes to maintain the upper operating limit elevation on the reservoir, with a modest expansion to the tolerance. PacifiCorp also proposes expanding the range of the lower operating limit outside the irrigation season because recent data has shown that reservoir constraints are difficult to maintain during high runoff events such as summer rain and spring runoff (ironically, high water frequently results in elevation readings below the operating limits as the reservoir elevation must be lowered at Cutler Dam, the compliance point, in order to help move high flows through the system), and to increase operational flexibility. As outlined in the PAD, PacifiCorp is seeking operational flexibility within the proposed additional range to support variable energy generation needs. PacifiCorp's proposed operations in the new license would mimic the existing operational range (see Table 1-1 above) from elevation 4407.5 to 4406.5 feet 85 percent of the time ('normal' operations, occurring a minimum of 310 days per year, including the irrigation season) with a tolerance limit of +/-0.5 feet (primarily to accommodate high water events and occasional un-forecasted irrigation variation), and allow a wider operating range from elevation 4,406.5 to 4405.0 feet up to 15 percent of the time ('extended' range operations, up to 55 days per year, outside of the irrigation season and not during high flows) as determined by daily average adjusted elevations at Cutler Dam. These values (4407.5 – 4406.5 feet, 85 percent of the time, and 4407.5 – 4405.0 feet, 15 percent of the time) represent the range PacifiCorp is proposing, for purposes of managing potentially

[7] Elevations reported herein refer to National Geodetic Vertical Datum of 1929, or NGVD29.

increased daily, weekly, and seasonal reservoir elevation fluctuations to better support variable energy generation needs.

For the narrower 4406.5 to 4407.5 feet normal range (proposed for 85 percent of the time), a tolerance limit of +/-0.5 feet is proposed to avoid nuisance exceedances during irrigation season rainfall events that typically result in spilling upstream reservoir storage water from Bear Lake, or those resulting from high flows throughout the system, such as those occurring as noted previously during runoff and other high flows that may ensue when the reservoir level is lowered at Cutler Dam in order to manage the high flows. Historically, the FERC has allowed a temporary exceedance for these events, occurring as a result of weather or other conditions outside the control of PacifiCorp. This proposal adopts the FERC position already established. Note that during the irrigation season, generally April 15 – October 31, no operational changes to the reservoir limits are proposed.

Since the issuance of the PAD, PacifiCorp has been evaluating the feasibility of different elevation scenarios and how these scenarios could help increase operational flexibility. PacifiCorp previously indicated a desire to explore the total range of potential operational flexibility in the reservoir (a range of approximately 11 feet). This option is no longer being explored as it was determined that 64 percent of the volume of the reservoir lies within the upper 2.5 feet (as measured at Cutler Dam), and 30 percent of the reservoir volume lies within the top 1 foot. As a result, increasing the operating range would not increase the volume of water available for energy generation. Additionally, the removal of Wheelon Dam is no longer being contemplated as the studies demonstrated that Wheelon Dam removal would not change the distribution pattern of sediment deposition in the reservoir in any meaningful way.

PacifiCorp is not proposing to permanently lower the reservoir operating range an additional 1.0 feet, but rather has identified a seasonal operational range that would allow the Project to be responsive to the short-term generation demands and load changes that have resulted from grid integration of solar and wind generation resources and the challenges of the Electrical Imbalance Market. This will allow the Project to continue to meet daily high electricity demands and use the wider extended operating range (potentially extending down to elevation 4405.0 feet) over approximately week-long cycles (Figure 1-3), as well as to optimize for emergency back-up reserves which do not effect daily generation or flows, except for the occasional (approximately yearly) event when emergency backup is needed, and the outflow is increased to allow for maximum power generation (30 MW) for typically 2 hours maximum, which has essentially no reservoir impact due to the relatively small volume released.

Figure 1-3 illustrates the typical extended range (i.e., 15 percent of the time, 2.5-foot range) operations scenario. In this example the total inflow into Cutler Reservoir is 1,090 cfs, a typical winter flow. The blue line represents the generation flow through Cutler, and the orange line shows the reservoir elevation. Customer demand forecasts typically guide when stored water would be used for generation. When energy demand is low and/or there is a surplus of energy across grid resources, water is stored (first part of the week), and then when demand becomes high, stored water is then used for generation (second half of the week). In practice, the economics are rarely this clear, so this pattern is anticipated to be fairly rare (i.e., less than 15 percent of the time, and never during irrigation or extreme winter ice temperatures). However, when conditions are ideal, Table 1-2 would allow the type of operation shown in Figure 1-3 roughly half of the time *when variable operations are possible.* This is calculated by determining the fraction of the time the reservoir level was below elevation 4406.5 feet, which is approximately 50 percent of the time.

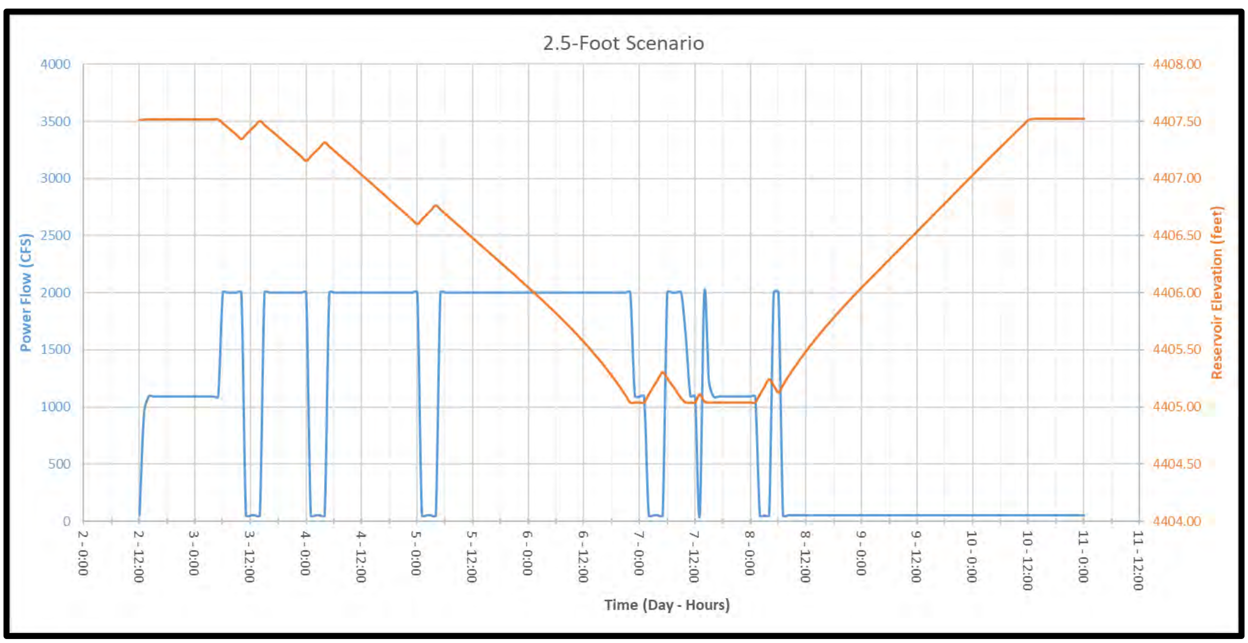


FIGURE 1-3 EXAMPLE OF POSSIBLE EXTENDED RANGE ACTIVE MANAGEMENT OVER AN 8-DAY WINDOW UTILIZING THE FULL 2.5-FT. EXTENDED RANGE

In summary, PacifiCorp proposes to keep the same operating range the majority (85 percent) of the time, modify the allowable reservoir elevation range seasonally, modestly increase the tolerance range, and define a target percentage for the length of time in each range type, allowing up to 15 percent of the calendar days within the extended operating range (below 4406.5 feet, down to 4405.0 feet) except during the irrigation season and as further detailed below (Table 1-2). Elevations are expected to stay within the tolerance zone 95 percent of the time in both normal and extended conditions, with exceptions due to high runoff and unexpected irrigation fluctuations.

TABLE 1-2 PROPOSED RESERVOIR ELEVATION FLUCTUATION EVALUATION RANGE*

RANGE TYPE	OPERATING RANGE (ELEVATION IN FEET)	TOLERANCE (FEET)	PERCENT TIME WITHIN TOLERANCE	PERCENTAGE OF CALENDAR DAYS FOR RANGE TYPE
Normal	4,407.5 – 4,406.5	(+0.5 @ 4,408.0)	95%	At least 85% (~310 days)
Extended	4,406.5 – 4,405.0	(-0.5 @ 4,404.5)	95%	15% (~55 days) or less

*Quantified by daily average adjusted reservoir elevations at Cutler Dam.

The increased (from +/- 0.25 to +/-0.5) target for tolerance range will assist in irrigation operations but may also help respond to generation fluctuations during other portions of the year. It will also be useful during high runoff when reservoir sloping creates unusually high reservoir levels in the southern portion of the reservoir, when due to the sloping effect described previously, reservoir levels at Cutler Dam are frequently lower than the lower compliance limit.

As noted above, it is not possible to operate in the extended range during the irrigation season nor when inflows approach and exceed hydraulic capacity, such as during normal-to-high spring runoff years. This is for two reasons: the bathymetry forces the water level higher as flows increase and there is no room for decreases in power flows when inflows are above hydraulic capacity. Therefore, the extended range would typically only be utilized during the November-to-March time period and would further exclude periods of extreme low temperature (typically sometime between mid-December and end of January) when downstream ice-damming concerns are present.

1.4 UPDATE ON CUTLER RESERVOIR DRAWDOWN AND MODELING

A drawdown of Cutler Reservoir was conducted in the fall of 2019 for the purpose of obtaining light detection and ranging (LiDAR) and bathymetry data of the reservoir to populate a two-dimensional (2D) hydraulic model and one-dimensional (1D) sediment transport model. In addition, the drawdown provided a unique opportunity to collect a range of specific resource data under drawdown conditions. The drawdown was scheduled for fall of 2019 due to irrigation contract and seasonal-based restrictions, and to gather critical information prior to study implementation in 2020. The drawdown was conducted from October 25 to November 16, 2019, which was as early as possible that year in order to avoid the potential of extremely cold ambient temperatures with the resultant complexities of acquiring LiDAR and related imagery with ice and snow conditions, as well as potential study effects (i.e., to aquatic species). Unfortunately, unseasonably cold temperatures set in once the drawdown was underway, which persisted through most of the drawdown, creating unavoidable issues with data and imagery collection for a several of the studies.

The 2D hydraulic and 1D sediment transport models were developed in 2020 after the drawdown. The models were constructed for the reservoir, upstream tributaries, and downstream reaches and then calibrated. Hydraulic calibration included adjusting hydraulic parameters within the model to reproduce inundation boundaries within the Project Area and water surface elevation (WSE) data at specific points within the reservoir. Aerial photos collected during the drawdown were used to verify the inundation boundaries during the drawdown. Sediment transport calibration included adjusting the hydraulic and reservoir bed parameters to match the minimum reservoir bed elevation during the drawdown. Detailed modeling methods are presented in the Hydraulic Modeling ISR (Appendix G). The models informed PacifiCorp's evaluation of a range of alternatives for future operations and other studies.

The calibrated 2D hydraulic model was used to simulate reservoir elevation fluctuation for proposed operations. Figure ISR-1-1 in Attachment ISR-1 shows the overview of the various index sheets that follow. Colored in pink, Figure ISR-1-2 through Figure ISR-1-7 of Attachment ISR-1 illustrate water elevation fluctuations at 0.5-foot increments for the proposed normal (equal to the current operating range, i.e., from elevation 4,407.5 to 4,406.5 feet or at least 85 percent of calendar days in a year with a tolerance limit of +0.5 feet). Colored in blue, the same figures illustrate water elevation fluctuation at 0.5-foot increments for the proposed extended operating range (i.e., from elevation 4,406.5 to 4,405.0 feet or up to 15 percent of calendar days with a tolerance limit of -0.5 feet). Table ISR-1-1 of Attachment ISR-1 shows this data in a tabular format. Individual resource reports (Appendices B-J) present the results of specific resource data in relation to these modeled reservoir elevation fluctuations for proposed operations. Figure ISR-1-8 and Figure ISR-1-9 in Attachment ISR-1 illustrates the WSE at the proposed normal (equal to the current operating range) and proposed extended operating ranges (seasonally operating down to 1.0 feet below the current winter operating range).

1.5 PROCESS AND SCHEDULE

1.5.1 STUDY PLAN MODIFICATIONS AND SUBSEQUENT FERC DETERMINATION

18 CFR § 5.15(c) of the Commission's regulations provides the process for determining the need for second-year studies. According to the SPD issued by FERC on February 7, 2020, PacifiCorp is required to file its ISR by February 9, 2021. Within 15 days of filing the report, PacifiCorp must conduct an ISR meeting with the resource agencies, interested parties, and FERC staff to discuss study results and modifications to the RSP, including the need for second-year studies pursuant to 18 CFR § 5.15(c)(2). PacifiCorp must file a summary of the ISR meeting within 15 days of the meeting pursuant to 18 CFR § 5.15(c)(3), after which relicensing stakeholders may file, within 30 days, any disagreement concerning the ISR meeting summary and PacifiCorp's study proposals, as well as any recommendations for modifications to ongoing studies or requests for new studies. Recommendations for modified or new studies must be accompanied by justification in accordance with FERC's regulations pursuant to 18 CFR § 5.15(c)(4). PacifiCorp subsequently has 30 days to file any responses to comments and FERC will resolve any disagreements and/or modifications to the RSP within another 30 days. The Licensee has scheduled the ISR meeting for no later than February 23, 2021. Due to COVID-19 restrictions on in-person gatherings, the meeting will be held virtually via Microsoft Teams.

Any request to modify a study or for a new study must demonstrate that the approved study was not conducted as described in the FERC-approved RSP and SPD, was conducted under anomalous environmental conditions, or that environmental conditions have changed in a material way since the SPD's issuance. The request must also explain why the study's objectives cannot be met via the approved study's methods and why the proposal for modification was not made earlier, or that significant new information has become available that affects the study.

1.5.2 TIMELINE THROUGH UPDATED STUDY REPORT MEETING

Relicensing stakeholders have 60 days from the filing of this ISR to file any disagreement concerning PacifiCorp's meeting summary, setting forth the basis for the disagreement and any modifications to ongoing studies or proposed new studies. FERC will resolve any disagreements and amend the approved RSP as appropriate within approximately 120 days of the filing of this ISR, and PacifiCorp will be responsible for conducting any FERC stipulated second-year studies, or additional phases of existing studies, as appropriate in 2021.

In accordance with the Process Plan and Schedule proposed by PacifiCorp and approved by FERC (Table 1-3), an Updated Study Report (USR), if applicable, must be filed with FERC no later than February 9, 2022 (although it can be completed earlier), to provide study results from any second-year or additional studies. Within 15 days following the filing of the USR, PacifiCorp is required to host an USR meeting with relicensing stakeholders and FERC staff to discuss the USR results. Within 15 days following the USR meeting, PacifiCorp is required to file a meeting summary with FERC.

1.5.3 RELICENSING ACTIVITIES

Table 1-3 below represents relicensing activities for the Project, including *dates that have already elapsed*, and the remaining relicensing milestones for PacifiCorp, FERC, and stakeholders.

TABLE 1-3 OVERVIEW PROCESS PLAN AND SCHEDULE OF RELICENSING ACTIVITIES

RESPONSIBLE PARTY	PRE-FILING MILESTONE	DATE	FERC REGULATION
PacifiCorp	*Issue Public Notice for NOI/PAD*	*3/29/19*	*5.3(d)(2)*
PacifiCorp	*File NOI/PAD*	*3/29/19*	*5.5, 5.6*
FERC	*Tribal Consultation Meeting*	*4/28/19*	*5.7*
FERC	*Issue Notice of Commencement of Proceeding and SD1*	*5/28/19*	*5.8(a)(c)*
FERC	*Scoping Meetings and Project Site Visit*	*6/26/19 – 6/27/19*	*5.8(b)(viii)*
Stakeholders	*File Comments on PAD/SD1 and Study Requests*	*7/29/19*	*5.9(a)(b)*
FERC	*Issue SD2 (if necessary)*	*9/13/19*	*5.10*
PacifiCorp	*File Proposed Study Plan*	*9/11/19*	*5.11(a)*
Stakeholders	*Proposed Study Plan Meeting*	*10/9/19*	*5.11(e)*
Stakeholders	*File Comments on Proposed Study Plan*	*12/11/19*	*5.12*
PacifiCorp	*File Revised Study Plan*	*1/10/20*	*5.13(a)*
Stakeholders	*File Comments on Revised Study Plan*	*1/23/20*	*5.13(b)*
FERC	*Issue Director's Study Plan Determination*	*2/7/20*	*5.13(c)*
PacifiCorp	*First Study Season and Study Review*	*2/7/20 – 1/7/21*	*5.15(a)*
PacifiCorp	*File Progress Update Report*	*8/1/20*	*5.15(b)*
PacifiCorp	*File Initial Study Report*	*2/8/21*	*5.15(c)(1)*
Stakeholders	Initial Study Report Meeting	2/23/21	5.15(c)(2)
PacifiCorp	File Initial Study Report Meeting Summary	3/10/21	5.15(c)(3)
Stakeholders	File Comments on Meeting Summary, Recommendations for Ongoing studies, or Requests for New Studies	4/9/21	5.15(c)(4)
All	File Comments on Recommendations/New Study Requests	5/9/21	5.15(c)(5)
FERC	FERC resolves any disagreements and amends the approved study plan (as appropriate)	6/8/21	5.15(c)(6)
FERC	If applicable, if no disagreements, meeting summary and proposed amendment to study plan approved.	7/8/21	5.15(c)(7)
PacifiCorp	Second Study Season (as needed) and Study Review	12/1/20-10/1/21	5.15(a)
PacifiCorp	File Updated Study Report	nlt 2/8/22	5.15(c)(1)
Stakeholders	Updated Study Report Meeting	nlt 2/23/22	5.15(c)(2)
PacifiCorp	File Updated Study Report Meeting Summary	nlt 3/10/22	5.15(c)(3)
PacifiCorp	File Draft License Application	11/2/21	5.16(a)-(c)
Stakeholders	File Comments on Draft License Application	1/31/22	5.16(e)
PacifiCorp	File Final License Application	3/31/22	5.17, 5.18
FERC	Issue Tending Notice and Decision on AIRs	04/14/2022	5.19
FERC	Issue Notice of Acceptance and Ready for EA	06/13/2022	5.22
Stakeholders	Comments/Interventions and Preliminary T&Cs	08/12/2022	5.23
FERC	Issue Non-Draft EA	2/8/2023	5.24
FERC	Issue Modified T&Cs	5/9/23 – 5/24/23	5.24
FERC	Issue Final License Order	8/22/2023	2.25

1.6 SUMMARY LIST OF STUDIES APPROVED IN FERC'S SPD

Volume I of this ISR includes the public results to date of the nine relicensing studies identified in the RSP and SPD. Confidential results of the cultural resources surveys are provided in Volume II and are being filed with FERC, the Utah Historic Preservation Commission, and Native American Tribes, as applicable, as "Privileged" to protect sensitive archaeological data and other culturally important information in accordance with FERC regulations. Table 1-4 lists studies as identified in the RSP, the results of which are presented in Volume I and Volume II of this ISR.

TABLE 1-4 LIST OF APPROVED RELICENSING STUDIES FOR RELICENSING

STUDY NAME	VOLUME	APPENDIX
Threatened and Endangered Species	I	B
Shoreline Habitat Characterization	I	C
Land Use	I	D
Fish and Aquatic	I	E
Water Quality	I	F
Hydraulic Modeling	I	G
Sediment	I	H
Recreation Resources	I	I
Cultural Resources	I	J
Privileged Portions of Cultural Resources	II	Filed under separate cover

Each ISR (presented as separate appendices herein) provides the information specified under FERC's ILP requirements pursuant to 18 CFR § 5.15 and is organized as follows:

- Introduction
- Project Nexus and Rationale for Study
- Study Objectives
- Study Area
- Methods
- Modifications to Methods (if applicable)
- Results
- Summary (including need for a second phase or continued data collection, if applicable)
- References

1.7 STUDIES CONTAINING A SECOND PHASE/CONTINUED DATA COLLECTION

Based on results detailed in this ISR only two studies, Shoreline Habitat Characterization (Appendix C) and Land Use (Appendix D) have identified the need for a second study phase or continued data collection. The Shoreline study plan suggested the potential for a second phase of study; PacifiCorp decided to implement the second phase based on the seasonality requirements (it can only occur in the potentially-affected winter period) and the required timing of the DLA and FLA, respectively. That study phase may be completed by early March of 2021. Land Use included a winter bank stability downstream of Cutler Dam component of the study. This component was initiated in late winter of 2020, but rapidly warming temperatures and correlated higher water flows necessitated the study be terminated prematurely; it was repeated entirely starting in early December of 2020, and completed by the end of January 2021. Both of these study updates are potentially planned to be addressed in the USR, later in 2021. The seven other studies (i.e., Threatened and Endangered Species, Fish and Aquatic, Water Quality, Hydraulic Modeling, Sediment, Recreation, and Cultural) have successfully implemented the RSPs approved in FERC's SPD, or with minor modifications to methods as explained in the individual ISRs (Appendices B-J). The seven other studies have filled data gaps sufficient to conduct potential effects analysis in the DLA, and no modified or additional studies are proposed.

2.0 INITIAL STUDY REPORTS

Appendices B through J to this ISR present the study reports for each of the nine studies approved in FERC's SPD and implemented in 2019 (preliminarily) and 2020. As noted previously, confidential portions of the results of the cultural resources surveys are included in a separate volume of this ISR (Volume II) being filed as "Privileged" to protect sensitive archaeological data and other culturally important information in accordance with FERC regulations. Information related to protecting sensitive archaeological data and other culturally important information is also restricted under Section 106 of the NHPA.

ATTACHMENT ISR-1
DRAWDOWN AND MODELING SURFACE ELEVATION FIGURES AND TABLES

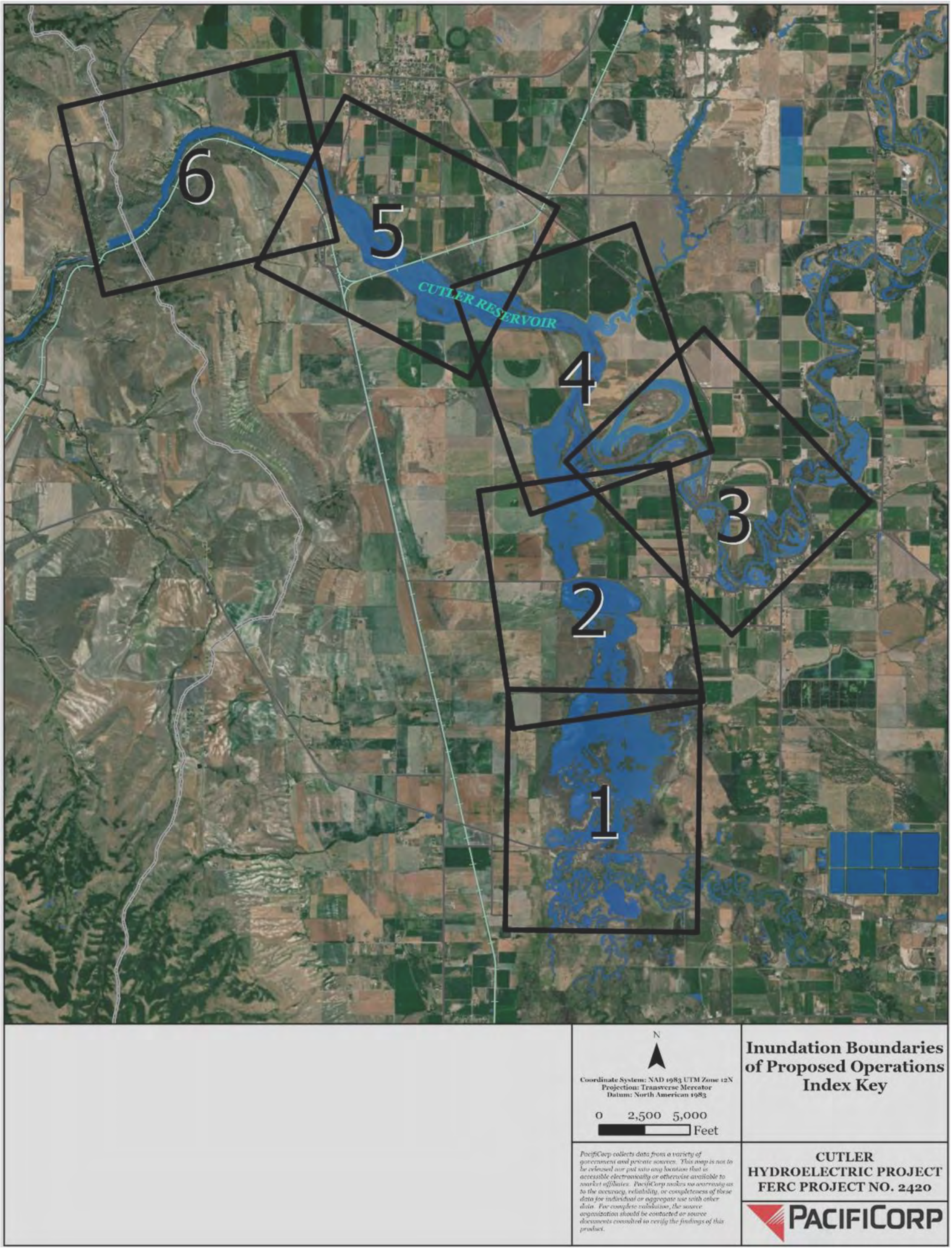


FIGURE ISR-1-1 INDEX KEY FOR INUNDATION BOUNDARY SHEETS 1 THROUGH 6

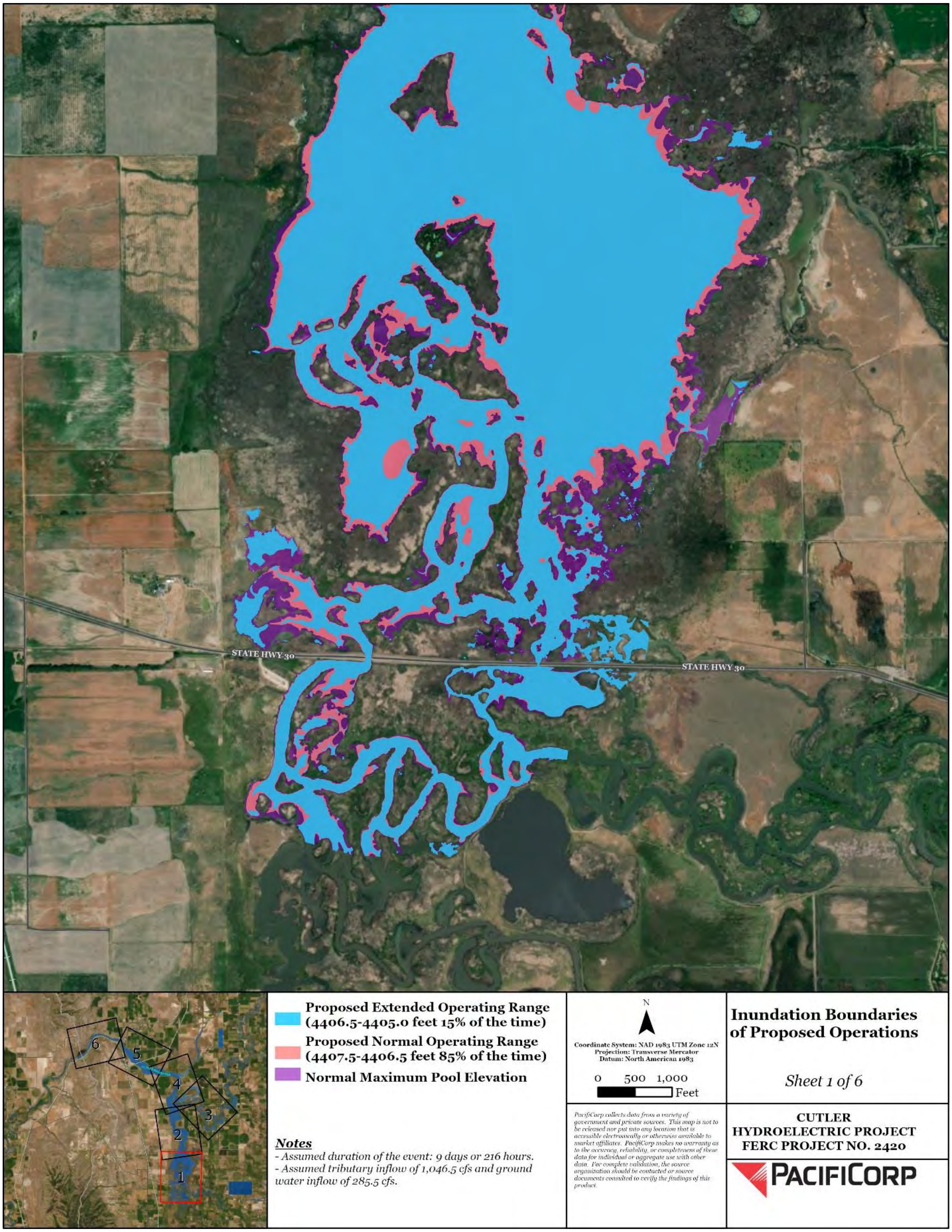


FIGURE ISR-1-2 SHEET 1 – INUNDATION BOUNDARIES FOR PROPOSED NORMAL, PROPOSED EXTENDED, AND NORMAL MAXIMUM POOL ELEVATIONS

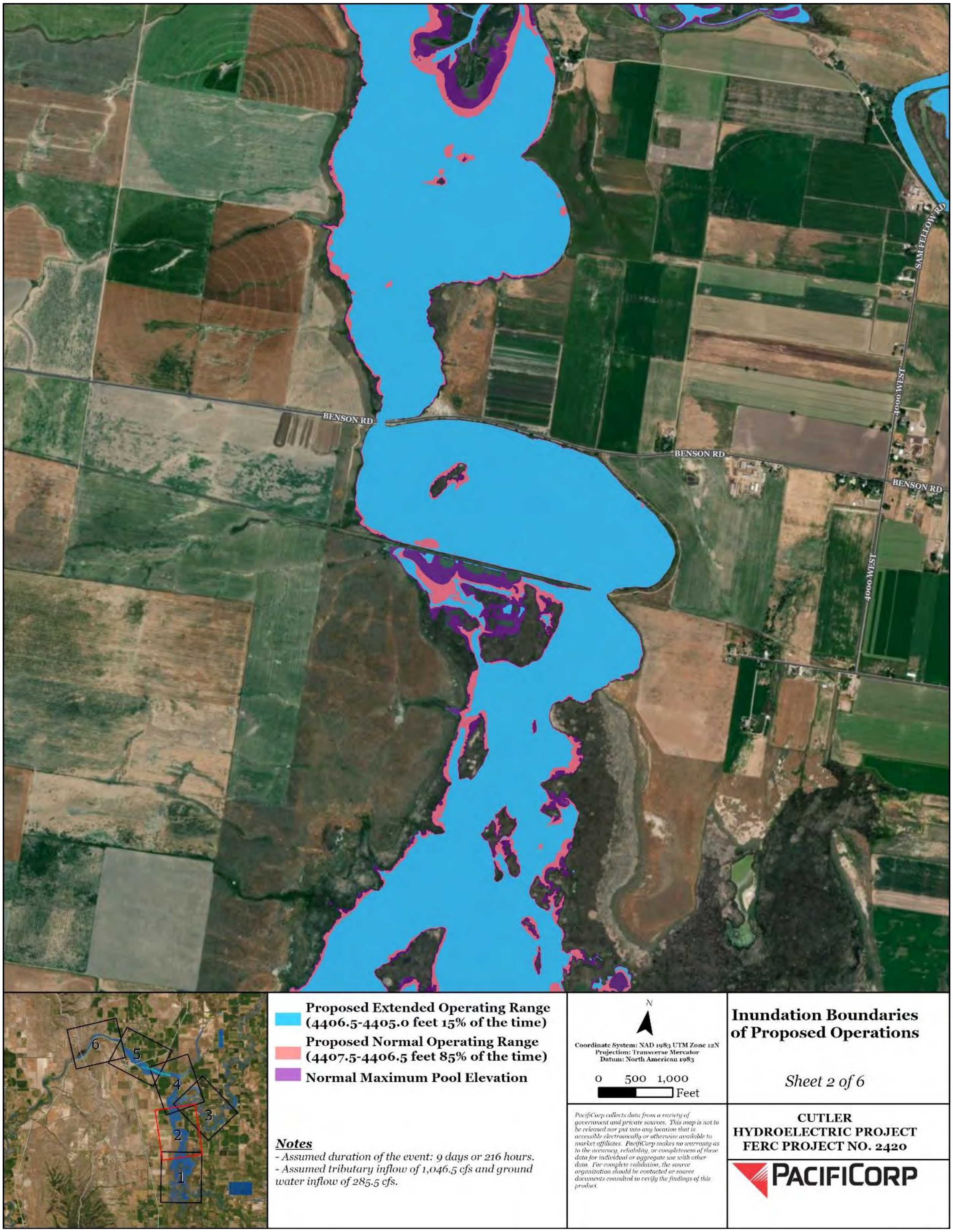


FIGURE ISR-1-3 SHEET 2 – INUNDATION BOUNDARIES FOR PROPOSED NORMAL, PROPOSED EXTENDED, AND NORMAL MAXIMUM POOL ELEVATIONS

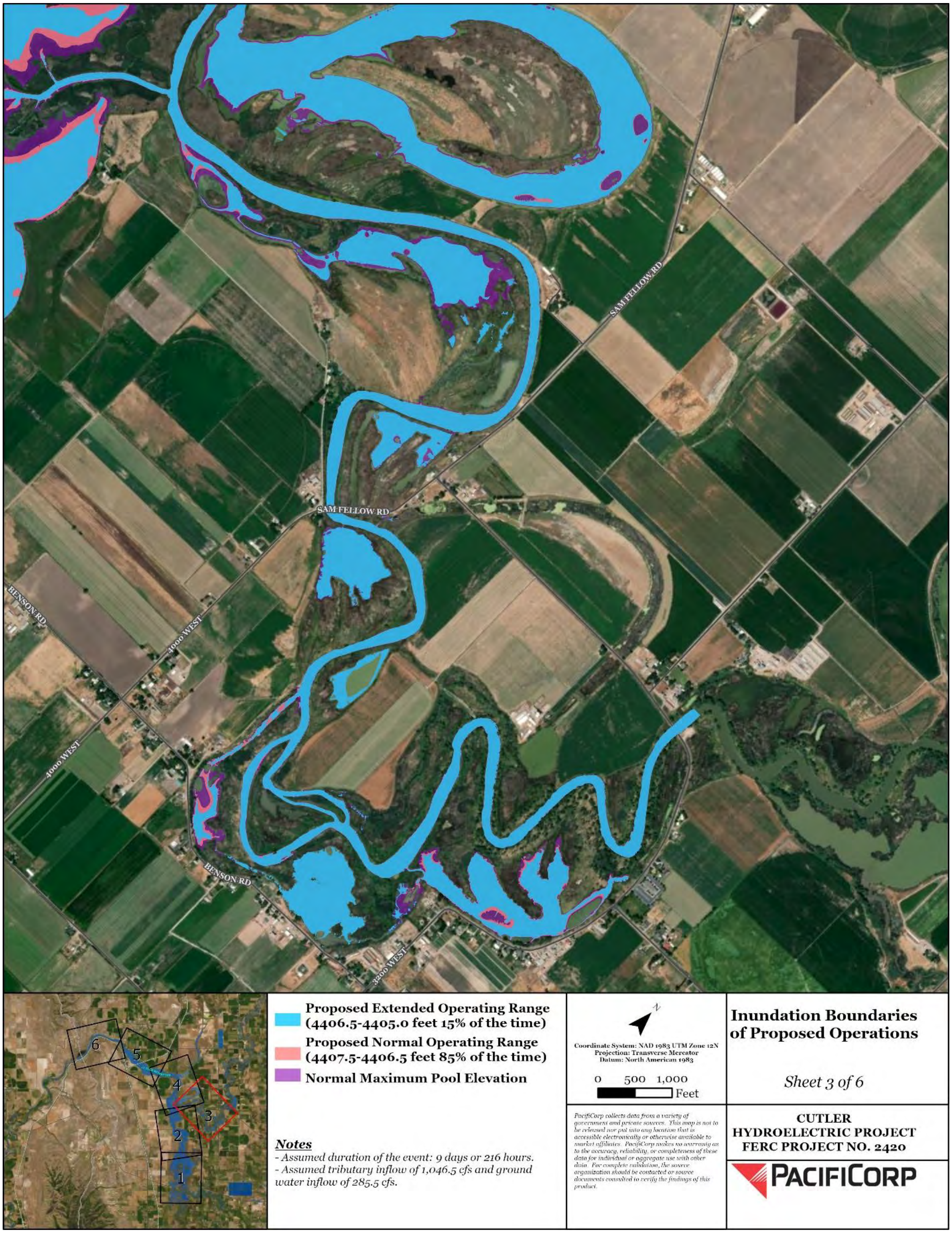


FIGURE ISR-1-4 SHEET 3 – INUNDATION BOUNDARIES FOR PROPOSED NORMAL, PROPOSED EXTENDED, AND NORMAL MAXIMUM POOL ELEVATIONS

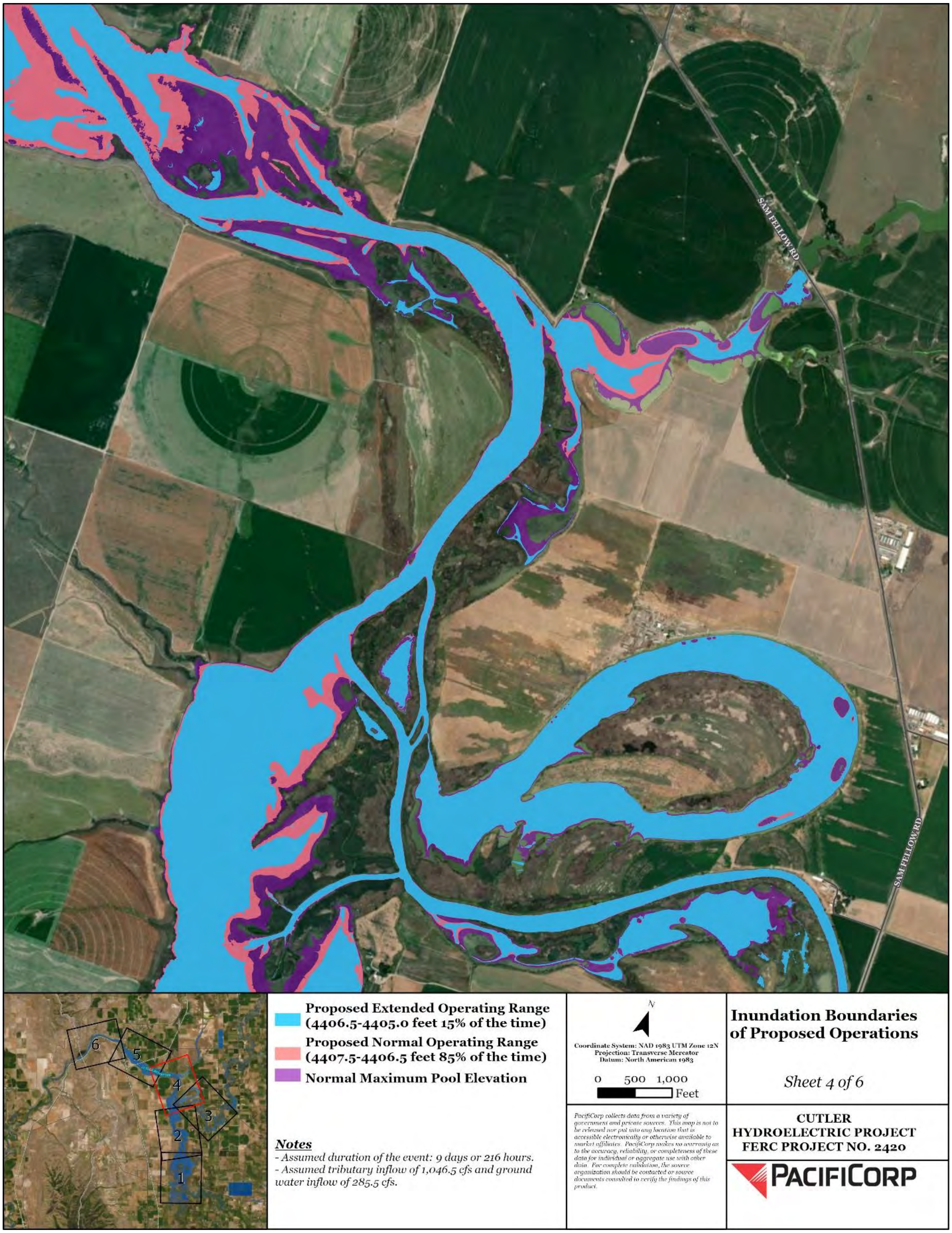


FIGURE ISR-1-5 SHEET 4 – INUNDATION BOUNDARIES FOR PROPOSED NORMAL, PROPOSED EXTENDED, AND NORMAL MAXIMUM POOL ELEVATIONS

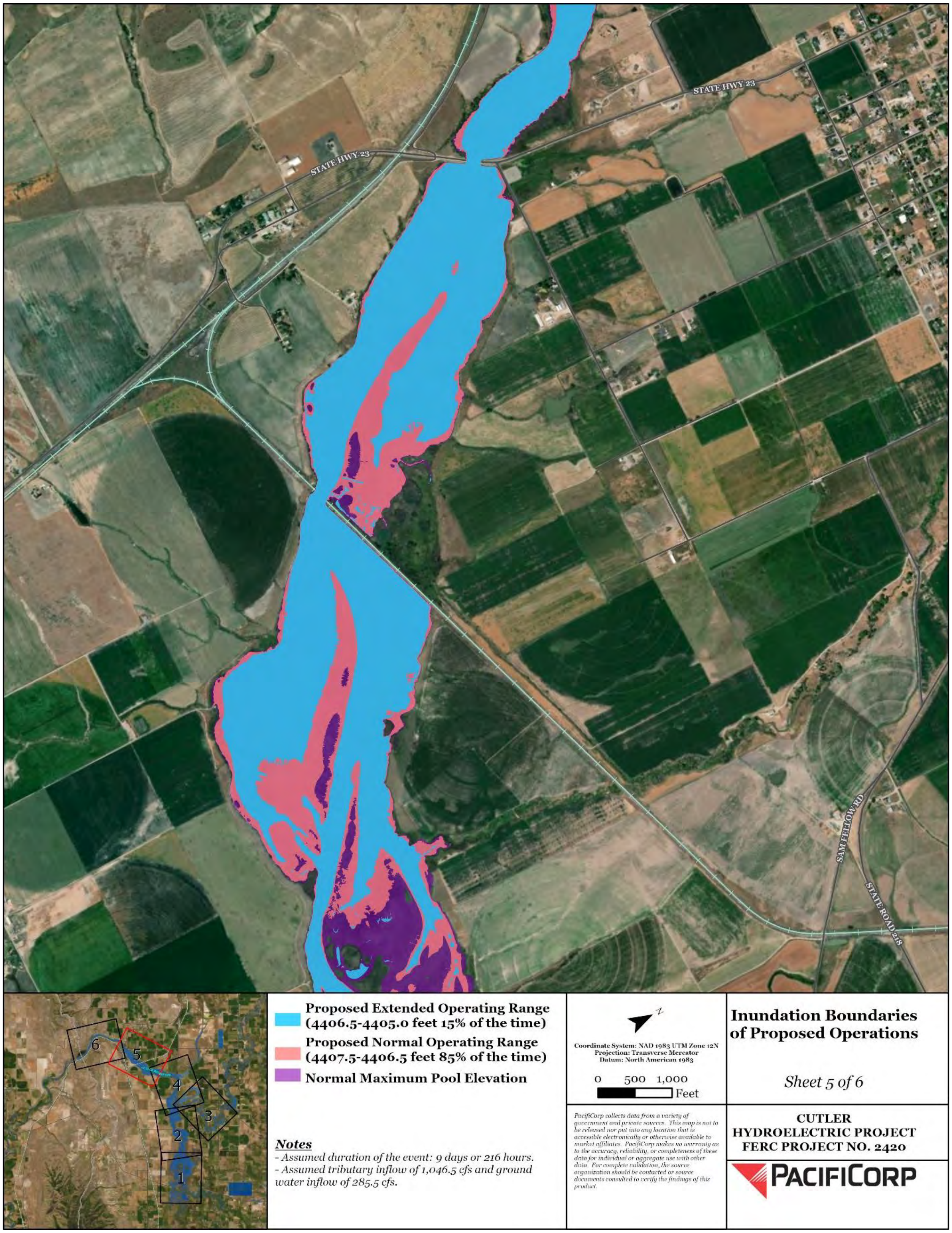


FIGURE ISR-1-6 SHEET 5 – INUNDATION BOUNDARIES FOR PROPOSED NORMAL, PROPOSED EXTENDED, AND NORMAL MAXIMUM POOL ELEVATIONS

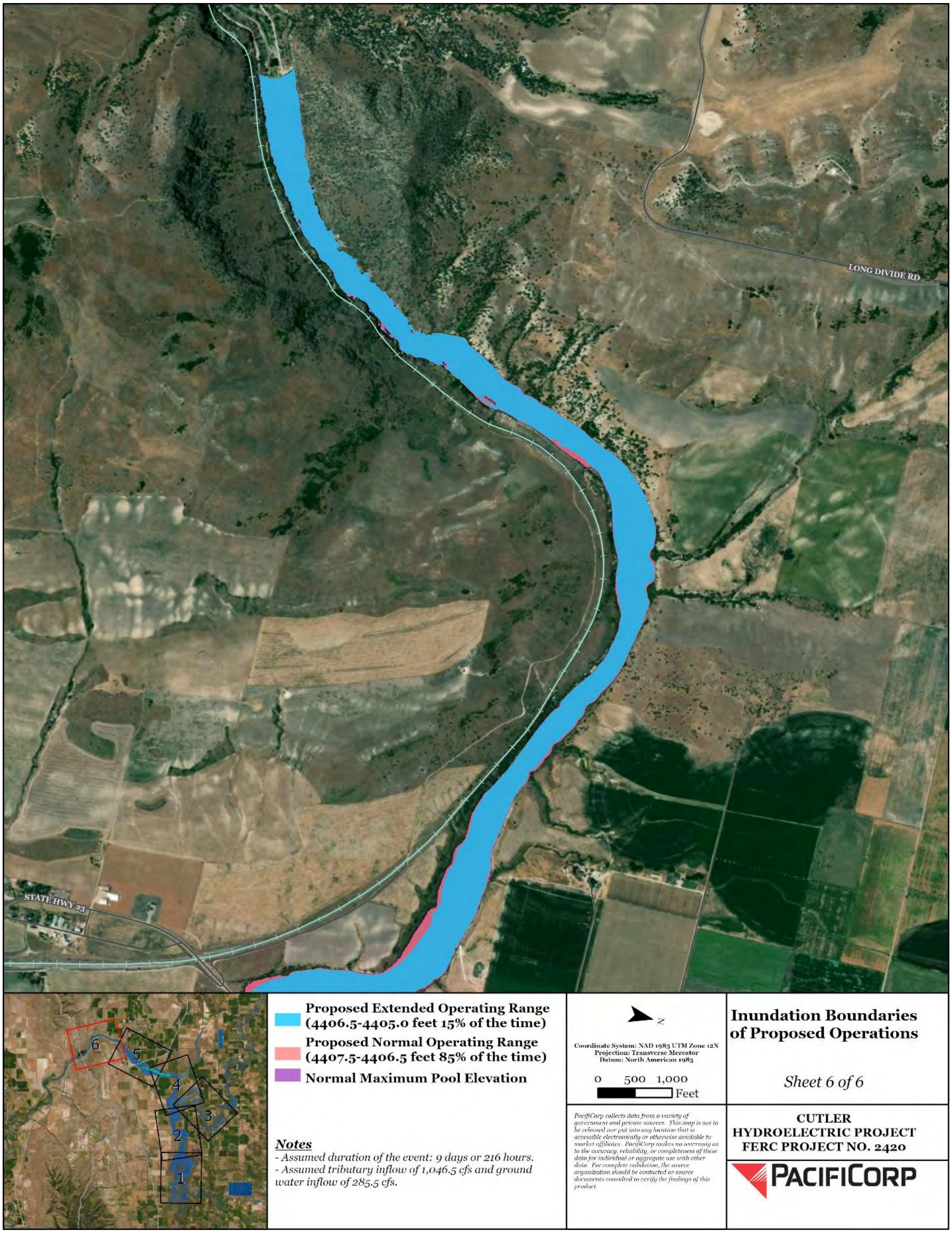


FIGURE ISR-1-7 **SHEET 6 – INUNDATION BOUNDARIES FOR PROPOSED NORMAL, PROPOSED EXTENDED, AND NORMAL MAXIMUM POOL ELEVATION**

TABLE ISR-1-1 SUMMARY TABLE OF RESERVOIR SURFACE ELEVATIONS BY LOCATION

		RESERVOIR SURFACE ELEVATIONS (NGVD 29, FEET)								
Stage at Cutler Dam (feet, NGVD29)	**Duration from start of event (hours)**	**Hwy 30**	**Fisherman Bridge**	**Benson Marina**	**Bear River Confluence**	**Clay Slough Confluence**	**Railroad Bridge Up**	**Cache Junction Up**	**Wheelon Dam Up**	**Cutler Dam**
4407.5	17.25	4407.70	4407.68	4407.67	4407.69	4407.61	4407.55	4407.55	4407.52	4407.51
4407.0	48.75	4407.48	4407.45	4407.43	4407.44	4407.29	4407.11	4407.09	4407.04	4407.01
4406.5	71.25	4407.13	4407.08	4407.06	4407.08	4406.89	4406.63	4406.61	4406.54	4406.51
***4406.0	85.25	4406.90	4406.83	4406.80	4406.84	4406.56	4406.17	4406.13	4406.05	4406.00
***4405.5	97.50	4406.67	4406.57	4406.55	4406.61	4406.25	4405.72	4405.65	4405.56	4405.50
***4405.0	133.00	4406.23	4406.05	4406.02	4406.17	4405.71	4405.19	4405.13	4405.07	4405.04
Minimum during entire event	-	4406.20	4406.02	4405.99	4406.16	4405.71	4405.19	4405.13	4405.07	4405.04

*Assumed duration of the event: 9 days or 216 hours.

**Assumed tributary inflow of 1,046.5 cubic feet per second (cfs) and ground water inflow of 285.5 cfs.

***All reported reservoir surface elevations associated with Cutler stages below 4406.5 feet are for proposed operations only.

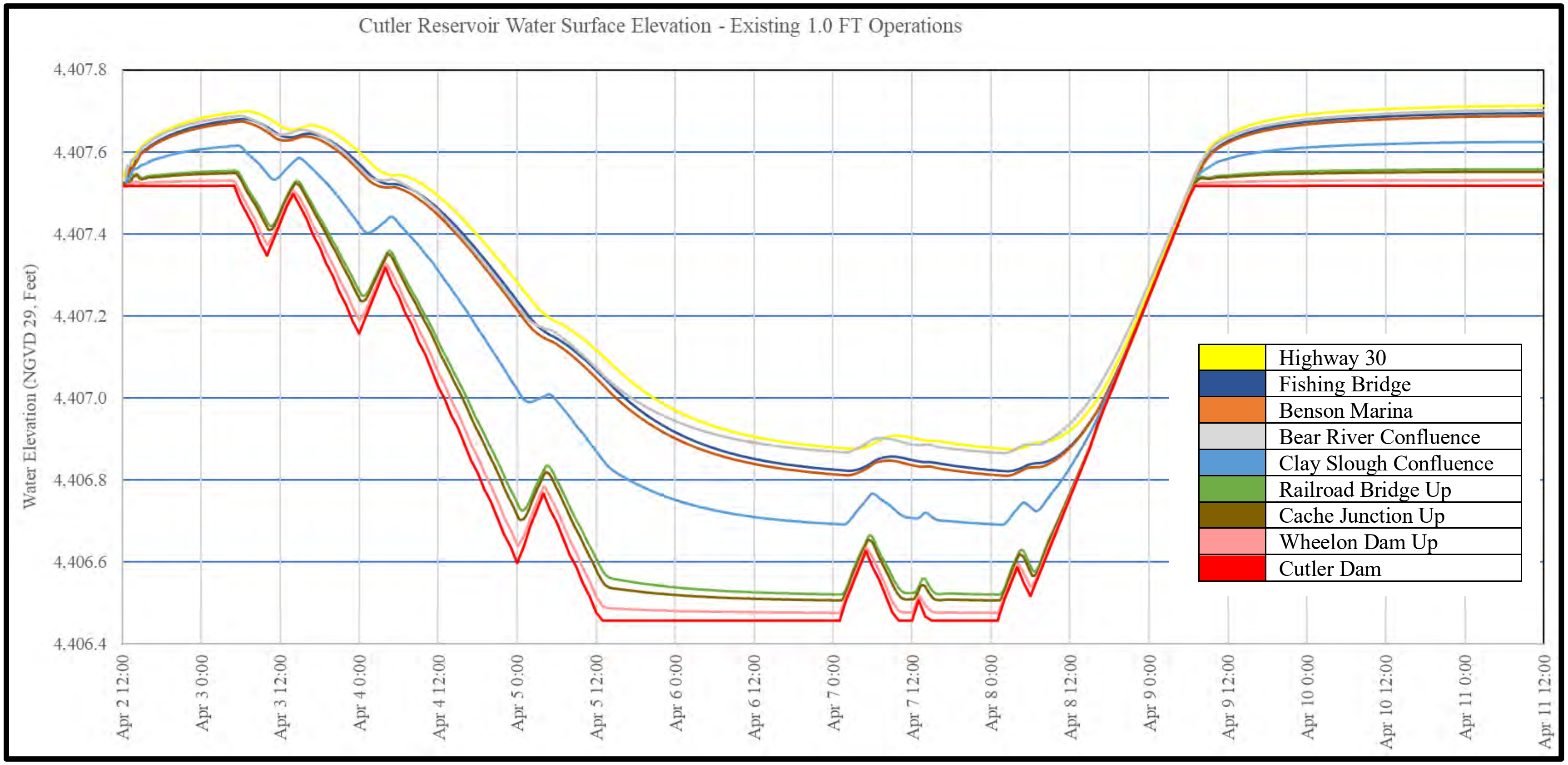


Figure ISR-1-8 Cutler Reservoir Water Surface Elevation at Proposed Normal Operations (4407.5-4406.5 feet as measured at Cutler Dam)

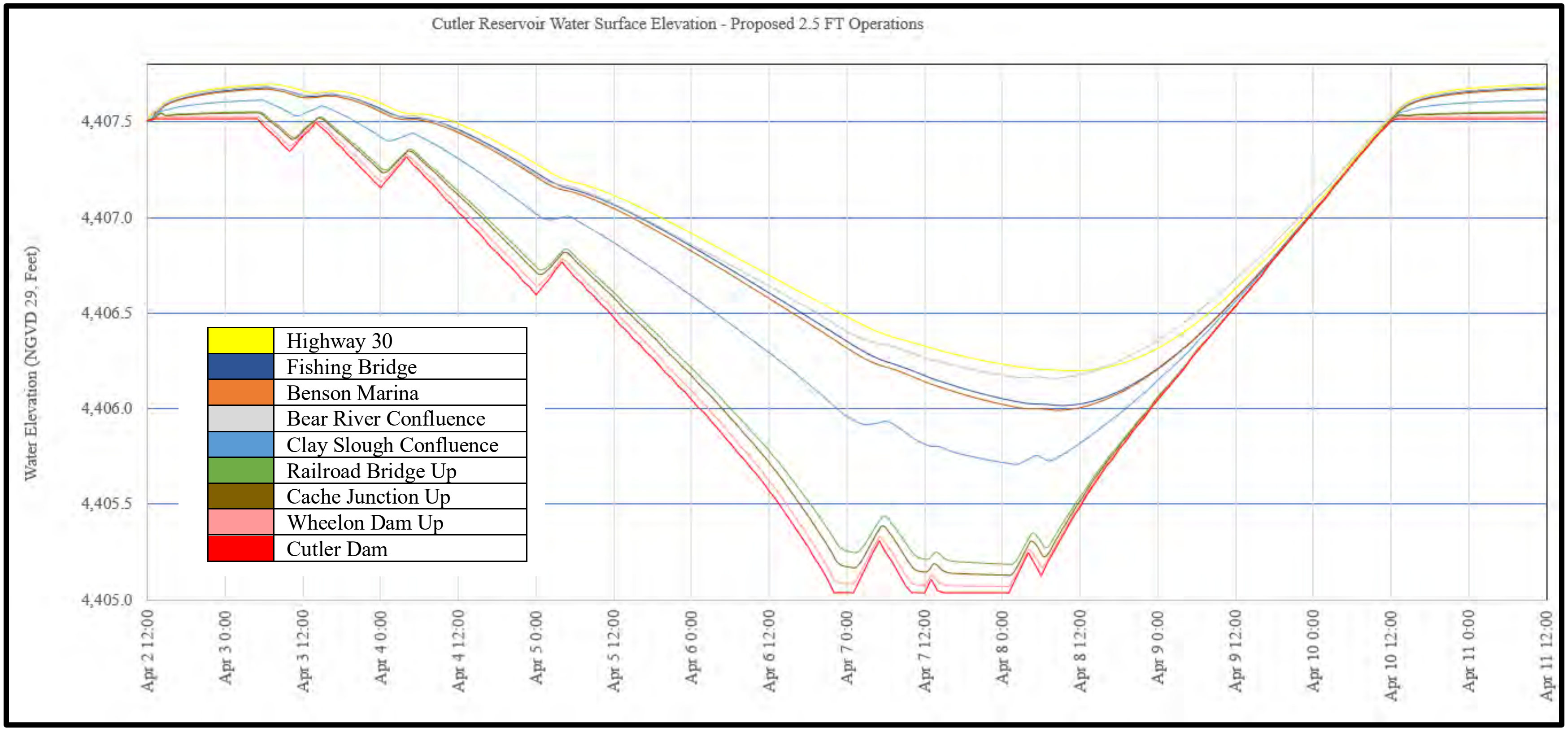


FIGURE ISR-1-9 CUTLER RESERVOIR WATER SURFACE ELEVATION AT PROPOSED EXTENDED OPERATIONS (4406.5-4405.0 FEET AS MEASURED AT CUTLER DAM)

APPENDIX A
FERC STUDY PLAN DETERMINATION

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, DC 20426
February 7, 2020

OFFICE OF ENERGY PROJECTS

Project No. 2420-054 – UT
Cutler Hydroelectric Project
PacifiCorp

VIA FERC Service

Ms. Eve Davies
Cutler Licensing Project Manager
PacifiCorp
1407 West North Temple, Room 210
Salt Lake City, Utah 84116

Reference: Study Plan Determination for the Cutler Hydroelectric Project

Dear Ms. Davies:

Pursuant to 18 C.F.R. § 5.13(c) of the Commission's regulations, this letter contains the study plan determination for the Cutler Hydroelectric Project (Cutler Project) located on the Bear River near the city of Logan in Box Elder and Cache Counties, Utah. The determination is based on the study criteria set forth in section 5.9(b) of the Commission's regulations, applicable law, Commission policy and practice, and the record of information for the project.

Background

On September 11, 2019, PacifiCorp filed a Proposed Study Plan (PSP) for nine studies in support of its intent to relicense the project. The PSP addresses studies on terrestrial and botanical resources, fish and aquatic resources, water quality, wildlife resources, recreation, and cultural resources.

PacifiCorp held an initial study plan meeting to discuss the PSP on October 8, 2019. On October 15, 2019, PacifiCorp filed a letter providing additional information that was requested by stakeholders at the study plan meeting. Following the initial study plan meeting, PacifiCorp held additional meetings with stakeholders to discuss the PSP. On December 10, 2019, PacifiCorp filed summaries of these meetings and its responses to stakeholder comments. Comments on the PSP were filed by the City of Logan, The Bear River Canal Company (BRCC), the National Audubon Society, the Bridgerland Audubon Society, and U.S. Fish and Wildlife Service (FWS). PacifiCorp filed its

Revised Study Plan (RSP) on January 10, 2020. Bridgerland Audubon Society and National Audubon Society filed comments on the RSP. PacifiCorp filed a letter in response, in which they modified the RSP to adopt some of the additional study details requested by Bridgerland Audubon Society and National Audubon Society.

General Comments

Some of the comments on the RSP do not directly address the study plans or proposed methodologies. For example, some comments request that PacifiCorp provide additional information, present information differently, or recommend protection, mitigation, and enhancement measures. This determination does not address such comments, but only addresses comments specific to the merits of the proposed studies submitted pursuant to section 5.13 of the Commission's regulations and comments received thereon.

Study Plan Determination

PacifiCorp's RSP is approved,[1] with the staff-recommended modifications discussed in Appendix B. As indicated in Appendix A, of the nine studies proposed, seven are approved as filed, and two are approved with staff-recommended modifications (*see* Appendix A).

The specific modifications and basis for modifying the RSP are discussed in Appendix B. Commission staff reviewed all comments and considered all study plan criteria in section 5.9 of the Commission's regulations. However, only the specific study criteria particularly relevant to the determination are referenced in Appendix B.

Studies for which no issues were raised in comments on the RSP are not discussed in this determination, except for those addressed independently by Commission staff in Appendix B. Unless otherwise indicated, all components of the approved studies not modified in this determination must be completed as described in PacifiCorp's RSP and January 30, 2020 response letter. Pursuant to section 5.15(c)(1) of the Commission's regulations, the Initial Study Report for all studies in the approved study plan must be filed by February 9, 2021.

Nothing in this study plan determination is intended, in any way, to limit any agency's proper exercise of its independent statutory authority to require additional studies. In addition, PacifiCorp may choose to conduct any study not specifically required herein that they feel would add pertinent information to the record.

[1] The approved RSP includes modifications specified by PacifiCorp in their January 30, 2020 response letter to the following studies: (1) *Threatened and Endangered Species Study*, (2) *Shoreline Habitat Characterization Study*, (3) *Fish and Aquatic Resources Study*, and (4) *Water Quality Study*.

If you have any questions, please contact Khatoon Melick at (202) 502-8433, or via e-mail at khatoon.melick@ferc.gov.

Sincerely,

for
Terry L. Turpin
Director
Office of Energy Projects

Enclosures: Appendix A – Summary of Determinations on Proposed and Requested Studies
Appendix B – Staff's Recommendations on Proposed and Requested Studies

APPENDIX A

SUMMARY OF DETERMINATIONS ON PROPOSED AND REQUESTED STUDIES

Study	Recommending Entity	Approved	Approved with Modifications	Not Required
Threatened and Endangered Species Study (TERR 1)	PacifiCorp	X		
Shoreline Habitat Characterization Study (TERR 2)	PacifiCorp		X	
Land Use Study (TERR 3)	PacifiCorp	X		
Fish and Aquatic Study (AQ1)	PacifiCorp	X		
Water Quality Study (AQ2)	PacifiCorp		X	
Hydraulic Modeling Study (AQ3)	PacifiCorp	X		
Sedimentation Study (AQ4)	PacifiCorp	X		
Recreation Resources Study (REC 1)	PacifiCorp	X		
Cultural Resources Study (CULT 1)	PacifiCorp	X		

APPENDIX B

STAFF'S RECOMMENDATIONS ON PROPOSED AND REQUESTED STUDIES

The following discusses staff's recommendations on studies proposed by PacifiCorp and requests for study modifications. We base our recommendations on the study criteria outlined in the Commission's regulations [18 C.F.R. section 5.9(b)(1)-(7)].

I. Required Studies

Shoreline Habitat Characterization Study (Terr 2)

Applicant's Proposed Study

The project is currently operated to maintain the water surface elevation in Cutler Reservoir within 4,406.5 to 4,407.5 feet ± 0.5 foot from March 1 through December 1, and 4,406.0 to 4,407.5 feet +0.25/-0.5 foot from December 2 through February 28 each year. PacifiCorp is considering expanding the operating range of Cutler Reservoir by lowering the minimum water surface elevation to as low as 4,396.0 feet (the elevation of the sill of spill gates). This would enable the project to be more responsive to short-term energy demands and load changes. PacifiCorp is also considering adjusting the tolerance range from ± 0.25 foot to ± 0.5 foot.

The potential changes to the operational range of the reservoir could affect the type and amount of available shoreline habitat around the project reservoir, as well as the spread of invasive plant species. The purpose of the *Shoreline Habitat Characterization Study* is to: (1) quantify littoral habitat; (2) characterize emergent and adjacent wetland and upland habitats; (3) map invasive plant species within the project boundary; (4) assess the effects of changes in reservoir operation on littoral habitats and distribution of invasive species; and (5) assess the effects of changes in reservoir operation on wildlife, including associated habitat, and the spread of invasive plant species within the project boundary.

In 2019, PacifiCorp conducted drawdown field work within the Cutler Reservoir in order to collect LiDAR[2] and bathymetry data for the *Hydraulic Modeling Study* that

[2] LiDAR, is a remote sensing technology that uses laser to measure variable distances to the Earth and when combined with other data recorded (e.g. GPS data) can generate precise, three-dimensional information about the shape of the Earth and its surface and/or bathymetric characteristics (Source: https://www.americangeosciences.org/critical-issues/faq/what-lidar-and-what-it-used; Accessed: January 29, 2020).

will inform PacifiCorp in determining potential alternative operating ranges for future operations and inform this and other studies in the RSP.

Vegetation Classification

PacifiCorp proposes to determine vegetation classification based on the collected LiDAR data. Imagery and ancillary LiDAR data will be processed using ENVI Feature Extraction[3] object-oriented classification algorithms, which will be a broad classification identifying habitat types such as: emergent marsh, wet meadow, upland, cropland, mud flats, woody/shrubby vegetation, and bare ground. PacifiCorp proposes to ground-truth the LiDAR imagery within the project boundary in order to complete an accuracy assessment of the data.

PacifiCorp does not propose to inventory invasive weeds in the project boundary but will incorporate existing weed information provided by Cache County, PacifiCorp, the state of Utah, and adjacent private landowners, along with incidental observations gathered during field surveys for Ute-ladies'-tresses orchids and accuracy assessment field efforts. PacifiCorp states that its annual weed monitoring maps and data, the incidental data collected during Ute ladies'-tresses orchids surveys, and accuracy assessment efforts should provide coverage of a significant portion of the project area. Specific weeds that will be documented during these efforts include: thistles (*Cirsium* spp.), goatsrue (*Galega officinalis*), dyer's woad (*Isatis tinctoria*), tamarisk (*Tamarix ramosissima*), field bindweed (*Convolvulus arvensis*), puncturevine (*Tribulus terrestris*), and Russian olive (*Elaeagnus angustifolia*).

During the 2019 drawdown fieldwork, which was focused on the interaction between water surface elevations, wetted perimeters, and proximity to habitat types, approximately 10 cameras were installed in areas adjacent to important bird nesting sites. These cameras will be used to validate the wetted perimeter footprint predicted for each location using the hydraulic model developed in the *Hydraulic Modeling Study*.

Analysis and Data Collection – Desktop Analysis and Field Surveys

This component of the study will have two phases. In Phase 1, PacifiCorp proposes to conduct a desktop analysis of existing information to determine bird species, amphibians, terrestrial wildlife, and weeds dependent on riparian/wetland habitat that are known to be or are likely present in the study area, and the data pertaining to their reproductive characteristics. This preliminary analysis will inform which species and

[3] ENVI Feature Extraction allows users to extract features such as roads, buildings, bridges, lakes, etc., from high-resolution imagery (Source: http://www.harrisgeospatial.com/portals/0/pdfs/envi/feature_extraction_module.pdf; Accessed; January 29, 2020).

habitats have the potential to be affected by the proposed changes in operation, and thus which affected habitats should be targeted for surveys. Phase 1 will examine how future project operations may affect respective bird and other rare or sensitive species assumed to be present. The list of species assumed to be present will be based on existing records for northern Utah and southeast Idaho. This list will be organized by those species with potential effects during the breeding season, non-breeding season, or both, and will highlight birds with a specific conservation status. Effects on non-avian, state-listed species will be similarly analyzed in this phase.

The *Hydraulic Modeling Study* will yield information on what habitats, if any, would be affected by future project operations. Phase 2, field surveys to assess the effects of project operations on birds/other rare/sensitive species in affected habitats, will only be conducted if the Phase 1 analysis and results of the *Hydraulic Modeling Study* show that the potential changes to reservoir operations may affect shoreline resources differently than current reservoir operations. Should surveys be necessary, they would only be conducted in areas identified in the *Hydraulic Modeling Study* where effects would occur and PacifiCorp would coordinate with local ecologists and stakeholders to identify exact survey locations or routes within the potentially affected areas.

Comments on the Study

National Audubon Society comments that the RSP does not define the "specific conservation status" for species that will be used to characterize birds during the desktop analysis, and therefore it is difficult to discern what species may be included in the assessment. National Audubon Society suggests clarifying what the specific conservation status is that will allow for species inclusion. National Audubon Society also provides a list of species that should be included in the study and notes its interest in providing further input to PacifiCorp regarding the species to be included.

Bridgerland Audubon Society notes that the photo monitoring conducted by PacifiCorp occurred outside of the breeding season and that they documented spring nesting on islands close to the reservoir shoreline (e.g., White-faced Ibis, Franklin's Gull, Double-crested Cormorant, Snowy Egret) that could be accessible to coyotes and other predators under existing conditions where water depths between the reservoir and island shorelines are often less than 18 inches. Bridgerland Audubon Society states that photo monitoring during the nesting season in 2020 and 2021 could help ascertain whether predators are accessing these islands via land bridges and whether future drawdowns should be restricted to times outside of nesting periods.

Reply Comments

In its January 30, 2020 response letter, PacifiCorp states that the assumption is that predators already have the ability to wade or swim to islands to prey upon bird colonies, and that photo monitoring during the nesting season would not answer the question of whether land bridges resulting from reservoir fluctuations would improve access and whether future drawdowns should occur outside of the nesting periods.

Discussion and Staff Recommendations

Vegetation Classification

The RSP does not include Box Elder County in the list of sources where PacifiCorp will seek existing information on invasive weeds.[4] Because the project is located in both Cache and Box Elder Counties, to have a comprehensive list of invasive weeds relevant to the project area, we recommend that PacifiCorp consult with Box Elder County for any existing invasive weed information that may be available that would be relevant to the project [section 5.9(b)(4)].

Data Collection and Analysis

As part of Phase 1, PacifiCorp proposes to develop a list of species that have the potential to be affected by the project and that "[t]his list will be organized by those species with potential impacts during the breeding season, non-breeding season, or both, and will highlight birds with a specific conservation status." To clarify National Audubon Society's concern regarding the "specific conservation statues" of species, we recommend that, at a minimum, the "specific conservation status" include federally listed species, Birds of Conservation Concern,[5] and state listed species that may be affected by the project, [section 5.9(b)(6)].

In the PAD, PacifiCorp noted that fluctuations in the reservoir due to changes in operations could result in the formation of land bridges and thereby increase the ability for predators such as skunks and racoons to move through the area. Such land bridges could result in an increased risk of nest predation. PacifiCorp acknowledges that nest predation is already occurring under current conditions, but it is not clear if the formation of land bridges would result in easier predator access to these islands and increased nest predation. Photo monitoring of nesting sites where these land bridges are anticipated to occur could help quantify predation events and determine if there is a relationship among lowered reservoir elevations, formation of land bridges, and increased predation relative to the existing conditions. Conducting the photo monitoring is necessary because it would inform whether the nesting period should be considered in determining the timing of operational changes to the water surface elevations in the reservoir [section5.9(b)(5)]. Therefore, we recommend that PacifiCorp replicate the photo monitoring it conducted

[4] See RSP at 2-9 and 2-11.

[5] See https://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php

during the 2019 drawdown during the 2020 and 2021 nesting seasons [section 5.9(b)(6)]. We estimate the cost of this effort, including camera deployment, data collection and analysis over two nesting seasons would be $20,000 [§5.9(b)(7)].

Fish and Aquatic Resources Study (AQ 1)

Applicant's Proposed Study

The purpose of the *Fish and Aquatic Resources Study* is to: (1) determine the status of aquatic organisms and their habitat; (2) characterize the benthic invertebrate and mollusk community within the project area; (3) evaluate the effects of a fall 2019 reservoir drawdown on the aquatic community; and (4) relate potential project operational changes and the potential effects on the aquatic community within the reservoir. Preparation of this study plan included reviewing existing information on aquatic species or relevant management plans for fishery, freshwater mollusks, and the benthic community.

Comments on the Study

Bridgerland Audubon Society notes that PacifiCorp has proposed to increase the allowed reservoir drawdown, which is currently at 1.0 – 1.5 feet, to as much as 11 feet potentially exposing 60 percent of the lakebed. Bridgerland Audubon Society comments that the study plan should clearly indicate how it will assess the influence of the magnitude and the frequency of drawdown fluctuations on the fish community and benthic invertebrates in Cutler Reservoir.

Reply Comments

In its January 30, 2020 response letter, PacifiCorp notes that a proposed operating range for the reservoir has not been determined, and that the full mechanical range for drawdowns (11.5 feet) is not being proposed. PacifiCorp states that the reservoir drawdown in the fall of 2019 provided important information on the effects on fish and aquatic organisms of the reservoir elevation at the project. PacifiCorp states that this information, along with the results of the proposed studies and ongoing stakeholder consultation, will be used to inform the future operations plan.

Discussion and Staff Recommendation

The data collected during the fall 2019 drawdown includes information on fish communities, macroinvertebrates, and mollusks in the project reservoir. In addition, the data collected in the other approved studies and proposed ongoing stakeholder consultations should help to identify any potential effects of proposed operational changes in the project reservoir on the aquatic community. Although PacifiCorp has not yet provided the data collected during the 2019 drawdown, the results of that effort, along with the preliminary results of the other approved studies and stakeholder consultation, will be included in PacifiCorp's Initial Study Report (ISR) filed pursuant to section 5.15(c) of the Commission's regulations. If it is determined that the preliminary data provided in the ISR along with the ongoing data collection efforts will not provide sufficient information for our environmental analysis, modifications to the study plan can be made at that time pursuant to section 5.15. Therefore, we do not recommend any modification to the study at this time.

Water Quality Study (AQ 2)

Applicant's Proposed Study

The purpose of the *Water Quality Study* is to characterize water quality within the reservoir, including its main tributaries up to the reservoir's zone of influence, and the Bear River reach up to two miles downstream of Cutler Dam, or as adjusted given additional information from the *Hydraulics Modeling Study*. PacifiCorp proposes a two-phased study plan approach. Phase 1 will synthesize existing water quality data for Cutler reservoir including water quality data gathered during the fall 2019 drawdown. Phase 1 will identify any data gaps and detail any proposed data collection in 2021 (Phase 2) to fill those gaps, if found.

Comments on the Study

Bridgerland Audubon Society contends that PacifiCorp should implement Phase 2 of the study at the onset given that it's already apparent that the data collected during the November 2019 drawdown would not provide information on when the project reservoir might reach critically low dissolved oxygen (DO) levels. Bridgerland Audubon Society notes that the most critical period for low DO is in July and August when warmer water temperatures, robust algae populations with high nighttime respiration rates, and nighttime suspension of photosynthesis all contribute to low diurnal DO concentrations just prior to dawn. Bridgerland Audubon Society also notes that DO monitoring conducted by the Utah Division of Water Quality in 2010 for its Total Maximum Daily Load reports limited measurements to just a few sites where flows and turbulence were uncharacteristically high and may misrepresent DO levels. Finally, Bridgerland Audubon Society states that it is already apparent that there are insufficient data to assess the extent of hypoxic conditions in most of the reservoir and, therefore, Phase 2 of the study should be required.

Reply Comments

In its January 30, 2020 response letter, PacifiCorp notes that existing water quality data includes the results of monitoring during the November 2019 drawdown and data collected by numerous entities (e.g., Utah State University, Utah Division of Water Quality, independent consultants, and PacifiCorp) for other periods of the year. PacifiCorp expects that the collective body of water quality data will support an assessment of seasonal, diurnal, and spatial variability of Cutler Reservoir's water quality, and therefore, Phase 1 of the study should be conducted first, to inform the need for any Phase 2 studies.

Discussion and Staff Recommendation

Bridgerland Audubon Society did not provide a detailed analysis of all of the existing information that PacifiCorp proposes to review as part of a Phase 1 analysis [section 5.9(b)(4)]. Without this analysis we are unable to determine what, if any, data gaps exist [section 5.9(b)(6)]. Therefore, it is premature to implement Phase 2 of the study at this time, and PacifiCorp's proposal to first evaluate the existing data and the need for additional data collection as part of a Phase 1 analysis is a reasonable cost-effective approach [section 5.9(b)(7)]. However, we do note that PacifiCorp does not describe its proposed methodology for conducting Phase 2 or a process for developing the methodology [section 5.9(b)(6)]. Therefore, if upon completion of PacifiCorp's Phase 1 analysis, it is determined that Phase 2 water quality data collection is necessary, PacifiCorp should provide a detailed methodology for Phase 2 that is designed to address the data gaps identified in Phase 1. The Phase 2 methodology should be included with PacifiCorp's ISR filed pursuant to section 5.15(c) of the Commission's regulations. Providing the detailed methodology with the ISR will provide an opportunity for stakeholders to review Phase 1 results and evaluate and comment on PacifiCorp's Phase 2 study, if needed [section 5.9(b)(6)]. Because PacifiCorp's study plan already includes a provision to potentially develop a Phase 2 study, our recommended modification should not result in any additional cost [section 5.9(b)(7)].

APPENDIX B
THREATENED AND ENDANGERED SPECIES INITIAL STUDY REPORT

THREATENED AND ENDANGERED SPECIES INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT

(FERC NO. 2420)

Prepared for:

PacifiCorp
Salt Lake City, UT

Prepared by:

Cirrus Ecological Solutions, LC

February 2021

THREATENED AND ENDANGERED SPECIES
INITIAL STUDY REPORT

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Cutler Hydroelectric Project (FERC No. 2420)

Initial Study Report

Threatened and Endangered Species

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THREATENED AND ENDANGERED SPECIES
INITIAL STUDY REPORT

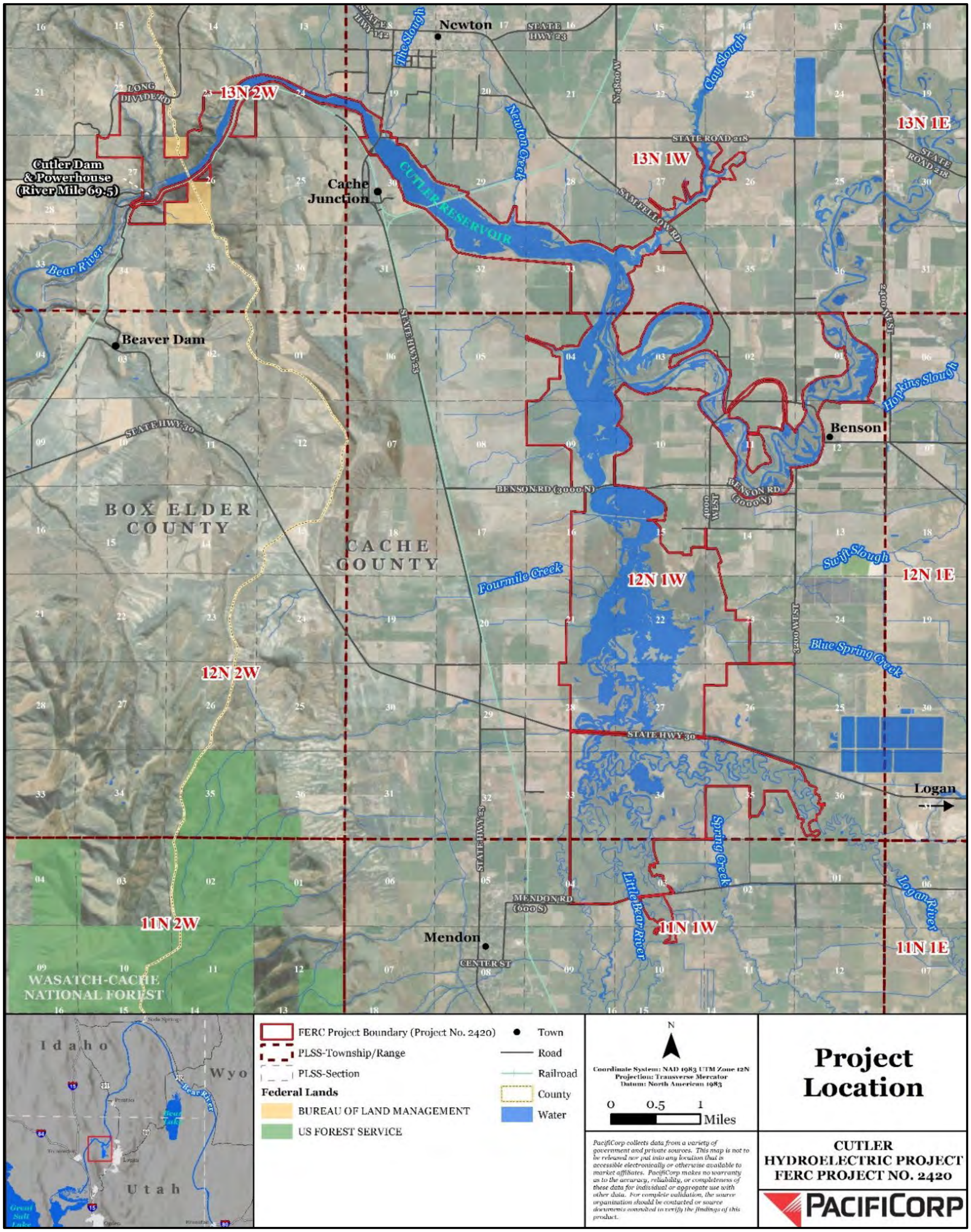
CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

1.0 INTRODUCTION

PacifiCorp is the owner, operator, and Federal Energy Regulatory Commission (FERC) licensee for the Cutler Hydroelectric Project (FERC No. 2420) (Project). The Project is located on the Bear River in Cache Valley, Utah, between the Wasatch and Wellsville Mountains. Cutler Dam is located in Box Elder County; however, most of the Project reservoir lies within Cache County. The Project reservoir is formed at the confluence of Spring Creek and the Bear, Logan, and Little Bear Rivers (Figure 1-1). PacifiCorp operates the Project under a 30-year license issued by FERC on April 29, 1994; the current license will expire on March 31, 2024. PacifiCorp initiated the formal relicensing process utilizing the Integrated Licensing Process (ILP) by filing the Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on March 29, 2019.

The relicensing process involves cooperation and collaboration amongst PacifiCorp, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. PacifiCorp's coordination with stakeholders included federal and state agencies, NGOs, Native American tribes, and tribal organizations, throughout the study scoping process, public meetings, workshops, scoping meetings, and a site visit. These meetings facilitated the identification of study needs to be addressed. Study scoping occurred in March 2019 through February 2020 when FERC issued the Study Plan Determination. PacifiCorp, FERC, and stakeholders identified the potential need for a Threatened and Endangered species study during the study scoping process.



Source: PacifiCorp 2018

FIGURE 1-1 CUTLER PROJECT LOCATION MAP

2.0 PROJECT NEXUS AND RATIONALE FOR STUDY

This study report describes work related to species listed under the Endangered Species Act (ESA). The ESA was passed in 1973 to protect those plants, animals, and associated habitats that are in danger of becoming extinct. The ESA is administered by the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Marine Fisheries Service (NOAA Fisheries). Terrestrial and freshwater species (like those found at the Cutler Project) are the primary responsibility of the USFWS. Under authority of the ESA, federal agencies are required to analyze the effects of actions they undertake or authorize on federally listed species, in consultation with the USFWS.

Species may be listed as endangered or threatened under the ESA. An endangered species is "in danger of extinction throughout all or a significant portion of its range." A threatened species is "likely to become endangered within the foreseeable future" (USFWS 2017). This study addresses *only* federally listed species under the ESA; several rare or other categories of species (such as state-listed) are known to exist within the Project Area, the Project Boundary, and the nearby area. These species are covered in the Shoreline Habitat Characterization Study Report (Appendix C of this ISR).

Information concerning threatened and endangered species relevant to the Project is summarized in Section 6.7 of the PAD, which states that one federally listed species, Ute ladies'-tresses orchid (*Spiranthes diluvialis*), is known to occur in and near the Project Area. A large population occurs near the Project Area in the Bear River Land Conservancy (BRLC) Mendon Meadow Preserve, while a smaller population occurs within the Project Boundary (SWCA 2018). Other federally listed species are unlikely to occur in the Project Area due to habitat restriction or range constraints, as described in the PAD.

Potential changes in Project operations have the potential to affect Ute ladies'-tresses due to potential changes in water levels in Cutler Reservoir. Hydrologic conditions are an essential parameter in this species' habitat requirements. Although it is possible that hydrologic conditions in Ute ladies'-tresses habitat could be influenced by changes in the management of Cutler Reservoir, the distance of the individuals to the shoreline and water table will affect the degree to which the population may be influenced. These changes are expected to vary across the Project Area and were studied specifically in areas of suitable habitat for the orchid.

Information regarding the presence of Ute ladies'-tresses in the Project Area is necessary to assess potential Project effects. Therefore, field surveys utilizing a methodology based on USFWS recommendations were necessary for this species to allow subsequent assessment and disclosure of the potential effects of proposed operational changes on the species and its habitat.

3.0 STUDY OBJECTIVES

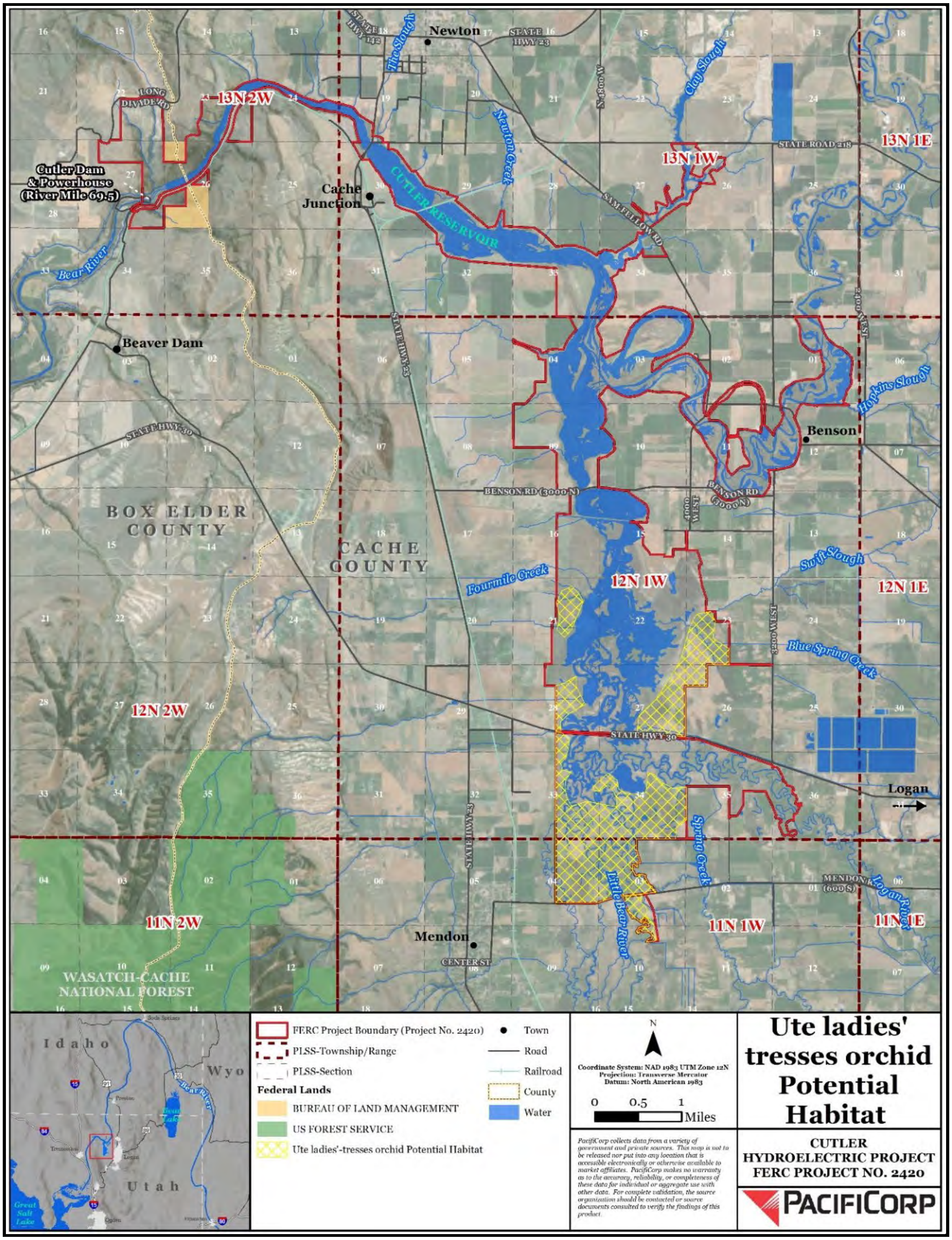
The Threatened and Endangered Species Study Plan, included in the Revised Technical Study Plans (RSP), identified the following goals and objectives:

- Identify federally listed and other rare or protected plant and terrestrial/aquatic wildlife species potentially occurring in the Project Area, as described in the PAD. Ute ladies'-tresses is the only federally listed species known to occur (or with the potential to occur) in or near the Project Area. Prior to the 2019 (and subsequent 2020) field survey work, information about the occurrence of this species within the Project Area was based on limited surveys conducted during a single season. The objective of this study was to systematically estimate the extent and location of occurrences of Ute ladies'-tresses within the Project Area.

- Assess potential impacts and effects of PacifiCorp's proposed operations. This information is not included in the Initial Study Report (ISR). It will be presented in the Draft License Application (DLA), which will be submitted in 2021.

3.1 STUDY AREA

The study area for the Ute ladies'-tresses includes the Cutler Reservoir Project Boundary. The study focused on locating and surveying suitable habitat for this species (e.g., wet meadow and potentially shoreline habitat). All surveyed areas were located inside the Project Boundary (Figure 3-1); generally, in the North and South Marsh management units.



Source: PacifiCorp 2018

FIGURE 3-1 STUDY AREA AND POTENTIAL HABITAT FOR UTE LADIES'-TRESSES ORCHID SURVEY

4.0 METHODS

4.1 BACKGROUND DATA AND INFORMATION

This study reviewed and incorporated existing information related to the Ute ladies'-tresses and its habitat within the Project Boundary. References for studies, reports, and other sources of information analyzed as part of this study are provided in this section. Information sources included but were not limited to the following:

1. U.S. Fish and Wildlife Service. 1992. Interim Survey Requirements for Ute Ladies'-tresses orchid (*Spiranthes diluvialis*).
2. PacifiCorp. 2019. Pre-Application Document. March 29, 2019.
3. Fertig, W. B., R. Black, and P. Wolken. 2005. Rangewide Status Review of Ute Ladies'-Tresses (*Spiranthes diluvialis*).
4. U.S. Wildflower's database of wildflowers for Utah, https://uswildflowers.com/wfquery.php?State=UT.
5. Biotics database. 2005. Utah Division of Wildlife Resources, NatureServe, and the network of Natural Heritage Programs and Conservation Data Centers.
6. Utah National Heritage Program. 2019. Data request/database search.

A preliminary survey for Ute ladies'-tresses was conducted in 2018 (SWCA 2018). This survey was commissioned by PacifiCorp and focused on the South Marsh, based on known potential habitat, and the nearby Mendon Meadows population. This survey identified potential habitat and one small occurrence of the species in the South Marsh area. The BRLC Mendon Meadows supports a large population of Ute ladies'-tresses. This parcel of land is located near but outside the FERC Project Boundary (Figure 1-1). BRLC has been monitoring this population and has completed yearly counts since 2013.

4.2 SURVEY METHOD

As stated in the RSP, the Interim Survey Requirements for Ute ladies'-tresses issued November 23, 1992, by the USFWS provided guidance for conducting surveys (USFWS 1992). This method was adapted to guide surveys completed for this study. Typically, the USFWS survey protocol requires 3 years of surveys because the species may not flower every year. However, because Ute ladies'-tresses was known to be present in the Project Area, the RSP assumed that a single year of surveys would suffice to confirm the current status of the population. Accordingly, a single additional survey was scheduled for 2020, when most other studies were scheduled to commence.

Given this species' variability in flowering, PacifiCorp voluntarily completed field surveys for Ute ladies'-tresses in 2019 prior to the FERC study plan determination, and again in 2020 to collect two additional years of field surveys, following the preliminary surveys conducted in 2018, in preparation for commencing the relicensing process. Both years of subsequent data are considered in this study report.

Following the initial 2018 preliminary survey, additional surveys for Ute ladies'-tresses were completed in August of 2019 and 2020 during the flowering period for this species, when it may be detected during pedestrian surveys. The 2019 surveys were conducted after visiting the nearby BRLC Mendon Meadows population to confirm that the local population was flowering. The 2020 survey timing was confirmed both by checking the nearby BRLC population flowering, and by relocating occurrences in the study area that were identified in 2019 and documenting they were flowering.

Prior to conducting the field surveys, aerial imagery of the Project Area was reviewed to locate potential habitat at the macro level. Subsequently, on-the-ground reconnaissance was conducted to further evaluate potential habitat and identify actual suitable habitat areas within. The reconnaissance included inspection from roads and boats moving along the shoreline (in riverine and reservoir shoreline habitats) as well as pedestrian surveys of higher potential areas.

Suitable habitat in the Project Area can occur in a fine mosaic pattern, with unsuitable habitat intermixed with adjacent suitable habitat. Topographic changes of less than a foot can make an area either too wet or too dry to be potentially suitable habitat, especially in combination with the occurrence of localized areas of groundwater discharge. Horizontally, these changes can occur in less than 10 feet. The complex interaction of habitat variables at fine scales requires that suitable habitat be identified in the field.

All suitable habitat identified through aerial imagery interpretation and field reconnaissance lies within the areas of potential habitat (Figure 3-1), primarily in the North and South Marsh units of the Project Area.

Based on the field habitat determination, suitable habitat was surveyed with pedestrian coverage. Survey routes were closely spaced to provide virtually 100 percent coverage of the suitable habitat. Habitat often occurred as long, narrow fringes, and survey routes conformed to the habitat boundaries. Data collected during the surveys included the number of individuals/flowering stems within occupied habitat polygons and pertinent habitat parameters.

The 2019 survey evaluated the entire Project Boundary to identify areas of potentially suitable Ute ladies'-tresses habitat using a combination of aerial imagery and on-the-ground reconnaissance. The 2020 surveys revisited the 2019 occurrence locations. In addition, some higher-potential suitable habitat that was unoccupied in 2019 was resurveyed in 2020.

5.0 RESULTS

Ute ladies'-tresses were confirmed in the South Marsh management unit of the Project. Each unique clump of orchids is referred to as an occurrence in this report. Ute ladies'-tresses occurrences were represented by small groups of one to several flowering stems (Photo 5-1 and Photo 5-2). Often there were multiple groups in close proximity. The number of flowering stalks in an occurrence ranged from 1 to 13. Often there were multiple occurrences in relatively close proximity within an occupied habitat patch. The species was not identified in any other management unit of the Project, although potential suitable habitats were surveyed throughout the Project Boundary, particularly in the riverine and wet meadow habitats in the North Marsh and Bear River management units (Cirrus 2019).

Photo 5-1 Occurrence of Ute Ladies'-tresses in the Project Area with High Number of Flowering Stalks

Photo 5-2 Typical Single-stalk Occurrence of Ute Ladies'-tresses

Ute ladies'-tresses were discovered in wet meadow habitat in soils that were moist to wet seasonally or year-long, but most occurrences were associated with soils that were moist to wet in August. The summer of 2020 was an exceedingly dry summer, yet soils where Ute ladies'-tresses occurred remained moist. Groundwater from the Wellsville Mountains and foothills supported sub-irrigated hydrology in occupied wet meadow habitat. This sub-irrigated wet-meadow habitat primarily occurs on the southwest side of Cutler Reservoir.

Other wet meadow/irrigated pastures associated with surface water occur in the Project Area, particularly on the east side of Cutler Reservoir and the Little Bear River. Ute ladies'-tresses were not found in surface-irrigated wet meadows. Based on extensive surveys in the Project

Area, it appears that surface-irrigated pastures are not suitable habitat or are poor-quality habitat for Ute ladies'-tresses.

All occupied, sub-irrigated habitat was higher than the elevation of Cutler Reservoir and independent of the water level in the reservoir. Shoreline habitat along the Cutler Reservoir, the Bear, Little Bear, and the Logan rivers within the Project Area were searched for Ute ladies'-tresses; none were discovered. Further, these areas did not appear to have the appropriate water regime and habitat conditions to support Ute ladies'-tresses.

The hydrologic observations of Ute ladies'-tresses habitat in the Project Area were consistent with the hydrology that supports the Mendon Meadows population of the species. The Mendon Meadows population occurs in a sub-irrigated wet meadow that is associated with groundwater from the Wellsville Mountains and foothills.

Ute ladies'-tresses was found in two sub-irrigated wet meadow habitat types in the Project Area. Habitat type 1 is a wet meadow that occurs along the margins of low-lying swales supporting Cattails (*Typha latifolia*) and Olney's Three-square Bulrush (*Scirpus americanus*). Photo 5-3 – Photo 5-8 provide examples of habitat type 1, as well as additional occurrences of Ute ladies'-tresses. These swales appear to be historic river channels that still carry water or that have standing water in the spring. In these habitats, Ute ladies'-tresses occurs in the transition zone between the cattail-bulrush habitat and adjoining upland areas. Depending on the topography of the swale and adjacent upland, the transition between cattail-bulrush habitat and uplands can occur over a short horizontal distance (i.e., less than 20 feet).

Primary associated plant species included Creeping Bentgrass (*Agrostis stolonifera*), Baltic Rush (*Juncus balticus*), Prairie Cordgrass (*Spartina pectinata*), Western Ragweed (*Ambrosia psilostachya*), Slender Wheatgrass (*Elymus tracycaulus*), and Indian Paintbrush (*Castilleja exilis*). Other associated species included Nuttall's Sunflower (*Helianthus nuttalli*), Horsetail (*Equisetum arvense*), Reed Canary Grass (*Phalaris arundinacaea*), Western Aster (*Aster ascendens*), and White Sweetclover (*Melilotus albus*).

Habitat type 2 is also a wet meadow with a seasonally high water table. August soil conditions were dry to moist. Photo 5-3– Photo 5-11 provide examples of habitat type 2, as well as occurrences of Ute ladies'-tresses. The topography is flat, supporting a large seasonally-wet meadow. The occupied habitat is a larger, several-acre block with the transition between deep water and upland habitat. This habitat is characterized by Nuttall's Sunflower, Creeping Bentgrass, Baltic Rush, Indian Paintbrush, and Western Ragweed. This habitat extends beyond the Project Boundary to the west onto adjacent private property.

No occurrences were found in cattail or bulrush habitat. These habitats are apparently too wet and too densely vegetated to support Ute ladies'-tresses Orchids.

The 2020 surveys revisited the occurrences of Ute ladies'-tresses that were located in 2019. In some cases, Ute ladies'-tresses orchids were found near the same locations as in 2019. However, the same individuals were not flowering in 2020. New occurrences of Ute ladies'-tresses were found in 2020 in habitat where no Ute ladies'-tresses were located in 2019. Conversely, some areas where Ute ladies'-tresses were present in 2019 had no individuals flowering in 2020.

The Ute ladies'-tresses occurrence reported in 2018 (within habitat type 1) (SWCA 2018) was resurveyed in both 2019 and 2020, but no individuals were found. Based on the survey results, it appears that Ute ladies'-tresses orchids may flower once and then not flower again for a period of years.

There were a total of 10 occurrences of Ute ladies'-tresses in the Project Area totaling 50 individuals in 2019 and 2020. Comparing these counts to the Mendon Meadows population, the density and overall population within the Project Boundary is much lower. While both the Mendon Meadows and the occupied habitat within the Project Boundary are sub-irrigated meadows, the Mendon Meadows habitat is characterized by Baltic Rush overstory with moss under the thatch, giving the ground a "spongy, cushioned" feel. Moss was not present in the Project Area and may be related to a drier or less consistent water regime, which could affect the population density.

The pastures in the Project Area that have occupied Ute ladies'-tresses habitat have been grazed by livestock. The long-term grazing history (season of use and intensity) is not known, but within the Project Boundary during the current license period, grazing in the occupied pastures has typically been from June-August or September. It is suspected that early- or late-season grazing may reduce competition from other species. Mid-summer grazing could adversely affect Ute ladies'-tresses by either direct herbivory or by trampling.

PHOTO 5-3 OCCUPIED HABITAT IN THE PROJECT AREA, HABITAT TYPE 1

PHOTO 5-4 OCCUPIED HABITAT IN THE PROJECT AREA, HABITAT TYPE 1

PHOTO 5-5 TYPICAL MULTI-STALK OCCURRENCE OF UTE LADIES-TRESSES

PHOTO 5-6 VIEW SHOWING POSITION ADJACENT TO WETTER CATTAIL-BULRUSH HABITAT; HABITAT TYPE 1

PHOTO 5-7 VIEW OF RELATIONSHIP BETWEEN WETTER CATTAIL-BULRUSH HABITAT AND DRIER *AGROSTIS* HABITAT WHERE UTE LADIES'-TRESSES OCCUR; HABITAT TYPE 1

PHOTO 5-8 OCCUPIED HABITAT; HABITAT TYPE 1

PHOTO 5-9 UTE LADIES-TRESSES ORCHID; HABITAT TYPE 2

PHOTO 5-10 UTE LADIES-TRESSES ORCHID; HABITAT TYPE 2

PHOTO 5-11 VIEW OF HABITAT TYPE 2

6.0 SUMMARY

This study implemented the methods specified in the Threatened and Endangered Species Study Plan. Specifically, the Project Area was surveyed for Ute ladies'-tresses orchids following the methodology established by the USFWS (USFWS 1992), as modified for this study. This study met objectives set in the RSP, which was to document the extent and location of Ute ladies'-tresses orchid within the Project Boundary. No additional surveys are needed. Analysis of potential proposed Project operation effects on threatened and endangered species will be included in the DLA.

7.0 REFERENCES

PacifiCorp. 2018. Cutler Hydroelectric Project FERC Project No. 2420. Maps created in 2018.

SWCA Environmental Consultants (SWCA). 2018. Ute Ladies'-Tresses Reconnaissance Survey Report. Prepared for PacifiCorp. September 2018.

U.S. Fish and Wildlife Service (USFWS). 2017. Endangered Species: Endangered Species Act Overview. [Online] URL: https://www.fws.gov/endangered/laws-policies/ Accessed December 6, 2018.

U.S. Fish and Wildlife Service (USFWS). 1992. Interim Survey Requirements for Ute Ladies'-tresses Orchid (*Spiranthes diluvialis*). November 23, 1992. https://www.fws.gov/utahfieldoffice/Documents/Plants/SPDI_interimSurveyRequirements_1992.pdf.

APPENDIX C
SHORELINE HABITAT CHARACTERIZATION INITIAL STUDY REPORT

SHORELINE HABITAT CHARACTERIZATION INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT

(FERC NO. 2420)

Prepared for:

PacifiCorp
Salt Lake City, UT

Prepared by:

Cirrus Ecological Solutions, LC

February 2021

SHORELINE HABITAT CHARACTERIZATION
INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT

(FERC NO. 2420)

Prepared for:

PacifiCorp
Salt Lake City, UT

Prepared by:

Cirrus Ecological Solutions, LC

February 2021

SHORELINE HABITAT CHARACTERIZATION INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT (FERC NO. 2420)

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INITIAL STUDY REPORT

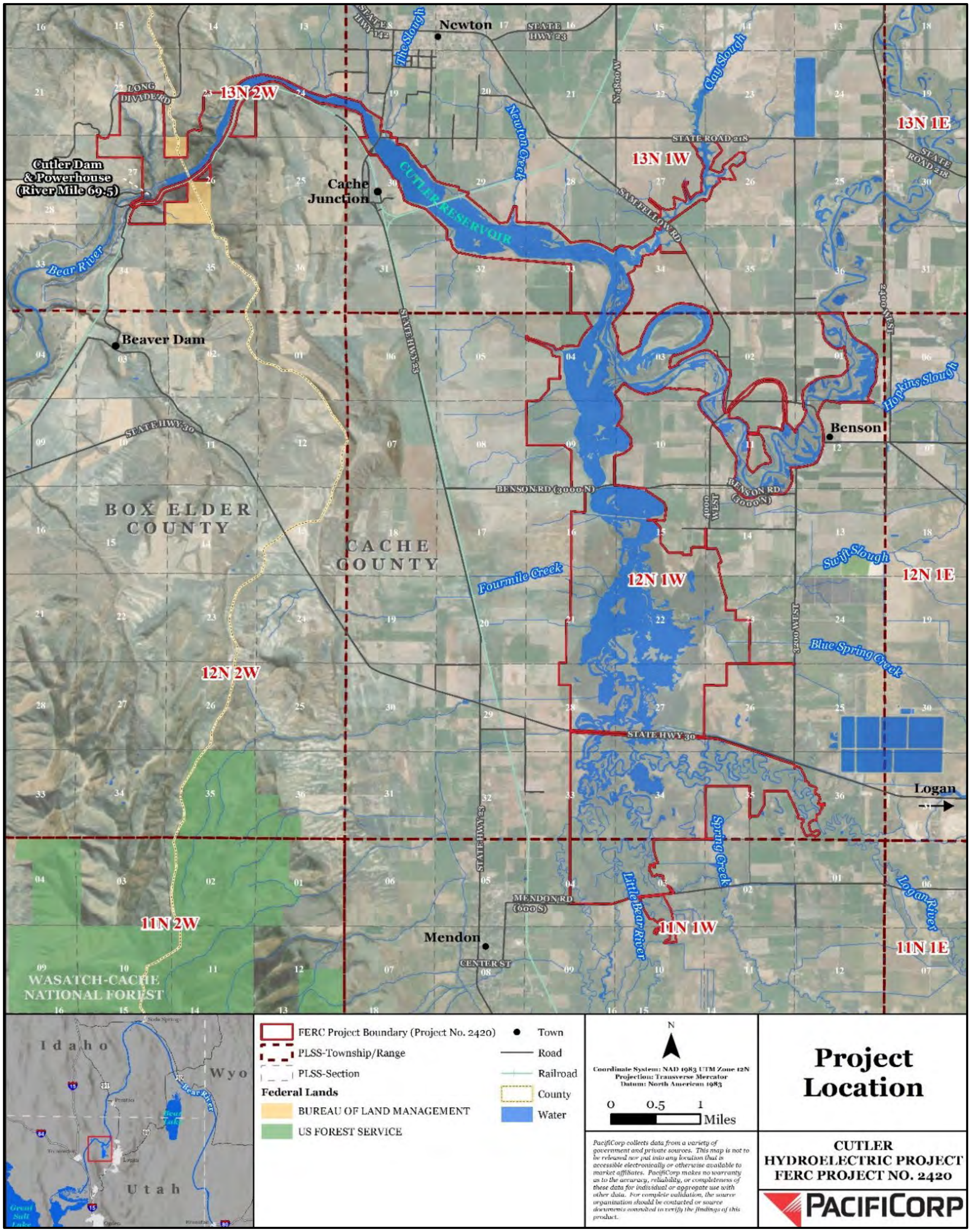
CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

1.0 INTRODUCTION

PacifiCorp is the Federal Energy Regulatory Commission (FERC) licensee for the Cutler Hydroelectric Project (FERC No. 2420) (Project). The Project is located on the Bear River in Cache Valley, Utah, between the Wasatch and Wellsville Mountains. Cutler Dam is located in Box Elder Count; however, most of the Project reservoir lies within Cache County. The Project reservoir is formed at the confluence of Spring Creek and the Bear, Logan, and Little Bear Rivers (Figure 1-1). PacifiCorp operates the Project under a 30-year license issued by FERC on April 29, 1994; the current license will expire on March 31, 2024. PacifiCorp initiated the formal relicensing process utilizing the Integrated Licensing Process (ILP) by filing the Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on March 29, 2019.

The relicensing process involves cooperation and collaboration between PacifiCorp, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. PacifiCorp coordinated with stakeholders throughout the study scoping process, public meetings, workshops, scoping meetings, and a site visit. These meetings facilitated the identification of study needs to be addressed. Study scoping occurred in March 2019 through February 2020, when FERC issued the Study Plan Determination. PacifiCorp, FERC, and stakeholders identified the potential need for a shoreline habitat characterization study during the study scoping process.



Source: PacifiCorp 2018

FIGURE 1-1 CUTLER PROJECT LOCATION MAP

2.0 PROJECT NEXUS AND RATIONALE FOR STUDY

Potential changes to Project operations may affect the type and amount of shoreline habitat available at Cutler Reservoir, as well as the spread of invasive species. Potential changes in Project operations may impact birds (primarily) and potentially other terrestrial wildlife species (e.g., amphibians) by changing water elevations during the non-breeding season, exposing isolated areas to terrestrial predators if water levels drop, or by changing the nature of the habitats.

This study is necessary to comply with, or respond to, federal regulations that protect shorebirds and other terrestrial wildlife (including rare or state-listed conservation priority species) and their habitat, and matters of agency and public interest or concern.

3.0 STUDY OBJECTIVES

The shoreline habitat component of the Revised Study Plan (RSP) identifies the following goals and objectives:

- Quantify changes in littoral habitat.
- Characterize emergent and adjacent wetland and upland vegetation.
- Map invasive species.
- Assess the effect of proposed operational changes on littoral habitats and invasive species distribution and associated effects on terrestrial and amphibian wildlife.[1]
- Assess the effects of water surface elevation (WSE) changes, including:
  - The effect of reservoir fluctuations on riparian and wetland habitat and associated wildlife, including waterfowl, wetland-dependent birds, amphibian species, and other terrestrial wildlife dependent on riparian/wetland habitat.
  - Potential effects on upland wildlife habitat and associated wildlife.
  - The potential for introduction and spread of terrestrial and wetland/littoral invasive plant species within the Project Boundary.

While the last two objectives are to evaluate effects of PacifiCorp's potential changes to Project operations on shoreline resources, those objectives are not addressed in this Initial Study Report (ISR). This ISR provides the basis for evaluation of the effects of potential changes in Project operations on shoreline resources. Evaluation of the last two objectives will be documented in the Draft License Application (DLA), which will be submitted in late fall 2021.

3.1 STUDY AREA

The shoreline habitat study area lies within, and surrounding, the ordinary high-water line (OHWL), which is generally defined by the current reservoir elevation range. The study area includes all shoreline and littoral habitat as well as any upland islands and peninsulas that might support breeding shorebirds, amphibians, and terrestrial wildlife dependent on riparian/wetland

[1] Effects on fish and other aquatic species and impacts due to changes in littoral or loss of terrestrial habitat through erosion will be addressed in separate studies.

habitat. The invasive plant component includes some uplands beyond the littoral zone. All analyzed areas are located inside the current FERC Project Boundary.

4.0 METHODS

This study will consist of two phases. The first phase, described in this section, establishes baseline environmental conditions, determines the necessity of a second phase, and provides some of the data necessary for an impact and effect analysis that will be completed for the DLA.

The first phase includes a literature review of the wildlife and noxious weed species are present in the study area, a description of the vegetation and habitat type classification, discussion of field work completed, and an analysis of data collected and determination of the necessity of a Phase 2 collection of additional data. Section 4.5 outlines the modifications made to the methods after the release of the RSP.

Any data gaps identified in the first study phase will be addressed by the second study phase (Attachment C-1) to ensure sufficient results for a potential impact and effect analysis that will be completed for the DLA.

Below, the methods for the first phase of the study are described in detail. The results of this phase of analysis are presented in Section 6.0.

4.1 EXISTING DATA AND LITERATURE REVIEW

The review of existing data included special status birds, amphibians, and terrestrial wildlife dependent on open water and riparian/wetland habitat that are known to be or are likely present in the study area, and the data pertaining to their habitat needs.

This evaluation included a literature review sufficient to answer the following two questions:

1. Is there suitable habitat for this species within the study area?
2. If so, is this habitat subject to potential changes under future project operations?

Species for which both questions were answered in the affirmative were carried forward into further analysis. The habitat evaluated in the study area included the reservoir and all shoreline and littoral habitat as well as any upland islands and peninsulas.

Section 6.7 of the Pre Application Document (PAD) identified special status species (threatened and endangered species, conservation agreement and wildlife species of concern for the state of Utah, Intermountain Region sensitive species, and migratory birds) that are likely to be in the vicinity of the study area, additional steps were taken to ensure all species that could potentially be in the study area were identified and carried forward into data analysis.

The review of existing data included noxious weeds found in Cache and Box Elder counties. Similar to the special status wildlife species described above, noxious weeds were identified in the PAD. An additional review was completed to ensure all noxious weeds that could potentially occur within the study area were identified in the PAD.

To determine if any special status wildlife species needed to be added to the list identified in the PAD, information was collected from state and federal agencies, breeding bird survey (BBS) data, eBird, the Audubon Society, and published literature. To determine if noxious weed species needed to be added to the list identified in the PAD, existing noxious weed information, including that from Cache and Box Elder counties, PacifiCorp, state and sovereign lands, and adjacent landowners, was collected along with incidental observations gathered during field surveys for Ute ladies'-tresses (*Spiranthes diluvialis*) (Appendix B) and accuracy assessment field efforts.

4.1.1 SPECIAL STATUS WILDLIFE SPECIES

Three sources were used for identifying special status wildlife species: the Utah Sensitive Species List (UDWR 2017), the Intermountain Region Sensitive Species list (USFS 2016), and the U.S. Fish and Wildlife Service (USFWS) list of migratory birds (USFWS 2020a). Each of these sources and how they were used are described in further detail below.

The Utah Department of Wildlife Resources (UDWR) maintains a Utah Sensitive Species List (UDWR 2017), which identifies all federally listed species, conservation agreement species, and wildlife species of concern for the state of Utah. The Sensitive Species List was used to evaluate and assess individual species' distribution and habitat needs to determine which species, if any, that were not included in the PAD should be carried forward into data analysis. Note that potential effects to a federally listed plant species (Ute ladies'-tresses) are detailed in the Threatened and Endangered Species ISR (Appendix B).

The U. S. Forest Service (USFS) maintains a list of Intermountain Region (R4) Sensitive Species (USFS 2016). These are species that the regional forester identified as having the potential for being listed under the Endangered Species Act (ESA) as threatened or endangered. Even though there are no USFS-administered lands involved in the Project, there are USFS lands nearby, and this list is a good resource for species in the area that could be sensitive to Project-level impacts. This list was evaluated, and each species' distribution and habitat needs were assessed to determine which species, if any, that were not included in the PAD should be carried forward into data analysis.

The USFWS maintains a list of all migratory bird species protected under the Migratory Bird Treaty Act (MBTA) (USFWS 2020a). A comprehensive list of all migratory bird species that could potentially be present in the study area was compiled using the following procedures.

BBS data were used to determine which of the species identified in the MBTA had been recorded in the area during past surveys (USFWS 2020b). BBS data are collected annually along the same transects. Therefore, most of the species using the general area around the reservoir would be identified at one of the transects. The species lists for the four closest transects to the study area were obtained. These transects included the Johnson Canyon (data available sporadically from 1987–2008 and 2016–2019), Bear River (data available from 1992–1998 and 2003–2017), Logan Canyon (data available from 1997–2019), and Hyrum (data available from 1975–1979) routes (USFWS 2020b).

In addition to BBS data, eBird provides user-submitted data for species identified at various locations (Cornell Lab of Ornithology 2020a). The reservoir is a popular spot for birding, and many lists have been submitted for the Cutler Reservoir. Data from eBird also provide the dates for arrival and departure of each migratory species from the area.

Finally, a Christmas Bird Count (CBC), organized by the National Audubon Society, has been completed in Logan City each year from 1956 to 2016. In December of each year, volunteers identify and count birds in a 15-mile radius for a 24-hour period (National Audubon Society

2020). This long-standing data set provides an additional data source to help identify any birds that might be present in the area.

Utilizing the BBS, eBird, and CBC data likely provides a comprehensive list of migratory birds that could be found near the study area. Birds that appeared to be anomalies (only appeared in a transect or list once and do not typically have a range overlapping the study area) in the BBS, eBird, or CBC data were not carried forward into data analysis.

The Birds of North America online resource (Cornell Lab of Ornithology 2020b) was used to determine which species from the BBS, eBird, and CBC lists may have habitat in the study area but were not included in the PAD.

In April of 2020, UDWR staff conducted surveys for the Deseret Mountainsnail (*Oreohelix peripherica*), a terrestrial mollusk and Utah State Sensitive Species, on north-facing slopes of the south side of Cutler Canyon, above the reservoir/Bear River in the vicinity of Cutler Dam. The survey locations were based on historic records for the species and searched potential habitat which consists of woodland leaf litter pockets in potentially cooler ravine microhabitats on the north-facing canyon slopes; prior to the 2020 surveys, there were no recent records for the species in the vicinity of the Project. UDWR staff confirmed the Deseret Mountainsnail was present in several locations (Table 5-1).

4.1.2 NOXIOUS WEEDS

No separate systematic on-the-ground inventory of noxious weeds in the study area was conducted, but the annual PacifiCorp weed monitoring maps and data, incidental data collected during Ute ladies'-tresses surveys, and habitat accuracy assessment efforts provide coverage of most of the study area.

The Utah State University (USU) extension program maintains county-specific noxious weed species lists (Utah State University Extension 2020). These resources were used to evaluate each species' distribution and habitat needs to determine which could potentially be present in the study area that were not included in the PAD.

In addition, identification of areas dominated by *Phragmites,* (i.e., a specific noxious weed) was possible through the vegetation classification process described in Section 5.2.

4.2 VEGETATION CLASSIFICATION

Vegetation classification was based on aerial drone imagery and light detection and ranging (LiDAR) data collected in the fall of 2019, with ground-truthing. Imagery and ancillary LiDAR data were processed using ENVI Feature Extraction object-oriented classification algorithms into a broad classification identifying habitat types. Identification of areas dominated by *Phragmites* was possible using this process.

4.2.1 ACCURACY ASSESSMENT

The resulting classification was field validated to ensure accuracy was sufficient for future use. The accuracy assessment was conducted by generating stratified random points within each habitat class. The number of random points was determined using established statistical methods, specifically the sample size equation based on the multinomial distribution developed by Tortora (1978):

$$N = \frac{B\Pi_i(1 - \Pi_i)}{{b_i}^2}$$

In this equation Π_i is the proportion of the i^{th} class out of k classes that is closest to 50 percent of the total area of the classification, b_i is the desired precision for this class (5 percent is standard and held constant for all classes), and B is determined from the chi squared table with one degree of freedom based on the value of:

$$1 - \frac{\alpha}{k}$$

In this equation α is the 100^{th} percentile of the desired confidence interval (85 percent is standard for landcover mapping products) and k is the number of classes.

Once the number of points needed was determined, the points were stratified by landcover class. Points were assigned to each class based on the proportion of the classification they represent, with a minimum of 30 points per class. For example, if 500 points are needed and there are four classes with proportions of the total measuring 60, 20, 15, and 5 percent, the allocated points would be 300, 100, 75, and 30, respectively.

Visiting each random point in the field was necessary to determine the correct habitat class. The class values collected in the field, relative to the class values based on imagery classification, were compiled in an error matrix from which the standard accuracy statistic $\widehat{K}$ was calculated using the following equation:

$$\widehat{K} = \frac{N \sum_{i=1}^{k} x_{ii} - \sum_{i=1}^{k} (x_{i+} * x_{+i})}{N^2 - \sum_{i=1}^{k} (x_{i+} * x_{+i})}$$

where k is the number of landcover classes in the matrix, x_{ii} is the number of observations in row i and column i, and are the totals for row i and column i, and N is the total number of accuracy assessment points. This equation yields values between 0 and 1 with values closer to 1 representing higher agreement between the classification and ground reference information. For landcover classifications of this type, values above 0.80 are considered to have strong agreement and a value above 0.80 was the goal (Congalton et al. 1983).

4.3 CUTLER 2019 DRAWDOWN FIELD WORK

Fieldwork associated with the Cutler Reservoir drawdown focused on the interaction between WSEs, wetted perimeters, and proximity to important habitat types.

4.3.1 LAND BRIDGE FORMATION

Land bridge formation connecting islands in the reservoir to the shore was documented using time-lapse cameras. Ten cameras were installed to validate the predicted wetted perimeter footprint generated by the hydraulic model developed in the Hydraulic Modeling Study Plan (Appendix G).

4.4 ANALYSIS AND COLLECTION OF ADDITIONAL DATA

The proposed extended operation range could change the water levels in the reservoir compared to the current normal operating range. This could change the amount of habitat available for those species that utilize littoral habitat and outlines the methods used to determine how habitat might change for wildlife species that were deemed potentially present.

4.4.1 QUANTIFYING CHANGES IN LITTORAL HABITAT

The hydraulic model was utilized for comparative analysis of potential changes in littoral habitat availability between the normal operating range and the proposed extended operating range for each of the species identified. The model output was used to analyze two factors relative to each species: the net change in the amount of littoral habitat available, and any shift in the location of available habitat.

To assess changes in habitat amount, specific water-depth classes were selected based on the littoral habitat needs of each species. Data for these depth classes were exported from the hydraulic model at 12-hour time steps for 10 days (based on the potential future winter operating plan, as detailed in Section 1.3 of this report; 10 days would cover the time period of the total swing through the expanded operating range, starting and ending at the normal high reservoir elevation), starting at noon on Day 1 and ending at noon on Day 10 for a total of 19 time steps. For each of the 19-time steps, the model output was used to determine how many acres were available in each water-depth class over time under each operating scenario. The results were then compared to determine net change in available habitat in the study area for each species. For further information regarding the hydraulic model, see Appendix G of this ISR.

To assess shifts in the location of suitable littoral habitat, the output from the hydraulic model described above was used to indicate where each water-depth class was located under each operating scenario. The resulting polygons were then compared to calculate the extent of habitat overlap between the normal and extended operating range scenarios. This is useful information because individual wildlife may have become familiar with the study area under current operating conditions, and thus they may know where their preferred habitat is located. Extensive overlap would indicate that habitat was available in the same locations under both operating scenarios. Less overlap would mean wildlife may have to search for suitable habitat in new (but generally nearby) locations under the proposed extended operating range, resulting in additional energy expenditure.

In summary, to determine if any wildlife species identified has the potential to be affected by the proposed extended operations, the acreage and location of habitat available under the current operating range was compared to the acreage and location of habitat available under the proposed extended operating range. The acreage of overlap between these two scenarios is a good indicator of whether or not habitat is similarly located under each scenario.

4.4.2 ADDITIONAL LAND BRIDGE ASSESSMENT

Based on FERC staff recommendations in the FERC Study Plan Determination, this study was updated to include monitoring predator access to core colonial bird nesting areas under current operating conditions. Motion- and heat-sensitive cameras were installed around these core colonial bird nesting areas to determine if predators access these areas in the absence of land bridges during the breeding season under current operating conditions. Specifically, 19 outward facing cameras were placed on and around these nesting areas (Figure 4-1).

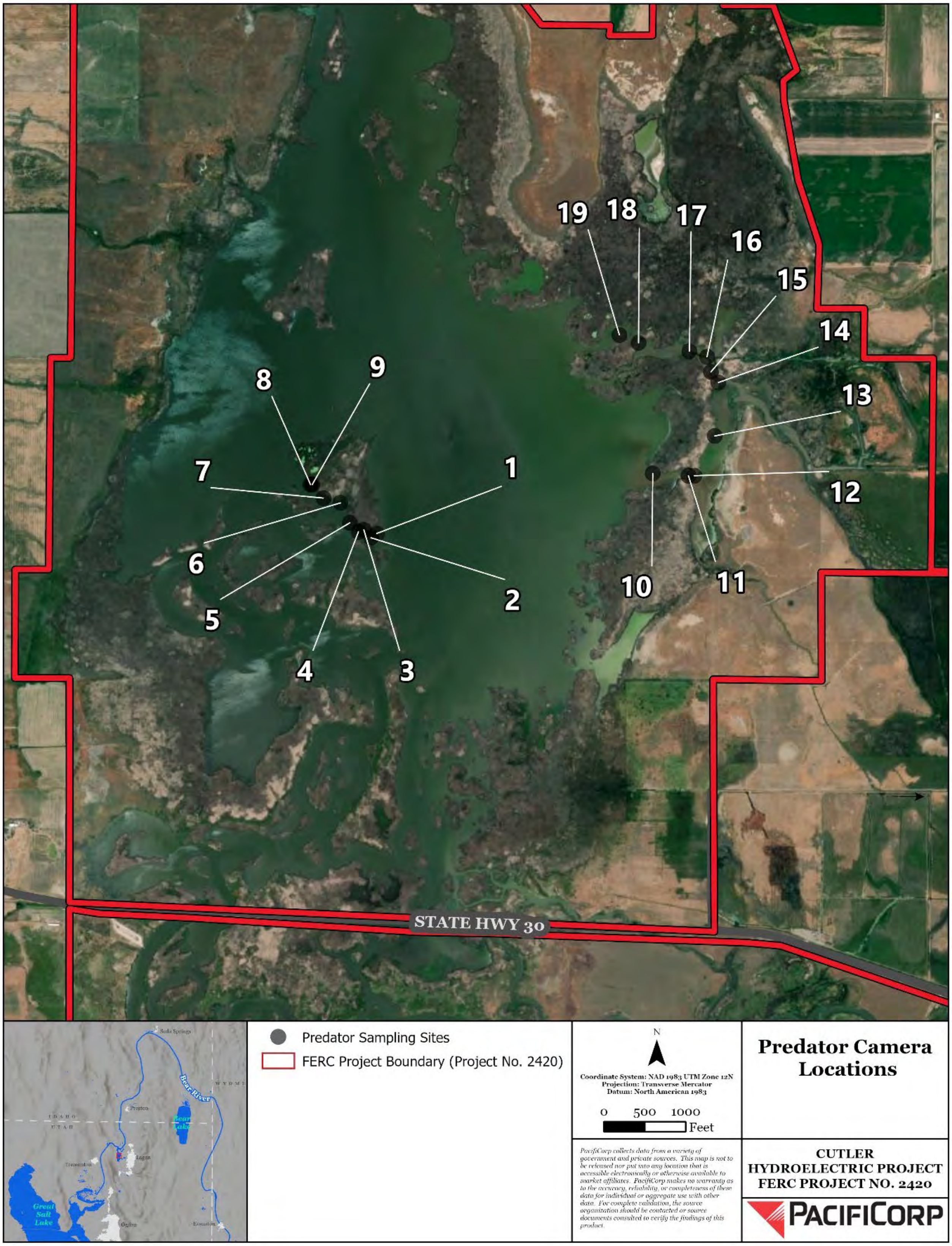
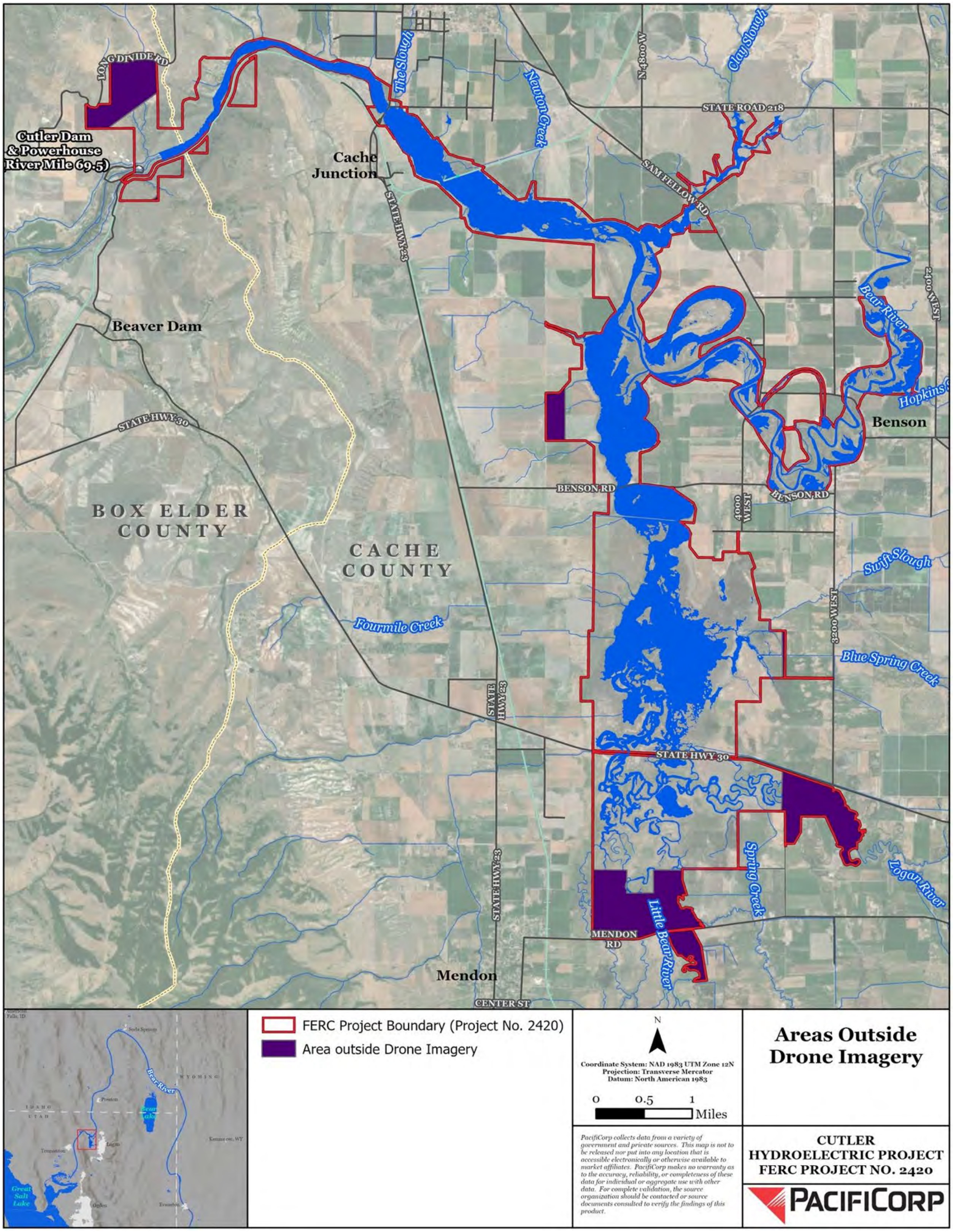


FIGURE 4-1 PREDATOR MONITORING CAMERA LOCATIONS

4.5 MODIFICATIONS TO METHODS

4.5.1 VEGETATION CLASSIFICATION

Drone imagery collected during the fall 2019 drawdown was used for vegetation classification. However, the drone imagery did not cover the entire study area. The drone imagery covered most of the study area with the exception of approximately 942 vegetated acres, primarily in the southern portion of the study area (Figure 4-2). Within the area not covered by the drone, imagery from the National Agricultural Imagery Program (NAIP) was used for vegetation classification.



PacifiCorp 2020

Figure 4-2 Portions of Study Area Not Covered by Drone

The use of NAIP imagery necessitated a modification to the imagery processing methods described in the RSP's vegetation classification methods. The properties of the NAIP imagery (i.e., large pixel size and differing plant phenology) made it unlikely that suitable results could be obtained by classifying the NAIP imagery using ENVI Feature Extraction methods. As a result, the NAIP imagery was classified by manually digitizing vegetation classes on-screen based on data and knowledge gained through the accuracy assessment work.

The vegetation types identifiable using the manually digitized NAIP imagery were classified as upland, woody, and mixed marsh. The spatial and spectral resolution of this imagery did not allow the differentiation between Cattail-dominated and Rush-dominated areas or the identification of sparsely-vegetated areas or *Phragmites*-dominated areas. This level of resolution for vegetation classification in these areas was deemed acceptable for several reasons:

- The area that was not covered by the drone imagery represents only a small portion (approximately 10 percent) of the study area.
- The area not covered is characterized primarily by uplands that were far from the reservoir, and areas far upstream from the Cutler Dam. In the areas far upstream from the dam, the hydrologic impacts of reservoir level fluctuation are extremely small, (based on hydraulic model results) because water in these areas is mostly river channels flowing into the main body of the reservoir.
- The area manually classified into vegetation types similar to those classified from the drone imagery using automated methods.
- There is very little *Phragmites* in these areas and the inability to detect *Phragmites* in the NAIP imagery does not produce meaningful inaccuracy in the context of the study area as a whole.

- Cattail-dominated and Rush-dominated marsh are functionally similar so lumping them together as mixed marsh in these areas does not present a problem with regard to wildlife habitat questions.

- None of the analyses depend on vegetation classes being arrived at in the same way to be valid.

5.0 RESULTS

This section presents the results found during the existing data and literature review, vegetation classification, field work to determine the presence of land bridges and access for predators to core colonial bird nesting areas, and analysis and collection of additional data. These results include the modifications to methods described.

5.1 EXISTING DATA AND LITERATURE REVIEW

Some species that utilize the habitat in the study area were not carried forward into analysis for one or more of the three reasons, marked with an (A), (B), or (C) in the final column of Table 5-1 in Section 5.1.1. Those species that did not have an overlapping distribution or habitat in the study area did not receive a determination in the final column because that column is not applicable to them.

Species marked with an (A) utilize habitat that would not be affected by changing water levels. Because the study area includes some upland habitat around the reservoir (Figure 1-1), some upland-dependent species are within the study area. However, fluctuations in water levels at the reservoir would not affect these upland habitats, and thus would have no effect on the species utilizing these habitats.

Species marked with a (B) migrate out of the area during the winter months (November through the end of March). As described in ISR Section 1.3, the proposed extended operating range only occurs outside the irrigation season, from November through the end of March. In order for short-term changes in water levels to affect this species, the species must be present at the time when the short-term changes occur. Therefore, those species that are not present from November through the end of March were not included in the further discussion of Section 5.1.2.

Species marked with a (C) hibernate in upland terrestrial habitats during the winter months (November through the end of March). As described above, this is the period of time when the proposed extended operations would occur. Therefore, those species that hibernate from November through the end of March were not included.

Any potential change in proposed reservoir operations would only take place from November through the end of March. These months are outside of a typical breeding season for migratory birds in Utah (Cornell Lab of Ornithology 2020b). Therefore, the only species that could be affected are those that are present during the non-breeding season, when proposed extended operations would take place. Generally, one of the most important aspects of non-breeding habitat is the availability of suitable foraging habitat (Marra et al. 2015, Brown and Sherry 2005). describes foraging habitat for migratory birds that are present in the area and identifies species for which there is the potential for foraging habitat effects during the non-breeding season.

5.1.1 SPECIAL STATUS WILDLIFE SPECIES

All species included in Section 6.7 of the PAD are included in Table 5-1, as well as any species identified through the literature review that were not initially included in the PAD.

TABLE 5-1 SPECIAL STATUS SPECIES IDENTIFIED IN THE PAD OR POTENTIALLY IN THE STUDY AREA

SPECIES NAME	HABITAT	STATUS[1]	HABITAT/ DISTRIBUTION IN STUDY AREA?	HABITAT CHANGES ANTICIPATED UNDER FUTURE PROJECT OPERATIONS?
Mammals				
Big Free-tailed Bat[2] *Nyctinomops macrotis*	Live in rocky and woodland habitats with caves, mines, buildings and rock crevices. Forages over a variety of habitats.	WSoC	Yes	No (B)
Canada Lynx *Lynx canadensis*	Live in coniferous or mixed forests, with thick undergrowth for hunting, old growth with deadfall for denning and resting. Extirpated from Utah.	Federally Threatened	No	N/A
Fringed Myotis[2] *Myotis thysanodes*	Live in caves, mines, and buildings in desert and woodland areas, but forages over a variety of habitats.	WSoC	Yes	No (C)
Townsend's Western Big-eared Bat[2] *Corynorhinus townsendii townsendii*	Use a wide variety of roosting and foraging habitats, including caves and mines for roosting and open areas for foraging.	R4 Sensitive, WSoC	Yes	No (A)
Birds				
American Avocet[2] *Recurvirostra americana*	Forage shallow open waters (0-20 cm deep); substantially more in shallow open waters than other habitats, including short emergent habitat.	Migratory	Yes	Yes
American Bittern[2] *Botaurus lentiginosus*	Typically forage in aquatic freshwater habitat among emergent vegetation, typically in areas with water 4–5 cm deep. Wade in the water searching for invertebrates and small vertebrates along the shoreline. Occasionally forage in upland grassland habitat.	Migratory	Yes	No (B)
American Coot[2] *Fulica americana*	Forage in aquatic habitat as well as upland habitat. Generally utilize water less than 6 meters deep to dive for submerged vascular plants and aquatic invertebrates. Tend to prefer habitat close to cover, typically along stands of emergent vegetation. Also forage on dry land, including agricultural fields and other areas far from water.	Migratory	Yes	Yes
American Crow[2] *Corvus brachyrhynchos*	Forage in a wide variety of habitat types including terrestrial and wetland habitat; along water bodies, and feed along the ground.	Migratory	Yes	No (A)

Species Name	**Habitat**	**Status[1]**	**Habitat/ Distribution In Study Area?**	**Habitat Changes Anticipated Under Future Project Operations?**
American Goldfinch[2] *Spinus tristis*	Forage among grasses and shrubs in grasslands, floodplains, weedy fields, and agricultural areas.	Migratory	Yes	No (A)
American Kestrel[2] *Falco sparverius*	Forage in open habitat with short vegetation, including grasslands, fields, pastures, and meadows. Large trees are not a requirement for suitable foraging habitat.	Migratory	Yes	No (A)
American Pipit[2] *Anthus rubescens*	Forage on the ground and can be found along streams, ponds, and wetlands. Will wade into shallow water to forage.	Migratory	Yes	Yes
American Robin[2] *Turdus migratorius*	Forage in a wide variety of habitat, including urban and suburban areas, agricultural fields, open areas, forests, woodlands, and along streams and rivers.	Migratory	Yes	No (A)
American Tree Sparrow[2] *Spizella arborea*	Forage in weedy fields and grassland habitat for seeds and the occasional insect.	Migratory	Yes	No (A)
American White Pelican *Pelecanus erythrorhynchos*	Forage in water with islands for resting and nesting.	WSoC, Migratory	Yes	Yes
American Wigeon[2] *Mareca americana*	Forage in shallow wetlands, mudflats, and slow-moving water, water's edge, upland habitat near water, or in areas where they can steal food from other diving ducks. Graze on submerged vegetation, emergent plants, and invertebrates.	Migratory	Yes	Yes
Bald Eagle *Haliaeetus leucocephalus*	Roosts in large trees. Generally nests in mature, old-growth trees within 2 kilometers of water.	R4 Sensitive, WSoC, Migratory	Yes	Yes
Bank Swallow[2] *Riparia riparia*	Forage in a variety of open and water-related habitat including wetlands, agricultural areas, marshes, and prairies.	Migratory	Yes	No (B)
Barn Owl[2] *Tyto alba*	Forage in open habitat where prey is abundant, including fields, pastures, meadows, and marshes.	Migratory	Yes	No (A)
Barn Swallow[2] *Hirundo rustica*	Forage while in flight, often close to the ground or body of water. Typically forage in parks, and over open water found in urban areas and grasslands.	Migratory	Yes	No (B)

SPECIES NAME	HABITAT	STATUS[1]	HABITAT/ DISTRIBUTION IN STUDY AREA?	HABITAT CHANGES ANTICIPATED UNDER FUTURE PROJECT OPERATIONS?
Barrow's Goldeneye[2] *Bucephala islandica*	Forage by diving along shorelines that are generally less than 4 meters deep. Prefer open water without emergent or submergent vegetation.	Migratory	Yes	Yes
Belted Kingfisher[2] *Megaceryle alcyon*	Forage in streams, rivers, lakes, ponds, wetlands and reservoirs with abundant fish and aquatic vertebrates or invertebrates. Typically capture prey within the top 60 centimeters of the water.	Migratory	Yes	Yes
Black-billed Magpie[2] *Pica hudsonia*	Forage in open areas, from suburban areas to grasslands, farmland, and riparian areas. Generally avoid dense woodlands.	Migratory	Yes	No (A)
Black-chinned Hummingbird[2] *Archilochus alexandri*	Forage on nectar-producing flowers from ground level to the tops of trees.	Migratory	Yes	No (A,B)
Black-crowned Night-heron[2] *Nycticorax nycticorax*	Use a wide variety of wetland habitat. Prefer shallow water (less than 9 cm deep) with emergent vegetation to wade for aquatic vertebrates and invertebrates. Typically found along the edges of the water body, often hunting from vegetation hanging over the water.	Migratory	Yes	Yes
Black-headed Grosbeak[2] *Pheucticus melanocephalus*	Forage in trees and shrubs in many open and woodland habitat types for insects and berries.	Migratory	Yes	No (A,B)
Black-necked Stilt[2] *Himantopus mexicanus*	Forage in shallow water up to the height of their breast, generally around 11 cm deep.	Migratory	Yes	Yes
Black Rosy-finch *Leucosticte atrata*	Live in alpine habitat in the summer, above the timberline in the winter.	Migratory	No	N/A
Black Tern[2] *Chlidonias niger*	Forage in aquatic habitat, often in flocks where food is abundant. Hover near the surface of water to grab fish and insects.	Migratory	Yes	No (B)
Blue-gray Gnatcatcher[2] *Polioptila caerulea*	Forage on small insects and spiders in woodland, forest, and riparian habitat.	Migratory	Yes	No (A,B)
Blue-winged Teal[2] *Anas discors*	Forage in shallow water and mudflats by placing their bill, head, or whole body underwater to glean insects from	Migratory	Yes	Yes

SPECIES NAME	HABITAT	STATUS[1]	HABITAT/ DISTRIBUTION IN STUDY AREA?	HABITAT CHANGES ANTICIPATED UNDER FUTURE PROJECT OPERATIONS?
	submerged vegetation. Foraging water depths vary widely by food availability and season, on average water is 30 centimeters deep.			
Bobolink *Dolichonyx oryzivorus*	Forage in damp meadows and prairies with dense grasses and forbs.	WSoC, Migratory	Yes	No (A,B)
Bonaparte's Gull[2] *Chroicocephalus philadelphia*	Forage in a range of aquatic habitat, including wetlands, lakes, ponds, rivers, and oceans. Feed by diving into water or dipping into the surface of the water to grab fish and other small aquatic organisms.	Migratory	Yes	Yes
Brewer's Blackbird[2] *Euphagus cyanocephalus*	Forage in open habitat including urban and suburban areas, agricultural fields, pastures, and grasslands.	Migratory	Yes	No (A)
Brewer's Sparrow *Spizella breweri*	Forage in arid sagebrush and desert grasslands.	Migratory	No	N/A
Broad-tailed Hummingbird[2] *Selasphorus platycercus*	Forage in woodlands and scrubby riparian habitat among nectar-producing flowers.	Migratory	Yes	No (A,B)
Bufflehead[2] *Bucephala albeola*	Forage in open, shallow water (less than 3 meters deep) where they dive for invertebrates avoiding diving into areas with dense stands of emergent or submergent vegetation.	Migratory	Yes	Yes
Bullock's Oriole[2] *Icterus bullockii*	Forage among trees near riparian habitat.	Migratory	Yes	No (A,B)
Burrowing Owl *Athene cunicularia*	Forage in open habitat with little to no vegetation in desert, shrub steppe, and prairie habitat.	WSoC, Migratory	Yes	No (A)
Cackling Goose[2] *Branta hutchinsii*	Forage for both submergent vegetation as well as on short vegetation in upland habitat.	Migratory	Yes	Yes
California Gull[2] *Larus californicus*	Forage in open habitat including farmland, marshes, meadows, garbage dumps, streams, and rivers.	Migratory	Yes	Yes
California Quail[2] *Callipepla californica*	Utilize a wide variety of habitat including grasslands, shrublands, riparian areas and sagebrush scrub.	Migratory	Yes	No (A)
Canada Goose[2] *Branta canadensis*	Forage in lakes, slow-moving rivers, marshes, mud flats, ponds, grassy fields, pastures, and agricultural fields.	Migratory	Yes	Yes

SPECIES NAME	**HABITAT**	**STATUS**[1]	**HABITAT/ DISTRIBUTION IN STUDY AREA?**	**HABITAT CHANGES ANTICIPATED UNDER FUTURE PROJECT OPERATIONS?**
Canvasback[2] *Aythya valisineria*	Forage in a variety of aquatic habitat, often diving to reach submerged vegetation and invertebrates diving for food in water between 0.5 and 2 meters deep.	Migratory	Yes	Yes
Caspian Tern[2] *Hydroprogne caspia*	Forage in aquatic habitat, flying at heights ranging from 3 to 30 meters over shallow (0.5 to 5 meters) water diving into the water to capture fish.	Migratory	Yes	No (B)
Cattle Egret[2] *Bubulcus ibis*	Forage in shallow water (up to 80 cm deep) with emergent vegetation or in open upland habitat including fields, meadows, pastures, and agricultural areas.	Migratory	Yes	No (B)
Chipping Sparrow[2] *Spizella passerina*	Forage in a wide variety of habitat including open grassy areas, weedy fields, sagebrush, chaparral, and urban areas.	Migratory	Yes	No (A,B)
Cinnamon Teal[2] *Anas cyanoptera*	Forage in wetland habitat, flooded areas and marshes where they forage for aquatic vegetation and invertebrates on the surface of the water or just below the surface of the water; typically in areas less than 20 cm deep.	Migratory	Yes	Yes
Clark's Grebe *Aechmophorus clarkii*	Forage in fresh or salt water of varying depths.	Migratory	Yes	Yes
Cliff Swallow[2] *Petrochelidon pyrrhonota*	Feed while in flight, often over 50 meters above the ground. Prefer open habitat such as grasslands, pastures, fields, and floodplains. When foraging over water, cliff swallows fly low, near the surface of the water.	Migratory	Yes	No (B)
Columbian Sharp-tailed Grouse *Tympanuchus phasianellus columbianus*	Forage in sagebrush steppe, meadows, mountain shrubs, brushy grasslands and riparian areas.	R4 Sensitive, WSoC, Migratory	Yes	No (A)
Common Goldeneye[2] *Bucephala clangula*	Forage in aquatic habitat including coastal bays, estuaries, lakes, rivers, and ponds; along shallow shorelines less than 4 meters deep that have little emergent or submergent vegetation.	Migratory	Yes	Yes
Common Grackle[2] *Quiscalus quiscula*	Forage in a wide variety of habitat, generally on the ground but also in trees and shrubs.	Migratory	Yes	No (A,B)

SPECIES NAME	HABITAT	STATUS[1]	HABITAT/ DISTRIBUTION IN STUDY AREA?	HABITAT CHANGES ANTICIPATED UNDER FUTURE PROJECT OPERATIONS?
Common Loon[2] *Gavia immer*	Forage in large water bodies with islands and fish.	R4 Sensitive, Migratory	Yes	Yes
Common Merganser[2] *Mergus merganser*	Forage in lakes, reservoirs, rivers, bays, and estuaries; typically in shallow water (less than 4 meters).	Migratory	Yes	Yes
Common Poorwill[2] *Phalaenoptilus nuttallii*	Forage in open habitat where they hunt for nocturnal insects from the ground or low perch.	Migratory	Yes	No (A,B)
Common Raven[2] *Corvus corvax*	Forage in a wide variety of habitat including riparian areas, open habitat, and forests; generally anywhere food is available, which includes carrion, small mammals, eggs, insects, and grains.	Migratory	Yes	No (A)
Common Yellowthroat[2] *Geothlypis trichas*	Forage in thickets and dense vegetation, which is generally present near the edge of water.	Migratory	Yes	No (A,B)
Double-crested Cormorant[2] *Phalacrocorax auritus*	Forage in water less than 10 meters deep with little emergent vegetation diving into mid-water or lower to catch fish.	Migratory	Yes	Yes
Dusky flycatcher[2] *Empidonax oberholseri*	Forage among shrubs and trees capturing insects in the air.	Migratory	Yes	No (A,B)
Eared Grebe[2] *Podiceps nigricollis*	Forage in shallow wetlands, ponds and lakes, diving for fish up to 5 meters in the water.	Migratory	Yes	Yes
Eastern Kingbird[2] *Tyrannus tyrannus*	Forage in open habitat including grasslands, shrublands, and fields catching prey from a perch.	Migratory	Yes	No (A,B)
Ferruginous Hawk *Buteo regalis*	Forage in open prairie, sagebrush, and deserts with short vegetation.	WSoC, Migratory	Yes	No (A)
Forster's Tern[2] *Sterna forsteri*	Forage in aquatic habitat ranging from freshwater to saltwater. Prey is typically caught to a depth of 30 cm.	Migratory	Yes	No (B)
Fox Sparrow[2] *Passerella iliaca*	Forage in dense riparian habitat, often among the leaf litter.	Migratory	Yes	No (A)
Franklin's Gull[2] *Leucophaeus pipixcan*	Forage in flocks over wet pastures, grasslands, and fields searching for grains and insects along the ground.	Migratory	Yes	Yes

Species Name	Habitat	Status[1]	Habitat/ Distribution In Study Area?	Habitat Changes Anticipated Under Future Project Operations?
Gadwall[2] *Anas strepera*	Forage in both deep and shallow wetlands, at and below the surface of the water; generally forage on submerged vegetation and seeds by head dipping or tipping.	Migratory	Yes	Yes
Golden Eagle *Aquila chrysaetos*	Forage in open habitat, including grasslands, shrublands, and meadows.	Migratory	Yes	No (A)
Grasshopper Sparrow *Ammodramus savannarum*	Forage in prairies, cultivated grasslands, open pastures, and fields.	WSoC, Migratory	Yes	No (A,B)
Gray Catbird[2] *Dumetella carolinensis*	Forage in shrubby habitat, looking for insects and berries on the ground, in shrubs, and at treetops.	Migratory	Yes	No (A,B)
Great Blue Heron[2] *Ardea herodias*	Forage in aquatic habitat, wading along the edges of water among emergent vegetation for fish and aquatic vertebrates. Occasionally in upland habitat for small mammals. Forage in water up to 40 cm deep.	Migratory	Yes	Yes
Great Egret[2] *Ardea alba*	Forage in a wide variety of wetland habitat. Typically in water up to 28 cm deep, generally in open water.	Migratory	Yes	No (B)
Greater Yellowlegs[2] *Tringa melanoleuca*	Forage in aquatic habitat, generally wading in shallow water no higher than their belly (about 11 cm).	Migratory	Yes	Yes
Green-winged Teal[2] *Anas carolinensis*	Forage in shallow water near shorelines, typically in water less than 12 cm deep.	Migratory	Yes	Yes
Green-tailed Towhee *Pipilo chlorurus*	Forage in shrubby and disturbed habitats, mountainous terrain, sagebrush, and deserts.	Migratory	Yes	No (A)
Herring Gull[2] *Larus argentatus*	Forage in aquatic habitat near shallow water and exposed shores for aquatic vertebrates and fish.	Migratory	Yes	Yes
Hooded Merganser[2] *Lophodytes cucullatus*	Forage in aquatic habitat, generally in open waters of rivers, lakes, creeks, and flooded forests; typically in areas with water less than 1.5 meters deep.	Migratory	Yes	Yes
Horned Grebe[2] *Podiceps auritus*	Forage in small to medium freshwater ponds and marshes; in shallow water (less than 6 meters).	Migratory	Yes	Yes
House Finch[2] *Carpodacus mexicanus*	Forage in a wide variety of habitat in search of seed on the ground and in shrubs and trees.	Migratory	Yes	No (A)

SPECIES NAME	HABITAT	STATUS[1]	HABITAT/ DISTRIBUTION IN STUDY AREA?	HABITAT CHANGES ANTICIPATED UNDER FUTURE PROJECT OPERATIONS?
House Wren[2] *Troglodytes aedon*	Forage in thickets and shrubby habitat on the ground and in vegetation for insects.	Migratory	Yes	No (A,B)
Killdeer[2] *Charadrius vociferus*	Forage on the ground in open habitat and shallow water wading into the water's edge for invertebrates.	Migratory	Yes	Yes
Lark Sparrow[2] *Chondestes grammacus*	Forage in grassland and shrubland habitat on the ground for insects and seeds.	Migratory	Yes	No (A,B)
Lazuli Bunting[2] *Passerina amoena*	Forage for insects and seeds in shrubby, brushy habitat near the ground as well as in trees.	Migratory	Yes	No (A,B)
Least Sandpiper[2] *Calidris minutilla*	Forage along the margins of lakes, ponds, ditches, marshes, and rivers generally within 1 meter of the water's edge.	Migratory	Yes	No (B)
Lesser Scaup[2] *Aythya affinis*	Forage in the open water of shallow wetlands and lakes that are generally less than 5 meters deep diving for aquatic invertebrates near the bottom substrate.	Migratory	Yes	Yes
Lesser Yellowlegs *Tringa flavipes*	Forage in fresh, brackish, and saltwater, and occasionally in upland habitat. Typically in tarus-deep water, but will forage up to their belly height, between 4 to 16 cm deep, averaging about 3 cm deep.	Migratory	Yes	No (B)
Lewis's Woodpecker *Melanerpes lewis*	Forage in open ponderosa pine forests with snags.	WSoC	No	N/A
Lincoln's Sparrow[2] *Melospiza lincolnii*	Forage in fields, riparian vegetation, and roadsides on the ground among shrubby vegetation.	Migratory	Yes	No (A)
Long-billed Curlew *Numenius americanus*	Forage in grasslands, mudflats, sagebrush prairie, and shallow open water.	WSoC, Migratory	Yes	No (B)
Long-billed Dowitcher[2] *Limnodromus scolopaceus*	Forage in shallow water, mudflats, wetlands, and wet meadows probing for food in water 0 to 16 cm deep.	Migratory	Yes	Yes
Mallard[2] *Anas platyrhynchos*	Forage in aquatic freshwater habitat, generally in shallow water near emergent vegetation; tipping their heads into the water to grab vegetation, invertebrates, and occasionally small vertebrates. Prefer water less than 40 cm deep.	Migratory	Yes	Yes

SPECIES NAME	HABITAT	STATUS[1]	HABITAT/ DISTRIBUTION IN STUDY AREA?	HABITAT CHANGES ANTICIPATED UNDER FUTURE PROJECT OPERATIONS?
Marbled Godwit *Limosa fedoa*	Forage in tidal mudflats, sandy beaches, along the edges of wetlands and in upland habitat including fields and agricultural areas.	Migratory	Yes	No (B)
Marsh Wren[2] *Cistothorus palustris*	Forage at or near the surface of water and among the emergent vegetation for invertebrates.	Migratory	Yes	Yes
Merlin[2] *Falco columbarius*	Forage from the air in open habitat including grasslands, fields, and riparian areas with few trees.	Migratory	Yes	No (A)
Mountain Bluebird[2] *Sialia currucoides*	Forage in open habitat, including meadows, prairies, riparian areas, and agricultural fields; generally hunting for invertebrates from perches.	Migratory	Yes	No (A,B)
Mourning Dove[2] *Zenaida macroura*	Forage in a wide variety of habitat types including riparian areas where seeds are abundant most often on the ground.	Migratory	Yes	No (A)
Northern Harrier[2] *Circus hudsonius*	Forage over open habitat, often in marshy and wetland habitat; typically areas with tall vegetation.	Migratory	Yes	No (A)
Northern Pintail[2] *Anas acuta*	Forage in shallow (less than 30 cm deep) freshwater wetlands and upland agricultural fields. They dabble or dive for vegetation, seeds, and invertebrates.	Migratory	Yes	Yes
Northern Rough-winged Swallow[2] *Stelgidopteryx serripennis*	Forage in open habitat, often over water where they catch insects in the air.	Migratory	Yes	No (B)
Northern Shoveler[2] *Anas clypeata*	Forage in freshwater wetlands in open water often skimming the surface of the water with their bills for invertebrates and vegetation.	Migratory	Yes	Yes
Northern Shrike[2] *Lanius borealis*	Forage in open and semi-open habitat, generally in areas with shrubs and fence rows for perching.	Migratory	Yes	No (A)
Osprey[2] *Pandion haliaetus*	Forage in salt or freshwater habitat in both shallow and deep water; biggest requirement is the presence of fish.	Migratory	Yes	Yes
Peregrine Falcon[2] *Falco peregrinus*	Foraging habitat varies widely, nesting habitat most commonly associated with cliffs.	R4 Sensitive, Migratory	Yes	No (A)

Species Name	Habitat	Status[1]	Habitat/ Distribution In Study Area?	Habitat Changes Anticipated Under Future Project Operations?
Pied-billed Grebe[2] *Podilymbus podiceps*	Forage in open water by diving for submergent vegetation and dabbling among emergent vegetation.	Migratory	Yes	Yes
Prairie Falcon[2] *Falco mexicanus*	Forage in open habitat where they can swoop on prey from above.	Migratory	Yes	No (A)
Red-breasted Merganser[2] *Mergus serrator*	Forage in shallow (less than 5 meters) freshwater and saltwater wetland and estuarine habitat; in open water where they can dive for fish.	Migratory	Yes	Yes
Red-necked Phalarope[2] *Phalaropus lobatus*	Forage in freshwater and saltwater marshes, lakes, wetlands, ponds, and flooded fields by swimming, wading, and walking in aquatic habitat where they hunt for invertebrates.	Migratory	Yes	Yes
Red-tailed Hawk[2] *Buteo jamaicensis*	Forage in open habitat such as prairies, meadows, grasslands, and riparian areas, generally perching on tall trees or man-made structures.	Migratory	Yes	No (A)
Red-winged Blackbird[2] *Agelaius phoeniceus*	Forage for insects in marsh, wetland, prairie, field, and lakeshores habitat.	Migratory	Yes	No (A)
Redhead[2] *Aythya americana*	Forage in marshes, lakes, coastal lagoons, and shallow wetlands less than 1 meter deep. They dabble, dip, and dive for vegetation and invertebrates.	Migratory	Yes	Yes
Ring-billed Gull[2] *Larus delawarensis*	Forage in fresh or saltwater habitat, utilizing deeper water for plunging onto the surface of the water or shallower water for wading feeding on land near water or among plowed fields.	Migratory	Yes	Yes
Ring-necked Duck[2] *Aythya collaris*	Feed within flooded emergent vegetation and open water with submerged plants; generally in water less than 1.5 meters deep. Feed by taking shallow dives, but also tip and dabble at the surface for plants and invertebrates.	Migratory	Yes	Yes
Ring-necked Pheasant[2] *Phasianus colchicus*	Forage in open habitat including agricultural areas, fields, grasslands, and shrubby habitat on the ground for seeds and vegetation.	Migratory	Yes	No (A)
Ross's Goose[2] *Chen rossii*	Forage in small groups, often with snow geese in open areas with short vegetation including agricultural areas, fields, and meadows near wetlands used for roosting.	Migratory	Yes	Yes

Species Name	Habitat	Status[1]	Habitat/ Distribution In Study Area?	Habitat Changes Anticipated Under Future Project Operations?
Rough-legged Hawk[2] *Buteo lagopus*	Forage in open habitat including fields, marshes, bogs, and grasslands; often perching in tall trees or man-made structures to detect prey on the ground.	Migratory	Yes	No (A)
Ruddy Duck[2] *Oxyura jamaicensis*	Forage in open areas of shallow water, usually within 2 meters of emergent vegetation breeding season. In the non-breeding season, they forage in open water with submergent vegetation typically diving for invertebrates.	Migratory	Yes	Yes
Rufous Hummingbird[2] *Selasphorus rufus*	Forage in a variety of habitat, including forest and woodland habitat, riparian areas, suburban areas, and shrubby habitat with nectar-producing flowers.	Migratory	Yes	No (A,B)
Sage Thrasher *Oreoscoptes montanus*	Forage in sagebrush, shrubby habitats, and shrub-steppe.	Migratory	No	N/A
Sandhill Crane[2] *Grus canadensis*	Forage on land in areas with soft soils including shallow marshes, exposed lake bottoms, fields, and agricultural areas.	Migratory	Yes	No (A)
Savannah Sparrow[2] *Passerculus sandwichensis*	Forage on the ground in open habitat including grasslands, cultivated fields, roadsides, saltmarshes, and mudflats.	Migratory	Yes	No (A)
Short-eared Owl[2] *Asio flammeus*	Forage in open areas with grasslands and prairie.	WSoC	Yes	No (A)
Snow Goose[2] *Chen caerulescens*	Forage in freshwater and brackish marshes, slow-moving rivers, lakes, impoundments, and farm fields.	Migratory	Yes	Yes
Snowy Egret[2] *Egretta thula*	Forage in salt and freshwater ponds, lakes, marshes, tidal flats, and wetland areas; preferring shallow water (less than 20 cm deep) to wade for food.	Migratory	Yes	No (B)
Solitary Sandpiper[2] *Tringa solitaria*	Forage in wet or muddy habitat, generally lakes and ponds; in shallow water up to their bellies (generally less than 3 cm) wading for insects and small frogs.	Migratory	Yes	No (B)
Song Sparrow[2] *Melospiza melodia*	Forage on the ground near dense underbrush and thickets along water courses.	Migratory	Yes	No (A)
Sora[2] *Porzana carolina*	Forage in wetlands with dense emergent vegetation and shallow water (typically 5–15 cm deep), and among floating and submergent vegetation.	Migratory	Yes	No (B)

Species Name	Habitat	Status[1]	Habitat/ Distribution In Study Area?	Habitat Changes Anticipated Under Future Project Operations?
Spotted Sandpiper[2] *Actitis macularius*	Forage in open habitat, generally within 200 meters of water, on the ground, where they find freshwater and terrestrial invertebrates.	Migratory	Yes	No (B)
Spotted Towhee[2] *Pipilo maculatus*	Forage in habitat with dense shrub growth, in thick cover on the ground, rarely in the open; occasionally they will forage in trees.	Migratory	Yes	No (A)
Swainson's Hawk[2] *Buteo swainsoni*	Forage in open habitat, including grassland and agricultural areas hunting from the air or high perches while searching for small mammals, birds, and reptiles.	Migratory	Yes	No (A,B)
Tree Swallow[2] *Tachycineta bicolor*	Forage in open habitat and above open water where they catch insects while flying through the air.	Migratory	Yes	No (A)
Trumpeter Swan[2] *Cygnus buccinator*	Forage in freshwater ponds, lakes, or marshes with abundant aquatic vegetation.	R4 Sensitive, Migratory	Yes	Yes
Tundra Swan[2] *Cygnus columbianus*	Forage on aquatic plants and grasses in water up to 1 meter deep and in open agricultural fields occasionally.	Migratory	Yes	Yes
Turkey Vulture[2] *Cathartes aura*	Forage in a variety of habitat including open agriculture areas, riparian areas, woodlands, and grasslands.	Migratory	Yes	No (A)
Vesper Sparrow[2] *Pooecetes gramineus*	Forage on the ground in sparse habitat with grasses, shrubs, and forbs available for cover.	Migratory	Yes	No (A,B)
Violet-green Swallow[2] *Tachycineta thalassina*	Forage at various heights for flying insects, including over open water.	Migratory	Yes	No (B)
Virginia Rail[2] *Rallus limicola*	Forage in shallow water (typically 0–15 cm deep) or mudflats near and among emergent vegetation.	Migratory	Yes	Yes
Western Grebe[2] *Aechmophorus occidentalis*	Forage in open fresh or saltwater lakes and marshes diving for fish.	Migratory	Yes	Yes
Western Kingbird[2] *Tyrannus verticalis*	Forage in open habitat where they catch insects from the air.	Migratory	Yes	No (A,B)
Western Meadowlark[2] *Sturnella neglecta*	Forage in open habitat where they capture insects on the ground and consume seeds.	Migratory	Yes	No (A)

SPECIES NAME	HABITAT	STATUS[1]	HABITAT/ DISTRIBUTION IN STUDY AREA?	HABITAT CHANGES ANTICIPATED UNDER FUTURE PROJECT OPERATIONS?
Western Sandpiper[2] *Calidris mauri*	Forage in both saltwater and freshwater habitat often on mudflats and in shallow water up to their bellies, generally less than 2 cm deep.	Migratory	Yes	No (B)
Western Yellow-billed Cuckoo *Coccyzus americanus occidentalis*	Forage in large stands of riparian woodlands greater than 25 contiguous acres at least 330 feet wide below 7,000 feet in elevation.	Federally Threatened	No	N/A
White-crowned Sparrow[2] *Zonotrichia leucophrys*	Forage on the ground in open grassland habitat, fields, roadsides, riparian areas, and scrub.	Migratory	Yes	No (A)
White-faced Ibis[2] *Plegadis chihi*	Forage in shallowly flooded pond margins, reservoirs, marshes, wetlands, and flooded fields in shallow water (less than 60 cm deep) probing for aquatic invertebrates.	Migratory	Yes	No (B)
White-throated Swift[2] *Aeronautes saxatalis*	Forage in a wide range of habitat including woodlands, meadows, fields, and areas with strong uplifting air.	Migratory	Yes	No (B)
Willet *Tringa semipalmata*	Forage in shallow water and mudflats where they probe for invertebrates and small fish in water less than 7 cm deep.	Migratory	Yes	No (B)
Willow Flycatcher *Empidonax traillii*	Forage from perches in willow thickets near water catching insects in the air, and gleaning them from leaves.	Migratory	Yes	No (B)
Wilson's Phalarope[2] *Phalaropus tricolor*	Forage in aquatic and upland habitat including flooded fields and meadows, wetlands, and marshes probing for aquatic invertebrates.	Migratory	Yes	No (B)
Wilson's Snipe[2] *Gallinago delicata*	Forage in wet soils on land and in shallow water, generally less than 4 cm deep probing for larval insects and other invertebrates.	Migratory	Yes	Yes
Wilson's Warbler[2] *Cardellina pusilla*	Forage among shrubs and trees in riparian habitat gleaning insects from leaves and foliage.	Migratory	Yes	No (A,B)
Wood Duck[2] *Aix sponsa*	Forage in flooded timber and shallow wetlands with dense emergent vegetation in areas 18–40 cm deep along the edges of flooded areas.	Migratory	Yes	Yes
Yellow Warbler[2] *Dendroica petechia*	Forage among shrubs and trees in riparian habitat gleaning insects from leaves or catch insects in the air.	Migratory	Yes	No (A,B)

SPECIES NAME	HABITAT	STATUS[1]	HABITAT/ DISTRIBUTION IN STUDY AREA?	HABITAT CHANGES ANTICIPATED UNDER FUTURE PROJECT OPERATIONS?
Yellow-breasted Chat[2] *Icteria virens*	Forage in low, dense shrubs and thickets, often in riparian habitat.	Migratory	Yes	No (A,B)
Yellow-headed Blackbird[2] *Xanthocephalus xanthocephalus*	Forage in wetlands, prairies, meadows, and woodlands near water often the water's surface.	Migratory	Yes	No (A)
Yellow-rumped Warbler[2] *Dendroica coronata*	Forage in a variety of habitat including woodlands, shrublands, wetlands, riparian areas, and agricultural areas.	Migratory	Yes	No (A)
Amphibians				
Great Plains Toad *Bufo cognatus*	Live in shallow water in desert and grassland habitat in southeastern Utah.	WSoC	No	N/A
Western Toad *Bufo anaxyrus*	Live in wetlands, slow-moving streams, ponds, lakes, and reservoirs.	WSoC	Yes	No (C)
Reptiles				
None	N/A	N/A	N/A	N/A
Mollusks				
Deseret Mountainsnail *Oreohelix peripherica*	Live in intermountain woodlands (e.g., mixed-aspen, Gambel oak, mountain mahogany, mountain maple) from 4,700-6,000 feet in elevation.	WSoC	Yes	No (A)

A – Species for which there are no potential habitat changes because they utilize habitat that would not be affected by changing water levels during the winter months.
B – Species for which there are no potential habitat changes because they migrate during the winter months (November through the end of March) and would thus not be affected by changing operations in the winter.
C – Species for which there are no potential habitat changes because they hibernate during the winter months (November through the end of March) and would thus not be affected by changing operations in the winter.
1 – Special species status designation for each species. Some species have more than one designation. Federally Threatened = Species listed as federally threatened by the USFWS. R4 Sensitive = USFS Intermountain Region sensitive species. WSoC = Wildlife Species of Concern for the state of Utah. Migratory = USFWS migratory bird.
2 – Species added for consideration based on the existing data and literature review that are not listed in the PAD.

5.1.2 FINAL LIST OF WILDLIFE SPECIES INCLUDED IN PROJECT EFFECTS ANALYSIS

After consulting the resources identified in Section 5.1.1, a final table of wildlife species was created (Table 5-2). This final list includes all the species that have the potential to be affected by proposed reservoir operations. All the species listed in Table 5-2 are classified as migratory birds. Three are also R4 sensitive species (Bald Eagle [*Haliaeetus leucocephalus*], Trumpeter Swan [*Cygnus buccinator*], and Common Loon [*Gavia immer*]), and there are also conservation agreement species and/or wildlife species of concern (Bald Eagle and American White Pelican [*Pelecanus erythrorhynchos*]). As previously mentioned, operational changes would only take place during the non-breeding season for birds. Therefore, only those species that are present during the non-breeding season (November through the end of March) are included.

BBS data includes population trends at the local and national level for migratory birds (Table 5-2). Population trend data shows how a species' population is doing over a period of time. This can provide some insight into whether a species' population is increasing or decreasing at the state level compared to national trends.

Table 5-2 summarizes the final list of wildlife species included in the analysis as well as their periodicity and population trends at the local and national scale.

TABLE 5-2 LIST OF WILDLIFE SPECIES ANALYZED FURTHER AND CORRESPONDING PERIODICITY AND POPULATION TRENDS

SPECIES NAME	MONTHS PRESENT AT RESERVOIR	TREND DATA			
		U.S.	UTAH	IDAHO	WYOMING
American Avocet	March to November	0.1	3.8	-2.3	1.9
American Coot	January to January	-1.9	-1.2	-3.6	-2.3
American Pipit	September to April	No data available			
American White Pelican	January to January	6.5	7.2	3.9	9.0
American Wigeon	January to January	-0.5	0.9	-0.1	-0.9
Bald Eagle	January to January	8.5	10.7	6.2	9.9
Barrow's Goldeneye	October to May	-1.7	No data available	-1.5	-1.6
Belted Kingfisher	January to January	-1.6	-1.4	-2.7	-1.0
Black-crowned Night-heron	March to October	-0.6	-0.6	-2.8	-3.1
Black-necked Stilt	April to November	2.1	4.2	5.0	No data available
Blue-winged Teal	March to October	-0.7	-1.5	-5.4	-1.6
Bonaparte’s Gull	April to June September to November	No data available			
Bufflehead	October to May	2.2	No data available	1.7	1.5
Cackling Goose	December to March	No data available			
California Gull	January to January	-2.2	2.7	-7.8	-4.4
Canada Goose	January to January	9.1	7.7	5.0	9.9
Canvasback	January to January	0.7	No data available	-0.5	3.1
Cinnamon Teal	January to January	-2.3	0.3	-3.1	-1.4
Clark’s Grebe	March to November	-0.9	2.8	-5.3	0.3
Common Goldeneye	September to May	1.4	No data available		0.4

SPECIES NAME	MONTHS PRESENT AT RESERVOIR	TREND DATA			
		U.S.	UTAH	IDAHO	WYOMING
Common Loon	April to June October to December	1.2	No data available	0.5	0.6
Common Merganser	September to May	-0.4	3.0	-4.0	0.1
Double-crested Cormorant	March to November	3.8	5.5	2.3	1.6
Eared Grebe	April to December	1.2	3.8	-1.6	-0.1
Franklin's Gull	April to November	-4.6	-5.6	-3.5	-4.5
Gadwall	January to January	1.3	1.9	-0.4	1.5
Great Blue Heron	January to January	0.8	-0.1	0.3	0.1
Greater Yellowlegs	January to January	No data available			
Green-winged Teal	January to January	-1.0	-1.6	-1.1	-2.9
Herring Gull	October to April	-3.8	No data available		
Hooded Merganser	November to April	5.3	No data available		
Horned Grebe	March to April September to December	-1.0	No data available		
Killdeer	January to January	-0.5	-3.3	-2.4	-2.0
Lesser Scaup	September to May	0.2	0.4	-0.8	-2.5
Long-billed Dowitcher	April to May August to November	No data available			
Mallard	January to January	1.2	1.0	-0.6	-0.4
Marsh Wren	January to January	2.0	1.2	2.6	1.6
Northern Pintail	January to January	-2.5	-1.3	-3.7	-2.2
Northern Shoveler	January to January	1.1	1.6	0.0	-0.9
Osprey	April to November	3.1	7.8	-0.3	5.3
Pied-billed Grebe	January to January	0.0	0.9	-0.7	-1.7
Red-breasted Merganser	December to May	-5.0	No data available		
Red-necked Phalarope	May to October	No data available			

SPECIES NAME	MONTHS PRESENT AT RESERVOIR	TREND DATA			
		U.S.	UTAH	IDAHO	WYOMING
Redhead	January to January	-0.2	0.6	-5.5	-0.4
Ring-billed Gull	January to January	0.5	5.3	-4.4	2.4
Ring-necked Duck	September to May	4.4	1.4	7.7	3.2
Ross's Goose	March to April November to December	No data available			
Ruddy Duck	January to January	0.4	1.3	-7.0	0.3
Snow Goose	March to April November to December	No data available			
Trumpeter Swan	November to April	No data available			
Tundra Swan	October to April	No data available			
Virginia Rail	January to January	0.8	2.2	-1.1	0.4
Western Grebe	March to December	-0.9	2.8	-5.3	0.3
Wilson's Snipe	January to January	-0.7	-0.7	-1.7	-1.0
Wood Duck	January to January	1.7	No data available	1.2	2.5

Source: Cirrus 2020

5.1.3 NOXIOUS WEEDS

Noxious weed data was compiled from a variety of sources (Table 5-3). Figure 5-1 through Figure 5-6 depict the existing information about known weed occurrences in the study area. Specific weeds that were noted during incidental surveys included: Thistles (*Cirsium* spp.), goatsrue (*Galega officinalis*), dyer's woad (*Isatis tinctoria*), tamarisk (*Tamarix ramosissima*), field bindweed (*Convolvulus arvensis*), puncturevine (*Tribulus terrestris*), common reed (*Phragmites australis*) and Russian olive (*Elaeagnus angustifolia*). All species included in Table 6-17 of Section 6.6.4 of the PAD are included in Table 5-3. No species were added to the list from the literature review that were not already included in the PAD.

TABLE 5-3 COMMON NOXIOUS WEED SPECIES IN CACHE AND BOX ELDER COUNTIES AND KNOWN OBSERVATIONS IN THE STUDY AREA

SPECIES NAME	SCIENTIFIC NAME	COUNTY	KNOWN PRESENCE IN STUDY AREA?
African Mustard	*Brassica tournefortii*	Box Elder, Cache	
African Rue	*Peganum harmala*	Box Elder, Cache	
Bermudagrass	*Cynodon dactylon*	Cache	X
Black Henbane	*Hyoscyamus niger*	Box Elder, Cache	
Blueweed (viper's bugloss)	*Echium vulgare*	Box Elder, Cache	
Camelthorn	*Alhagi maurorum*	Box Elder, Cache	
Canada Thistle	*Cirsium arvense*	Box Elder, Cache	X
Cogongrass (Japanese blood grass)	*Imperata cylindrica*	Box Elder, Cache	
Common Crupina	*Crupina vulgaris*	Box Elder, Cache	
Common St. Johnswort	*Hypericum perforatum*	Box Elder, Cache	
Cutleaf Vipergrass	*Scorzonera laciniata*	Box Elder, Cache	
Dalmation Toadflax	*Linaria dalmatica*	Box Elder, Cache	
Dames Rocket	*Hesperis matronalis*	Cache	
Diffuse Knapweed	*Centaurea diffusa*	Box Elder, Cache	
Dyers Woad	*Isatis tinctoria*	Box Elder, Cache	X
Elongated Mustard	*Brassica elongata*	Cache	
Field Bindweed	*Convolvulus* spp.	Box Elder, Cache	X
Garlic Mustard	*Alliaria petiolata*	Box Elder, Cache	
Giant Reed	*Arundo donax*	Cache	
Goatsrue	*Galega officinalis*	Box Elder, Cache	X
Hoary Cress	*Cardaria* spp.	Box Elder, Cache	X
Houndstongue	*Cynoglossum officinale*	Box Elder, Cache	X
Japanese Knotweed	*Polygonum cuspidatum*	Cache	
Johnson Grass	*Sorghum halepense*	Box Elder, Cache	
Jointed Goatgrass	*Aegilops cylindrica*	Box Elder, Cache	X

SPECIES NAME	**SCIENTIFIC NAME**	**COUNTY**	**KNOWN PRESENCE IN STUDY AREA?**
Leafy Spurge	*Euphorbia esula*	Box Elder, Cache	
Malta starthistle	*Centaurea melitensis*	Box Elder, Cache	
Mediterranean Sage	*Salvia aethiopis*	Box Elder, Cache	
Medusahead	*Taeniatherum caputmedusae*	Box Elder, Cache	
Musk Thistle	*Carduus nutans*	Box Elder, Cache	X
Myrtle Spurge	*Euphorbia myrsinites*	Box Elder, Cache	
Oxeye Daisy	*Leucanthemum vulgare*	Box Elder, Cache	
Perennial Pepperweed	*Lepidium latifolium*	Box Elder, Cache	X
Phragmites, Common reed	*Phragmites australis* ssp.	Box Elder, Cache	X
Plumeless Thistle	*Carduus acanthoides*	Box Elder, Cache	
Poison Hemlock	*Conium maculatum*	Box Elder, Cache	X
Puncturevine	*Tribulus terrestris*	Box Elder, Cache	
Purple Loosestrife	*Lythrum salicaria*	Box Elder, Cache	X
Purple Starthistle	*Centaurea calcitrapa*	Box Elder, Cache	
Quackgrass	*Elymus repens*	Box Elder, Cache	X
Rush Skeletonweed	*Chondrilla juncea*	Box Elder, Cache	
Russian Knapweed	*Acroptilon repens*	Box Elder, Cache	
Russian Olive	*Elaeagnus angustifolia*	Box Elder, Cache	X
Scotch Broom	*Cytisus scoparius*	Box Elder, Cache	
Scotch Thistle	*Onopordum acanthium*	Box Elder, Cache	X
Small bugloss	*Anchusa arvensis*	Box Elder, Cache	
Sorghum Almum	*Sorghum almum*	Box Elder, Cache	
Spotted Knapweed	*Centaurea stoebe*	Cache	
Spring Millet	*Milium vernale*	Box Elder, Cache	
Sqaurrose Knapweed	*Centaurea virgata*	Cache	
Syrian Beancaper	*Zygophyllum fabago*	Box Elder, Cache	
Tamarisk	*Tamarix ramosissima*	Box Elder, Cache	

SPECIES NAME	**SCIENTIFIC NAME**	**COUNTY**	**KNOWN PRESENCE IN STUDY AREA?**
Ventenata	*Ventenata dubia*	Cache	
Yellow Starthistle	*Centaurea solstitalis*	Box Elder, Cache	
Yellow Toadflax	*Linaria vulgaris*	Cache	

Source: Cirrus 2020

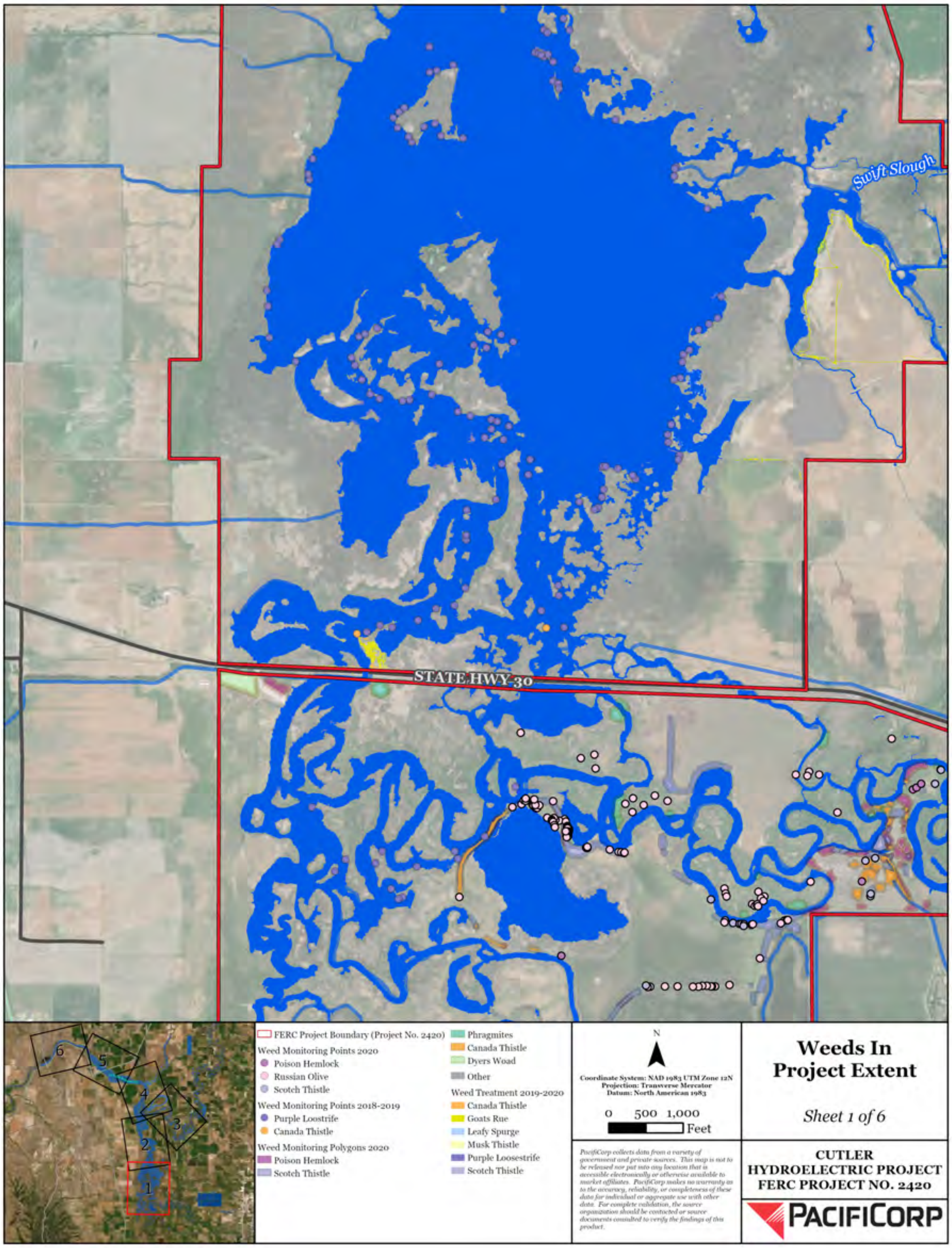


Figure 5-1 Existing Information about Known Weed Occurrences in the Study Area (1 of 6)

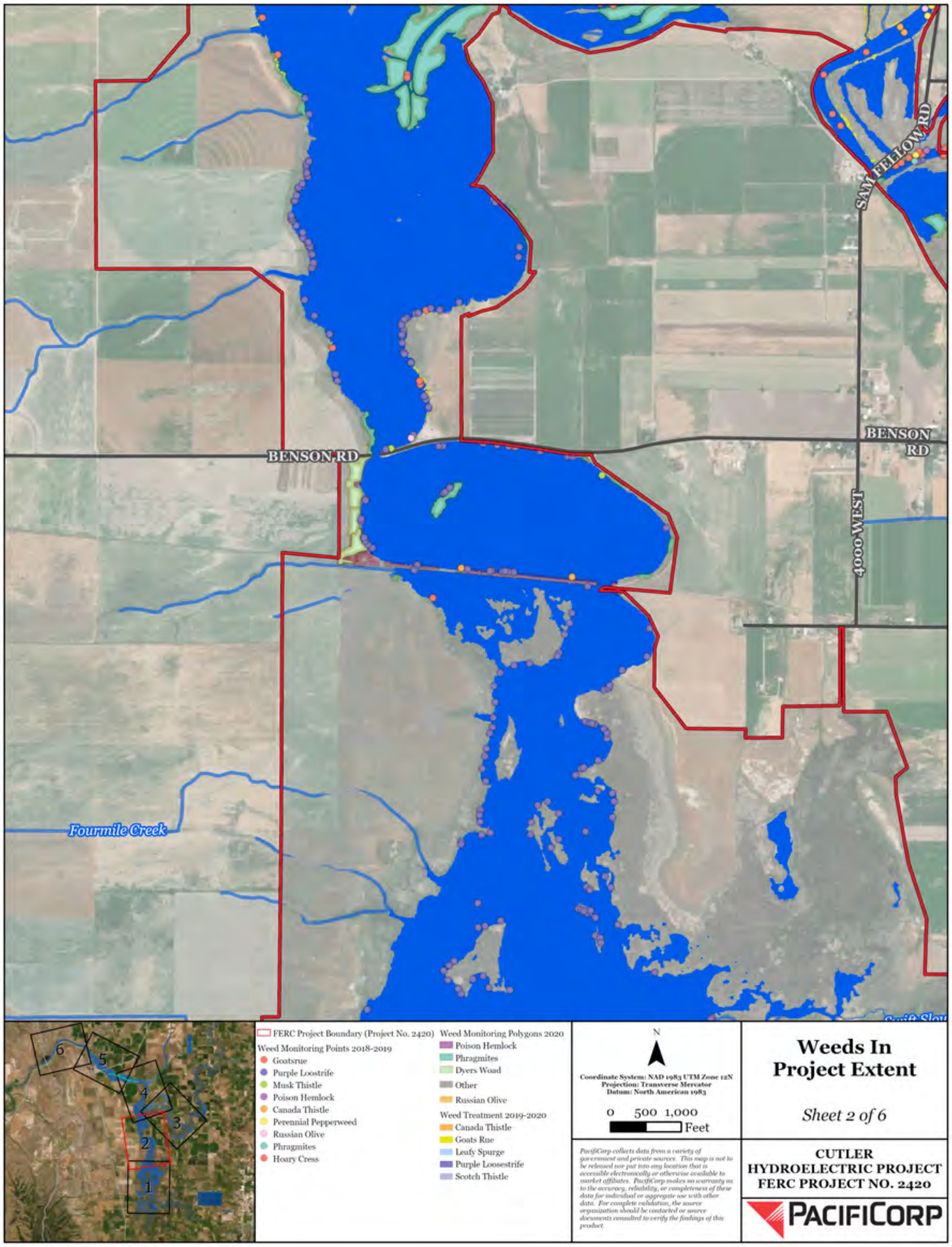


FIGURE 5-2 EXISTING INFORMATION ABOUT KNOWN WEED OCCURRENCES IN THE STUDY AREA (2 OF 6)

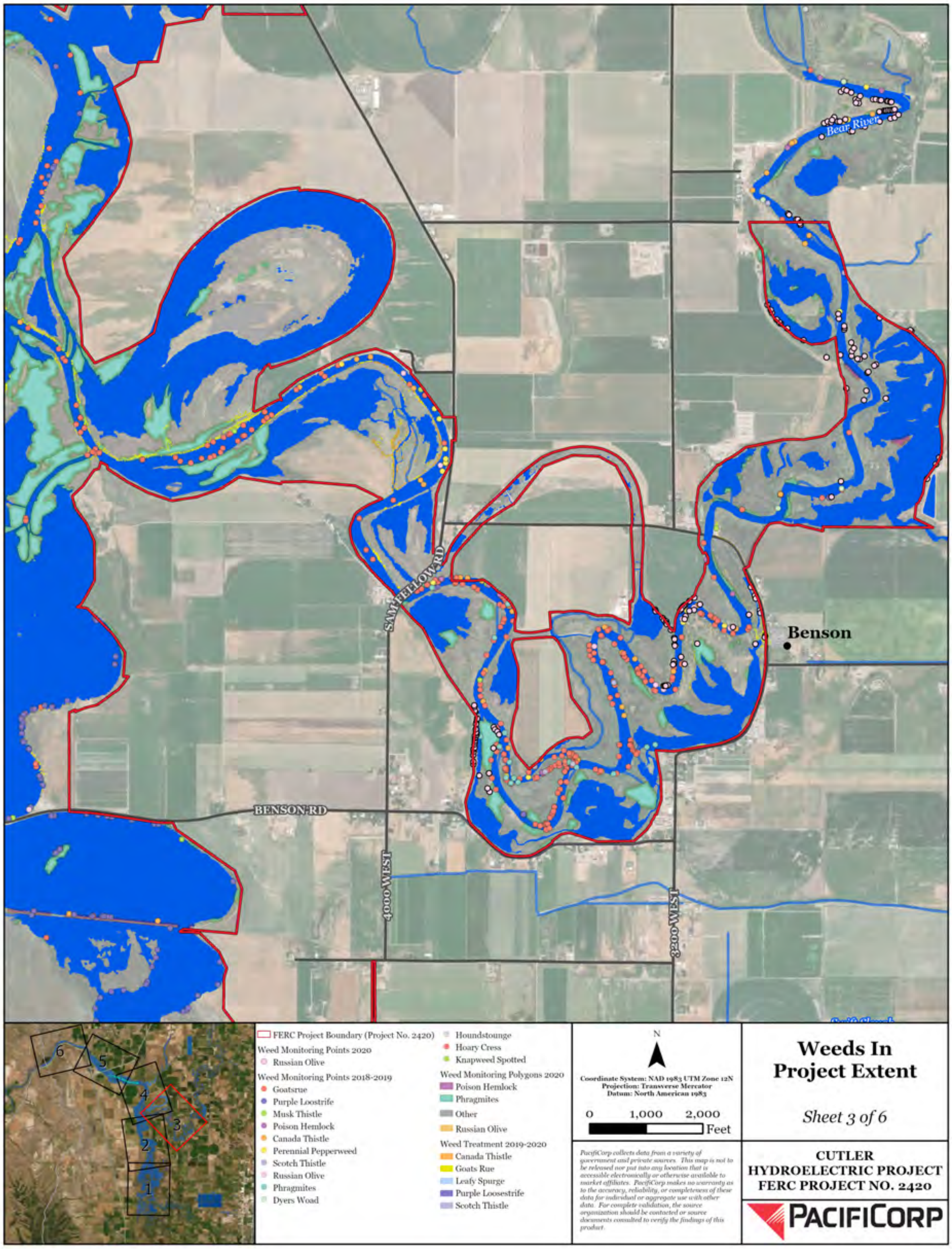


FIGURE 5-3 EXISTING INFORMATION ABOUT KNOWN WEED OCCURRENCES IN THE STUDY AREA (3 OF 6)

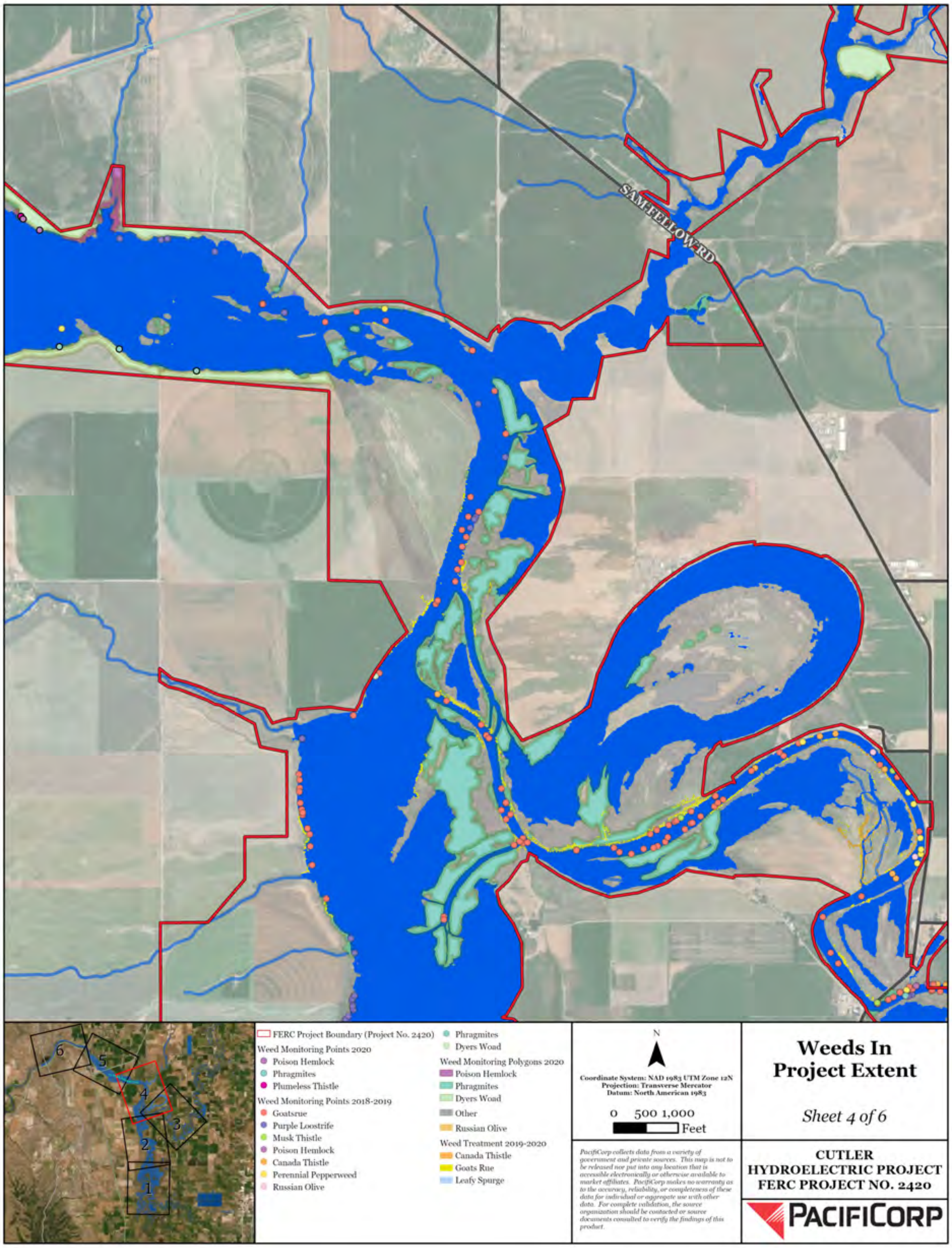


Figure 5-4 Existing Information about Known Weed Occurrences in the Study Area (4 of 6)

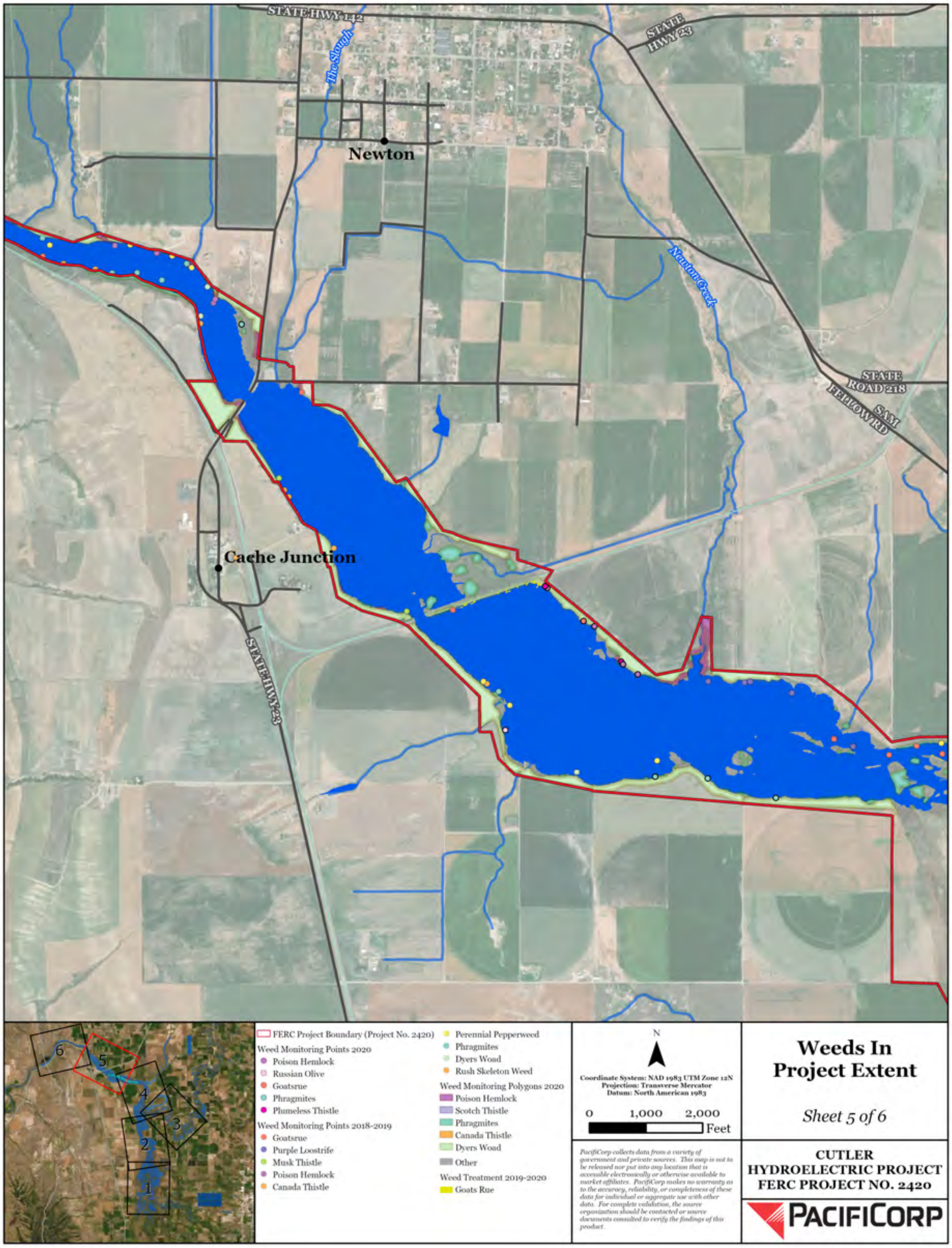


FIGURE 5-5 EXISTING INFORMATION ABOUT KNOWN WEED OCCURRENCES IN THE STUDY AREA (5 OF 6)

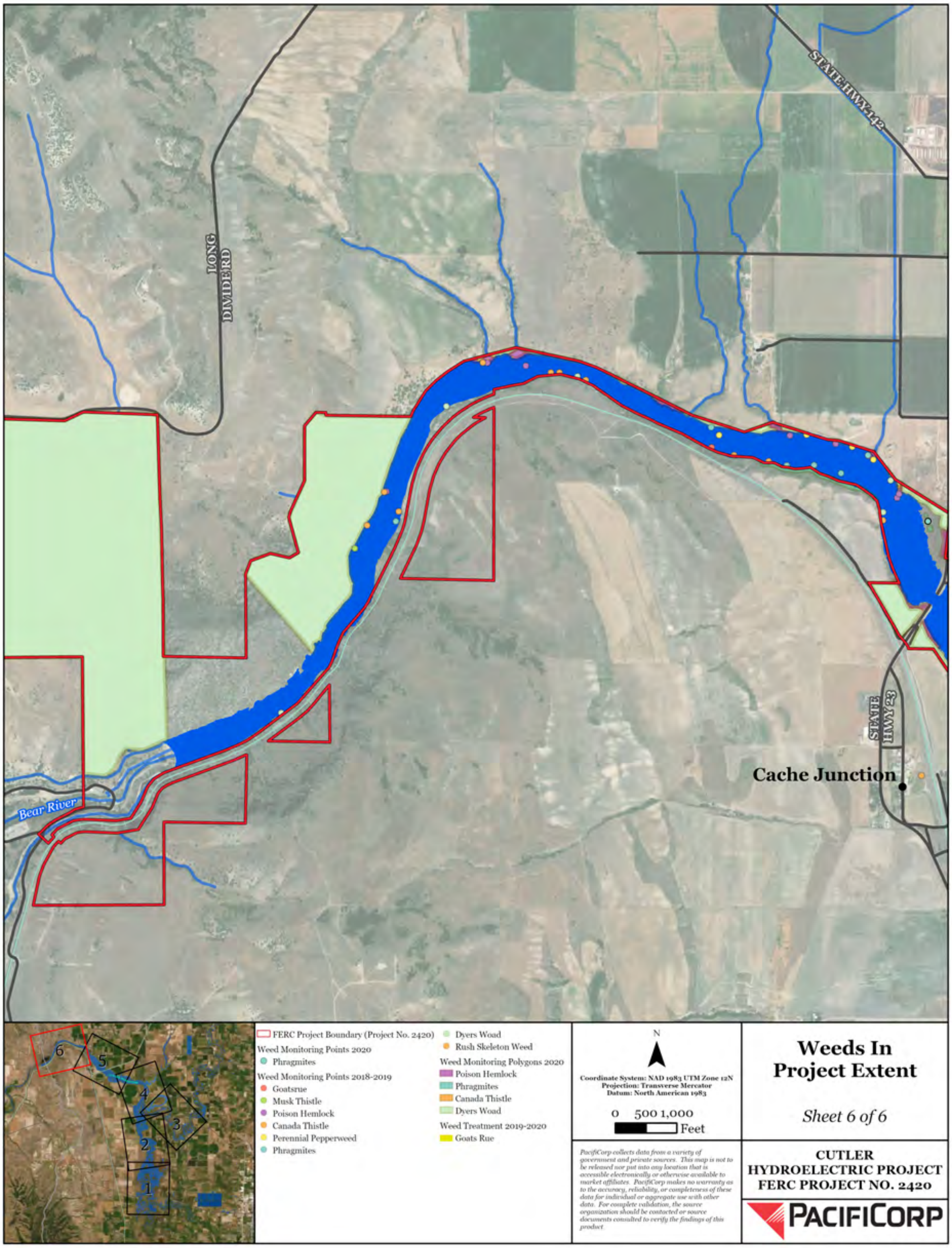


FIGURE 5-6 EXISTING INFORMATION ABOUT KNOWN WEED OCCURRENCES IN THE STUDY AREA (6 OF 6)

5.2 VEGETATION CLASSIFICATION

Classification of vegetation in the study area was conducted according to the methods described in Section 4.2, with the modification described in Section 4.5.1. The final classification breaks the study area into seven habitat classes: sparse, upland, woody, cattail-dominated marsh, rush-dominated marsh, mixed marsh, and *Phragmites*-dominated marsh. A brief description of each of these classes is provided below:

- Sparse – Areas with little to no vegetation. This may include roads (paved, dirt, or graveled), road shoulders, plowed agricultural fields, rock outcrops, alkali flats, or areas where high use by livestock has greatly reduced vegetation.

- Upland – Areas characterized by upland, but may sometimes include wetland, vegetation. Essentially, portions of the study area that are vegetated but not dominated by marsh vegetation types, although they may include areas of irrigated (surface- or sub-) wet meadows. Most of these areas are dominated by bunchgrasses, upland shrubs, or agricultural pastures and fields.

- Woody – Areas characterized by woody vegetation. The type of woody vegetation varies throughout the study area. Dominant woody species include Juniper (*Juniperus* sp.), Cottonwoods (*Populus* sp.), Willows (*Salix* sp.), and Russian Olive. Note that Russian Olive is classified as a weed species, but it is not differentiated from other woody species as part of vegetation classification. Understory vegetation in woody areas varies greatly throughout the study area but no attempt was made to differentiate understory since understory is typically not visible in aerial imagery.

- Cattail-Dominated Marsh – Marshy areas characterized by almost total Cattail (*Typha* sp.) cover. Other types of vegetation may occur in cattail-dominated marsh at low cover percentages.

- Rush-Dominated Marsh – Marshy areas characterized by almost total Rush (Juncaceae family) domination. Other types of vegetation may occur in rush-dominated marsh at low cover percentages.

- Mixed Marsh – Marshy areas where cattails, rushes, and other marshy vegetation are present without one type of marsh vegetation being dominant.
- *Phragmites*-Dominated Marsh – Marshy areas with almost total cover domination by *Phragmites*. This weed species forms dense monocultures, making it possible to differentiate areas dominated by phragmites from other types of marsh vegetation as part of this classification.

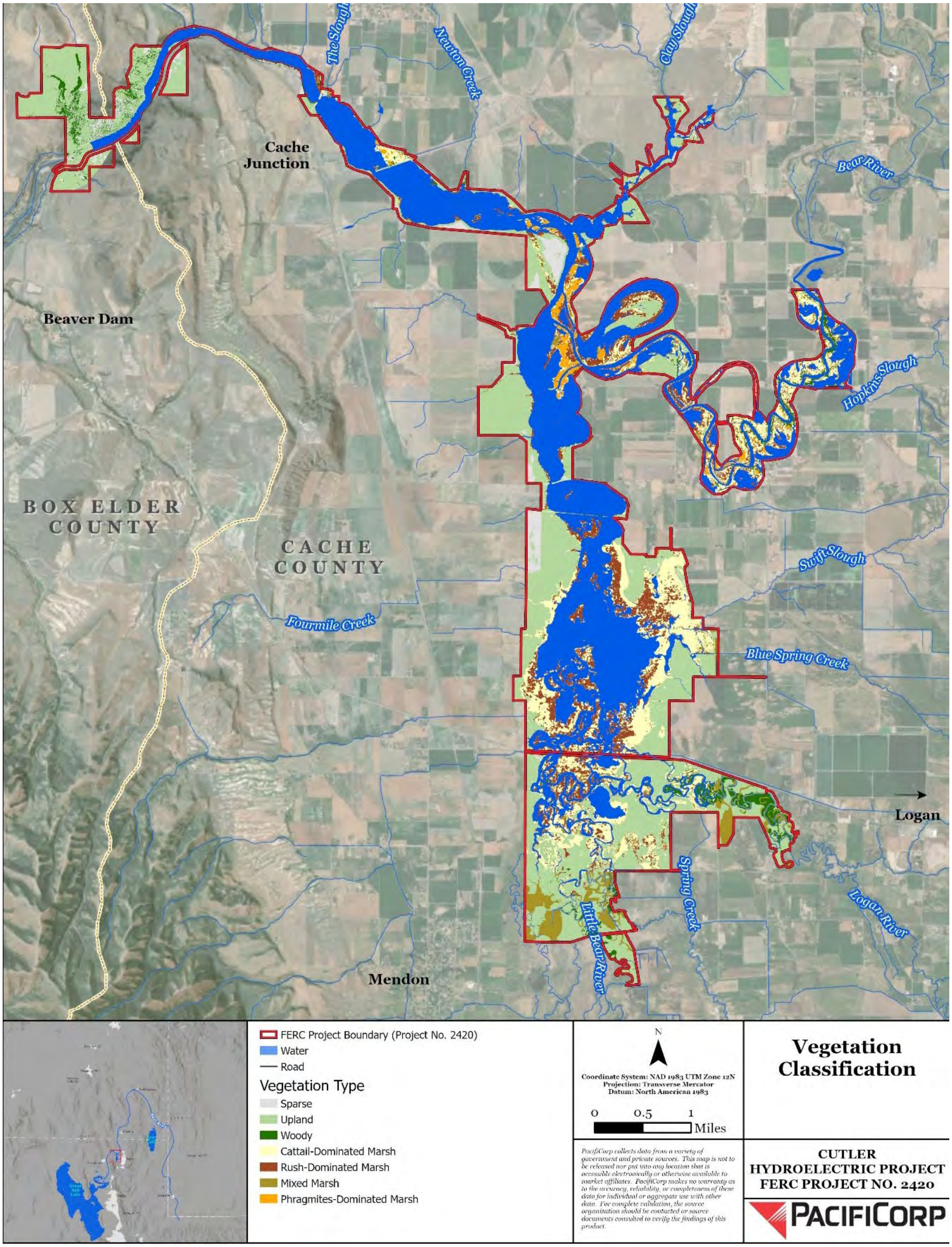
The breakdown of vegetation classes by acreage within the study area is provided below in Table 5-4.

TABLE 5-4 ACREAGE AND PERCENTAGE OF STUDY AREA COVERED BY VARIOUS VEGETATION CLASSES

VEGETATION CLASS	ACREAGE	PERCENT OF STUDY AREA
Sparse	263.5	2.9
Upland	2,925.2	31.7
Woody	277.4	3.0
Cattail-Dominated Marsh	1,171.8	12.7
Rush-Dominated Marsh	736.3	8.0
Mixed Marsh	303.0	3.3
Phragmites-Dominated Marsh	104.8	1.1
Remainder of study area – Open Water Area within the OHWL (manually digitized and excluded from classification)	3,435	37.3
Total	**9,217**	**100**

Source: Cirrus 2020

Figure 5-8 shows the coverage of the vegetation classes as they are spatially distributed within the study area. Note that Table 5-4 and Figure 5-7 include the acreage of both the ENVI classifications and the manually digitized vegetation classes.



Source: PacifiCorp 2020

FIGURE 5-7 VEGETATION CLASSES WITHIN THE STUDY AREA

5.2.1 ACCURACY ASSESSMENT

Accuracy assessment of the ENVI vegetation classification was conducted as described in this section. The number of accuracy assessment sample sites was calculated using the first equation and resulted in a total of 528 accuracy assessment points determined to be necessary. Those 528 points were stratified by vegetation class, with each class assigned a number of points based on each class' percentage of the total area. Using this method, some classes fell below the minimum 30 point-per-class threshold and the number of accuracy assessment points for those classes were increased to 30. This increase resulted in a total of 577 accuracy assessment points generated (Table 5-5). Note that only the vegetation classes created using the automated methods had an accuracy assessment conducted on them in this manner. The manually digitized vegetation classes created were not included in this accuracy assessment. As such, the acreages presented in Table 5-5 (subset of the total area where drone imagery was collected) differ from those presented in Table 5-4 (total area).

TABLE 5-5 DISTRIBUTION OF ACCURACY ASSESSMENT POINTS BY LANDCOVER CLASS

VEGETATION CLASS	ACREAGE	PERCENT OF STUDY AREA	POINTS PER CLASS BASED ON PERCENTAGE OF AREA	FINAL POINTS PER CLASS
Sparse	263.5	5.44%	29	30
Upland	2,283.5	47.18%	249	249
Woody	175.0	3.64%	19	30
Cattail-Dominated Marsh	1,171.8	24.22%	128	128
Rush-Dominated Marsh	736.3	15.21%	80	80
Mixed Marsh	104.1	2.15%	11	30
Phragmites-Dominated Marsh	104.8	2.16%	11	30
Total	**4,839.0**	**100%**	**527**	**577**

The vegetation class of each of the 577 accuracy assessment points were verified. The resulting error matrix is presented below in Table 5-6. The error matrix shows the number of accuracy assessment points that fall within each pairwise comparison between the rows and columns. The figures in the highlighted diagonal cells indicate the number of assessment points that coincided with the model's classification. Figures in cells outside the diagonal indicate classification errors.

Based on the error matrix presented in Table 5-6 and the last equation in Section 4.2.1, the standard accuracy statistic $\widehat{K}$ was calculated as 0.91. This is above the threshold of 0.80 described as the minimum accuracy acceptable in Section 4.2.1.

No accuracy assessment was deemed necessary for the vegetation classes generated using the method described, because those areas were manually created rather than created using automated processes. Furthermore, the accuracy of the vegetation classes in these areas are less important given the extent of project-related effects and their minimal impact on these areas.

Table 5-6 Error Matrix Displaying the Results of Accuracy Assessment

		Actual Classes							
Classification Classes	**Class**	**Sparse**	**Upland**	**Woody**	**Cattail DM**	**Rush DM**	**Mixed M**	**Phrag DM**	**Total**
	Sparse	28	2	0	0	0	0	0	**30**
	Upland	0	245	3	0	1	0	0	**249**
	Woody	0	0	30	0	0	0	0	**30**
	Cattail DM	0	12	0	114	2	0	0	**128**
	Rush DM	0	3	0	4	73	0	0	**80**
	Mixed M	1	7	0	0	0	22	0	**30**
	Phrag DM	0	0	0	1	0	0	29	**30**
	Total	**29**	**269**	**33**	**119**	**76**	**22**	**29**	**577**

5.3 Cutler 2019 Drawdown Fieldwork

Fieldwork was completed in 2019 to evaluate the interaction between WSEs, wetted perimeter, and proximity to important/core habitat types. Based on FERC staff recommendations in the FERC Study Plan Determination, field work included monitoring predator access to core colonial bird nesting areas under current operating conditions.

5.3.1 Land Bridge Formation

In the fall of 2019, the Cutler Reservoir was drawn down to its lowest mechanical elevation limit to facilitate relicensing studies, including LiDAR and other imaging. During this time, 10 cameras were installed to validate the predicted wetted perimeter footprint generated by the hydraulic model (see Appendix G for additional detail). The wetted area between islands was reduced by channel narrowing that occurred as the water was drawn down, but at every area sampled there was still a wetted channel remaining after full drawdown was achieved. The images captured by the cameras matched up well with the simulations created by the hydraulic model (see Section 5.4.1 of this appendix and Appendix G). Once the predicted wetted perimeter was validated, the calibrated model was used to predict the wetted perimeter footprint under the proposed expanded operations range. These results, and corresponding tables and figures, are detailed in Appendix G.

5.3.2 PREDATOR ACCESS TO CORE COLONIAL NESTING BIRD AREAS

Between February 25 and July 2, 2020, roughly 503,000 images were collected using remote cameras to document predators accessing core colonial nesting bird areas. These images were analyzed to detect potential predators accessing the colonial nesting bird areas by swimming, wading, or walking across ice. This monitoring effort was not intended to detect every predator at the core colonial nesting bird areas but rather to determine if predators are currently present under existing operating conditions, or if predator access to these areas would be a novel effect of potential future operations.

Of the 503,000 images, 119 images documented the presence of predators at 10 of the 19 sites. The remaining images were either other animals or empty images created by false triggers of the remote camera.

During the nesting bird area monitoring period from February 25 to July 2, 2020, operations for Cutler Reservoir fluctuated normally with no depletions below 4,406.73 feet (i.e., within the current FERC-required operation range limits). During the normal operation range, when the predator cameras were deployed, no land bridge formation was detected providing access to core colonial bird nesting sites.

Large portions of the reservoir were frozen from February 25 to March 1, 2020, and 40 of the predator images captured documented predators walking over ice during this time period. The remaining images documented predators swimming in open water. At 6 of the 10 sites where predator detections occurred, the only predator detections were of predators walking over ice (Table 5-7).

TABLE 5-7 SUMMARY OF CAMERA DATA AT THE CORE COLONIAL BIRD NESTING AREAS

CAMERA LOCATION	PREDATOR DETECTED?	PREDATOR TYPE	ACCESS CONDITIONS
Site 1	Yes	Raccoon	Walking over ice
Site 2	Yes	Raccoon	Swimming
Site 3	Yes	Raccoon	Walking over ice
Site 4	No	–	–
Site 5	Yes	Raccoon	Walking over ice
Site 6	Yes	American Mink	Walking over ice
Site 7	No	–	–
Site 8	Yes	Raccoon	Walking over ice
Site 9	Yes	Raccoon	Walking over ice
Site 10	No	–	–
Site 11	Yes	Raccoon	Swimming
Site 12	No	–	–
Site 13	No	–	–
Site 14	Yes	Raccoon	Swimming
Site 15	No	–	–
Site 16	Yes	Raccoon	Swimming
Site 17	No	–	–
Site 18	No	–	–
Site 19	No	–	–

Two predator species were documented in images: Racoons (*Procyon lotor*) and American Mink (*Neovison vison*; Photo 5-1 through Photo 5-3). In many cases it is likely that multiple images of the same animal were captured, as the image timestamps were close. The objective of this study modification was to determine if predators access core colonial nesting bird areas under existing operating conditions rather than to document the frequency or rate of predation. As a result, no attempt was made to differentiate individuals (Photo 5-1 through Photo 5-3).

PHOTO 5-1 RACCOON WALKING OVER ICE AT SITE 3

PHOTO 5-2 AMERICAN MINK WALKING OVER ICE AT SITE 6

PHOTO 5-3 TWO RACCOONS SWIMMING IN WATER AT SITE 11

5.4 ANALYSIS AND COLLECTION OF ADDITIONAL DATA

Each species identified as potentially being present during the proposed extended operations period (November through the end of March; summarized in Table 5-2) was addressed. No effects were analyzed for the breeding season, as the breeding season for birds does not overlap with the proposed extended operation period. Therefore, all effects would be limited to the preferred foraging habitat during the non-breeding season for each of the species identified in Table 5-2.

5.4.1 QUANTIFYING CHANGES IN LITTORAL HABITAT

The availability of suitable foraging habitat is important for migratory birds during the non-breeding season. Analyzing the amount of non-breeding foraging habitat available during each of the 19 time steps from the hydraulic model provided a comparative analysis between the current/proposed normal operating range (4,407.5–4,406.5 feet as measured at Cutler Dam) and the proposed extended operating range for each species described in Table 5-2.

Based on the literature, each of the species in Table 5-2 utilizes a specific water-depth class for foraging during the non-breeding season (Table 5-1). Therefore, to match the foraging habitat requirements during the non-breeding season for the 55 species identified as utilizing habitat that may change under the proposed future operating condition in Table 5-2, 20 different water-depth classes were extracted from the hydraulic model simulations. Some species utilize all water-depth classes, and thus did not fall into any specific category. For these species, the total acres of water surface available in the normal operating range was compared to the total acres of water surface available in the proposed extended operating range. Therefore, there were 19 specific water-depth classes and one for all water in the entire reservoir.

In each of the figures in Section 5.4.1, the total acres of habitat available under the current/proposed normal operating range (blue line) is shown in the same graph as the total acres of habitat available under the proposed extended operations range (orange line) for each water-depth class. It is important to remember that this graph shows a change in habitat availability over a 10-day period, and that when the divergence between the blue and orange lines are visibly greater, this shows the time period when the model indicates the greatest change between the two operating regimes, generally between days 5 and 9. These lines show that there is very little differentiation between the two systems at both the beginning and end of each 10-day period. When the orange line is above the blue line, it suggests more habitat is available for this species under the proposed operating range on that day. When the blue line is above the orange line, it suggests there would be less habitat available under the proposed extended operating range compared to the normal operating range on that day.

The green line represents the total acres of overlap between the two scenarios. When the green line is higher on the graph, there is a lot of overlap between the two scenarios, which means the habitat created under both scenarios is generally located in the same place. However, as the green line begins to drop lower, the habitat created under the two scenarios overlaps less, and is thus found in different, although generally adjacent and/or nearby, locations.

Species that utilize the water-depth class between 0 and 4 centimeters deep are Wilson's Snipe (*Gallinago delicata*) and American Pipit (*Anthus rubescens*).

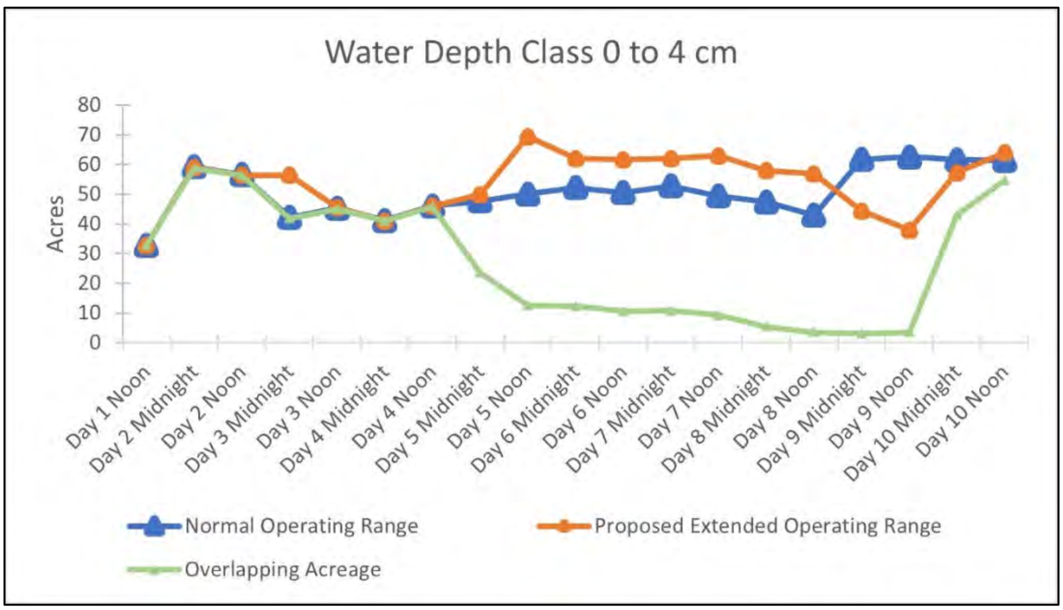


FIGURE 5-8 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 4 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 9 centimeters deep are the Black-Crowned Night-Heron (*Nycticorax nycticorax*).

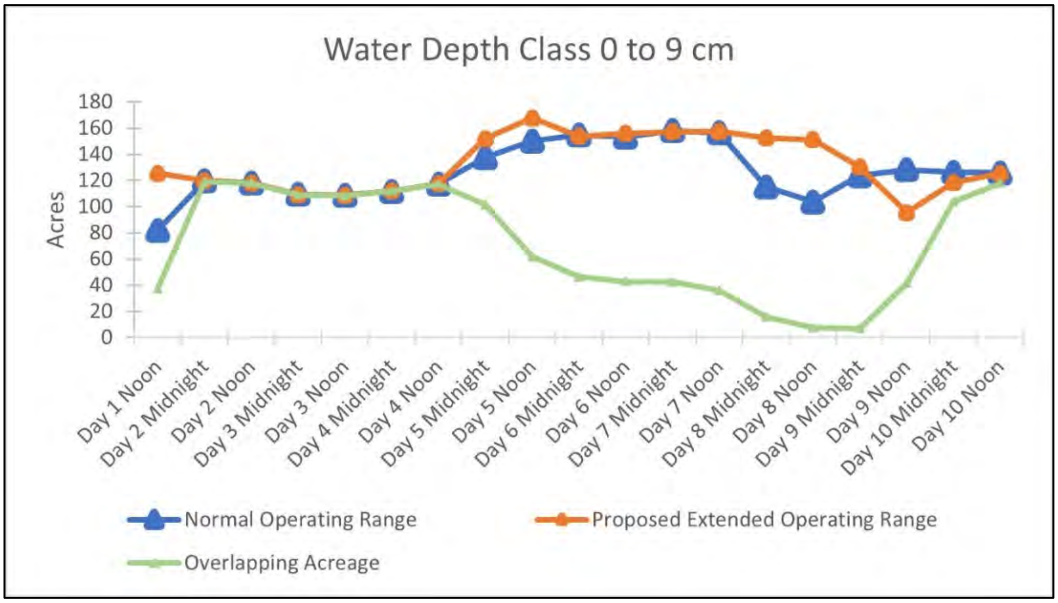


FIGURE 5-9 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 9 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 11 centimeters deep are the Black-Necked Stilt (*Himantopus mexicanus*), Greater Yellowlegs (*Tringa melanoleuca*), and Killdeer (*Charadrius vociferous*).

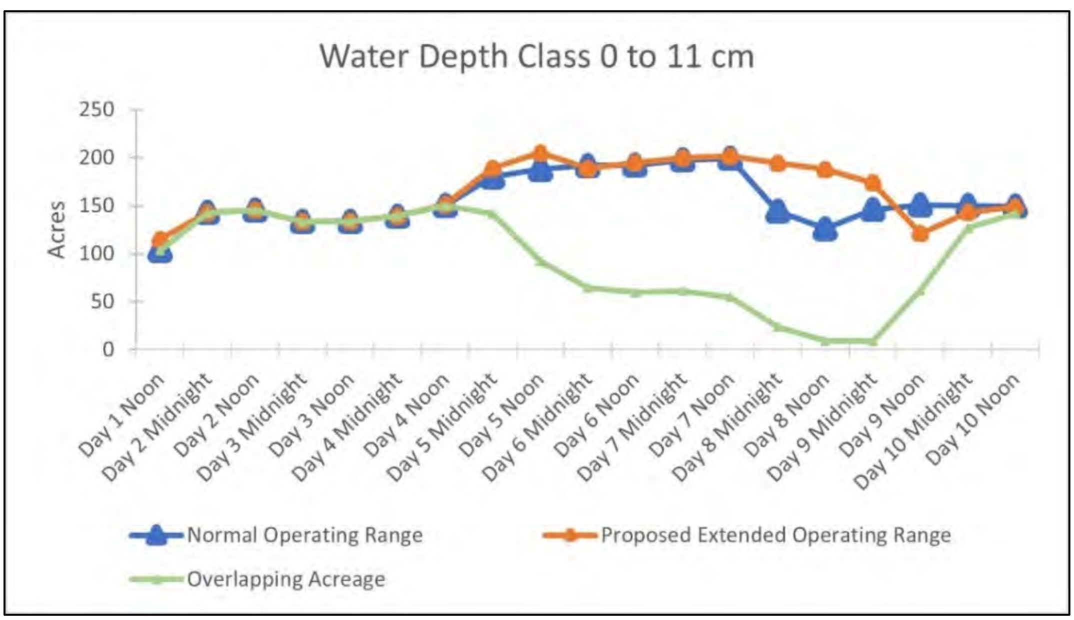


FIGURE 5-10 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 11 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 12 centimeters deep are the Green-winged Teal (*Anas carolinensis*).

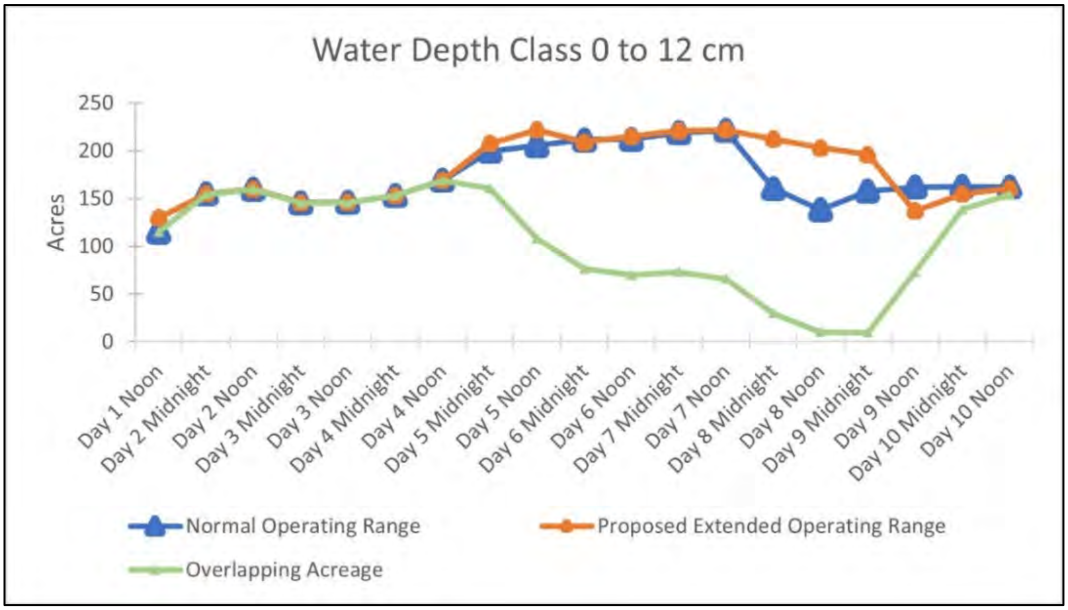


FIGURE 5-11 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 12 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 15 cm deep are the Ross's Goose (*Chen rossii*), Snow Goose (*Chen caerulescens*), and Virginia Rail (*Rallus limicola*).

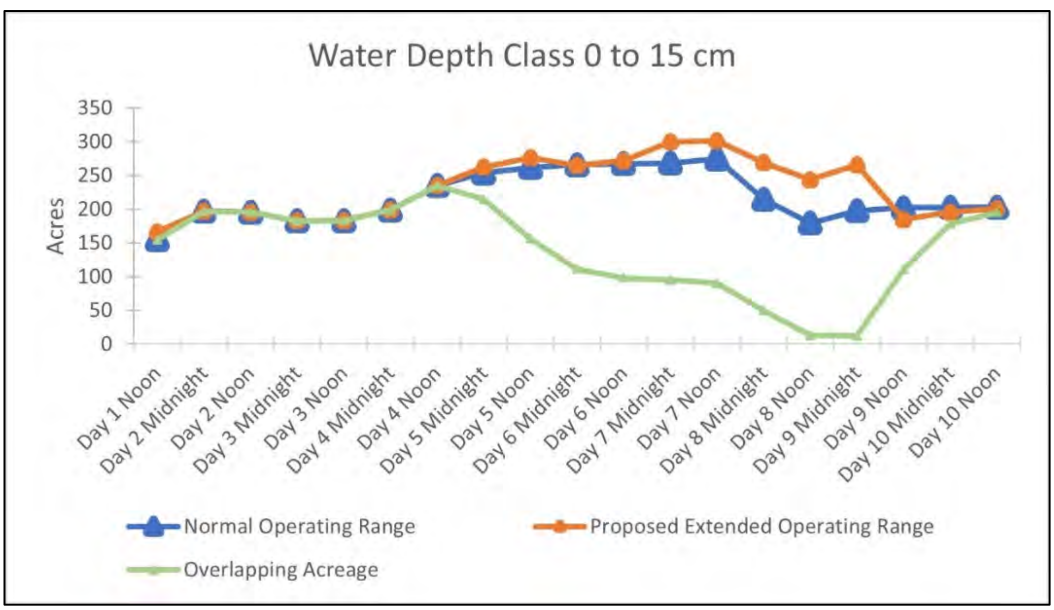


FIGURE 5-12 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 15 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 16 centimeters deep Long-Billed Dowitcher (*Limnodromus scolopaceus*).

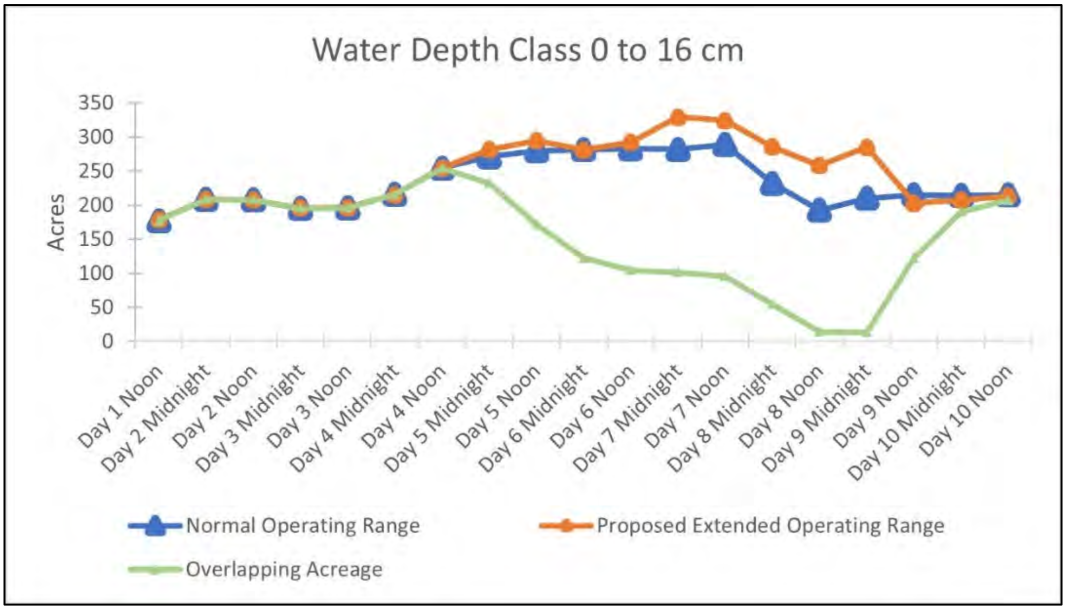


FIGURE 5-13 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 16 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 20 cm deep are the American Avocet (*Recurvirostra american*) and Cinnamon Teal (*Anas cyanoptera*).

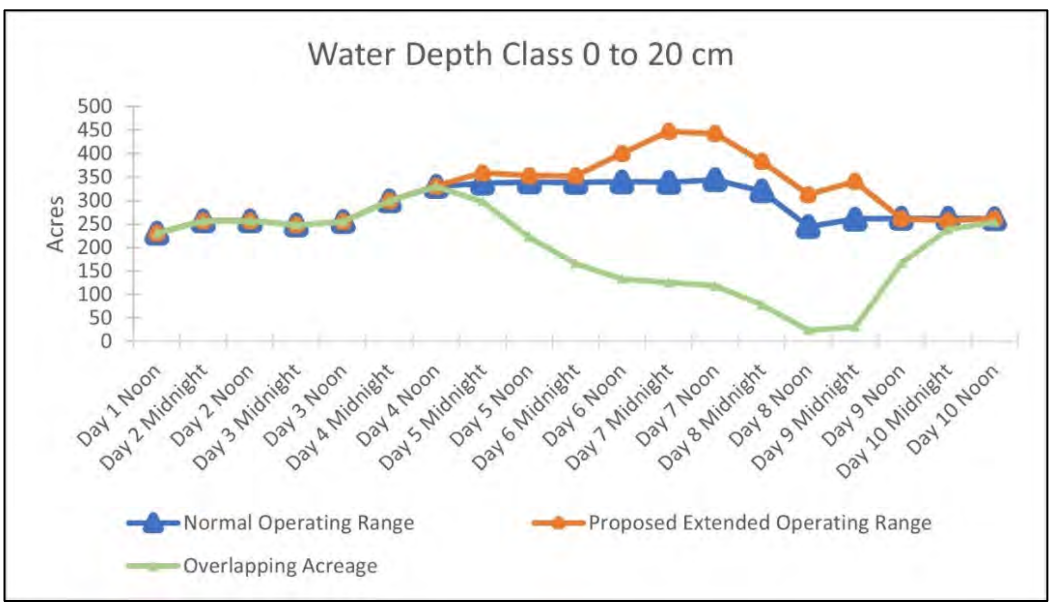


FIGURE 5-14 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 20 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 30 cm deep are the Blue-winged Teal (*Anas discors*), Northern Pintail (*Anas acuta*), and Trumpeter Swan (*Cygnus buccinator*).

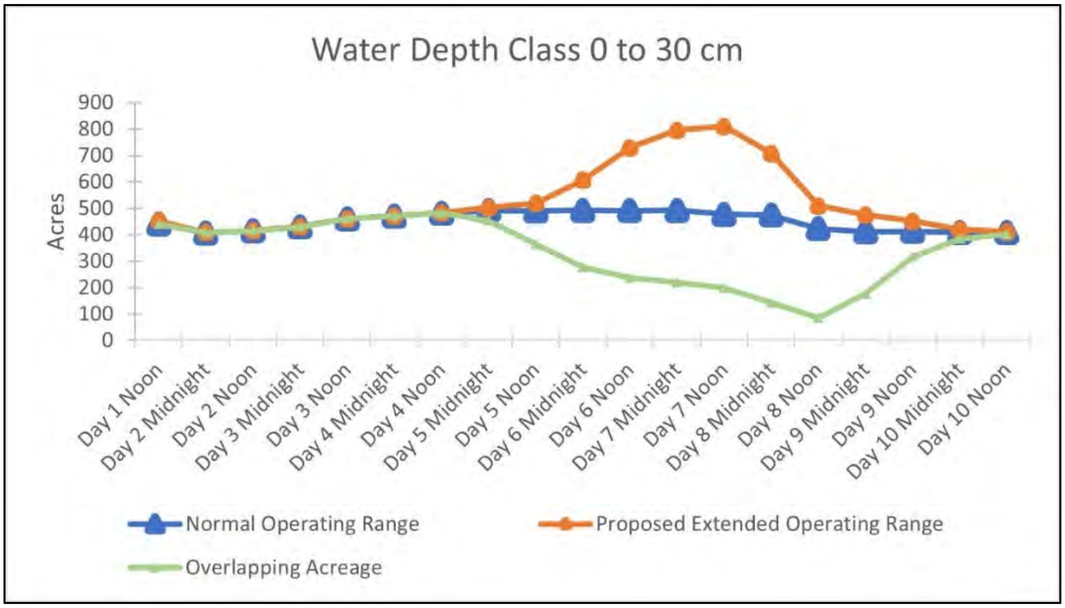


FIGURE 5-15 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 30 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 40 centimeters deep are the Great Blue Heron (*Ardea herodias*), Mallard (*Anas platyrhynchos*), and Marsh Wren (*Cistothorus palustris*).

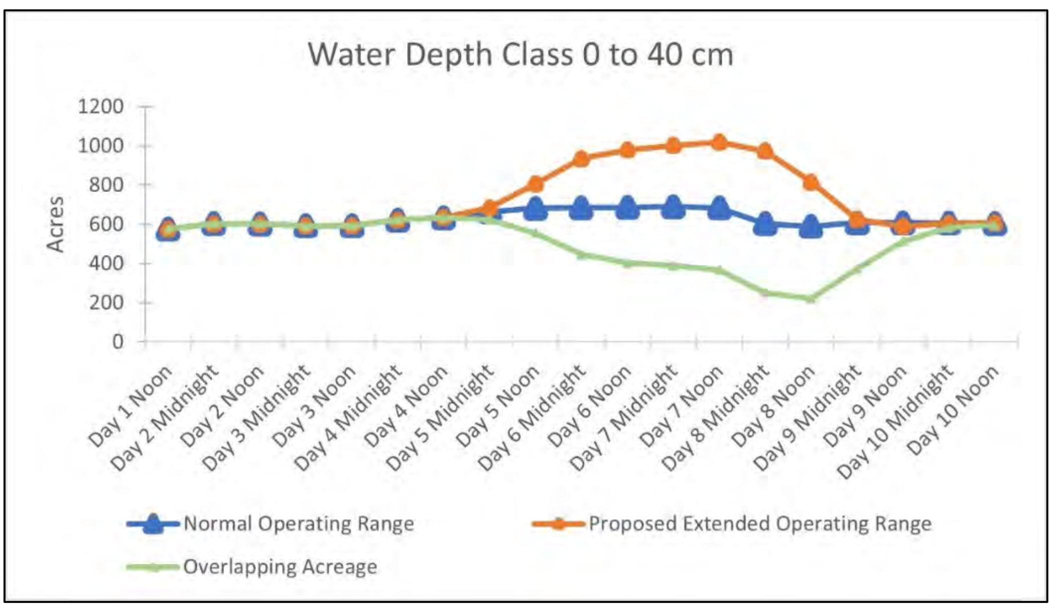


FIGURE 5-16 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 40 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 50 centimeters deep are the Red-necked Phalarope (*Phalaropus lobatus*).

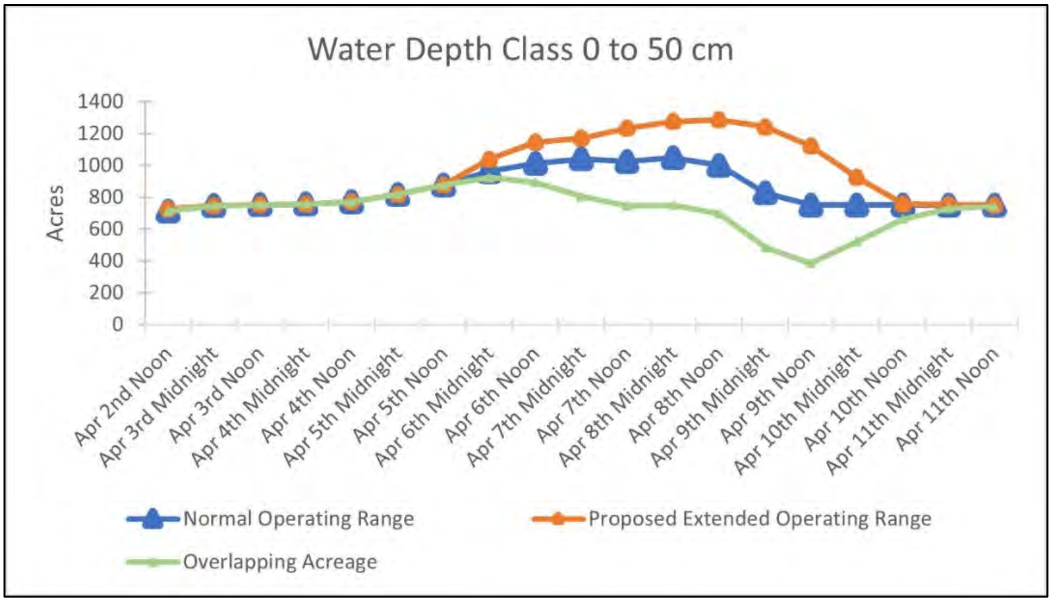


FIGURE 5-17 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 50 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 18 and 40 centimeters deep are the Gadwall (*Anas Strepera*) and Wood Duck (*Aix sponsa*).

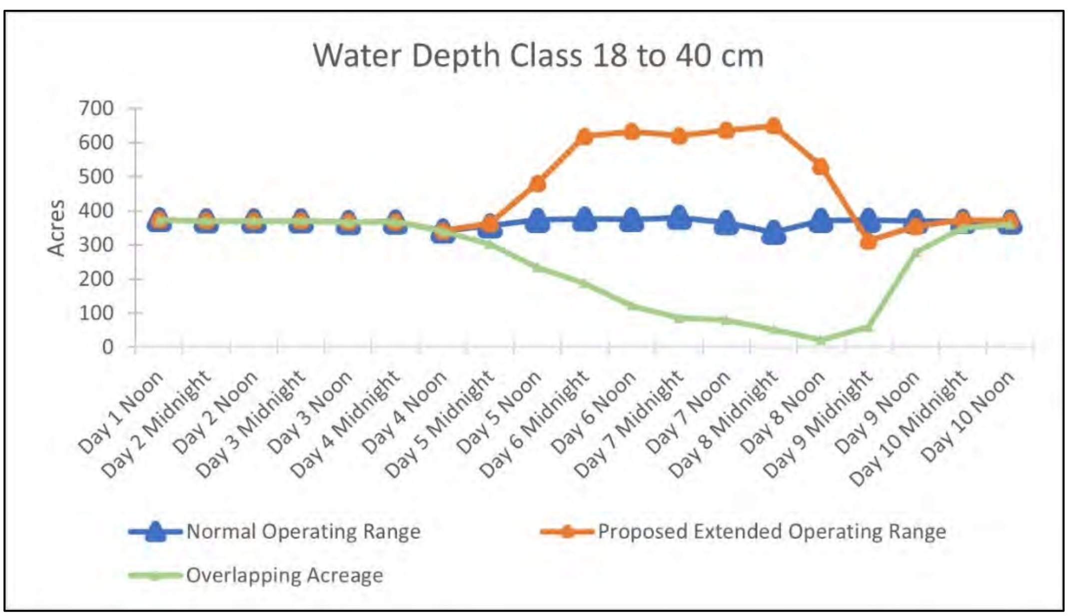


FIGURE 5-18 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 18 TO 40 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 100 centimeters deep are the Redhead (*Aythya americana*) and Tundra Swan (*Cygnus columbianus*).

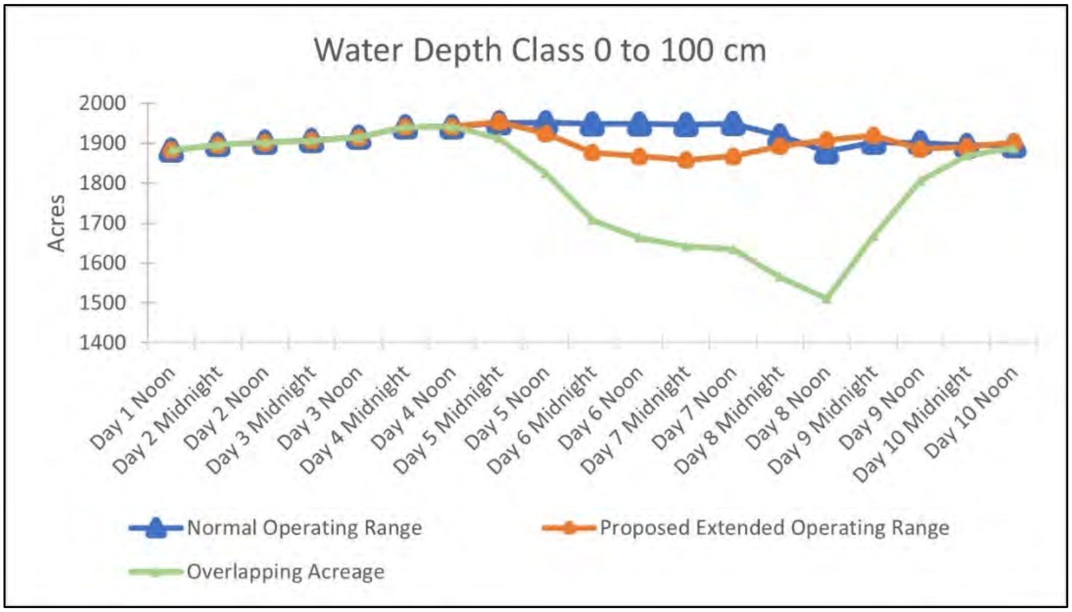


FIGURE 5-19 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 100 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 150 centimeters deep are the Hooded Merganser (*Lophodytes cucullatus*) and Ring-Necked Duck (*Aythya collaris*).

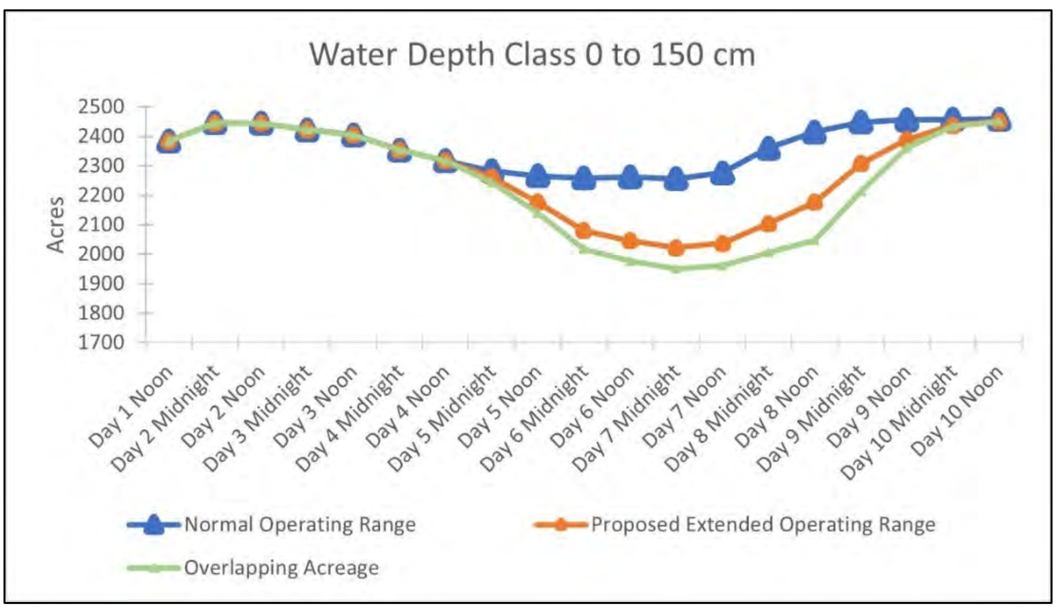


FIGURE 5-20 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 150 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 200 centimeters deep are the Ruddy Duck (*Oxyura jamaicensis*).

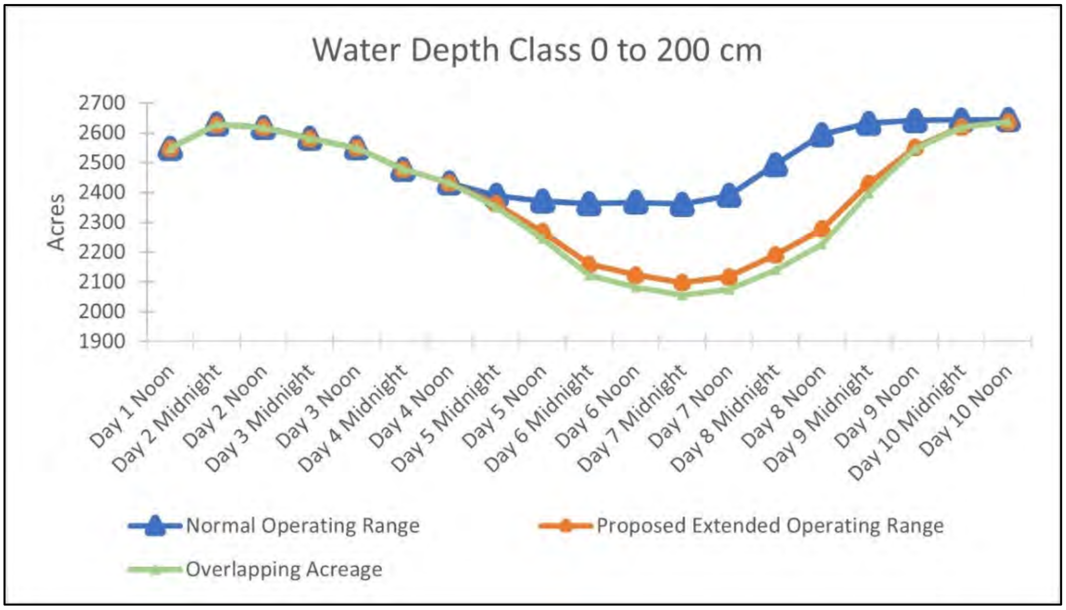


FIGURE 5-21 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 200 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 50 and 200 centimeters deep are the Canvasback (*Aythya valisineria*).

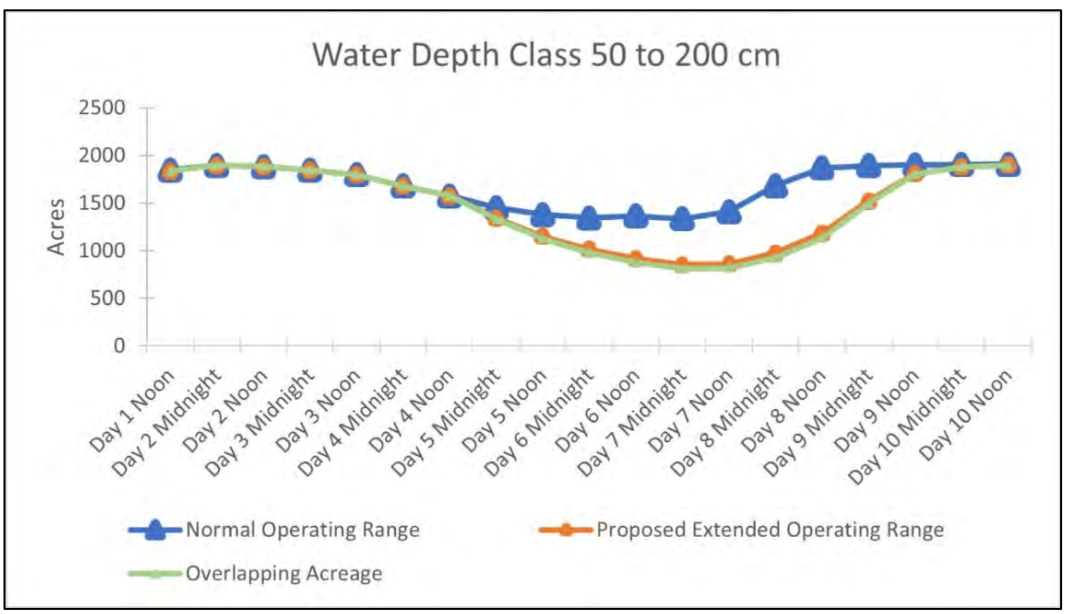


FIGURE 5-22 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 50 TO 200 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 250 centimeters deep are the American White Pelican (*Pelecanus erythrorhynchos*).

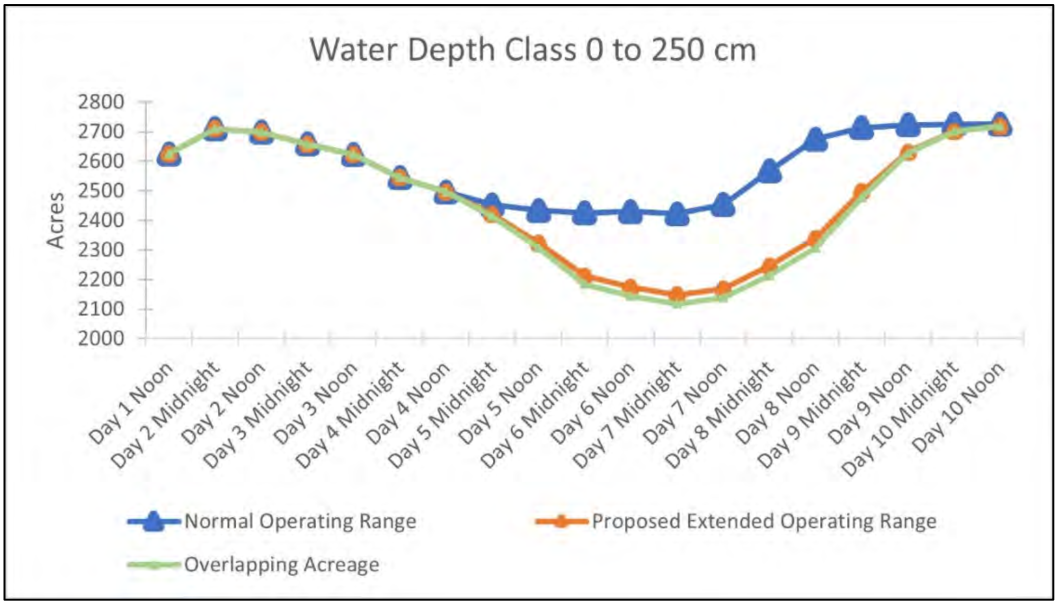


FIGURE 5-23 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 250 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 300 cm deep are the Bufflehead (*Bucephala albeola*) and Western Grebe (*Aechmophorus occidentalis*).

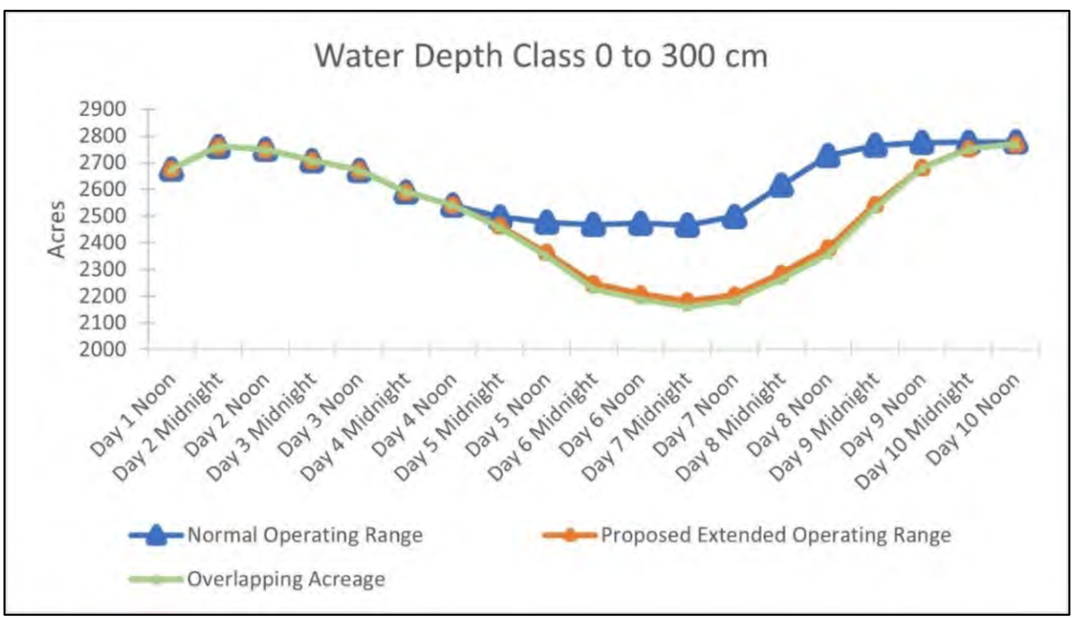


FIGURE 5-24 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 300 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 400 cm deep are the Barrow's Goldeneye (*Bucephala islandica*), Clark's Grebe (*Aechmophorus clarkia*), Common Goldeneye, (*Bucephala clangula*) and Common Merganser (*Mergus merganser*).

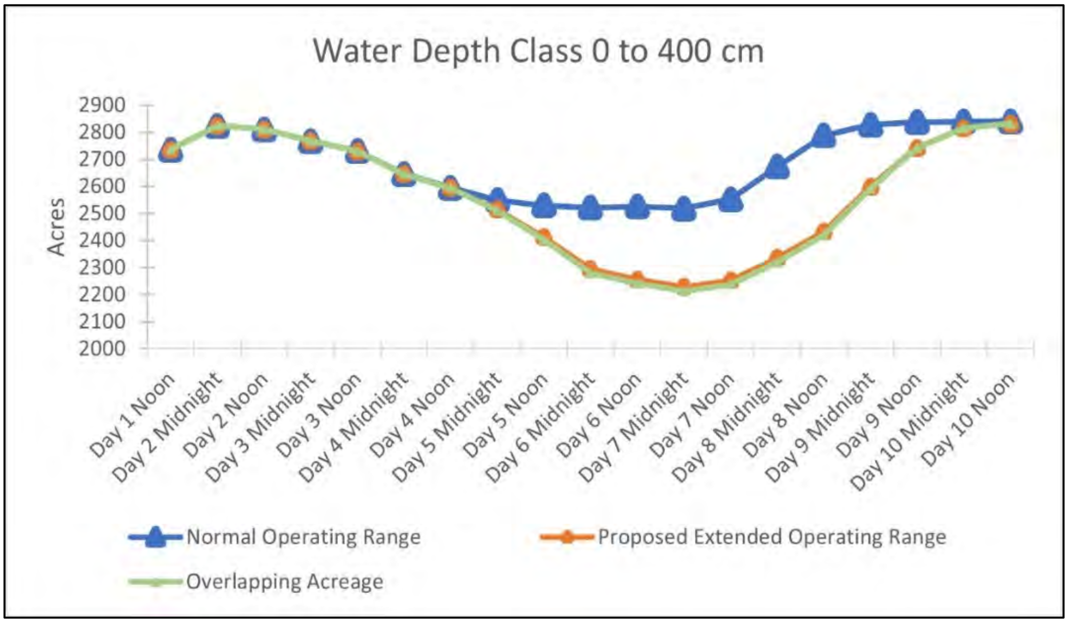


FIGURE 5-25 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 400 CM WATER-DEPTH CLASS

Species that utilize the water-depth class between 0 and 500 cm deep are the Common Loon, (*Gavia immer*) Eared Grebe (*Podiceps nigricollis*), Lesser Scaup (*Aythya affinis*), Pied-Billed Grebe (*Podilymbus podiceps*), and Red-Breasted Merganser (*Mergus serrator*).

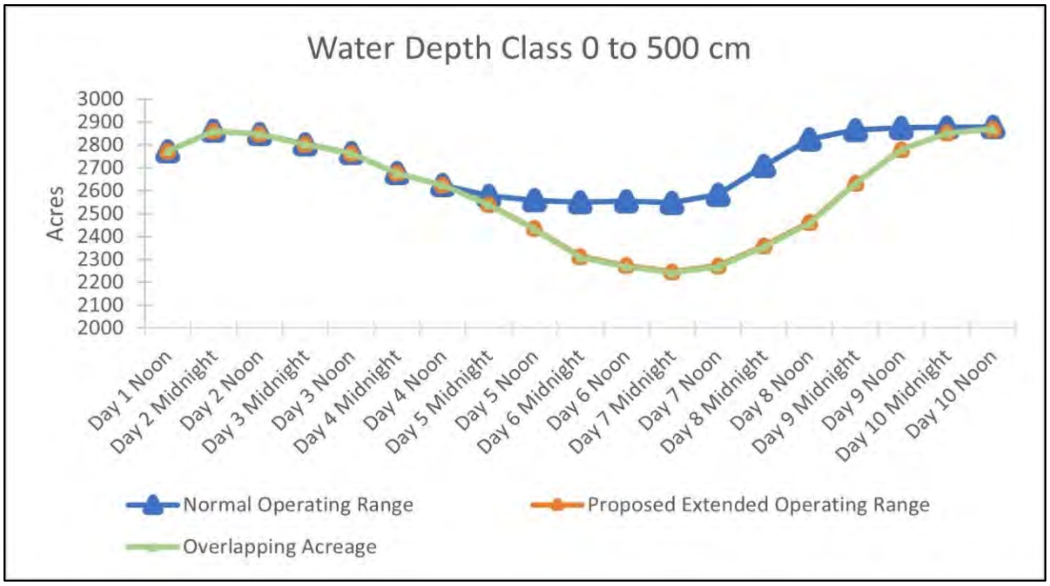


FIGURE 5-26 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT AT THE 0 TO 500 CM WATER-DEPTH CLASS

Species that utilize all available water depths at Cutler Reservoir based on their diverse foraging strategies are the American Coot (*Fulica americana*) American Wigeon (*Mareca americana*), Bald Eagle, Belted Kingfisher (*Megaceryle alcyon*), Bonaparte's Gull (*Chroicocephalus Philadelphia*), Cackling Goose (*Branta hutchinsii*), Canada Goose (*Branta canadensis*), California Gull (*Larus californicus*), Double-Crested Cormorant (*Phalacrocorax auratus*), Franklin's Gull (*Leucophaeus pipixcan*), Herring Gull (*Larus argentatus*), Horned Grebe (*Podiceps auratus*), Northern Shoveler (*Anas clypeata*), Osprey (*Pandion haliaetus*), and Ring-Billed Gull (*Larus delawarensis*).

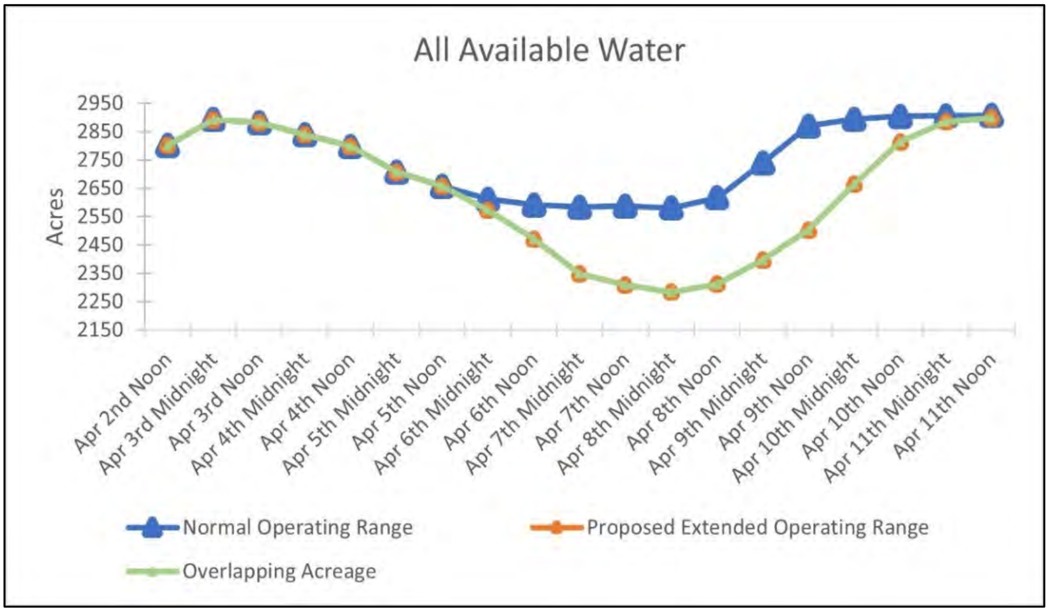


FIGURE 5-27 TOTAL ACRES OF HABITAT AND OVERLAPPING HABITAT FOR THE WATER AT THE ENTIRE RESERVOIR

6.0 SUMMARY

The methods specified for Phase 1 of the Shoreline Study Plan, including the FERC staff modifications listed in the Study Plan Determination, have been completed. The Phase 1 results presented were used, in part, to help determine the need for further study in Phase 2 (see description in Attachment C-1). Phase 1 quantified changes in littoral habit between current/proposed normal and proposed extended operating ranges. As a result, Phase 2 of this study may be needed to determine the occupancy of littoral habitats in the areas, and time of year, where habitat change may be greatest. Although not yet mandated by the ILP process, due to the seasonality of the proposed Phase 2 study (November–March, per the proposed extended operating range; also refer to Future Studies Section) and the need to prepare and file the DLA by late fall of 2021, PacifiCorp has chosen to begin the Phase 2 study, concurrently with preparation and submittal of this ISR. Following the completion of Phase 2 in early 2021, the data gap identified by FERC in Scoping Document 2 will be filled and the results will be sufficient for an impact and effect analysis to be completed for the DLA, although at this time, that analysis is not complete.

7.0 FUTURE STUDIES

The results presented in ISR Section 1.3 identify the potential for effects to littoral bird habitat, particularly during the period when a proposed extended operating range could occur, generally November to March, as detailed in Section 5.1.2. This triggers the need for Phase 2 surveys to document actual bird use of potentially affected survey units, as described in Attachment C-1. Phase 2 data collection will take place from November 2020 through March 2021.

8.0 REFERENCES

Brown, D. R., and T. W. Sherry. 2005. Food supply controls the body condition of a migrant bird wintering in the tropics. Population Ecology.

Cirrus Ecological Solutions. 2020. Threatened and Endangered Species Initial Study Report. Prepared for PacifiCorp. 2020

Congalton, R.G., Oderwald, R.G., and R.A. Mead. 1983. Assessing Landsat classification accuracy using discrete multivariate statistical techniques. *Photogrammetric Engineering & Remote Sensing*, 49(12):1671-1678.

Cornell Lab of Ornithology. 2020a. eBird. The Cornell Lab of Ornithology. Accessed 2020 at https://ebird.org/home

Cornell Lab of Ornithology. 2020b. Birds of the World. The Cornell Lab of Ornithology. Accessed 2020 at https://birdsoftheworld.org/bow/home

Integrated Waterbird Management & Monitoring. 2017. Integrated Waterbird Management and Monitoring Approach for Nonbreeding Waterbirds. Monitoring Manual. Version 9: October 2017.

Marra, P. P., C. E. Studds, S. Wilson, T. S. Sillett, T. W. Sherry, and R. T. Holmes. 2015. Non-breeding season habitat quality mediates the strength of density-dependence for a migratory bird. Proceedings Royal Society B. 282.

National Audubon Society. 2020. Join the Christmas Bird Count. Accessed 2020 at https://www.audubon.org/conservation/join-christmas-bird-count

PacifiCorp. 2018. Cutler Hydroelectric Project FERC Project No. 2420. Maps created in 2018.

Tortora, R. 1978. A note on sample size estimation for multinomial populations. *The American Statistician*, 32(3):100-102.

United States Fish and Wildlife Service (USFWS). 2020a. Migratory Bird Treaty Act Protected Species (10.13) List. Updated March 2020. Available: https://www.fws.gov/birds/management/managed-species/migratory-bird-treaty-act-protected-species.php

United States Fish and Wildlife Service (USFWS). 2020b. Breeding Bird Survey. United States Geological Service. Patuxent Wildlife Research Center. Available: https://www.pwrc.usgs.gov/bbs/

United States Forest Service (USFS). 2016. Intermountain Region (R4) Threatened, Endangered, Proposed, and Sensitive Species. June 2016. Known/Suspected Distribution by Forest.

Utah Division of Wildlife Resources (UDWR). 2017. Utah Sensitive Species List. State of Utah. Department of Natural Resources. Division of Wildlife Resources.

Utah State University Extension. 2020. Noxious Weed Field Guide for Utah. 4th Edition.

Attachment C-1

Phase 2 Methods

Because Phase 1 of this study, incorporating results of the potentially affected habitat and the hydraulic study has yielded information on what habitats would be affected by potential future Project operations, the second phase of the Shoreline analysis requires a field survey to determine the number and species of individual birds using the areas where substantial changes in littoral habitat depth availability could occur, based on the results presented in Section 6.4.1. Data from this survey will inform the discussion of impacts on bird populations that will be presented in the Draft License Application.

Phase 2 surveys will only be conducted in those areas where effects would potentially occur, based on the results of the hydraulic modelling. Since surveys appear to be necessary, PacifiCorp has coordinated with local ecologists and relicensing stakeholders to help identify potential survey locations within the potentially affected areas. Five areas where there is the greatest potential for change in non-breeding habitat for birds to occur have been identified (Figure C-1).

In order to determine the magnitude of these potential effects, bird surveys will be conducted during the season when effects could occur, specifically November–March. This season corresponds to the non-breeding season and therefore only specific portions of the Integrated Waterbird Management & Monitoring (IWMM; Integrated Waterbird Management & Monitoring 2017) program protocols are appropriate for gathering the required data. Specifically, the methods described under SOP 2: Waterbird and Unit Condition Survey heading in the IWMM manual will be applied. This program, administered by the U.S. Fish and Wildlife Service, has been developed to monitor non-breeding waterbirds across the country using standardized methods (https://iwmmprogram.org). The relevant pages from the IWMM manual are included below.

SOP 2: Waterbird and Unit Condition Survey

Follow these instructions for preparing and conducting waterbird counts and assessing site conditions for each unit at time of survey. Associated data collection sheets can be found in Supplemental Materials 3 and 4.

Note: Bird Surveys have to include data for the measurements highlighted in bold on the following list for the survey to be entered in the IWMM database. Surveys with missing data for one or more required metrics cannot be saved in the IWMM online database.

Measurements

- Counts of waterbirds by species
- **Visibility (%)**
- **Wind speed (mph class)**
- Tide stage (class)
- Salinity (ppt)
- Gauge level
- **Water depth (cm class)**
- **Ice (% cover class)**
- **Flood duration (days class)**
- **Habitat cover (% of cover class)**
- **Interspersion (class)**
- **Vegetation height (cm or m class)**
- **Disturbance severity (class)**
- **Disturbance source (class)**
- **Chronic human disturbance (class)**

Equipment

- Good optical equipment, including a spotting scope
- Thermometer (°F)
- Refractometer or hydrometer (optional)
- Map of the project and unit boundaries
- AOU species code sheet (Supplemental Materials 1: alphabetical order or Supplemental Materials 2: taxonomic order)
- Waterbird Survey Form (Supplemental Materials 3: Single unit and Supplemental Materials 4: multiple units)

Survey Schedule

Waterbird surveys should ideally be conducted at least once per week during the peak migration periods for waterfowl and shorebirds (see Element 2: Survey timing and schedule). Estimates of use-days using weekly counts have greater statistical power than those conducted on a biweekly schedule (B. Tavernia, USGS, personal communication).

It is best to designate a particular day of the week for the surveys so that they are spaced as evenly as possible. In coastal areas, surveys should be conducted within two hours of high tide to control for the effect of the tidal state of nearby mudflats. At inland sites, the time of a 24 hour period for conducting surveys should be based on the management objective. For example, if a manager is interested in supporting roosting activities, the counts should occur during a period when birds are most likely to be roosting in a site. Flexibility in the timing of surveys is needed to address constraints such as staffing, other activities taking place within units (e.g. hunting or management), and weather.

If multiple units are surveyed, it is good practice to change the order of surveys by choosing different starting units on each visit (wherever possible). If count numbers are expected to be compiled, counts for all units should be completed in one day to minimize the interchange of birds across units. Multiple-counting of individual waterbirds should be avoided. If birds regularly flush from units during counts, then efforts to minimize disturbance during surveys or concurrent surveys may be needed to minimize the multiple-counting of birds. When birds are observed moving from one unit to another, include waterbirds in the estimate for only the first unit in which you encounter them. Waterbirds observed outside the unit boundaries during flood events, as flyovers or on adjacent dry land should not be included in the survey unit observations.

There is no time limit for surveys, though ideally, all units within a project should be surveyed on the same day. However, in some instances, such as aerial counts, it may be necessary to collect unit conditions data that require ground-based assessments (mainly veg height, gage readings and salinity) on a day other than when the waterbird count is conducted. In these instances, the survey date recorded should be the date the waterbird count was conducted. The actual day the unit condition(s) were recorded should be included in the notes section of the database. Participants collecting unit conditions data on a different day than the waterbird count should evaluate the potential for the unit conditions to have changed significantly. If unit conditions have changed, the survey event should not be entered.

NOTE: During the waterfowl hunting season it is important to avoid conflict with hunting interests. Disturbance can be avoided by surveying from accessible points around the perimeter of wetlands, and by avoiding conducting surveys when hunting activity is highest.

Site and unit codes

Please contact the Project Coordinator for assistance on assigning codes. Project names and survey unit codes must be assigned by IWMM staff to ensure that they do not duplicate codes in use by other cooperators. If you do not know these codes, please leave them blank, but make sure that you provide enough detail (e.g., name of observer, location of surveys) so that the codes can be completed subsequently.

Percent Visibility

To conduct whole-area counts, it is required for large scale analyses that you be able to see ≥70% of the survey unit from one or multiple vantage points placed around the unit's perimeter. Estimate the percentage of the survey unit assessed for the whole-area count (Figure SOP-2.1).

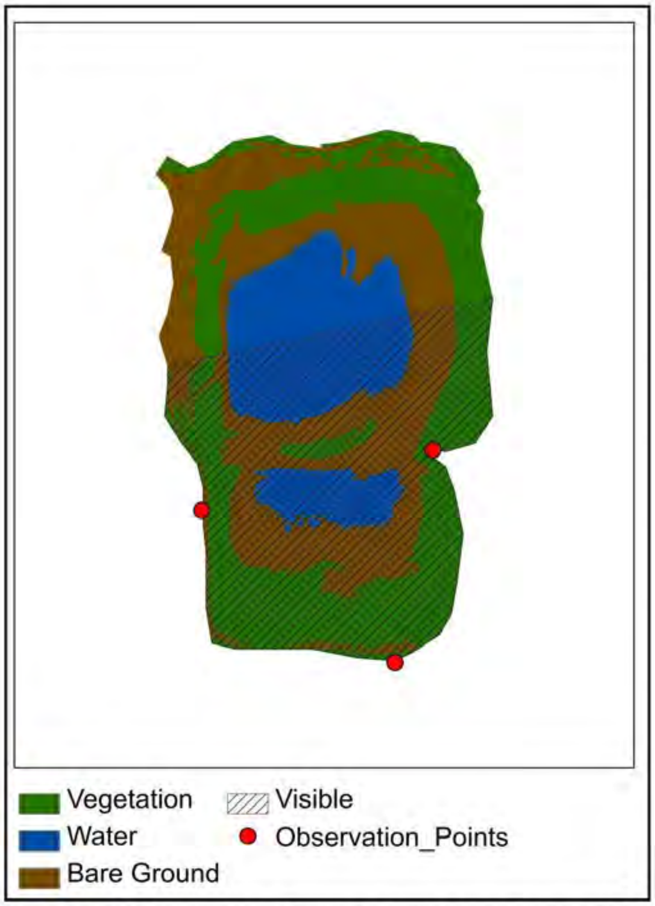


Figure SOP-2.1. Percentage of survey unit within whole-area count. In this case, 70% of the unit falls within the whole-area count.

Appropriate Weather

Surveys during inclement weather should be avoided. Whenever possible, do not survey waterbirds in fog, rain or strong winds (Beaufort force ≥ 3). Temperatures (˚F) at the start of the survey and Beaufort wind scale (Table SOP-2.1) are to be recorded. Estimate average wind speed (Beaufort scale) at the start of the survey.

Table SOP-2.1. The Beaufort Wind Scale

MPH	Beaufort	Description	Appearance of wind effects
<1	0	Calm	Calm, smoke rises vertically
1-3	1	Light Air	Smoke drift indicates wind direction, still wind vanes
4-7	2	Light Breeze	Wind felt on face, leaves rustle, vanes begin to move
8-12	3	Gentle Breeze	Leaves and small twigs constantly moving, light flags extended
13-18	4	Moderate Breeze	Raises dust and loose paper; small branches are moved
19-24	5	Fresh Breeze	Small trees in leaf begin to sway
25-31	6	Strong Breeze	Large branches in motion; umbrellas used with difficulty

Local Tide Conditions

Please classify local tide conditions into one of the categories found in Table SOP-2.2 (from International Shorebird Survey protocol; http://ebird.org/content/iss/).

Table SOP-2.2. Local Tide Conditions.

Class	Description
1	High
2	Almost high and rising
3	Almost high and falling
4	Half tide, rising
5	Half tide, falling
6	Almost low, rising
7	Almost low, falling
8	Low
9	Not observed, not applicable, or observations made during more than one of these periods

Salinity

If your unit is exposed to saltwater, then measure salinity using a either a hydrometer or a refractometer (SOP 3); salinity should be reported in parts per thousand.

Salinity may vary throughout your unit, so careful consideration needs to be given to the number and distribution of salinity samples taken. No single sampling approach will apply universally, but the following considerations are offered as guides:

- Seek background on your unit, looking for information specific to factors that may cause salinity to vary (e.g., location of freshwater inlets)
- Ensure that selected sampling locations can be safely and legally accessed
- Select sampling locations that will have standing water under most circumstances
- Use a GPS unit to record the position of sampling locations.
- Sampling designs should be clearly documented to allow a consistent approach to be used by the same observer across multiple years or by multiple observers.

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If multiple samples are taken, report the mean value. If you do not take readings, report "NA". If you are certain that the unit is never subject to saltwater incursion, report "**< 0.5**" (the numerical definition of freshwater).

Water Gauge Reading
If the unit has a water level gauge, please record a reading each time a count is conducted. Be sure to provide the measurement units of the water level gauge.

Water Depth
Estimate the percent of the unit in each of five water depth categories (Table SOP-2.3) corresponding to waterbird guild use (Ma et al. 2010). Percent cover estimates should sum to 100% across the six depth categories.

Table SOP-2.3. Categories of water depth.

Category
Dry
Saturated/mudflat
0 to 5 cm (0 to 2 in)
5 to 15 cm (2 to 6 in)
15 to 25 cm (6 to 10 in)
>25 cm (> 10 in)

If ice is present, **do not** treat it as dry – instead estimate the total depth of water and ice by including ice as part of the water column when estimating water depths. Water depth cover estimates are independent of vegetation cover, i.e. water depth under vegetation should be included.

There are two alternative approaches for estimating percent covers for water depth categories: (1) the preferred alternative is to use a water bathymetry map in conjunction with a water gauge reading to estimate percent covers (SOP 4); (2) the non-preferred alternative is to use an ocular assessment or other method. Record the method used to estimate water depth percentages as:

1 — Water bathymetry map in conjunction with a water gauge reading.
2 — Ocular assessment.
3 — Other method.

Percent of ice cover
Across the entire survey unit, visually estimate and record the percent of the water surface that is covered by ice. Sheet water present on thawing ice should be treated as ice.

Flood Duration

For flooded areas within your survey unit, please indicate how long surface water has been present by assigning these areas to one of the flood duration categories found in Table SOP-2.4. These flood duration categories are related to the abundance and energy content of food resources (e.g., Fredrickson and Reid 1991).

Table SOP-2.4. Flood Duration Categories

Code	Description
1	Surface water present > 90 days
2	Surface water present 30-90 days
3	Surface water present <30 days
4	Permanent inundation
5	No information

Assignment to these categories should be based on the majority condition (i.e., >50% of the area) for areas with surface water. **Note that if the majority of the unit is permanently covered by surface water; please select "Permanent Inundation" from the flood duration categories.**

This assessment can be made using either of two approaches: (1) the preferred approach is to use a time series of water gauge readings tied to bathymetric maps (SOP 4) to identify flooded areas and their periods of inundation; (2) the non-preferred approach is to base the assessment on personal or second-hand (i.e., through communication with local manager) knowledge of water-level management of the survey unit. Record the flood duration assessment method for each survey:

1 — Water bathymetry map in conjunction with a water gauge reading.
2 — First-hand knowledge.
3 — Second-hand knowledge, such as through communication with local manager.
4 — Other method.

Habitat Cover

Use ocular estimation to assess what percentage of a survey unit is open water, bare ground/mudflat, emergent, scrub-shrub, or forest. These classes are defined using classes found in the *Classification of Wetland and Deepwater Habitats of the United States* (Cowardin et al. 1979). See Table SOP-2.5 for a crosswalk between IWMM's habitat classes and those found in Cowardin et al. (1979).

Table SOP-2.5. Habitat classification crosswalk between the IWMM Initiative Protocol and Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979).

IWMM Habitat Class	Wetlands and Deepwater Habitats Class
Open Water	See rock bottom, unconsolidated bottom, aquatic bed
Scrub-shrub	See scrub-shrub
Forest	See forest
Emergent	See emergent, vegetated unconsolidated shore
Bare ground	Streambed, rocky shore, unvegetated unconsolidated shore

The following conditions apply when estimating cover of the different habitat classes:

- Percent covers for individual classes are considered mutually exclusive, so percent cover estimates across all habitat classes must sum to 100%.

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- Open water can include submerged aquatic vegetation and floating-leaved aquatics such as American lotus (*Nelumbo lutea*) and watershield (*Brasenia schreberi*).
- Both open water and bare ground classes can include scattered emergent or woody vegetation up to 30 % areal cover.
- Mowed or harvested emergent vegetation should be treated as emergent unless submersed by open water.
- Crops planted in wetlands should be treated as emergent.
- Disked areas should be treated as bare ground unless litter residue > 30% areal cover.
- Because this measure is intended to assess habitat structure not energy content, senesced vegetation (i.e., dead vegetation) should be included in percent cover estimates for applicable habitat classes.

Interspersion
The configuration of vegetation and water/bare ground patches within a survey unit can influence habitat quality. For this metric, vegetation patches are defined to include scrub-shrub, forest, and emergent vegetation areas whereas water/bare ground patches are defined to include open water, submerged aquatic vegetation, floating-leaved aquatic vegetation, and bare ground. Units with little or no vegetation (60-100% open water) would fall into class L as a single large patch of open water, likewise units with 100% vegetation cover would fall into the S class. A survey unit can fall into one of three configuration classes (Figure SOP-2.2) based on Suir et al. (2013). The three configuration classes are:

- Class L includes large and connected patches of water/bare ground features
- Class S contains small, disconnected patches of water/bare ground
- Class M contains discernible regions of both classes L and S

These classes reflect the interspersion, or inter-mixing, of vegetation and water/bare ground patches. Assign the survey unit to one of the configuration classes as an indicator of interspersion. Note that, when water/bare ground covers >60% of a unit, the only possible configuration class is L.

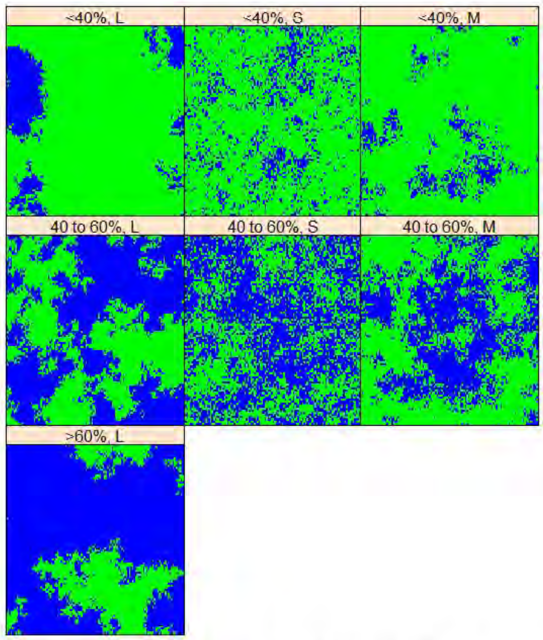

Figure SOP-2.2. Examples of three configuration categories (L; S; M). The three categories are illustrated for different levels of water/bare ground cover (<40%; 40 to 60%; >60%). Water/bare ground areas are represented in blue above whereas vegetated areas are represented in green.

Height

Use ocular estimation to assess what percentage of the unit is in each of seven categories of vegetation height (Table SOP-2.6). Note the height being measured is the uppermost canopy, so the percent cover estimates should sum to 100% across all categories.

Table SOP-2.6. Categories of vegetation height.

Category	Description
<2.5 cm	includes bare ground (e.g. mudflat) and water
2.5 to 15 cm	short vegetation, e.g. grazed grassland, sprouting crops, dwarf spikerush, etc.
15 to 30 cm	short herbaceous
30 to 60 cm	medium forbs and grasses
60 cm to 3 m	shrubs and low trees plus tall herbaceous vegetation and grasses.
3 to 6 m	shrubs, trees, tall herbaceous
>6 m	tall trees

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Disturbance severity

Please record whether there is a disturbance affecting the behavior or number of waterbirds in the survey unit either during your survey or immediately prior to it. Cooperators can conduct "flush counts" (surveys designed to intentionally flush a majority of birds in an effort increase detectability) to get more accurate counts of waterbirds in large or densely vegetated areas. Here, we are interested in disturbances that negatively influence your ability to get an accurate count. Score the disturbance on a scale 1 to 4 (Table SOP-2.7):

Table SOP-2.7. Severity scale and associated definitions of waterbird response to disturbance.

Scale	Severity	Definition
1	Light/none	no effect on waterbirds
2	Moderate	some waterbirds move but stay within unit
3	Heavy	some waterbirds leave unit
4	Limiting	most/all waterbirds leave the unit

Disturbance source

If there is a disturbance of waterbirds (see *Disturbance Severity* above), check the appropriate box to identify its source. Several sources can be ticked. For example, a fisherman in a boat should be ticked as both "Fishing" and "Boats". Potential sources are listed in Table SOP-2.8.

Table SOP-2.8. Types of disturbance.

Code	Description
1	Pedestrian
2	Loose dog
3	Hunting
4	Fishing
5	Boats
6	Motor vehicles
7	Aircraft
8	Raptor
9	Other

Chronic Human Disturbance

Characterize the unit for the period between the last and the current waterbird survey (Table SOP-2.9). For private lands, ask the area manager or landowner. For public lands, check site regulations or consult with management or law enforcement staff.

Table SOP-2.9. Chronic disturbance classes and their definitions.

Class	Description
1	No entry into the unit for any reason.
2	Closed to all use with entry into unit by resource managers or designees for management activities surveys, or other controlled non-hunting activities.
3	Managed access for all activities including firearms hunting. May include effort to control use levels and temporal closures (i.e. hunting units that close in the afternoon).
4	Open access via trail, viewing platforms etc. No firearms hunting allowed.
5	Open access, including firearms hunting, often with routine restrictions but without a site specific management program to control the level of authorized use.
6	Unknown

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Counting and estimating waterbird numbers

Counts or approximated counts of individual waterbirds (see list in SM1) are recorded by species on either the Waterbird Count or Survey Condition form for an individual survey unit (SM-3), or on the alternate form for surveying multiple management units (SM-4). Counts of species listed in SM1 & SM2 should always be recorded. Scientific names are based on the 58th Supplement to the American Ornithological Union's (AOU) checklist (Chesser et al. 2017)

Be careful not to count individual waterbirds more than once. When in doubt about whether an individual waterbird was already seen, err on the side of <u>not</u> double-counting and assume it was already counted. If you find that no waterbirds are present, still record survey condition information (e.g., disturbance, depth, etc.), and enter the survey condition data into the database.

Visually scan the wetland systematically, counting individual waterbirds of each species listed in Supplemental Materials 1. For larger projects, or projects where there are large numbers of waterbirds, it is often more practical to estimate numbers. A spotting scope will be required at most wetlands Estimating numbers may also be necessary if waterbirds move around the wetland or are in very tightly packed flocks.

To count waterbirds in a flock, first estimate a 'block' of waterbirds, e.g. 5, 10, 20, 50, 100, 500, 1000 waterbirds depending on the total number of waterbirds in the flock and the size of the waterbirds. To do this, count a small number of waterbirds (e.g., 10) to gain a sense of what a group of 10 waterbirds "looks like." Then count by 10s to 50s or 100 waterbirds to gain a sense of what 50 or 100 waterbirds "looks like." The block is then used as a model to measure the remainder of the flock. In the example below (Figure SOP-2.3) we use 'blocks" of 20 birds to arrive at an estimate of 320 waterbirds.

In some instances, it might not be possible to get an accurate count of each species in a mixed flock, particularly if the flock contains similar species, such as scaup or small shorebirds (i.e., "peeps"). In such cases, try to estimate the percentage of the flock belonging to each species by "sub-sampling". To do this, choose several subsets of waterbirds across the flock, then count and identify all individuals within those subsets. Then use these estimates to provide an extrapolated estimate of numbers of each species in the entire flock. When using this method, be mindful of the fact that species may not be distributed evenly among the flock, so carry out several sub-samples. As an example, in the raft of ducks in Figure SOP-2.3, you might count the waterbirds in 3 subsamples of 20 waterbirds, identifying 12, 10 and 14 Redheads among them. These 36 Redheads represent 60% of the 60 waterbirds in those 3 subsamples - extrapolating this to the whole flock (previously estimated to be 320 waterbirds) would produce an estimate of 192 Redheads.

<u>SURVEY TIP</u>: If you are surveying projects with large numbers of waterbirds, it is often best to count in teams of two, one person counting while the other records the numbers on the field sheet. Alternatively, some people like to use recording devices, so that they are not constantly interrupting counts to record information.

Figure SOP-2.3. Estimating flock size for a raft of ducks. Count members within a visualized group, for example 20 individuals, then see how many groups there are in the flock. In this example 16 groups x 20 individuals/group = 320 individuals in the flock.

Training—First-time IWMM cooperators should view the survey overviews located at http://iwmmprogram.org/protocols-data-forms/.

Inexperienced waterbird counters are advised to practice their counting and estimation techniques before participating in IWMM. This can be done in the field or at a desktop computer using Wildlife Counts software: http://wildlifecounts.com/index.html.

Young waterbirds/broods—Do not include dependent young waterbirds in counts. For geese, swans and ducks, assume juveniles are independent when they can fly. Any juveniles that did not hatch in the immediate vicinity should be included in counts (e.g. juvenile swans migrating in family groups).

Special survey techniques

Aerial Surveys—Although we do not require aerial waterbird surveys in the IWMM initiative, we would very much like to include aerial survey data if they are being completed for projects participating in the program. If you conduct aerial surveys, collect the same data as a standard ground-based whole-area count, using the same waterbird survey form.

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If aerial surveys are employed, the cooperators should note this in the IWMM database. In the bird survey database form select "Aerial Surveys" in the "Survey Type" dropdown box.

Flush Counts—Cooperators can conduct "flush counts" to get more accurate counts of waterbirds in large or densely vegetated areas. Flush counts are not required by IWMM, but if this method is employed, the cooperators should note this in the IWMM database. In the bird survey database form in select "Flush Counts" in the "Survey Type" dropdown box.

References

Chesser RT, Burns KJ, Cicero C, Dunn JL, Kratter AW, Lovette IJ, Rasmussen PC, Remsen JV, Rising JD, Stotz DF, Winker K. 2017. Fifty-eighth supplement to the American Ornithological Society's Check-list of North American Birds. The Auk 134:751-773.

Cowardin LM, Carter V, Golet FC, LaRoe ET. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Washington, D.C.

Fredrickson LH, Reid FA. 1991. 13.1.1 Nutritional values of waterfowl foods, Waterfowl Management Handbook. U.S. Fish and Wildlife Service, Washington, D.C.

Ma Z, Cai Y, Li B, Chen J. 2010. Managing wetland habitats for waterbirds: an international perspective. Wetlands 30:15–27.

Suir GM, Evers DE, Steyer GD, Sasser CE. 2013. Development of a reproducible method for determining the quantity of water and its configuration in a marsh landscape. Journal of Coastal Research, Special Issue 63:110–117.

SOP 3: Measuring Salinity

If measuring salinity with a hydrometer, you will also need a large, clear jar and a thermometer. The protocol for measuring salinity with a hydrometer (EPA 2006):

1. Put the water sample in a hydrometer jar or a large, clear jar.
2. Gently lower the hydrometer into the jar along with a thermometer. Make sure the hydrometer and thermometer are not touching and that the top of the hydrometer stem (which is not in the water) is free of water drops.
3. Let the hydrometer stabilize and then record the specific gravity and temperature. Read the specific gravity (to the fourth decimal place) at the point where the water level in the jar meets the hydrometer scale. Do not record the value where the meniscus (the upward curvature of the water where it touches the glass) intersects the hydrometer (Figure SOP-3.1).
4. Record the specific gravity and the temperature on your data sheet.
5. Use a hydrometer conversion table that comes with your hydrometer to determine the salinity of the sample at the recorded temperature. Record the salinity of the sample on the data sheet.

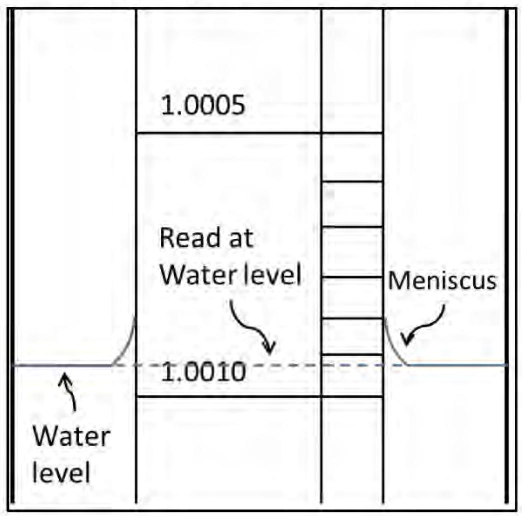


Figure SOP-3.1. Reading specific gravity from a hydrometer. Note that the reading should be taken at the water level NOT the meniscus. Redrawn from EPA (2006).

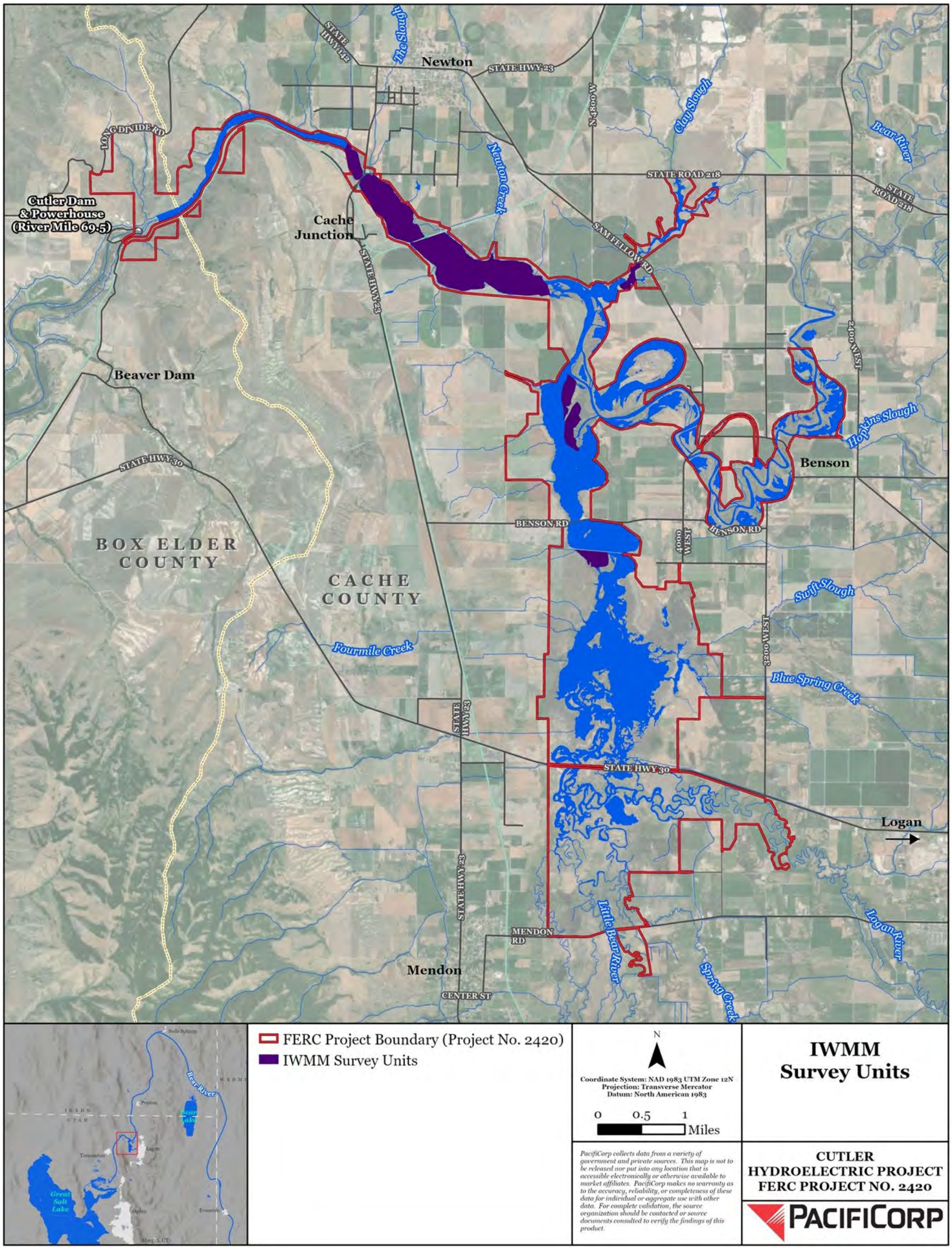
If measuring salinity with a refractometer, you will also need a dropper and a container of distilled water. The protocol for measuring salinity with a refractometer (EPA 2006):

1. Lift the lid that protects the refractometer's specially angled lens.
2. Place a few drops of your sample liquid on the angled lens and close the lid.
3. Peer through the eyepiece. Results appear along a scale within the eyepiece.
4. Record the measurement on your data sheet.

Rinse the lens with a few drops of distilled water, and pat dry, being very careful to not scratch the lens' surface.

References

[EPA] Environmental Protection Agency. 2006. Chapter 14: Salinity Pages 1–8 in Ohrel RL J., Register KM, editors. Volunteer estuary monitoring manual, a methods manual. 2nd edition. Washington, D.C.: EPA-842-B-06-003. Available: http://water.epa.gov/type/oceb/nep/monitor_index.cfm (January 2015).



Source: Cirrus 2020

FIGURE C-1 SURVEY UNITS WHERE PHASE 2 SURVEY PROTOCOLS WILL BE APPLIED

Appendix D
Land Use Initial Study Report

LAND USE
INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

Prepared for:

PacifiCorp
Salt Lake City, UT

Prepared by:

Cirrus Ecological Solutions, LC

February 2021

LAND USE
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LAND USE
INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)
PACIFICORP

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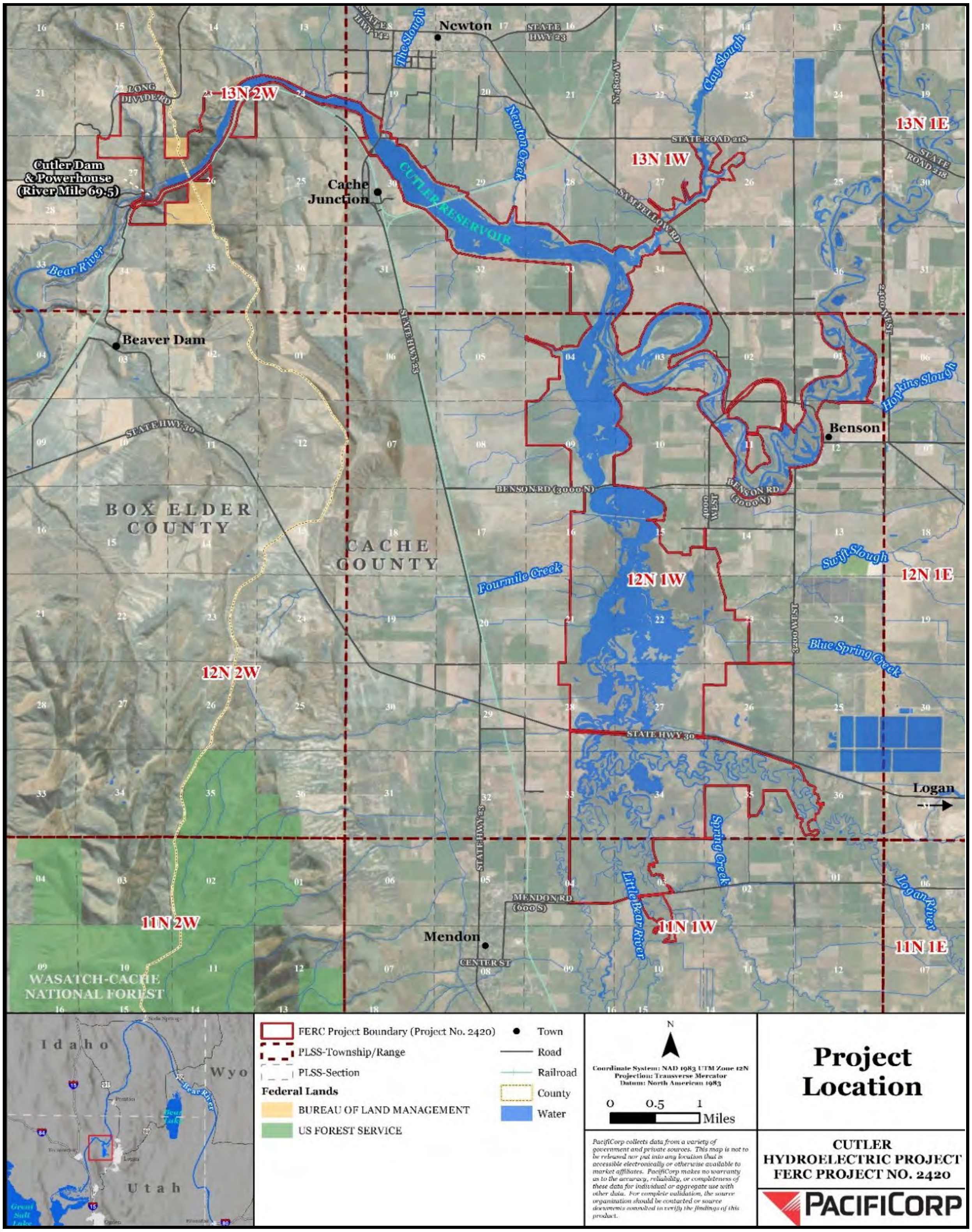
PacifiCorp

1.0 INTRODUCTION

PacifiCorp is the owner, operator, and Federal Energy Regulatory Commission (FERC) Licensee for the Cutler Hydroelectric Project (FERC No. 2420) (Project). The Project is located on the Bear River in Cache Valley, Utah, between the Wasatch and Wellsville Mountains. Although Cutler Dam is located in Box Elder County, most of the Cutler Reservoir lies within Cache County. Cutler Reservoir is formed at the confluence of Spring Creek and the Bear, Logan, and Little Bear Rivers (Figure 1-1). PacifiCorp operates the Project under a 30-year license issued by FERC on April 29, 1994; the current license will expire on March 31, 2024. PacifiCorp initiated the formal relicensing process utilizing the Integrated Licensing Process by filing the Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on March 29, 2019.

The relicensing process involves cooperation and collaboration between PacifiCorp, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. PacifiCorp coordinated with stakeholders throughout the study scoping process. They invited federal and state agencies, NGOs, and Native American tribes and tribal organizations to participate in a public meeting, workshops, scoping meetings, and a site visit. These activities facilitated the identification of study needs to be addressed. Study scoping occurred in March 2019 through February 2020, when FERC issued the Study Plan Determination (SPD). PacifiCorp, FERC and stakeholders identified the potential need for a land use study during the study scoping process.



Source: PacifiCorp 2018

FIGURE 1-1 CUTLER PROJECT LOCATION MAP

2.0 PROJECT NEXUS AND RATIONALE FOR STUDY

Although the maximum reservoir elevation would not change, future Project operations may allow greater fluctuations in minimum reservoir surface elevation than currently occur, resulting in several potential land-use effects. Although irrigation water withdrawals at existing diversions and pump sites would not be affected (greater fluctuations would not occur during the irrigation season), fences in place to control livestock movement could be bypassed by periodic fluctuations below the ordinary high-water level (OHWL), providing an opportunity for livestock trespass and/or escape. Changes in reservoir management could induce increased bank erosion, reducing adjacent agricultural/grazing land and wildlife habitat as well as impacting scenic values and water quality. Visual aesthetics could be further degraded by exposed reservoir bed. Several of these potential effects would vary according to the timing and duration of changes in reservoir elevation.

Sections 7.1.9 and 7.1.10 in the PAD describe the nexus between future Project operation and land use and aesthetic resources, respectively. Irrigation pumps currently withdraw water at numerous locations along the reservoir shoreline/Bear River banks for irrigation purposes. Some irrigators are part of PacifiCorp's Agricultural Lease Program, while others use non-Project-related lands as the destination for the irrigation, domestic, and industrial water rights that are withdrawn on Project lands. Because fullfillment of all water rights as specified by contract or other controlling document has a higher priority than hydroelectric generation at the Project, any proposed changes to future Project operations would specifically be limited to occur outside the irrigation season resulting in no changes to water delivery or diversions resulting from future Project operations.

The overall depth and gradient of Cutler Reservoir is shallow. As a result, the horizontal distance between the existing and future proposed minimum pool shorelines could be greater in lower gradient areas (such as those areas north of the reservoir confluence with the Bear River but south of Cutler Canyon).

Livestock fences are used to manage grazing in pastures adjacent to the Cutler Reservoir. Some fence lines terminate at the shoreline or slightly below the OHWL. This design prevents livestock from moving past the end of the fence into an adjacent pasture or riverbank. Where possible, PacifiCorp has altered most of the grazing leases on PacifiCorp lands to include a setback distance from the shoreline in support of bank stability and improved water quality. However, there are some grazed areas where this was not possible, or PacifiCorp buffer lands that are adjacent to other private land grazing pastures. Any PacifiCorp pastures without grazing setbacks and buffer or boundary fences that terminate at the shoreline may need the associated fencing extended to account for the full range of potential future operating pool elevations.

A proposed change in operations could affect reservoir bank erosion and stability. Any increase in bank erosion could lead to loss of shoreline lands and areas used for wildlife habitat, livestock grazing, and agriculture. Eroding banks could also contribute to water quality degradation and potential effects on aquatic species, which are discussed in the studies addressing those resources (Appendices E and F).

Changes in project operations could affect aesthetic resources in several ways. Eroding banks and shorelines could remove vegetation and potentially increase turbidity in combination with disturbed bed sediments. Changes in reservoir levels may periodically expose previously submerged areas of shallow, low-gradient reservoir bed, creating mud flats. Any repeatedly exposed mud flats could also become colonized by invasive weeds, such as *Phragmites*. Each of these could alter the existing level of visual aesthetics at Cutler Reservoir.

3.0 STUDY OBJECTIVES

The primary objective of the land use component of the Revised Study Plan (RSP) was to characterize the current status of the resources addressed in the Land Use Study and the processes through which Project operations may affect them. The focus was on water withdrawal infrastructure (e.g., irrigation diversion structures and pumps), fences used for livestock management, shoreline erosion features and control structures, and large-scale effects on visual aesthetics from key, high-use viewpoints and areas of frequent recreational use.

The RSP also included objectives to evaluate effects of PacifiCorp's potential changes to project operations on land use and aesthetic resources. This Initial Study Report (ISR) appendix provides the basis for that evaluation, which will be documented in the Draft License Application (DLA) (scheduled for submittal later in 2021).

4.0 STUDY AREA

The land use study area is primarily defined by the existing FERC Project Boundary (Project No. 2420). The study focused on the shoreline of Cutler Reservoir (Figure 1-1), and adjacent areas immediately above and below the OHWL as defined by the current range of reservoir elevations (note that the upper reservoir elevation limit is not proposed to change; the potential seasonal increased fluctuations would occur through changes to the lower elevation limit; see Section 1.3 of this ISR for additional detail regarding the proposed future operations plan). The Bear River from Cutler Dam downstream to Corinne is also included in the study area for eroding banks to monitor specific areas for bank instability (Figure 4-1). Land in the study area supports primarily agriculture and riparian/wetland or buffer habitat (PacifiCorp 1995).

Water withdrawals occur along the reservoir shoreline and tributary riverbanks. Irrigation pumps are typically used to pull water from the reservoir into canals, ditches, pipes, and other infrastructure that distribute water away from the reservoir. The study area for pumped withdrawals includes all points of withdrawal from Cutler Reservoir or its tributaries within the Project Boundary, typically below the OHWL. The study area incorporates surface structures (e.g., weirs or headgates) that regulate flow into irrigation systems.

The study area for fences is limited to sites where fences terminate at the water's edge. At these locations, livestock managers rely on elevation of the reservoir water surface to prevent livestock from moving past the end of the fence and trespassing into adjacent areas.

Reservoir shorelines, stream channel banks, and other morphologic features that could be impacted by potential seasonal changes in reservoir management are included in the study area for eroding banks. The locations of some existing erosion sites and erosion-control measures are currently known, but there may also be additional sites where notable erosion or instability exist. The study area for eroding banks is accordingly defined as the entire reservoir shoreline, reservoir tributaries to the existing FERC Project Boundary, and the Bear River from Cutler Dam downstream to Corinne (Figure 4-1). Eroding banks downstream of Cutler Dam were studied at select locations. All other erosion study sites were inside the existing FERC Project Boundary.

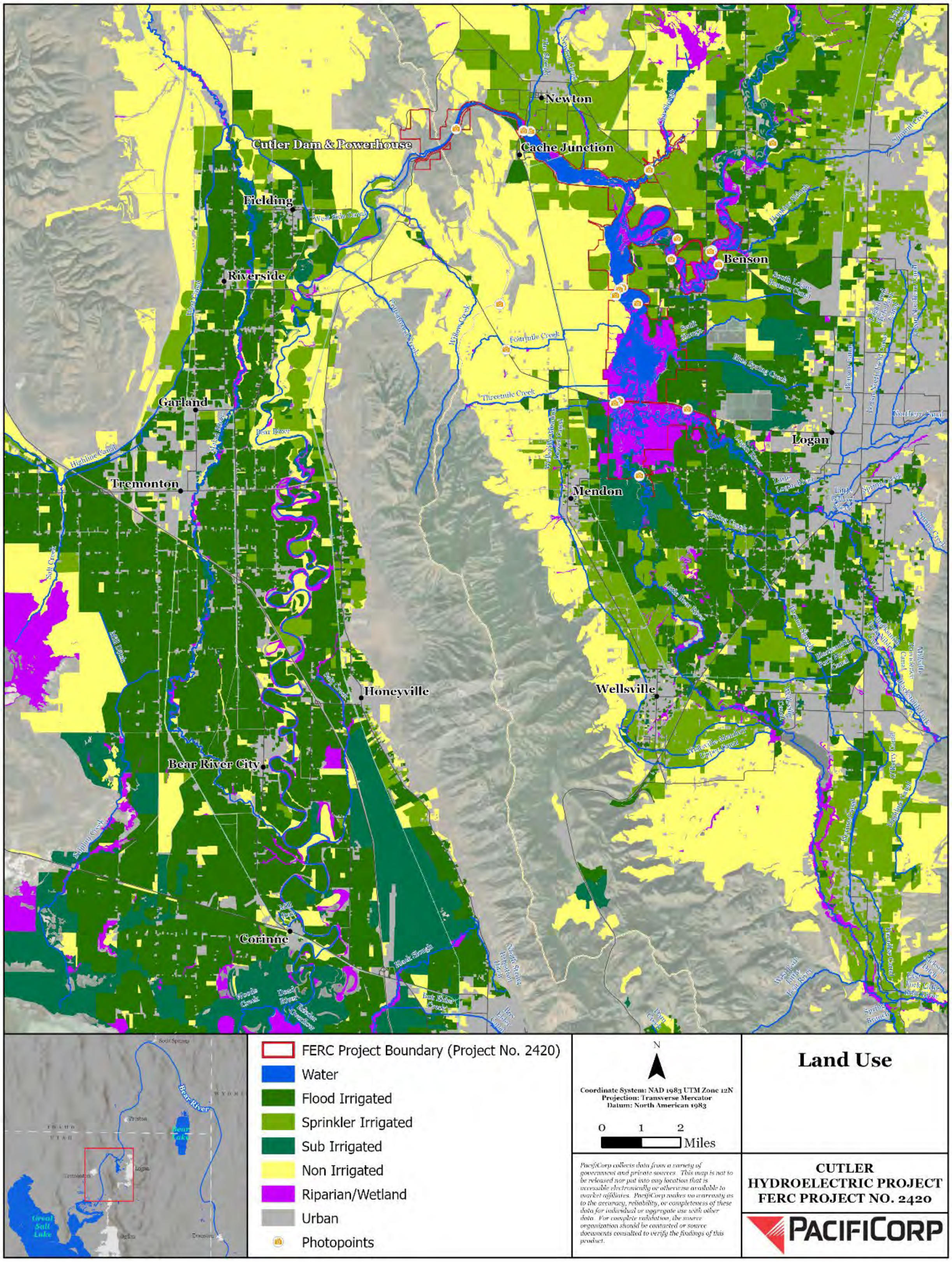


FIGURE 4-1 LAND USE STUDY AREA, INCLUDING THE FERC PROJECT BOUNDARY AND THE BEAR RIVER FROM CUTLER DAM TO CORINNE

The study area for the aesthetic resources component of this study comprises developed recreational sites and bridges on the reservoir as well as a viewpoint outside the Project Boundary where viewers may experience a vista that includes the reservoir (Figure 4-1).

5.0 METHODS

The following methods were employed to characterize the four land-use and aesthetic resources discussed above, providing a basis for subsequent evaluation of operational effects.

A drawdown of Cutler Reservoir was conducted in the fall of 2019 for the purpose of obtaining light detection and ranging (LiDAR) and bathymetry data from the reservoir. The data were used to populate a model that helped PacifiCorp determine a proposed range of alternatives for future operations, as well as to analyze potential changes resulting from proposed future Project operations. The data also helped support the other resource studies. The drawdown was scheduled for the fall of 2019 to gather critical information prior to study implementation in 2020 while complying with contractual (irrigation) and seasonal restrictions. The drawdown provided a unique opportunity to obtain the information necessary to model variable project operational conditions and collect resource data in various conditions. Therefore, for several resources, preliminary studies and/or data collection were initiated during the fall 2019 drawdown period, October 25 to November 16, 2019.

A two-dimensional (2D) hydraulic model and a sediment transport model were also employed to evaluate the existing conditions in the Project Area and to assess the feasibility of potential future operational scenarios. A detailed description of the resultant refined proposed operational scenario is included in Section 1.3 of the ISR. LiDAR data collection and drone image collection occurred during the fall 2019 drawdown. The calibrated hydraulic and sediment transport models provide a tool to predict conditions at different reservoir elevations. The hydraulic model was used in this report to identify the reservoir inundation boundary based on a given elevation at Cutler Dam. The LiDAR dataset was used to estimate physical dimensions of eroding banks.

5.1 WITHDRAWAL INFRASTRUCTURE

All water withdrawal infrastructure associated with Cutler Reservoir was inventoried for location, condition (e.g., active versus inactive),[1] and water rights. Data collection included existing records, photo interpretation, the state water rights database, and field surveys. Existing coverage of irrigation canals and points of withdrawal were screened prior to field surveys to identify the best access route to each site. Field surveys of each site were completed during the reservoir drawdown. Survey information included georeferenced photographs, a description of the irrigation structure type (e.g., pump, irrigation gate, dam safety components, low-level gate), and condition. Where possible, the withdrawal location below the OHWL was recorded with a Global Positioning System (GPS). Field survey measurement data were organized into geographic information system (GIS) coverage and a database for analysis.

Water rights associated with each withdrawal structure were determined using the location and descriptive information collected during surveys. Based on this information, point of diversion coverage maintained by the Utah Division of Water Rights was consulted to connect each withdrawal structure with the associated water right. Given the age of some infrastructure and availability of information, it was not possible to establish the water right for every diversion. Water rights information was cross-checked with the Cache County parcel map to identify instances where the property owner was different from the water right owner.

5.2 FENCES

All fences that terminate below the OHWL defined by the current reservoir elevation range of Cutler Reservoir were inventoried for location and condition. Existing fence locations included in PacifiCorp mapping coverage were used to develop field maps and screen potential field survey sites.

[1] As determined by physical appearance and other indicators of active operation.

Fences that terminated at or below the OHWL were inventoried during the 2019 reservoir drawdown. Georeferenced photographs of each site document general fence condition and relative location of the terminal fence end in relation to the OHWL. Field notes at each site included a description of the fence condition and need for repairs or potential retrofit (i.e., extension to accommodate potential greater seasonal elevation fluctuations). High-resolution aerial imagery collected during the 2019 reservoir drawdown was consulted to ensure that no fences were missed. Results of the fence inventory were organized into a GIS coverage database.

5.3 EROSION FEATURES AND CONTROL STRUCTURES

Prior to the 2019 drawdown, erosion features and bank stabilization projects in the Cutler Reservoir shoreline area were inventoried for location and condition. Consideration was given to currently eroded sites, sites with the highest potential for shoreline and channel bank erosion, and sites where PacifiCorp has undertaken erosion-control projects (i.e., bank re-contouring, rock placement, plantings, buffers, and fencing) using PacifiCorp's annual monitoring database and mapping information. Other information was collected from stakeholders and PacifiCorp employees who are familiar with the area and past erosion-control efforts. Targeted field surveys of these sites followed, including time-lapse photography of several locations during the drawdown to identify evidence of active erosion.

The Bear River downstream of Cutler Dam was studied at six representative locations to identify potential effects of Project management (Figure 5-1). Several commenters on the RSP expressed an interest in assisting with identifying areas of potential bank sloughing downstream of Cutler Dam. Their recommendations were used in selecting several of the monitoring locations within the area of flow attenuation downstream of Cutler Dam. Bank erosion was monitored during experimental releases in late 2020/early 2021 from Cutler Dam that simulated discharge under the proposed change in reservoir management. This portion of the bank stability study work was initiated in late winter/early spring of 2020, following the release of FERC's SPD, but had to be deferred partway through due to rapid seasonal changes in both temperatures and flow volume (possibly confounding results) after the first test flow. The study was re-started in early December 2020 and will not conclude until after this ISR has been published. As such, these results will be included in the Updated Study Report that will be filed later in 2021.

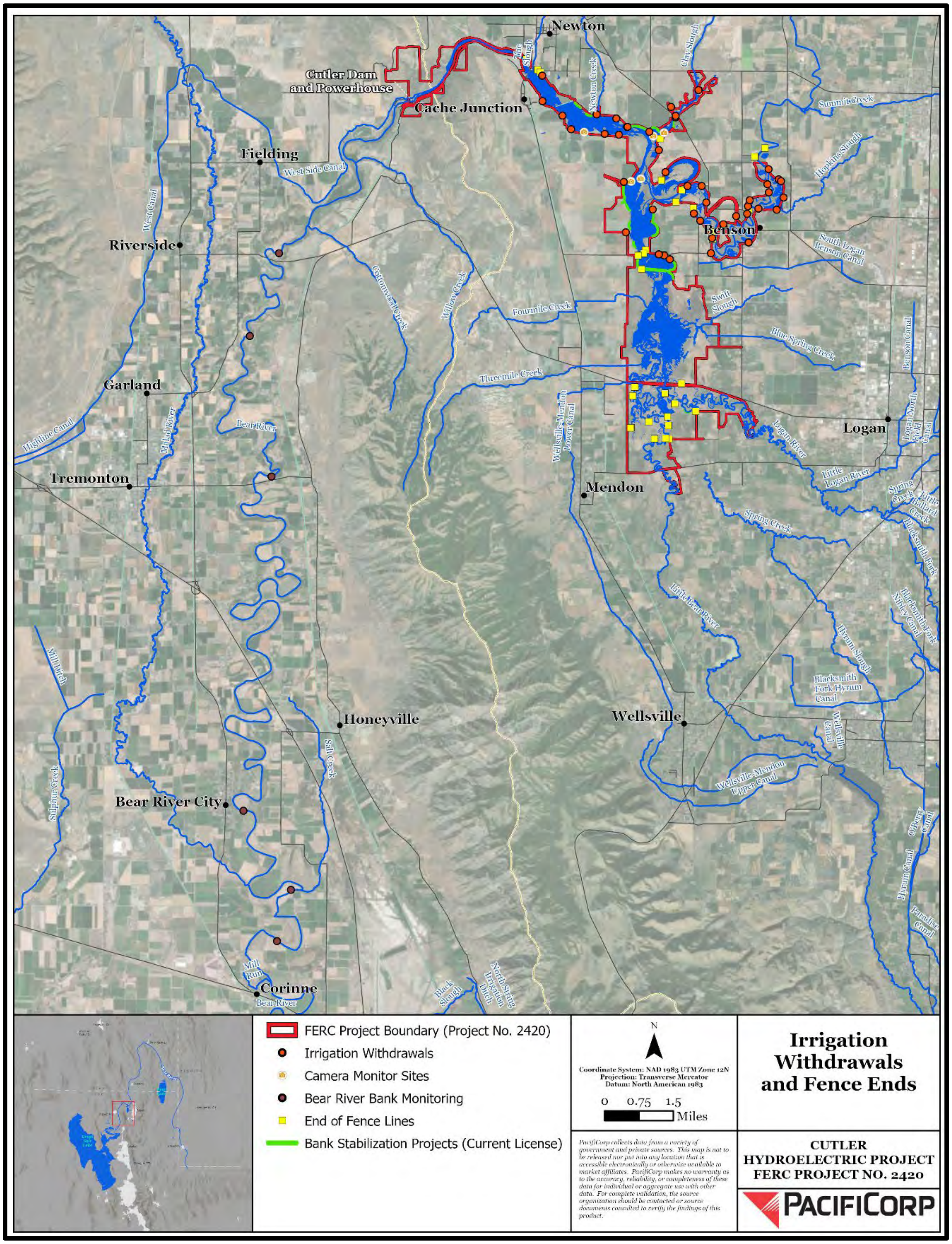


FIGURE 5-1 IRRIGATION WITHDRAWAL INFRASTRUCTURE AND FENCE END POINT LOCATIONS

Areas where past PacifiCorp bank stabilization projects have been implemented were surveyed in 2020 to determine the existing condition and function (i.e., ability to prevent ongoing erosion) of each project. These projects are also monitored annually per the existing license requirements. Existing erosion control structures were inventoried with georeferenced photos and additional GPS measurements. Needs for repair or retrofit of existing control measures were assessed with consideration of potential changes in future reservoir management. All field survey results were organized in a GIS coverage and a database.

Field surveys of these bank stabilization projects were completed during the fall seasons of 2019 and 2020. Each project was evaluated by making observations of emergent zone vegetation, slope vegetation, general condition of bank stabilization structures, and identifying any new erosion features.

Existing soil information from the Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO)[2] (NRCS 2020) was used to characterize soil and hydraulic properties of banks for reservoirs and tributary channels. Soil samples were collected from dominant soil types that comprise reservoir and river banks to confirm particle size distribution included in soil surveys. Shear strength measurements were also collected from eroding bank locations using a Gilson rotary shear vane (Model HM504-A).

Areas of potential bank erosion were identified by examining high-resolution aerial imagery collected during the 2019 reservoir drawdown. The OHWL was digitized as part of the Shoreline Characterization Study. This coverage was separated into four categories of bank types including vegetated, barren, sparse cover, and actively eroding, which also indicate the relative level of bank stability (i.e., stable or unstable). Characteristics of each category include:

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[2] The SSURGO database contains information about soil as collected by the National Cooperative Soil Survey over the course of a century. The information can be displayed in tables or as maps and is available for most areas in the United States and the Territories, Commonwealths, and Island Nations served by the U.S. Department of Agriculture, Natural Resources Conservation Service.

- Vegetated: bank stability is good with no obvious signs of erosion or instability (i.e., cracking, sloughing, etc.) and good vegetation cover.
- Armored: banks are stable and primarily covered by natural rock outcrops, boulders, or cobble or by rip-rap placed to prevent erosion from bridges, roads, railroad beds, etc.
- Sparse cover: banks are stable with limited or no sign of erosion (i.e., no sloughing or evidence of active movement). Vegetation cover is sparse, and slopes are generally less than in actively eroding areas.
- Barren: steep banks with obvious signs of active erosion (e.g., sloughing, slumping, vertical and horizontal cracks, undercut banks, etc.) with little or no vegetation cover.

The location of these categories were field validated and corrected during site visits completed in 2020. Field surveys of erosion features included georeferenced photos; GPS locations; field estimations of height and length; and observations of instability, slumping, cracks, and recent disturbance by livestock or recreational use.

LiDAR survey data collected during the 2019 reservoir drawdown was used to develop a high-resolution (6-inch pixel) elevation map for the physical dimensions of reservoir shorelines and channel banks and the adjacent bed areas. This coverage was used to characterize actively eroding (i.e., barren) bank segments. Changes in height and surface slope were measured outward from the OHWL for both the bank and bed areas using zonal statistics tools in ArcGIS.

5.4 AESTHETIC RESOURCES

This part of the study characterized scenic quality in the Project Area to establish a baseline for subsequent evaluation of the effects of potentially increased fluctuations in reservoir elevations from Project operations. Landscape value objectives, which include scenic integrity as a component (see Section 5.4.4), were developed that incorporated PacifiCorp’s Resource Management Plan (RMP) as well as existing landscape character and public expectations for Cutler Reservoir’s visual aesthetics. Baseline and drawdown photos were taken during the 2019 drawdown to provide a visual reference across a range of reservoir elevations. Visual conditions under proposed operations were then assessed relative to the landscape value objectives using a range of variables including form, line, color, and texture as they occur in this setting. Interpretation included the effects of seasonality. The methodology included these four components, which are discussed in detail below:

1. The 2019 drawdown provided the opportunity to collect photographic data across a range of reservoir elevations and establish a visual frame of reference for assessing changes associated with the proposed Project operating scenario once it was identified.

2. Hydraulic modeling of the subsequently identified proposed Project operating scenario generated modeled elevations across the reservoir at the fluctuation limits established in that scenario. Knowing where modeled elevations fell in relation to recorded elevations during the drawdown allowed assessment of projected visual conditions through interpolation of the photographic data.

3. Establishment of photopoints from which most viewers experience the Project Area landscape allowed collection of the actual photographic data from which projected visual conditions were interpolated.

4. The Scenery Management System (SMS) developed by the United States Forest Service (USFS) (1995) provided a systematic process for assessing baseline visual conditions and changes associated with the proposed operating scenario using the photographic visual reference.

5.4.1 2019 RESERVOIR DRAWDOWN

The fall 2019 drawdown was scheduled primarily to allow collection of LiDAR and bathymetric data. Over 21 days, the reservoir was lowered from full pool (4,407.3 feet[3] on October 24) down to 4,387.5 feet on November 6, then refilled. Full-pool photos were taken from all photopoints on October 24. Drawdown photos were captured at all photopoints November 1 (4,392.4 feet)

[3] Elevations reported herein refer to National Geodetic Vertical Datum of 1929, or NGVD29.

and November 6 (4,387.5 feet). These elevations are as measured at Cutler Dam by transducers deployed during the drawdown. Because the subsequently developed Project operating scenario includes only reservoir elevation ranges in the top 2.5 feet of the full operating range, from 4,407.5 to 4,405.0 feet (which includes one additional foot from the current winter low elevation limit of 4,406.0 feet; see Section 5.4.2 below), the November 6 photos were not carried into further analysis.

5.4.2 HYDRAULIC MODELING

Once the proposed Project operating scenario was identified in summer 2020 (see ISR Section 1.3), calibrated 2D hydraulic modeling was completed using data collected during the drawdown and from other sources. Among other objectives, the model results indicate how reservoir elevations would change in response to proposed Project operations.

Relative to this analysis of visual aesthetics, the model provided reservoir elevations at representative photopoints when the fluctuation limits defined by the Project operating scenario occur (i.e., elevation 4,407.5 to 4,406.5 feet under normal operations, occurring 85 percent of the time, and elevation 4,406.5 to 4,405.0 feet under extended operations, occurring 15 percent of the time; see Section 1.3 of the ISR). This provided a basis for assessing scenic effects related to operational drawdowns by interpolating from the reference photos taken during the 2019 drawdown.

The model results indicated when and where elevation changes beyond those occurring under current Project operating parameters are projected to occur (i.e., those that would potentially occur seasonally in the range below the current winter operating elevations, from 4,406.0 to 4,405.0 feet), thereby meeting the objective of this study.

5.4.3 PHOTOPOINTS

Photographic data was collected at photopoints that included PacifiCorp recreation sites, bridges within or near the Project Boundary, and State Highway 30 entering Cache Valley from the west. Upstream and downstream views were documented from several of these locations, resulting in 26 photopoints (see Section 6.5.3). Photographic data provided objective documentation of visual aesthetics across the Project Area that was used to verify and flesh out the variables employed in SMS.

Baseline (i.e., full pool elevation) photographs of the reservoir at the photopoints were compared to duplicates from the same viewpoints, using the same equipment and methods, during two phases of the fall 2019 drawdown.

Photographs were taken with a tripod-mounted Canon 7D DSLR camera. A 24-millimeter lens was used to most closely approximate the functioning of the human eye (Cicala 2012). To the extent possible, each photograph series was taken at the same time of day and under similar weather conditions. Where appropriate, single images from a photo point were stitched into panoramas where that resulted in a more informative visual representation, particularly for more distant views of horizontal shorelines.

5.4.4 SCENERY MANAGEMENT SYSTEM

The SMS was developed to serve two functions: inventory and analysis of the aesthetic values of national forest lands, and easy integration of aesthetics with other biological, physical, and social/cultural resources (USFS 1995). Those functions matched the needs of this study well. SMS generates a Landscape Value rating based on the following factors: Landscape Character, Scenic Attractiveness, Distance Zone, Concern Level, Scenic Class, and Scenic Integrity (see Section 6.5.4 for details).

5.5 MODIFICATIONS TO METHODOLOGIES

5.5.1 WITHDRAWAL INFRASTRUCTURE

No modifications were made to methodologies proposed in the RSP for evaluating irrigation withdrawals.

5.5.2 FENCES

No modifications were made to methodologies proposed in the RSP for evaluating the terminal ends of fences below the OHWL.

5.5.3 EROSION FEATURES AND CONTROL STRUCTURES

No modifications were made to methodologies proposed in the RSP for evaluating erosion features and control structures.

5.5.4 AESTHETIC RESOURCES

The methodology described above (Section 5.4) reflects three changes from the original study plan for visual aesthetics. First, the number and make-up of photopoints was revised. The RSP identified photopoints at 15 developed PacifiCorp recreation sites operated on the reservoir as well as two photopoints outside the Project Boundary from which travelers are exposed to panoramic views of the reservoir and its surroundings, for a total of 17 photopoints. As the study was implemented, PacifiCorp added photopoints, generally at bridges within or near the Project Boundary, with upstream and downstream views from several of the photopoints. The photopoint on the Long Divide Road was dropped as it did not provide a useful vista over the reservoir. As a result of these changes, the number of photopoints evaluated increased from 17 to 26.

Second, the RSP states, “Effects on aesthetic resources, specifically scenic quality, will be completed using information on the amount and extent of exposed areas resulting from a 3-foot and a full drawdown of the reservoir completed in fall 2019.” However, it was subsequently determined that a 3-foot elevation range as measured at Benson Marina as part of the full drawdown would <u>not</u> simulate potential proposed Project operations; further, once the drawdown was underway, it became clear that the reservoir elevations would not get to 3 feet below full pool at Benson Marina (i.e., the lowest elevation reached at Benson Marina was 2.6 feet below full pool). While the initially targeted 3-foot drawdown at Benson Marina was not achieved, the photographic data collected did capture the range of surface elevations possible, including 2.6 feet at Benson Marina, and thus provided a sound basis for meeting the study objective.

Also, as noted above (Section 5.4.1), the proposed Project operating scenario includes minimum reservoir elevations only 1 foot below the current winter operating elevation range. As a result, the full-drawdown photos are not included in this analysis, and the full-drawdown scenario is not discussed in the results (Section 6.5).

Third, the RSP notes that this analysis will define “scenic integrity objectives.” However, the summary rating from SMS is Landscape Value, which incorporates scenic integrity, and that is the value generated by this analysis (see Section 6.5.4.).

6.0 RESULTS

6.1 REVIEW OF EXISTING INFORMATION

The 1995 RMP for Cutler Reservoir (PacifiCorp 1995) includes conditions found in Article 402 of the current FERC license as well as goals and recommendations from agencies, advisory groups, and the public. Resource management goals in the RMP that are related to this Land Use Study include: enhance water quality (through establishment of grazing and buffer fences and installation of bank stabilization projects); protect, enhance, and develop wildlife habitat (again, through establishment of fences and conversion of some agricultural areas to wildlife habitat); enhance visual aesthetics (through removal/replacement of cars in some areas for bank stabilization, and recontouring and stabilization of additional areas of eroding reservoir shorelines); and provide agricultural land-use opportunities (PacifiCorp 1995). Reducing erosion from shorelines, river channel banks, and fields have helped to meet RMP goals for water quality, wildlife habitat, and visual aesthetics under the current license. Identifying specific water withdrawal structures will help maintain irrigation and agricultural land-use opportunities, where appropriate, and allow inactive/abandoned infrastructure to be identified.

Considerations identified by stakeholders related to the RSP are discussed in the FERC scoping document (FERC 2019) and the PAD (PacifiCorp 2019). Other considerations have been gathered during public meetings hosted by PacifiCorp with the intent of identifying specific concerns from stakeholders. Some of the concerns expressed by the public include potential effects of existing and future Project operations on:

- Water withdrawals and the Bear River water rights that support withdrawal at each location.
- Discharge from the nearby and upstream Logan City Wastewater Treatment Plant (WWTP).
- Reservoir bank erosion and potential loss of shoreline lands that currently include buffers, wildlife habitat, and property leased for agricultural land use.

- Channel bank erosion downstream of Cutler Dam resulting from water level fluctuations.
- Visual aesthetics at recreation sites and other high-use viewpoints on and near Cutler Reservoir.

Water rights in Utah and other Western states are controlled by the Doctrine of Prior Appropriation, under which the most senior water rights have priority over more junior water rights. The most senior water rights in Utah on the Bear River system between Bear Lake and Cutler Reservoir belong to the Bear River Canal Company (BRCC), which is supported by water from Cutler Reservoir (PacifiCorp 1995). The obligation to meet water rights is codified in state law, and in several decrees and agreements, and is part of PacifiCorp's existing license for operating Cutler Dam. Any potential change in future reservoir management must also continue to meet existing water rights and is proposed to do so.

Logan City WWTP discharge enters Cutler Reservoir through Swift Slough. The amount and quality of discharge is regulated by the Utah Division of Water Quality. The city is constructing a new facility to meet water quality standards in their permit. Discharge from the new facility will generally follow the same path as existing flows, with some exceptions. Receiving water elevation can potentially influence the rate that discharge moves away from a WWTP. Although changes in water level that reduce this flow rate could potentially influence WWTP operation efficiencies and create additional concerns in moving discharge into the reservoir, as Cutler's upper reservoir elevation will not change, this concern will not result in any changes to current WWTP conditions.

Erosion from Cutler Reservoir shorelines and Bear River channel banks has occurred in the past due to several factors, including the geologic history of Cache Valley soils; normal river bed and floodplain processes; land use practices that remove protective vegetation and expose soil surfaces; reservoir operations (both at Cutler and upstream) since the creation of the Bear River/ Bear Lake irrigation water storage and conveyance system; wave action created by recreation uses such as motorboats and jet skis; steep banks; and freeze-thaw cycles that lead to cracking and slumping. Limits on the Project reservoir water elevation are currently in place to regulate the increase or decrease in water surface elevation (known as the operating range or the reservoir dead band), regardless of whether PacifiCorp is generating power. The operating range minimizes changes to reservoir nesting wildlife habitat upstream of the dam, as well as decreases instability and erosion from saturated channel banks resulting from repeated large shifts in shoreline/bank water elevation acting on erodible (often high clay content) soils. Eroding banks in the Project Area have substantially improved during the last three decades due to removal and replacement of concrete and car bodies that were used to prevent erosion. PacifiCorp has replaced these materials primarily with a combination of recontouring and planting banks with native shrubs, and the addition of large rock past the toe of the resultant slope and planting the area in between the slope and the rock with emergent vegetation and willows ('breakwater' technique). Some areas have also used rock gabions, riprap, geotextiles, and bank revetments to dissipate energy from waves and flowing water. During periods when no power is generated and all inflow is passed through Cutler Reservoir, Bear River banks downstream of Cutler Dam still experience erosion due to natural variations in hydrology and the fundamental nature of rivers and land erosion.

Regarding aesthetic resources, the PAD (Section 7.10.1) states, "Historically, shoreline conditions around the main body of the reservoir were unattractive due to eroded banks and the lack of vegetative cover. Along many stretches of this shoreline, there were lines of rusted car bodies purposely placed end-to-end to provide bank stabilization. Implementation efforts associated with the Project RMP, however, have greatly improved the visual aesthetics of the shoreline by removing hundreds of old car bodies from the banks and establishing a vegetated shoreline buffer, including shrub plantings and bank stabilization, and fencing to exclude agricultural use from the shoreline. These measures have been quite effective, and there are currently no known issues regarding visual aesthetics within the Project Area or associated with the Project facilities or operations."

6.2 WITHDRAWAL INFRASTRUCTURE

All irrigation infrastructure identified in this study were irrigation pumps and intake pipes. A total of 44 sites were identified using location information from the Lower Bear River Distribution System and Utah Division of Water Rights and surveyed during a field visit. Forty of these sites can potentially withdraw water from the Cutler Reservoir or the Bear River. Three of the remaining sites are not operational because infrastructure is missing (e.g., pumps, intake pipes, etc.). One site cannot withdraw water because it is under construction. Figure 5-1 shows the location of survey sites, and Table 6-1 includes a summary of available information from the Lower Bear River Distribution System and the Utah Division of Water Rights. Additional detail is available in Attachment D-1, including field notes, available data from public records (e.g., parcel owner, water right number, etc.), and photographs.

A total of 21 structures were identified that historically or currently pumped water from the reservoir or minor inlets to the reservoir (e.g., Clay Slough). One additional structure that will pump from the reservoir is under construction. The remaining 22 structures are located on the Bear River. All reservoir sites are located from the Newton Bridge at the downstream end and extending upstream past the confluence with the Bear River to the Railroad Fishing Bridge south of Benson Marina. The furthest upstream site located on the Bear River is approximately 1,000 feet downstream of the current FERC Project Boundary. Most pumps are powered by electricity although a few are connected to propane or diesel motors with auxiliary fuel tanks. All pumps are monitored through a telemetry network that allows the Lower Bear Distribution System to observe pumping activity in real-time and quickly determine when pumps are not operating efficiently (J. Watterson, personal communication, October 21, 2020).

6.2.1 2019 DRAWDOWN RESULTS

From November 1 to 6, 2019, each structure was surveyed during during the reservoir drawdown to establish the elevation of the lower end of each intake pipe. Most pumps that draw water from the reservoir are connected to pipes that extend far into the reservoir to maximize water depth and pumping efficiency (based on net positive suction head) and also to reduce the potential for interrupting flow when reservoir water elevations vary. Pumps that draw from the Bear River have intake pipes that draw from equal or greater depths over a much shorter distance compared to pumps that draw from the reservoir.

TABLE 6-1 IRRIGATION WITHDRAWAL STRUCTURES AND POTENTIAL OPERATIONAL STATUS IN THE PROJECT AREA

ID	STATION NAME[1]	OPERATIONAL	ID	STATION NAME	OPERATIONAL
1	46 Dale Benson	Yes	24	Gordon W. Ricks	Yes
2	Duane W. Griffin	Yes	25	34 Harold Falslev (Kevin Falslev)	Yes
3	31 USU	Yes	26	Harold N. Falslev	Yes
4	32 USU	Yes	27	Falslev	No – relocated
5	Ex3 Garth Benson	Yes	28	Nolan R. Ballard	Yes
6	54 USU	Yes	29	Nolan R. Ballard	No – pump removed
7	37 Bullen Farms	Yes	30	Harold N. Falslev	Yes
8	35 J. Golden Rigby	Yes	31	W. Lee Reese, Robert E. Griffiths	Yes
9	Todd N & Norene R Trs Ballard	Yes	32	T01 Lee Reese	Yes
10	55a Todd Ballard	Yes	34	T03 Tom Reese	Yes
12	50 Bob Munk	Yes	35	39a Wayne Watterson	Yes
13	51 Russ Seamons	Yes	36	09 John Allen	Yes
14	William L. Lindley	Yes	37	08a Reese-Ballard	Yes
15	Paul F Cardon, Norma Seamons	Yes	38	Ex1 Preston, Saunders, Johnson	Yes
16	42 Joe Cowley	Yes	39	11c Jim Watterson	Yes
17	Paul F. Cardon	Yes	40	43 Bullen Farms	Yes
18	15b Larry Falslev	Yes	41	11a Lee Johnson (Kimber Johnson)	Yes
19	16 Mike Falslev (Previous: Rulon Falslev)	Yes	42	36 Norval Johnson (Nick Galloway)	Yes
20	22a Laron Falslev	Yes	43	53 Cecil Archibald	Yes
21	30 J.L. Watterson	Yes	44	PacifiCorp	No – intake and power removed
22	Norval H. Johnson	Yes	803	M. L. Ballard, Larry J And Mary Falslev Family Trust	Yes
23	11 Benson-Bear Lake Irr. Co.	Yes	804	West Cache Irrigation Company	Under construction

[1] Station names are as stated in Utah Division of Water Rights database.

During the 2019 drawdown, most intake pipes connected to pumps near the reservoir were exposed and accessible for surveying. Some structures on the reservoir and Bear River had already been winterized to remove the intake pipe and screened valve to prevent them from freezing in the sediment and ice. Some structures were connected to stilling wells or basins filled by a pipe or ditch connected to Cutler Reservoir. These were the largest withdrawal structures identified in the survey. Other pipes were connected to floats that allowed the pipe to remain at a fixed distance below the surface as water elevations changed in the reservoir or Bear River. Some intake pipes in the Bear River section extended several feet below the water surface and could not be located, even during the 2019 drawdown.

The 2019 drawdown reached the maximum mechanically attainable depth at Cutler Dam. Although the drawdown did create a corresponding decrease in water surface elevation in the river, intake pipes located on the Bear River (with the exception of one) remained submerged during the fall 2019 drawdown. Most of the intake pipes in Cutler Reservoir were exposed during the drawdown. However, it should be noted that the drawdown and future operating changes were/are explicitly timed to not interfere with the irrigation season, eliminating any issues regarding irrigation infrastructure. Several withdrawal locations could not be accessed by boat due to the shallow water during the drawdown. Efforts were made to contact landowners to visit those sites. Where landowners could not be contacted, drone technology was used to map locations and collect site characteristics during the drawdown period.

6.2.2 RESERVOIR MANAGEMENT AND IRRIGATION WITHDRAWALS

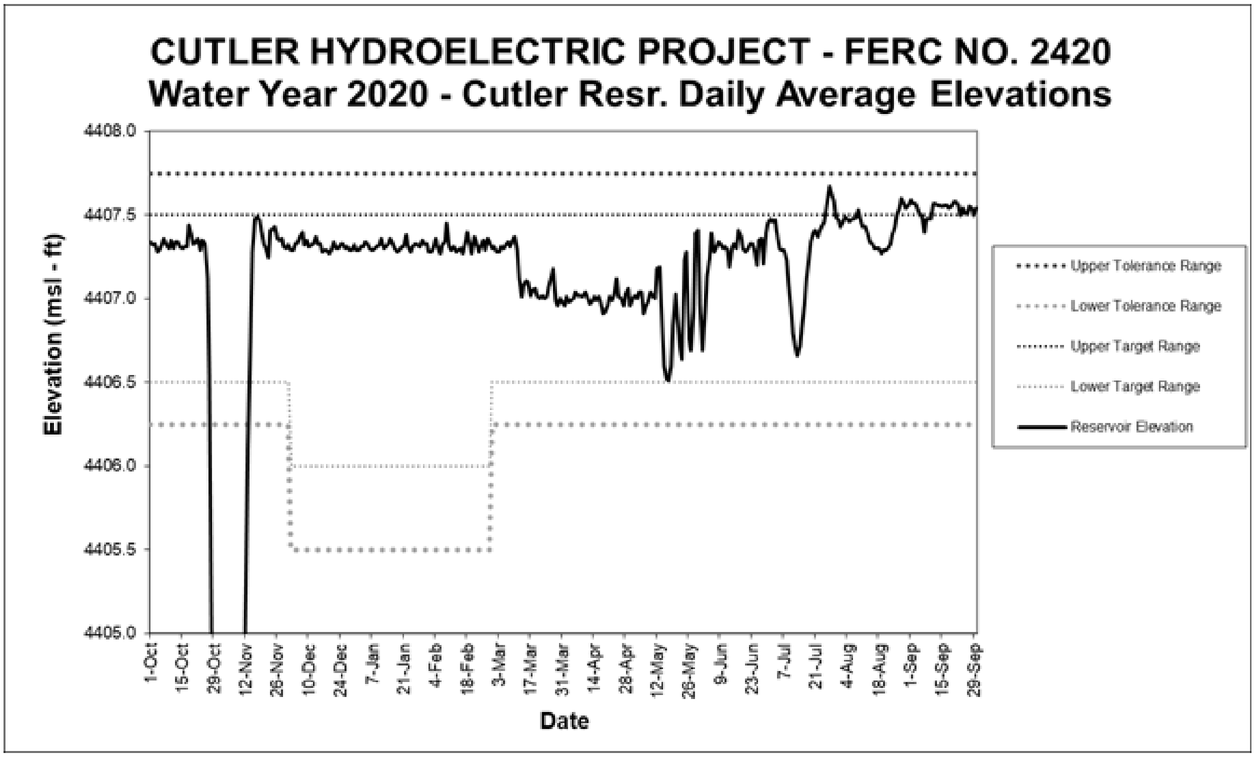
Reservoir management requirements are defined in the existing Cutler license and related RMP (PacifiCorp 1995). Table 6-2 shows the current operating range for Cutler Reservoir elevations measured at Cutler Dam (FERC 2002). Compliance with the operating range is verified from average daily reservoir levels and reported to FERC each year.

TABLE 6-2 CUTLER RESERVOIR ELEVATION OPERATING RANGE BASED ON THE 2002 AMENDED OPERATING PLAN.

TIME PERIOD	OPERATING RANGE (FEET ABOVE NGVD29)	TOLERANCE (FEET)	TARGET PERCENTAGE
March 1–December 1	4,407.5–4,406.5	+ 0.25 - 0.25	95%
December 2–February 28	4,407.5–4,406.0	+ 0.25 - 0.50	90%

Note: Water surface elevation is measured at Cutler Dam
Source: FERC 2002

Variations in daily water surface elevation measured during two recent water years are shown in Figure 6-1, as an example of typical fluctuations that occur within the operating range (with the exception of the fall 2019 study drawdown shown in the 'Water Year 2020' figure which is not typical). The periodic decrease in water surface elevation during March–June most frequently occurs when snowmelt runoff creates high water conditions throughout Cache Valley that overwhelm the ability to move water downstream of Cutler Dam most efficiently. When these conditions occur, the water elevation at the dam is deliberately lowered below the operating range lower limits to help move water through the system and minimize the resultant localized flooding effects. Rarely, excursions from the prescribed reservoir deadband can mimic this pattern when irrigation demand increases before storage from Bear Lake can be transferred to Cutler Reservoir. During this time, water elevations throughout the reservoir (rather than just at the dam) will be at the lower end of the compliance band. The transfer process can take several days depending on hydrologic conditions that vary between years (C. Baldwin, personal communication, October 26, 2020).



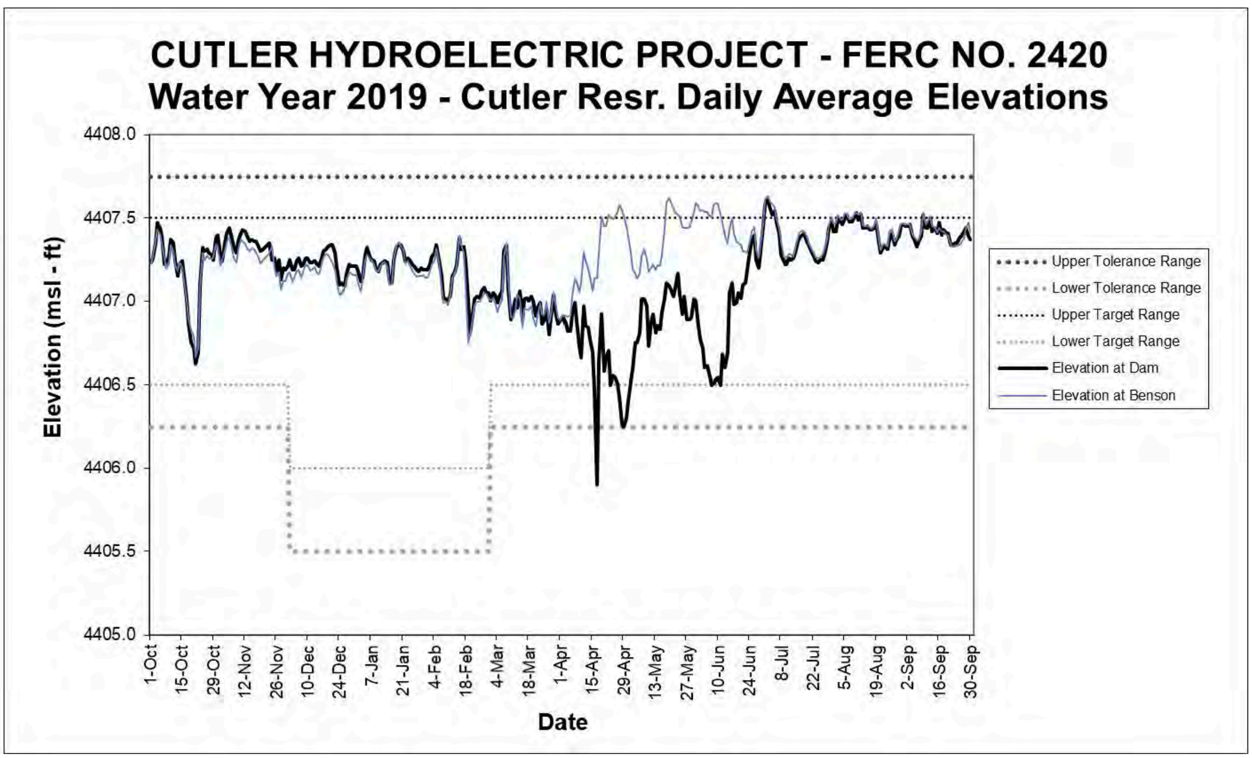


FIGURE 6-1 DAILY WATER SURFACE ELEVATION VARIABILITY IN WATER YEARS 2019 AND 2020

Changes have occurred in the reservoir bed elevation over time due to sediment transport and deposition, particularly resulting from notable high flows in the early 1980s. These changes have created additional complexity in how the water surface responds to reservoir discharge, particularly in upstream reservoir management units where some irrigation pumps are located. Options considered to improve the ability to manage reservoir elevation have included using the Benson Marina gage instead of the Cutler Dam gage (PacifiCorp 1999). Although lack of technology made this infeasible when original studies were completed, advances in technology now make this a reasonable future license-term potential (PacifiCorp 2018).

The irrigation season spans April through October of each year. Surplus water is typically not available during this time for power generation or other uses downstream of Cutler Dam, as all available water is generally needed to meet irrigation water rights, except during high inflows (typically during runoff), when all water volume exceeding BRCC water rights is passed downstream through either generation (via an intake to the powerhouse located at Cutler Dam) or the spill gates. The most senior rights to water from Cutler Reservoir (1889–1914) belong to BRCC and total 900 cubic feet per second. Water is delivered to BRCC through two diversion structures located at Cutler Dam, the West and Hammond (East) canal headgates. Other less-senior irrigation withdrawals in the Project Area occur upstream of the dam either from Cutler Reservoir or the Bear River. These withdrawals are monitored by the Lower Bear River Distribution System river commissioner (J. Watterson, personal communication, October 21, 2020).

Irrigation withdrawals located on the Bear River upstream of Hopkins Slough are typically not affected by reservoir management (Figure 5-1). Pumps located further downstream, on the reservoir, or away from the Bear River channel (e.g., pumping from ponds filled by diversions from the Bear River) are more likely to be influenced by sudden variations in water surface elevation. Site-specific conditions near each intake pipe and the design of each withdrawal structure also influence how water surface elevation influences pump performance.

When water surface elevations drop, the amount of energy required to move water up to the elevation of the pump increases. These changes are reflected in a lack of pressure and water volume coming from the irrigation pump, even though the intake pipe may still be completely submerged. If air enters the intake pipe, suction head is broken, and the pump must be manually primed. Extended pumping at low water surface elevation can also cause sedimentation around the screen at the end of the intake pipe. This may require excavation and relocation of the intake pipe, which is a substantial investment of time and resources. For all these reasons, no changes to existing reservoir operations during the irrigation season are proposed.

6.2.3 HYDRAULIC MODEL RESULTS

The inundation boundary defines the lateral extent of water in Cutler Reservoir and the Bear River. This boundary changes depending on inflow and outflow rates at the reservoir and could potentially affect irrigation withdrawal structures identified in Table 6-1. Withdrawal infrastructure locations identified during the existing record review, field survey, and imagery analysis were compared to the calibrated 2D hydraulic model inundation boundaries for proposed normal (elevation 4,407.5 to 4,406.5 feet) and extended (elevation 4,406.5 to 4,405.0 feet) operating ranges. Proposed operations are discussed in detail in Section 1.3 of the ISR.

The modeled inundation boundaries also determined how far upstream on the Bear River that changes in water surface elevation would occur following any potential decrease in surface elevation at Cutler Dam. The model accounted for travel time based on flow and discharge rates, so that the duration of any potential effects could be estimated for any location. Based on hydraulic modeling results, one irrigation pump intake on the Bear River could be exposed during the proposed normal operating range (which also could occur currently during the irrigation season and constitutes no change from the existing reservoir elevations). Model results indicate all other pump intakes remain submerged during the normal operation range. Model results indicated that intake lines to four additional pumps could be affected during the proposed extended operating range, although extended operations, by definition, could only occur outside the irrigation season.

Model results are considered to be conservative. As noted above, the upper reservoir limit is not proposed to change, and no changes are proposed during the irrigation season; therefore, the existing range of water surface elevations that occur during that time would continue.

6.3 Fences

Fences are used in the Project Area as part of the agricultural lease program under three main program components: grazing leases, farming leases, and wildlife food/cover leases. Fences may also be located on the Project Boundary/PacifiCorp ownership boundary, and function to protect shorelines and buffers from grazing on adjoining private lands. More specifically, only fences that terminate near or below the OHWL and rely on water surface elevation to prevent livestock trespass are reviewed in this study. Location of existing livestock management fences were identified from PacifiCorp map coverage and used to identify potential locations where a fence might end below the OHWL, followed by field verification.

6.3.1 2019 Drawdown Results

Fences that terminate near the OHWL were surveyed during the 2019 drawdown at the same time as field surveys for irrigation withdrawals. Terminal ends of fences found near or below the OHWL were recorded using a GPS unit with sub-meter accuracy.

High-resolution imagery (6-inch pixel size) was collected during the drawdown to provide visual coverage of the entire reservoir and shoreline area. This imagery was used to identify additional fence end points that were not shown on existing PacifiCorp map coverage or located by field surveys completed during the drawdown. Figure 5-1 shows the location of all fence end points located near or below the OHWL; there are 35 terminal endpoints of fences that meet this description.

6.3.2 Hydraulic Model Results

Terminal endpoints of fence locations identified during the field survey and imagery analysis were compared to the calibrated 2D hydraulic model inundation boundaries for proposed normal (elevation 4,407.5 to 4,406.5 feet) and extended (elevation 4,406.5 to 4,405.0 feet) operating ranges. Proposed operations are discussed in detail in Section 1.3 of this ISR. Based on this analysis, two fence endpoints remain submerged/connected through both operating ranges, 32 fence endpoints are either currently exposed or could be exposed during proposed normal operating range (or are located far enough upstream that they are not influenced by reservoir management; since the proposed future operations plan is the same as the existing operating range, this would not constitute a change from current conditions), and one fence endpoint may be exposed/left less functional during the proposed extended operating range (see Attachment D3, which shows all 35 fence endpoints identified).

6.4 Erosion Features and Control Structures

The 1995 RMP identified eroding shorelines and stream channel banks in the Project Area, including Cutler Canyon (about 3 miles), between Cutler Canyon Marina and Benson Marina (28 percent of shoreline area – no mileage provided), and the Bear River (about 5 miles). Reasons for erosion in these areas potentially include fine-textured soils, vertical banks, lack of vegetative cover, agricultural activities, and water-level fluctuations.

More recent studies mention erosion from the Cutler Reservoir shoreline (DWQ 2010) and the Bear River downstream of Cutler Reservoir (DWQ 2018) as a water quality concern. However, neither study linked erosion from these sources to Project operations.

Physical characteristics such as soil texture and bank dimensions can influence bank stability following changes in soil moisture and temperature. Saturated soils will drain from exposed surfaces in response to a decrease in water surface elevation. As soils drain, the internal pore pressure of saturated soils may cause instability and sloughing. Bank instability can also occur in the spring following cycles of freezing and thawing that create cracks, fissures, and generally disrupt soil structure. Surface vegetation protects soil surfaces and provides internal structure to shorelines and channel banks to resist slumping and other types of instability. Past agricultural practices have removed vegetation adjacent to Cutler Reservoir and the Bear River through tilling, herbicide application, and livestock grazing. This has reduced soil stability in affected areas. The creation and protection of vegetated buffers of various widths around almost all of the Cutler Reservoir shoreline over the current license period has in large measure ameliorated the effects of bare, eroding lands adjacent and within the FERC Project Boundary.

Modifications to existing Project operations were formally approved in 2002 (FERC 2002) based on the results of a 3-year study of the Bear River Basin (PacifiCorp 1999). Project operations during the current license period have resulted in relatively consistent surface elevations, as noted in annual monitoring reports submitted to FERC. This management effort was identified in previous reports as an opportunity for reducing erosion impacts from reservoir shorelines and channel banks (PacifiCorp 1995, PacifiCorp 1999).

PacifiCorp has participated in bank stabilization projects to reduce shoreline erosion, even prior to the 1994 license, which when coupled with establishment of vegetated buffers, has eliminated much of the active erosion on the reservoir shoreline. Some erosion still occurs however, primarily in response to waves generated by recreation and wind. PacifiCorp follows self-imposed discharge guidelines to limit bank erosion in the Bear River downstream of the Project. Also, when a significant mass of ice has built up on the river downstream, flow fluctuations are avoided to reduce the possibility of ice-dam flooding.

The remainder of this section reviews the results of data collection and analysis of bank conditions where erosion potential is greatest.

6.4.1 2019 DRAWDOWN RESULTS

As noted above, some areas with active reservoir shoreline erosion were identified prior to the 2019 drawdown. Sites were selected based on the presence of steep slopes, bare surfaces, large cracks, and sloughed material near the water's edge. Cameras were installed at five sites to collect time-lapse photos during the period of reservoir drawdown in 2019 to see if any slumping or soil movement occurred (Figure 5-1). Cameras were attached to a 9-foot metal post approximately 25 feet offshore and facing the shoreline. Photos were collected every 5 minutes October 26–November 15, 2019, to identify when soil movement occurred.

Maximum bank exposure generally occurred within the first 48 hours of the drawdown, with additional bed exposure occurring as water elevations continued to decrease. Prior to the drawdown, minimum daily temperatures were well above freezing, although on October 30, 2019, essentially at the start of the drawdown, minimum daily temperatures dropped substantially to 1 degree Farenhiet (°F) and remained well below freezing for several days. These temperatures are not typical of late October/early November in northern Utah and affected several facets of the preliminary drawdown studies. The drawdown was planned for as early as possible following the end of the irrigation season specifically to avoid the complication of extremely cold and sustained below-freezing temperatures. However, no movement of reservoir banks was observed by cameras during the drawdown period at any of the monitoring sites, even after temperatures had ameliorated.

High-resolution imagery (6-inch pixel size) was collected during the drawdown to provide visual coverage of the entire reservoir and shoreline area. This imagery was used to define the OHWL of Cutler Reservoir and the Bear River channel flowing into the reservoir. The high-resolution camera data collected during the 2019 drawdown covered all of the reservoir shoreline area and all tributaries to the reservoir in the FERC Project Boundary with the exception of the most upstream segments of the Little Bear River, Spring Creek, and the Logan River. The mapping accounted for 101 miles of reservoir shoreline and river channel banks. Reservoir inundation boundaries, defined by the hydraulic model for existing and proposed management scenarios, were captured entirely by the imagery.

6.4.2 BANK EROSION ON BEAR RIVER DOWNSTREAM OF CUTLER DAM

As noted in Section 5.3, results of this portion of the Land Use Study are pending; completion of field surveys during experimental test flows are planned during December 2020 and January 2021.

6.4.3 BANK STABILIZATION PROJECTS

Existing bank stabilization projects were identified at 18 locations in the Project Area (Figure 5-1). These projects have been implemented and maintained during the current license period over the last 30 years to improve the physical stability of shorelines and bank areas, and eliminate erosion at those sites (PacifiCorp 2018).

Table 6-3 summarizes bank stabilization project survey results documented in previous PacifiCorp surveys (2002 and 2013–2017; PacifiCorp 2018) and in field surveys completed for this study. The results of past monitoring are based on 1) condition of bank stabilization components and their ability to prevent erosion; 2) condition and trend of site vegetation; 3) presence of new or enlarged bank failures; and 4) incidental wildlife use (PacifiCorp 2002). Past monitoring results show a small decline in project condition in 2016 when damage to shrub plantings at some project locations was noted as a result of overspray from county herbicide applications (applied without consultation/coordination from a boat, creating large swaths of non-target damage). These sites were visited again in 2017. Although impairment was still evident, especially on older and established woody shrubs, each site was found to be regenerating at least some new growth.

Results from the 2020 field surveys for each project site are shown in Table 6-3 and in Attachment D2. In general, the survey found all projects remained in good condition and were maintaining bank stability. Some projects showed small segments of eroding banks that did not affect the overall performance. These are noted in the assessment of each project in Attachment D2. Projects that included the breakwater design were functioning particularly well. This design includes large rocks placed parallel to but 1–3 feet off the toe of recontoured banks, followed by planting emergent wetland and riparian vegetation between the rocks and the toe of the sloped shoreline. Wave energy is dissipated against rocks that protect adjacent soils. The recontoured banks are also planted with native shrubs extending up from the shoreline. Shoreline vegetation in these areas continues to provide bank stability as well as habitat for aquatic and terrestrial wildlife. In many locations, rocks were difficult to identify due to the density of aquatic vegetation growing through and around these features, increasing their resilience to erosive forces.

Other bank stabilization projects that include willow, cattail, and hardstem also continue to demonstrate good protection from erosion. Native vegetation has been replaced in some areas by invasive species such as *Phragmites*, which provides equal protection in regard to bank stabilization and surface cover (although it negatively affects native vegetation diversity and resultant wildlife habitat).

Projects that include riprap or gabion baskets (completed prior to development of the breakwater technique) are maintaining bank stability but do not seem to develop the diversity of native vegetation which would be expected to continue to resist erosive forces over time, such as observed in the breakwater areas. Sheet erosion from upslope areas has covered portions of some projects where riprap consisted of small cobbles and gravel. Limited vegetation was observed in these areas.

TABLE 6-3 SUMMARY OF CUTLER BANK STABILIZATION PROJECT MONITORING RESULTS INCLUDING BASELINE (2002) MEASUREMENTS AND SELECT MONITORING DATA.

Project Name	2002 (baseline)	2013	2014	2015	2016	2017	2020
J Benson	Good	Good	Good	Good	Good	Good	Good
G Benson	Good	Good	Fair	Good	Fair	Good	Good
GB South	Good	Good	Fair	Good	Fair	Good	Good
Stewart West	Poor	Good	Good	Good	Good	Good	Good
Ballard	Poor	Good	Good	Good	Good	Good	Good
Watterson Rip-Rap	Good	Good	Good	Good	Good	Good	Good
Watterson Gabions	Good	Good	Good	Good	Good	Good	Good
Archibald	Good	Good	Good	Good	Good	Good	Good
Larson	Good	Good	Good	Good	Good	Good	Good
Spring Creek	Good	Good	Good	Good	Good	Good	Good
RR Trail West	Poor	Good	Good	Good	Good	Good	Good
Benson West	Fair	Good	Good	Good	Good	Good	Good
Near Checkdam 12	Poor	Good	Good	Good	Good	Good	Good
Roundy Pump	Good	Good	Good	Good	Good	Good	Good
Middle Roundy	Good	Good	Good	Good	Good	Good	Good
Upper Roundy	Good	Good	Good	Good	Good	Good	Good

Source: PacifiCorp 2018
Green = Improvement in the buffer from the previous year.
Blue =Steady condition of the buffer with no change from the previous year.
Red = Decline in buffer condition from the previous year.

A few barren surfaces were noted at some project sites near the Railroad Bridge where access trails to the water's edge have been created by recreational use and wildlife. Small pockets of erosion were also observed at the ends of other projects where banks were exposed to wave action. As noted in the 2018 monitoring report, rock gabions at the Archibald and Watterson projects have tipped but are still maintaining bank stability where they are located (PacifiCorp 2018). Although these areas could be improved, the overall bank stability where these projects were installed remains in good condition. The analysis of current condition of existing erosion control features indicated that given current conditions, none are likely to need repair or retrofitting in the near term.

6.4.4 BANK EROSION POTENTIAL

Bank erosion potential in the Project Area involves a range of factors including soil characteristics; water level fluctuation and wave action; water velocity; and physical characteristics of the reservoir bed, shoreline, and riverbanks.

SSURGO2 soil survey results identified 35 different soil types in the Project Area that intersect or occur adjacent to the shoreline of Cutler Reservoir and the Bear River. This coverage was used to assign soil properties to the OHWL digitized from the high-resolution imagery collected during the drawdown. Total length of shoreline or bank by soil type was then determined and described in terms of soil characteristics relevant to bank stability.

Soil types that comprise most Cutler Reservoir shorelines and Cutler tributary river channel banks are shown in Table 6-4, followed by characteristics that relate to soil erosion and bank stability. The most common soil type on the Cutler Reservoir shoreline is mixed alluvial soils. This soil type is a composite of deposition from other soil types and likely has properties that are similar to soil types TrA, TtA, AhA, and CmE2, which are frequently found on lake terraces and lacustrine deposits.

Erosion hazard for all potentially affected soil types is slight or moderate. This rating reflects characteristics including hydraulic conductivity, susceptibility to frost action, and shear strength.

TABLE 6-4 PROPERTIES RELATED TO BANK STABILITY FOR SOIL TYPES COMMONLY FOUND IN CUTLER RESERVOIR SHORELINE AREAS.

NAME	EROSION HAZARD	SATURATED HYDRAULIC CONDUCTIVITY	POTENTIAL FROST ACTION	DESCRIPTION
Mm – mixed alluvial soil	Not rated	Not available	Not available	Depth to water table 12 in., poorly drained.
TrA – Trenton silty clay loam, 0–2 percent slopes	Slight	Moderately Low	Moderate	Depth to water table 51 in., somewhat poorly drained. 30–60 percent clay.
TtA – Trenton silty clay loam, moderately-deep water table, 0–2 percent slopes	Slight	Moderately Low	Moderate	Depth to water table 30 in., somewhat poorly drained. 30–60 percent clay.
AhA – Airport Silt Loam, 0 – 3 percent slopes	Slight	Moderately Low	High	Depth to water table 30 in., poorly drained. 20–35 percent clay
CmE2 – Collinston Loam, 10–30 percent slopes, eroded	Moderate	Moderately High	High	Depth to water table, none within the soil profile, well drained. 15–35 percent clay.
Ln – Lewiston Fine Sandy Loam	Slight	High	High	Depth to water table 39 in., somewhat poorly drained. 5–20 percent clay.

Source: NRCS 2020

Saturated hydraulic conductivity indicates the ability of soil to absorb or release water. Fine-textured soils such as silty clay loam or silt loam have relatively smaller pore sizes compared to loam or sandy loam. Soils with low hydraulic conductivity are slow to drain and experience increased internal pore pressure. However, these same soils are also slow to absorb water.

Potential frost action indicates the susceptibility of the soil to upward or lateral movement by the formation of ice lenses. This property is also influenced by soil pore size, saturated hydraulic conductivity, and contact with water through infiltration or a source such as groundwater or surface water. Soils with a high amount of silt and very fine sand have a relatively high potential for frost action compared to soils with more fine or coarse soil texture.

Measurements of shear strength provide an indication of the amount of force required for moving water to erode soil. Table 6-5 shows the results of shear strength measurements collected from shoreline soils between the Bear River confluence and Clay Slough. Shear strength is related to the cohesiveness and interlocking of soil particles. Critical shear strength is the force required to mobilize sediments through detachment or resuspension in a body of water. In general, shear strength (and critical shear strength) increases with clay content and degree of compaction (i.e., density). Erosive forces and their impact on soil are different under steady laminar flow in a river channel compared to turbulent flow which occurs during wave action. In particular, water velocity in rivers and wave intensity (i.e., size and rate) in lakes and coastlines can influence erosion rates.

Measurements in Table 6-5 indicate mean shear strength for all reservoir shoreline samples sites is well above 100 pounds per square foot (lb/ft^2). Critical shear strength values for cohesive material (e.g., greater than 50 percent clay) used in stream channel restoration are less than 1 lb/ft^2 (NRCS 2007). Critical bed-shear strength measured from lakes, reservoirs and tidal flats is less commonly studied, but a review of recent literature indicates values are also typically less than 1 lb/ft^2, including soils with densities of up to 1,600 kilogram per square meter (kg/m^2) (van Rijn 2020). Soil compaction in reservoir banks is greater than reservoir bed material near the shoreline, which provides greater resistance to erosive force from wave action. Ultimately, the combined force of wave action and instability created by freeze-thaw cycles exceeds the existing shear-strength of reservoir bank material, resulting in erosion.

Based on the high-resolution imagery collected during the 2019 drawdown, approximately 17,200 feet (3.3 miles) of eroding reservoir shoreline and riverbank segments were identified from the 531,900 feet (101.1 miles) of mapped shoreline and bank in the Project Area (Attachment D3). Most of these are located on the reservoir downstream of the Bear River confluence with Cutler Reservoir and on outside bends of the Bear River downstream of 4000 North.

TABLE 6-5 SOIL SHEAR STRENGTH (LB/FT2) MEASURED IN-SITU FROM CUTLER RESERVOIR SHORELINE BETWEEN NEWTON BRIDGE AND BENSON MARINA (SEPTEMBER 2020).

SITE	DESCRIPTION	SOIL (TYPE)	SAMPLE (LB/FT^2)			MEAN (lb/ft^2)	STD (lb/ft^2)
			1	2	3		
1	Upstream of RR Fishing Bridge, east side and south of Benson Marina.	Ln	123	184	246	184	61
2	Downstream of RR Fishing Bridge, west side and south of Benson Marina.	TrA	307	410	307	307	82
3	Downstream of Benson Marina crossing, west side of reservoir.	TrA	410	717	307	471	205
4	Mouth of Clay Slough, south side.	TrA[1]	1,024	1,024	1,024	1,024	0
6	Downstream of Newton Bridge, east side of reservoir.	CmE2	184	225	225	205	20

[1]All measurements were collected from saturated soils near or just below the water surface.
[2]Soil survey indicates soil type TrA at sample site. Irregularities in bank structure indicate a clay lens or deposit of material with high clay content.

Reservoir management changes the water surface elevation (WSEL) over time by regulating discharge from Cutler Dam. Changes in WSEL generally occur over several hours and at rates that do not generate surface fluctuations and resulting impacts on wave action at reservoir shorelines or channel banks. Existing eroding segments are primarily affected by waves created from wind and recreational use. The extent of wind-driven waves is dependent on fetch (the distance that wind blows over the water in a single direction), wind speed, and wind duration. Wind-generated waves occur primarily in response to storms during the fall, winter, and spring season and in wide areas where fetch is greatest. Waves are also generated by moving boats, with bigger waves created by faster moving and deeper-draft boats. Finally, water velocities are greatest in the thalweg or deepest part of the reservoir or river channel. Reservoir shorelines and riverbanks located near the thalweg are susceptible to this influence.

Eroding shorelines on the west side of Cutler Reservoir near the confluence with the Bear River are likely influenced by the thalweg carrying higher river flows and the relatively narrow width of the reservoir as flows move between islands (Attachment D3,Figure C-4). Recreational use could also generate waves as there are no restrictions on motor size in this part of the reservoir.

Eroding shorelines between Clay Slough and the Railroad Bridge could be influenced by wind-driven waves due to the increase of reservoir width and fetch (Figure D3-4, Attachment D3). Although as noted there are no restrictions on motor size or speed in this area, less recreational use occurs in this area due to shallow water depth and the narrow channel.

Eroding shorelines occur on the north and east side of Cutler Reservoir between the Railroad Bridge and Newton Bridge (Attachment D3, Figure D3-5,) and are likely impacted by waves generated from wind and recreation.

Eroding banks on the east side of Horseshoe Bend and the south side of Clay Slough are less likely influenced by waves and more likely effected by farming practices that extend to the edge of the bank (PacifiCorp owns very little or no bank in these areas to establish a buffer) and topography that results in steep slopes leading down to the water after more than a century of historic agricultural practices (Attachment D3, Figure D3-4).

The bed elevation of Cutler Reservoir and the Bear River was mapped using a combination of bathymetry and LiDAR measurements collected in September–November 2019 (Section 4.2 of Appendix H). This information was used in combination with erosion mapping along the OHWL to determine elevation change and slope of bank and bed areas for each eroding segment. Measurements were collected from areas defined by a horizontal distance extending outward from the OHWL. Field observations indicated that most of the change in elevation and slope of the reservoir bank and bed areas occur within a horizontal distance of 3 feet from the OHWL.

The potential maximum change and rate of change in WSEL in areas where bank stability is a concern was determined by analyzing changes in elevation and slope in the area extending horizontally outward from the OHWL a horizontal distance of 3 feet for all mapped eroding segments. A similar analysis of the area extending toward, or into the reservoir was used to evaluate bank exposure during a decrease in water surface elevation. Table 6-6 includes a summary of descriptive statistical results for each area, based on all eroding segments. The difference in elevation between the OHWL and the mean height or maximum height of the same area extending away from the OHWL was used to estimate bank height for each eroding segment. Results were classified into categories to show the distribution of the height of eroding bank segments (Table 6-7).

TABLE 6-6 SURFACE SLOPE CHARACTERISTICS OF ERODING BANK SEGMENTS MEASURED FROM AREAS ADJACENT TO THE OHWL.

	SURFACE SLOPE (DEGREES)			
	MEAN	MAXIMUM	MINIMUM	STANDARD DEVIATION
Reservoir Bank	41.6	92.9	1.0	10.4
Reservoir Bed	39.3	89.6	1.0	10.7

TABLE 6-7 BANK HEIGHT CHARACTERISTICS OF ERODING BANK SEGMENTS MEASURED FROM AREAS ADJACENT TO THE OHWL.

	MEAN BANK HEIGHT		MAXIMUM BANK HEIGHT	
BANK HEIGHT RANGE (FT)	TOTAL BANK LENGTH (FT)	PERCENT	TOTAL BANK LENGTH (FT)	PERCENT
0 – 1	1,981	12%	756	4%
1 – 2	4,923	29%	895	5%
2 – 3	3,618	21%	2,483	14%
3 – 4	2,423	14%	2,088	12%
4 – 5	2,982	17%	2,401	14%
>5	1,281	7%	8,586	50%
Total (ft)	17,209	100%	17,209	100%

Table 6-6 shows that mean slope of reservoir shorelines and channel banks (i.e., bank slope) is approximately 42 degrees or 90 percent slope. The mean slope of reservoir and channel bed areas where eroding segments were mapped is approximately 40 degrees or 84 percent slope which is slightly less than shoreline surface slope. Mean slope of both areas is close to 100 percent (i.e., a change of 1 foot horizontal results in a vertical change of 1 foot). Maximum slope of reservoir shorelines and channel banks where eroding segments were mapped is nearly 90 degrees, which represents a vertical face. These bank segments are most susceptible to erosion and instability. Mean bank height shows the majority of banks are less than 3 feet. This trend shifts substantially for maximum bank height, which shows that maximum height for most eroding banks is greater than 4 feet and half of all eroding banks have a maximum height greater than 5 feet.

Based on hydraulic modeling results, the rate of change (feet/hour) in WSEL where eroding banks are located ranges from 0.02–0.03 feet/hour for elevations between 4,407.5 and 4,406.5 feet measured at Cutler Dam. The rate of change in WSEL increases slightly in these same areas to 0.03–0.04 feet/hour for elevations between 4,407.5 and 4,405.0 feet measured at Cutler Dam. The change in reservoir WSEL decreases with distance upstream in response to a change at Cutler Dam. This process is explained in detail in Appendix G. Regarding eroding banks, a change between 4,407.5 and 4,406.5 feet measured at Cutler Dam over 2.3 days will produce a corresponding change of roughly 0.9 foot at Benson Marina over a period of 4 days and a change of nearly 1 foot at all downstream locations during this same time period. A change in WSEL between 4,407.5 and 4,405.0 feet measured at Cutler Dam over 3.8 days will reduce WSEL at the Benson Marina to roughly 4,406.8 feet over a period of 5 days. Other locations downstream of the Marina would experience greater change of WSEL in less time including Clay Slough (4,405.6 feet over 4.5 days) and Railroad Bridge/Cache Junction (4,405.2 feet over 3.5 days).

Eroding bank segments have been identified for the Cutler Reservoir shoreline and the Bear River downstream of the dam. The location of eroding banks can provide some indication of the processes that influence erosion including natural and human-generated processes. Ongoing potential for bank erosion can be evaluated using soil characteristics that indicate a response to environmental and hydrologic conditions and the physical dimensions of eroding banks. This study identified eroding bank segments in a number of locations around the reservoir. Because erosion is both a natural and human-influenced process, it is impossible to completely separate those influences. However, existing/proposed normal and proposed extended Project operations, along with other human activities (e.g., recreation and agriculture) could potentially be resulting in additive (to natural) erosion in the Reservoir Management Unit, the downstream portion of the River Management Unit, and the Bear River downstream of Cutler Dam. Of these areas, only locations on the Bear River downstream of Cutler Dam are of concern, as the Reservoir and River Management Units are being managed by PacifiCorp’s existing bank stabilization program.

6.5 AESTHETIC RESOURCES

6.5.1 2019 DRAWDOWN

The drawdown of Cutler Reservoir conducted in October and November 2019 contributed to the aesthetic resource study in two ways. First, the drawdown provided an opportunity to document changes in visual aesthetics across a range of surface elevations on Project Area scenic quality, providing a visual (i.e., photographic) frame of reference for assessing changes due to the proposed Project operating scenario across a range of locations and surface elevations. Second, it indicated that surface elevations are not uniform across the reservoir during a drawdown event. Surface elevation drives several changes in visual aesthetics, and specifically those related to bank erosion, turbidity, mudflat exposure, and weed invasion. These variables are discussed below (Sections 6.5.2 and 6.5.3).

6.5.2 HYDRAULIC MODELING RESULTS

The hydraulic modeling incorporated elevation data collected during the 2019 drawdown and the parameters included in the proposed Project operating scenario developed subsequently. In terms of analysis of aesthetic resources, the model generated reservoir elevations at the specified photopoints when drawdowns under the proposed scenario are projected to exceed those occurring under current Project operations (i.e., in winter, under the proposed expanded elevation range between 4,406.0 and 4,405.0 feet). Comparing these elevations to those recorded on the dates photographic data were collected provided the basis for interpolating projected visual conditions during proposed Project operations from the baseline and drawdown photos.

Differences between current Project operations and proposed normal and extended operations, as they apply to this analysis, can be summarized as follows (also see details in Section 1.3 of the ISR):

- During the irrigation season (generally April through October), the normal operating range would not vary from the current 1-foot band (4,407.5–4,406.5 feet), as measured at Cutler Dam.

- During the non-irrigation season (generally November through March), the extended operating range would extend an additional foot, to 4,405.0 feet (current winter operations extend to 4,406.0 feet).
- The normal operating range would be in effect 85 percent of the time, or a minimum of 310 days per year; the extended operating range would not occur more than 15 percent of the time, or 55 total days per year.
- Project operations in the extended range (outside the irrigation season) could occur in 10-day cycles, from 4,407.5 to 4,405.0 feet, and back to near the top of the normal operating range at 4,407.5 feet.

Based on these factors, changes to visual aesthetics beyond those currently experienced due to Project operations would be generated by the additional foot of elevation drop in the extended operating range, from 4,406.0 to 4,405.0 feet as measured at Cutler Dam. This could occur on a maximum of 55 late fall to early spring days. Elevations below 4,406.0 feet would last only a few days, as they would occur within discrete, 10-day cycles. This seasonal 1-foot change, occurring as outlined here, is the focus of this analysis.

The hydraulic model also projected the magnitude and extent of the lack of uniformity in elevations across the reservoir during drawdown cycles. These results are discussed in detail in Appendix G (hydraulic modeling) and Appendix H (sedimentation) of this ISR. For purposes of this analysis, characteristics of the reservoir bed and tributary inflow attenuate elevation decreases moving upstream from the dam, for example, a 2.5-foot decrease in reservoir elevation at the dam translates to a projected maximum 1.2-foot decrease at the south end of the reservoir over the proposed 10-day drawdown cycle. Accordingly, visual effects would be progressively less pronounced moving upstream from the dam.

6.5.3 PHOTOPOINTS

Photographic data were collected to objectively document baseline and 2019 drawdown visual aesthetics in the Project Area and to support and validate the SMS variables discussed below (Section 6.5.4). The criteria for photopoint selection were:

- Locations from which viewers can actually discern Cutler Reservoir visually,
- With emphasis on locations where viewers are most sensitive to visual aesthetics in the Project Area.

Accordingly, the photopoints included 10 PacifiCorp recreation sites, eight bridges in and around the Project Area, and a point on Highway 30 entering the valley from the west. Most bridge photopoints included upstream and downstream views, resulting in a total of 26 photopoints. Figure 6-2 identifies these photopoints.

Photo-documentation occurred on October 24, 2019, just prior to the test drawdown at essentially full-pool, and repeated on November 1, 2019, at elevation 4,390.5 feet, as measured at Cutler Dam using transducers deployed during the drawdown. A final round of photos was captured on November 6, 2019 at dam elevation 4,387.7 feet, but as noted previously these were not included in the analysis (see Section 5.4.1).

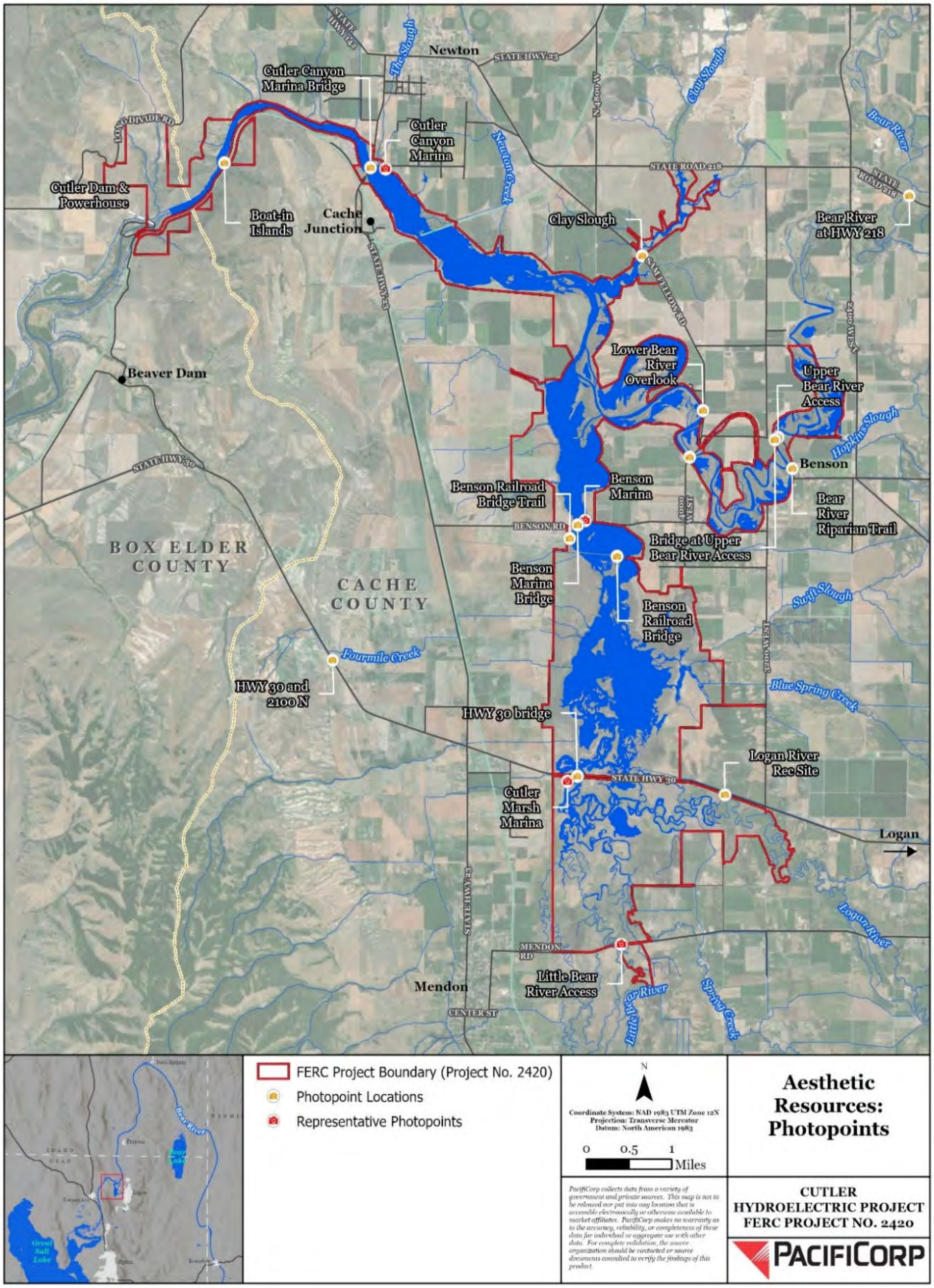


FIGURE 6-2 PHOTOPOINT LOCATIONS.

As discussed above (Section 6.5.2), changes in surface elevation associated with drawdowns at Cutler Dam decrease progressively with distance from the dam. As surface elevation is the main factor driving the visual effects addressed in this study (Section 2.0), changes evident at photopoints within a given portion of the reservoir during the test drawdown were similar. To avoid repetition in describing the two sequential views from each photopoint, points representing similarly affected areas were selected for more detailed discussion. The representative photopoints are:

- The intersection of Highway 30 and 2100 North in Mendon, Utah, representing the view seen by travelers entering the valley from the west.
- The Cutler Marsh Marina, representing conditions in the southern portion of the reservoir, where changes in surface elevation during the 2019 drawdown were minimal.
- Benson Marina, representing the central portion of the reservoir, where surface elevation changes were moderate during the full drawdown.
- Cutler Canyon Marina, representing the transition to Cutler Canyon, where surface elevation changes were substantial during the full drawdown.

Most bridge photopoints were in close proximity to the three representative recreation sites selected and experienced similar changes.

Figure 6-2 shows the location of the four representative photopoints discussed in detail. Table 6-8 provides corresponding figure numbers for each, surface elevations derived from transducer data on each photo date, and a list of other photopoints represented by each. Figures showing the two sequential images from each of the four representative photopoints follow. Photos from all points are included in Attachment D4.

TABLE 6-8 PROJECT AREA REPRESENTATIVE PHOTOPOINTS.

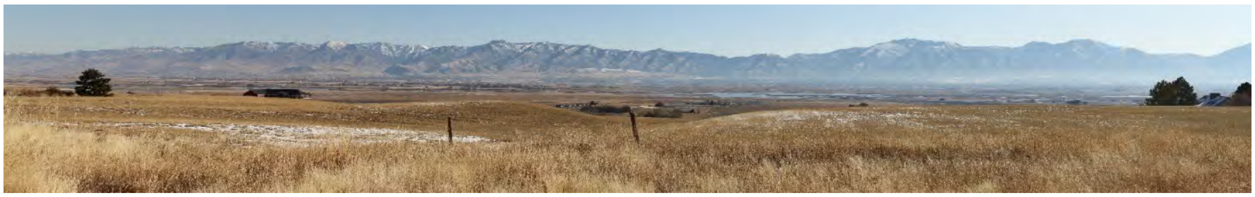
NAME	FIGURE NUMBER	SURFACE ELEVATION[1]	OTHER PHOTOPOINTS REPRESENTED[2]
Hwy. 30 and 2100 N., Mendon	Figure 6-3 and D4-26[3]	Varied (most of reservoir visible)	None
Cutler Marsh Marina (southern reservoir area)	Figure 6-4 and D4-5	Baseline: 4,407.4 feet Drawdown: 4,405.8 feet	Little Bear River Access (D-1), Logan River Recreation Site (D-2), Highway 30 Bridge (D-3 and D-4), Benson Railroad Bridge (D-6 and D-7), Benson Railroad Bridge Trail (D-8).
Benson Marina (central area)	Figure 6-5 and D4-11	Baseline: 4,407.4 feet Drawdown: 4,404.8 feet	Benson Marina Bridge (D-9 and D-10), Upper Bear River Access (D-14), Bridge at Upper Bear River Access (D-15 and D-16), Bear River Riparian Trail (D-17), 3800 N. 4000 W. Bridge, Benson (D-18), Lower Bear River Overlook (D-19), Clay Slough Crossing (D-20 and D-21).
Cutler Canyon Marina (Transition to Cutler Canyon)	Figure 6-6 and D4-24	Baseline: 4,407.4 feet Drawdown: 4,399.9 feet	Cutler Canyon Marina Bridge (D-22 and D-23), South Boat-In Island (D-25)

[1]Data from transducers deployed during drawdown. Values rounded to 0.1 foot.

[2]Note that the Highway 218 bridge near Amalga (D-12 and D-13) was included in the photopoints at stakeholder request but was unaffected by the drawdown. Does not appear in table.

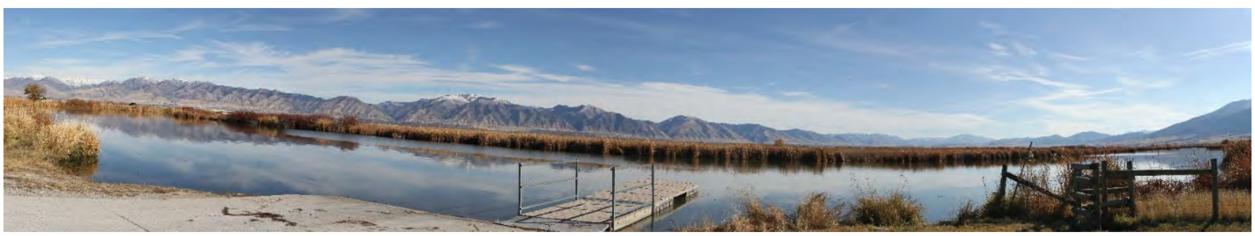
[3]Can be found in Attachment D4 to this document.

October 24, 2019, baseline (full-pool; elevation as measured at Cutler Dam 4,407.3 feet, per transducer data).

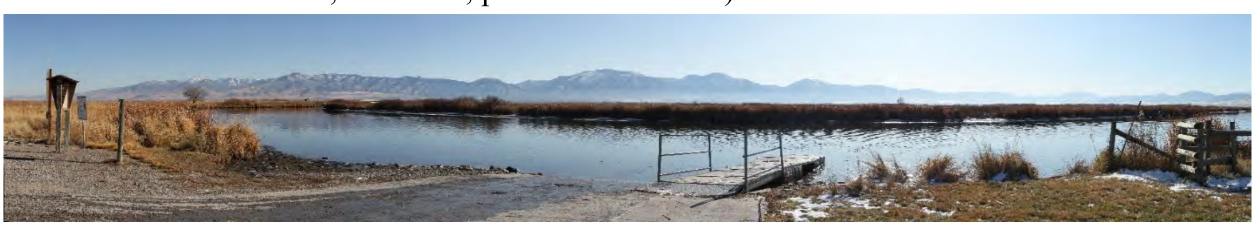


November 1, 2019, drawdown (elevation as measured at Cutler Dam 4,392.4 feet, per transducer data).

FIGURE 6-3 HIGHWAY 30 AND 2100 NORTH, MENDON, UTAH



October 24, 2019, baseline (full-pool; elevation as measured Cutler Dam 4,407.3 feet; elevation at Cutler Marsh Marina 4,407.4 feet, per transducer data).



November 1, 2019, drawdown (elevation as measured at Cutler Dam 4,392.4 feet; elevation at Cutler Marsh Marina 4,405.8 feet, per transducer data).

FIGURE 6-4 CUTLER MARSH MARINA

October 24, 2019, baseline (full-pool; elevation as measured at Cutler Dam 4,407.3 feet; elevation at Benson Marina 4,407.4 feet, per transducer data).

November 1, 2019, Drawdown (elevation as measured at Cutler Dam 4,392.4 feet; elevation at Benson Marina 4,404.8 feet, per transducer data).

FIGURE 6-5 BENSON MARINA

October 24, 2019, baseline (full-pool; elevation as measured at Cutler Dam 4,407.3 feet; elevation at Cutler Canyon Marina 4,407.4 feet, per transducer data).

November 1, 2019, Drawdown (elevation as measured at Cutler Dam 4,392.4 feet; elevation at Cutler Canyon Marina 4,399.9 feet, per transducer data).

FIGURE 6-6 CUTLER CANYON MARINA

6.5.4 SCENERY MANAGEMENT SYSTEM RESULTS

As outlined above (Section 5.4.2) the SMS incorporates the following variables in assessing and managing visual aesthetics:

- Landscape Character: This variable describes the visual and cultural image of a landscape, combining the physical, biological, and cultural attributes that make each landscape identifiable or unique. Landscape character embodies distinct landscape attributes that exist throughout an area. It provides a baseline for assessing changes due to management and for determining scenic integrity. It is a narrative description.

- Scenic Attractiveness: Classes are developed to determine the relative scenic value of lands within a particular Landscape Character. The three classes are: Class A, distinctive; Class B, typical; Class C, indistinctive. The landscape elements of landform, vegetation, rocks, cultural features, and water features are described in terms of their line, form, color, texture, and composition for each of these classes.

- Distance Zone: These reflect the distance of landscape features from the viewer. The classes are foreground (Fg) (up to 0.5 miles), middleground (Mg) (0.5 to 4 miles), and background (Bg) (greater than 4 miles).

- Concern Level: Sites, travelways, special places, and other areas are assigned a concern level value of 1, 2, or 3 to reflect the relatively high, medium, or low importance of aesthetics.

- Scenic Class: This is a measure of the relative scenic importance, or value, of discrete landscape areas. It is a numeric rating based on scenic attractiveness, distance zone, and concern level, in which classes 1–2 have high public value, classes 3–5 have moderate value, and classes 6–7 have low value.

- Scenic Integrity: Represents a measure of the degree of visible disruption of the landscape character. A landscape with very minimal visual disruption is considered to have high scenic integrity, and discordant relationships among scenic attributes diminish

Scenic Integrity. Scenic Integrity is expressed as very high, high, moderate, low, very low, and unacceptably low.

Interpreting the Scenic Class in conjunction with the Scenic Integrity category yields the Landscape Value, expressed as the numeric Scenic Class followed by the Scenic Integrity rating (e.g., 2-very high or 5-low). This is the summary value generated by SMS. It indicates the value of visual aesthetics in the area relative to its desired potential and sets the stage for evaluating change in visual aesthetic conditions as well as integrated management planning.

6.5.4.1 CURRENT CONDITIONS

Surface-elevation fluctuations under current Project operations, which are associated with existing visual aesthetics in the Project Area, range from full pool at approximately elevation 4,407.5 feet as measured at Cutler Dam, down to elevation 4,406.0 feet during the non-irrigation season, as indicated in Figure 6-2 above. This is the scenario reflected in the baseline (essentially full pool) photos (Section 6.5.3) and discussed in SMS terms for current conditions below.

LANDSCAPE CHARACTER

PacifiCorp's 1995 RMP provides a useful description of current and desired Landscape Character:

> The visual character of the reservoir area is rural and undeveloped with the presence of cattle grazing, agricultural crops, and scattering of farm buildings… The visual setting of the reservoir is particularly attractive from spring through fall when the surrounding snow-capped peaks contrast with the verdant valley floor. The mountains dominate the views immediately around the reservoir and are the most noticeable and important visual elements of the area. The reservoir itself is not highly visible due to the relatively flat terrain around all but the canyon portion. Because there is no tall vegetation delineating the shoreline, the periphery of the reservoir cannot be discerned from any distance. During most of the winter, the reservoir is frozen and covered with snow.

SCENIC ATTRACTIVENESS

Cutler Reservoir has an irregular, elongated form, occupying the lowest lying portion of Cache Valley. Natural emergent and riparian vegetation follows the reservoir boundary and occupies islands within it. Agricultural land, both pasture and cropland, abuts these generally narrow bands of natural vegetation. The reservoir's location on the broad, relatively flat valley floor make it difficult to visually discern except from viewpoints near or on the water.

The naturally occurring lines in this landscape shift from jagged peaks in the background, to less rugged middle-ground foothills, to flatter planes adjacent to the reservoir and on its banks. The overall theme is vertical bands that become smoother through the transition from background to foreground. Reflections on the water reverse this progression from many viewpoints.

In terms of naturally established form, the skyline around the valley is defined by rugged mountains, particularly the Bear River range to the east and the Wellsville range to the west. From some viewpoints on the reservoir, lower, more moderately sloped foothills define the horizon in the middle ground. In the foreground, flat fields dominate the view, in many areas obscured by stands of cattails, rushes, or shrub vegetation on the reservoir banks.

The color palette varies according to season, except for the consistent blue sky and generally turbid, gray-brown reservoir water. Water clarity improves in winter. Green dominates in spring, with dark conifers on the mountain slopes, grass with scattered brush and trees on the foothills, and emerging hay and grain in the fields joining emergent and riparian communities on the reservoir margin. As vegetation dries through the summer, tans and browns begin to increase, first on the foothills, then on the mountain slopes, and then the fields as crops ripen and are harvested. Killing frosts in fall take the last green except for the mountain conifers. Winter snow and ice fill the gaps between tan and gold vegetation, including the reservoir surface, with white.

Textures tend to track the vertical bands of landforms and vegetation. The irregularities characteristic of the mountains blur somewhat in the distance, less so on the middle-ground foothills. More textures emerge in the foreground. Smooth water surfaces adjoin the vertical stems of cattails and reeds. Shrub thickets and scattered trees break up bank textures, punctuated by bare clay outcrops on sloughing shorelines.

Water features are relatively uncommon in the arid West, but there are a number of reservoirs within a 100-mile radius of Cutler Reservoir. While Cutler is larger and more irregularly shaped, it is not qualitatively unique. Accordingly, it is classified as Class B, typical (see Section 6.5.4 for explanation of ratings).

DISTANCE ZONES

As noted above, the reservoir itself is not highly visible due to the relatively flat terrain around all but the relatively remote canyon portion. As a result, its visual impact is greatest when viewed in the foreground, from vantage points on or near the water. From some vantage points, particularly on Highway 30 where most traffic enters Cache Valley from the west, middleground and background views are also a consideration.

CONCERN LEVEL

The level of concern regarding the visual aesthetics of the Project Area is split in a similar way to the distance zones discussed above. The primary user group, recreationists using the Project Area and particularly the reservoir itself, are logically most concerned, while travelers on local roads and highways are presumably less concerned due to shorter exposure and different objectives. Again, Cutler Reservoir is not easily discerned in middleground and background views due to the generally flat terrain and lack of taller shoreline trees, so bridges are the main viewpoints for travelers.

PAD Section 7.1.8 provides the following description of recreational use:

> Current Project operations offer a broad range of recreation opportunities to the public year-round, which create benefits to recreation as the Project recreation facilities add to the region's recreational resources, allowing for more regional recreation capacity and a greater diversity of recreation opportunities. Under the current license, PacifiCorp implemented a Recreation Site Development Program to improve public access and develop recreation facilities in the Project…As part of this program, PacifiCorp developed and maintains 13 recreation facilities within the Project Boundary. Most of this land is available for hunting,

> bird watching, dog walking, and other forms of dispersed recreation, at no fee. The recreation facilities provide a range of amenities… Current operations do not impede recreation opportunities within the Project Boundary or regionally; in fact, they enhance it. Project recreational facilities add regional recreation capacity.

Based on these considerations, the Project Area is rated at concern level 1 (high) for recreational users on the reservoir, 2 (medium) for travelers on roads and highways crossing Project Area waterways, and 3 (low) for travelers entering the valley on Highway 30 from the west.

SCENIC CLASS

As noted above (Section 6.5.4), Scenic Class is a measure of the relative scenic importance, or value, of discrete landscape areas derived by combining scenic attractiveness, distance zone, and concern level (see Table 6-9). Scenic classes 1–2 have high public value, classes 3–5 have moderate value, and classes 6–7 have low value.

Based on the preceding discussions, there are three scenic classes associated with the Project Area:

- Recreational use – Scenic Class 1.
- Travel on Project Area roads and highways – Scenic Class 2.
- Travel on Highway 30 entering the valley from the west – Scenic Class 5.

TABLE 6-9 SCENIC CLASS DETERMINATION.

	DISTANCE ZONE[2] - CONCERN LEVEL[3]								
SCENIC ATTRACTIVENESS[1]	Fg-1	Mg-1	Bg-1	Fg-2	Mg-2	Bg-2	Fg-3	Mg-3	Bg-3
A	1	1	1	2	2	2	2	3	3
B	1	2	2	2	3	4	3	5	5
C	1	2	3	2	4	5	5	6	7

[1]A=Distinctive, B=Typical, C=Indistinctive.
[2]Fg=foreground, Mg=middleground, Bg=background.
[3]1=high, 2=medium, 3=low.

SCENIC INTEGRITY

In terms of the current Scenic Integrity of the Project Area, Cutler Reservoir itself is a non-natural landscape feature in itself. However, it is an established (present in some form since the early 1890s, and prior to statehood) and basically permanent feature and, therefore, not considered a disruption. Beyond that, as described above under Landscape Character (Section 6.5.4.1), the Project Area generally reflects its inherent character: rural and undeveloped with the presence of cattle grazing, agricultural crops, and scattering of farm buildings. This is particularly the case when the Project Area is viewed in the middleground and background.

When viewed in the foreground, Cutler Reservoir's Scenic Integrity diminishes somewhat. As discussed above (Section 6.1), PacifiCorp has made important strides in improving visual aesthetics since the 1995 Cutler RMP was completed, removing rusted cars, implementing plantings and other alternative bank-stabilization measures, and establishing vegetated shoreline buffers. These efforts are ongoing, and in the foreground view experienced by recreationists, disruptions in the form of bank-erosion features, water turbidity, and some irrigation facilities that are in disrepair or abandoned (3 of 55) constitute disruptions that affect visual aesthetics.

Accordingly, Scenic Integrity is rated as moderate for recreational use and high for travel on area roads and highways.

LANDSCAPE VALUES

Combining these Scenic Class and Scenic Integrity ratings indicates the following Landscape Values under current baseline conditions:

- Scenic Class 1/Moderate Scenic Integrity for recreationists.
- Scenic Class 2/Moderate Scenic Integrity for travelers on Project Area roads and highways.
- Scenic Class 5/High Scenic Integrity for travelers on Highway 30 entering the valley from the west.

LANDSCAPE VALUE OBJECTIVE

PacifiCorp's RMP includes the following:

> Goal 4: Enhance Scenic Quality – To reduce the visual impact of erosion and debris and to enhance the area's rural, undeveloped landscape. More abundant and mature plant growth of riparian vegetation will add color, texture, and definition to the landscape, improving its overall attractiveness.

This RMP goal, in conjunction with the existing current landscape character described above and public expectations for Cutler Reservoir's visual aesthetics (as summarized above under Concern Level), constitutes an appropriate Landscape Value objective. Based on the preceding discussion, current baseline conditions are consistent with this objective.

6.5.4.2 CONDITIONS UNDER PROPOSED PROJECT OPERATING SCENARIO

Changes from the current range of surface-elevation fluctuations that could occur under the proposed Project operating scenario are summarized above (see Section 6.5.2), which identifies the potential additional foot of elevation drop under the proposed extended operating range (i.e., 4,406.0 to 4,405.0 feet) as the primary change from current operations and constitutes the focus of this analysis. The baseline photos (October 24, 2019; near full pool, 4,407.3 feet at Cutler Dam, per transducer data) and drawdown photos (November 1, 2019; 4,392.4 feet at Cutler Dam) in Section 6.5.3 provide a visual reference for interpreting these changes. Use of the reference photos requires interpolation of the photographic data based on where the proposed lower elevation limit falls relative to the elevations occurring when the reference photos were taken during the 2019 drawdown.

To aid in this interpolation, Table 6-10 shows the projected lower elevation limit under the proposed extended operating range generated by the hydraulic modeling for each of the representative photopoints. Comparing these Table 6-10 elevations to Table 6-8 elevations indicates which photo most closely approximates visual conditions at the projected lowest elevation limit of 4,405.0 feet, measured at Cutler Dam.

TABLE 6-10 PROJECTED RESERVOIR ELEVATIONS AT REPRESENTATIVE PHOTOPOINTS ASSOCIATED WITH THE EXISTING AND PROPOSED EXTENDED ELEVATION RANGES AT CUTLER DAM.

NAME	REFERENCE FIGURE NUMBER	SURFACE ELEVATION[1] AT PROPOSED LOWER LIMIT OF EXTENDED OPERATING RANGE (4,405.0)	OTHER PHOTOPOINTS REPRESENTED[2]
Hwy. 30 and 2100 N., Mendon	Figure 6-3 and D-26[3]	Varied (most of reservoir visible)	None
Cutler Marsh Marina (southern reservoir)	Figure 6-4 and D-5	4,406.2 feet	Little Bear River Access (D-1), Logan River Recreation Site (D-2), Highway 30 Bridge (D-3 and D-4), Benson Railroad Bridge (D-6 and D-7), Benson Railroad Bridge Trail (D-8).
Benson Marina (central reservoir)	Figure 6-5 and D-11	4,406.0 feet	Benson Marina Bridge (D-9 and D-10), Upper Bear River Access (D-14), Bridge at Upper Bear River Access (D-15 and D-16), Bear River Riparian Trail (D-17), 3800 N. 4000 W. Bridge, Benson (D-18), Lower Bear River Overlook (D-19), Clay Slough Crossing (D-20 and D-21).
Cutler Canyon Marina (transition to Cutler Canyon)	Figures Figure 6-6 and D-24	4,405.1 feet	Cutler Canyon Marina Bridge (D-22 and D-23), South Boat-In Island (D-25)

[1] Derived from calibrated 2D hydraulic modeling. Values rounded to 0.1 foot.
[2] Note that the Highway 218 bridge near Amalga (D-12 and D-13) was included in the photopoints at stakeholder request but was unaffected by the drawdown and therefore does not appear in this summary table of representative photos although they are still included with all photos in Attachment D-4 to this appendix.
[3] See Attachment D-4.

For the State Highway 30 viewpoint, there is no discernible difference between the October 24, 2019 baseline photo and the November 1, 2019 drawdown photo, so either provides a good reference. For Cutler Marsh Marina, the projected lowest elevation of 4,406.2 feet is closer to the baseline photo elevation (4,407.4 feet) than the drawdown elevation (4,405.8 feet), making the baseline photo the best reference. For Benson Marina, the projected elevation of 4,406.0 feet falls about midway between the baseline and drawdown elevations (4,407.4 and 4,4043.8 feet, respectively), so interpolating between the two photos is appropriate. For Cutler Canyon Marina, the projected 4,405.1-foot elevation is much closer to the baseline elevation (4,407.4 feet) than the drawdown elevation (4,399.9 feet), making the baseline photo the more representative reference.

These reference photos, coupled with the SMS assessment of current conditions above (Section 6.5.4.1), provide the framework necessary to assess the impacts of drawing the reservoir down seasonally to the minimum reservoir elevation of 4,405.0 feet as proposed.

As explained above in Section 2.0, changes in water elevation during reservoir operational fluctuations could change visual aesthetic conditions in three ways: 1) bank erosion, associated loss of vegetation, and related increase in water turbidity, 2) exposure of reservoir beds as mud flats, and 3) invasion of mudflats by invasive plant species.

Erosion at Cutler Reservoir affects primarily the form (steep, abrupt slopes), color (generally lighter than adjacent vegetation and water), and composition (visually prominent bands and outcrops) of reservoir banks. Eroded banks are not visually evident from the photopoints employed in this study except those in or approaching Cutler Canyon, represented by the Cutler Canyon Marina photos (Figure 6-6), where slopes adjacent to the waterline are steeper and higher.

While they occur within the viewsheds of some of the non-representative photopoints (see Attachment D3), eroding banks are generally low enough to be difficult to discern or have been stabilized with plantings, as is the case on the west bank across from the Benson Marina photopoint (Figure 6-5). Based on these considerations, assessment of changes in bank erosion focuses on the Cutler Canyon photopoint (Figure 6-6), representing Cutler Canyon and the transition area into the canyon.

This analysis indicates that on-going bank erosion in the reservoir results primarily from wave action caused by wind and boat traffic rather than from surface-elevation fluctuation associated with Project operations (Section 6.4.4). Photo monitoring at locations with high erosion potential conducted during the 2019 full drawdown identified no bank movement (Section 6.4.1). As a result, the potential for proposed operations changes to create significantly more bank erosion is low. However, increasing the fluctuations and lowering the minimum water surface elevation in the canyon and transition area could expose more existing eroded banks, and potentially increase the erosive forces acting on them.

Referencing Figure 6-6, eroded banks across from the Cutler Canyon Marina are visible in the October 24 baseline photo, and they are notably higher at elevation 4,399.9 feet as shown in the November 1 drawdown photo. As indicated previously, the former photo characterizes visual conditions at the projected minimum operating level of 4,405.1 feet more closely than the latter. The reservoir elevation of 4,407.4 feet depicted by that photo would expose roughly the same amount more of eroded bank. Eroding banks are not a scenic factor in the viewsheds shown in Figures 6-3 through 6-5 for the other three photopoints.

From a scenic perspective, the turbidity of Cutler Reservoir water affects mainly the color variable. Water color is not evident from most study photopoints due to the low viewing angle that increases reflection of the sky and shoreline, but the reservoir is quite turbid during all but the late fall and winter months. While bank erosion is a factor (Section 2.0), persistent turbidity is more likely the result of sediment in inflows, algae growth, and carp foraging and movement.

Referencing Figures 6-3 through, drawdown resulted in no visible change in turbidity as reflected in perceived water color from any reference photopoint, so an addition 1-foot elevation drop seasonally to the minimum proposed elevation 4,405.0 feet at the dam resulting from Project operations would not be noticeable.

Mudflats and other expressions of exposed reservoir bed occur at the interface between the waterline and emergent or bank vegetation. Lowering water levels create and widen that gap, adding an element to the visual landscape and altering its composition. In regard to line and form, exposed reservoir bed is another vertical layer between the water's edge and the shoreline vegetation. In terms of color, the exposed material generally matches the water. As to texture, it provides a transition between the smooth water surface and the rougher pattern of adjacent vegetation.

The level topography of the valley floor affects the visual impact of this gap in two ways. First, relatively small drops in reservoir elevation can cause wide gaps when the water level falls below the elevation of the relatively flat reservoir bed. Second, these gaps may be evident from a bird's-eye view but become less visible from lower-angle perspectives at or near reservoir elevation (Figure 6-4 and Figure 6-5). They are much more visible from a bridge than from a shoreline recreation site. The steeper topography in Cutler Canyon make exposed reservoir bed and banks more visible (Figure 6-6).

Overall, exposure of reservoir bed is most visible in and immediately upstream of Cutler Canyon for two reasons: 1) the depth and slope of the reservoir bed allow greater drops in surface elevation than elsewhere in the reservoir (Section 6.5.2), and 2) the canyon's topography provides a more direct perspective of the shoreline.

Referencing Figure 6-3, no exposed reservoir bed is visible at that distance before or during drawdown from the Highway 30 photopoint. At Cutler Marsh Marina (Figure 6-4), the November 1 drawdown photo, the primary reference for this photopoint, shows a narrow band of muddy reservoir bed in the foreground. The proposed increase in drawdown limit would translate to 0.5 feet higher elevation than illustrated in the November 1 photo, which would marginally reduce the band of exposed reservoir bed.

At Benson Marina (Figure 6-5), interpolating between the October 24 baseline and November 1 drawdown photos, a wider band of rocky reservoir bed would be exposed, reflecting roughly the midpoint between the October 24 and November 1 photos.

At Cutler Canyon Marina (Figure 6-6), the October 24 baseline photo most closely illustrates project conditions. Given the shallow slope of the foreground bank, the projected reservoir elevation of 4,405.1 feet relative to that photo would expose a narrow band of muddy reservoir bed. The steep banks opposite the marina in the background would show roughly 2.3 feet more of rocky, partially eroding bank at that elevation, as discussed above for bank erosion.

The potential for weed invasion of exposed reservoir-bed areas, the last factor considered in this analysis, is no longer a consideration as the proposed Project operating scenario involves no changes during the growing season, when invasive plants could become established. Beyond that, the cyclic nature of the proposed non-irrigation season reservoir elevation fluctuations would preclude exposure of reservoir bed long enough for plants to establish.

The seasonality of proposed changes has other implications that would also reduce potential visual changes. In terms of exposed eroding banks and reservoir bed, the Project Area is covered with snow, or ice on the reservoir, during much of the non-irrigation season when minimum reservoir elevation limits could be up to 1 foot lower than current conditions. This coverage of snow and/or ice would reduce the visual changes of potentially increased bank and bed exposure.

In regard to the color of reservoir water, the factors that most influence turbidity (i.e., inflows, algae growth, and carp foraging and movement, as noted above) are all reduced in the winter, reducing the cumulative visual changes of any operations-related turbidity.

Most importantly, recreational use of the Project Area, including the recreation sites, decreases dramatically during the winter. As a result, many of the most sensitive viewers are not present.

Overall, this interpretation of proposed Project operation changes in light of the 2019 photopoint documentation suggests the following changes in SMS results from current conditions (Section 6.5.4.1):

- The Scenic Class determinations identified for existing conditions above (i.e., Class 1 for recreational use, Class 2 for travel on Project Area roads and highways, and Class 5 for travel on Highway 30 entering the valley from the west) would not change.
- The increased extent and visibility of eroded bank and reservoir bed exposure during lower reservoir minimum elevation limits would be noticeable for recreationists in the Cutler Canyon area but would not be sufficient to change the Scenic Integrity rating from moderate.
- The Scenic Integrity rating for recreationists and motorists elsewhere within the Project Area would not be affected and would remain at moderate.
- The Scenic Integrity for travelers on Highway 30 entering the valley from the west would remain unchanged at high.
- Proposed operations changes would not alter Landscape Values in the Project Area, which would remain as follows:

- Scenic Class 1/Moderate Scenic Integrity for recreationists.
- Scenic Class 2/Moderate Scenic Integrity for travelers on Project Area roads and highways.
- Scenic Class 5/High Scenic Integrity for travelers on Highway 30 entering the valley from the west.

The effects analysis documented in the DLA will assess these results in relation to the Landscape Value objective identified above (see Section 6.5.4.1).

7.0 SUMMARY

This study implemented the methods specified for the land use component in the RSP, and as modified in this ISR, for irrigation withdrawal infrastructure, fences, erosion features and erosion control structures, and aesthetic resources. No data gaps remain following implementation of the Land Use RSP, although due to weather-related seasonal study timing issues in early 2020 some data collection is still on-going as of the date of this report. Therefore, results of the bank stabilization study downstream of Cutler Dam will be reported in the USR to be filed later in 2021. Accordingly, this study met the first objective set in the RSP, which is to characterize the current status of the resources addressed in this study and the processes through which Project operations potentially affect them. This provides a sufficient basis for meeting the second study objective, to conduct an impact and effect analysis for the DLA

8.0 REFERENCES

Cicala, Roger. 2012. The Camera Versus the Human Eye. Petapixel.com. https://petapixel.com/2012/11/17/the-camera-versus-the-human-eye/. Nov. 17.

Federal Energy Regulatory Commission (FERC). 2002. FERC order accepting PacifiCorp's revised operations plan and water level targets for the Bear River. April 2002.

FERC. 2019. Scoping Document 1. Cutler Hydroelectric Project Utah. Project No. 2420-054.

Natural Resource Conservation Service (NRCS). 2007. Chapter 8 Threshold Channel Design, Part 654, National Engineering Handbook.

NRCS. 2020. Soil Survey Geographic (SSURGO) Database for Cache County and Box Elder Counties, Utah. Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Available online. Accessed January 2020.

PacifiCorp. 1995. Resource Management Plan for the Cutler Hydroelectric Project FERC No. 2420. Prepared by PacifiCorp. Assisted by EDAW, Inc, Ecosystem Research Institute, and VESTRA Resources. July 1995.

PacifiCorp. 1999. 3-Year Bear River Basin Study. Cutler Hydroelectric Project FERC Project No. 2420. July 1999.

PacifiCorp. 2002. Cutler Hydro Project No. 2420 Resource Management Plan Five-Year Implementation and Monitoring Report 1995-2002. Volume 1: Report.

PacifiCorp. 2018. Cutler Hydroelectric Project FERC Project No. 2420 Resource Management Plan Five-Year Monitoring Report 2013-2017. March 29, 2018.

PacifiCorp. 2019. Cutler Hydroelectric Project FERC No. 2420 Pre-Application Document Volume I – Main Document. March 2019.

Utah Division of Water Quality (DWQ). 2010. Middle Bear River and Cutler Reservoir Total Maximum Daily Load (TMDL). Prepared for Utah Division of Water Quality. Prepared by SWCA Environmental Consultants. February 2010.

DWQ. 2018. Lower Bear River Total Maximum Daily Load (TMDL). Prepared for Utah Division of Water Quality. Prepared by Tetra Tech and Cirrus Ecological Solutions.

USFS (U.S. Forest Service). 1995. Landscape Aesthetics: A Handbook for Scenery Management. Agriculture Handbook 701. USDA Forest Service.

van Rijn, L. 2020. Literature Review of Critical Bed-Shear Stress for Mud-Sand Mixtures. Downloaded 12/07/2020. Available for download at https://www.leovanrijn-sediment.com/papers/Threshsandmud2020.pdf

Attachment D-1

Irrigation Withdrawal Infrastructure

INTRODUCTION

This attachment includes field survey results for all irrigation withdrawals in the Project Area and a summary of publicly available data for each withdrawal structure and location. The information listed below is included (where available) for each withdrawal. A map of all survey sites with labels that indicate the WID for each location is at the end of this attachment (Figures 1 and 2).

ATTRIBUTE	DEFINITION
WID	Withdrawal identification. This number was created to organize field survey data.
Northing / Easting	Geographic coordinates in Universal Transverse Mercator (UTM) North American Datum (NAD) 83 projection.
WR# (map)	Water right number displayed on Utah Division of Water Rights (UDWRi) interactive map.[2]
WR name (map)	Water right name linked to the water right number displayed on UDWRi interactive map[2].
WR# (POD)	Water right number from the UDWRi point of diversion (POD) coverage[3]. The water right for each irrigation withdrawal site was selected based on the POD geographically closest to that site.
WR owner (POD)	Water right owner shown in the attribute table for the water right number/POD point selected for an irrigation withdrawal site.
Power source	Type of power used to operate pump including electricity, diesel fuel, or propane.
Field photo	Several pictures were collected at each field survey site. Each picture has been organized and included in the project record.
Description	A summary of field notes and additional information collected from UDWRi for each irrigation withdrawal is included here.
Elevation of withdrawal (ft. msl)	The elevation of the end of each irrigation withdrawal pipe (intake pipe) was determined from bed elevation coverage (developed from bathymetry and LiDAR measurements) and a high-resolution aerial image collected during the 2019 drawdown. This information can be used with the hydraulic model developed for the ISR to determine if proposed changes in reservoir management could affect water surface elevation, pump efficiency, and the ability of the water right holders' to meet water rights to the Bear River and Cutler Reservoir.
Operational status	Based on field survey results and information from stakeholders. Categories include potentially operational (i.e. all supporting infrastructure in place) and non-operational (i.e. no supporting infrastructure)
[1] Data available at https://www.cachecounty.org/gis/property-/-parcel-viewer.html [2] Data available at https://maps.waterrights.utah.gov/esrimap/map.asp [3] Data available at https://opendata.gis.utah.gov/datasets/utahDNR::utah-points-of-diversion	

WID:	1
Northing	4632826.375
Easting	417201.5165
WR# (map)	25-7329
WR name (map)	46 DALE BENSON
WR# (POD)	25-7329, 25-8297
WR owner (POD)	JANICE R. BENSON
Power source	Electricity
	
Description:	Surveyed 9/27/19. Photo shows pump house and intake. This site will receive an additional pump, managed by West Cache Irrigation Co. in the future. Existing pump has a single inflow, 8–10 in. diam pipe extending out ~40 feet, end of pipe is perforated, no screen. Currently has electric pressure pump with on/off pressure sensor, active condition with telemetry (see antenna), flow record rated good (1989-2019).
Elevation of withdrawal (ft. msl)	4,407.80
Operational status	Potentially operational.

WID:	2
Northing	4631930.891
Easting	417216.6507
WR# (map)	–
WR name (map)	–
WR# (POD)	25-7174
WR owner (POD)	DUANE W. GRIFFIN
Power source	Electricity
	
Description:	Surveyed 9/27/19. Photo shows pump house and flexible intake line, ~6 in. diameter extending out ~20 feet from shoreline, end of pipe enclosed in screen. Pump in working order. No telemetry visible, no UDWRi record.
Elevation of withdrawal (ft. msl)	4,408.10
Operational status	Potentially operational

WID:	3
Northing	4631419.979
Easting	417919.4648
WR# (map)	25-3259
WR Name (map)	31 USU
WR# (POD)	25-3259
WR owner (POD)	UTAH STATE UNIVERSITY
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/2/19. Photos shows pump and connection to stilling well. Intake pipe to well is ~12 in. PVC pipe extending 105 feet, no screen on end, sediment deposit on pipe for most of length. Ultrasonic flow sensor, pump is active, connected to antenna, flow record rated fair (1989-2019).
Elevation of withdrawal (ft. msl)	4,408.02
Operational status	Potentially operational

WID:	4
Northing	4630941.77
Easting	418219.741
WR# (map)	25-3260
WR name (map)	32 USU
WR# (POD)	–
WR owner (POD)	UTAH STATE UNIVERSITY
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/6/19. Photo shows pump (50 HP electric) and ~12 diam steel discharge pipe set on 14 ft. square concrete pad. Intake connected to adjustable (floating) withdrawal, rotating screen at end, draws from tributary pond. Flow monitored by ultrasonic sensor, flow record rated fair (1989–2019).
Elevation of withdrawal (ft. msl)	4,410.14
Operational status	Potentially operational

WID:	5
Northing	4631459.296
Easting	419114.2197
WR# (map)	EX2627
WR name (map)	EX3 GARTH BENSON
WR# (POD)	25-9371
WR owner (POD)	GARTH J. BENSON
Power source	Electricity
Picture (overview)	
Description:	Surveyed 9/27/19. Photo shows electric pressure pump with on/off pressure sensor and telemetry (see antenna). Connected to 75 ft. intake with 6 in. pipe and 4 ft. screen at end, partially buried in sediment, flow record rated good (1989-2019).
Elevation of withdrawal (ft. msl)	4,409.08
Operational status	Potentially operational

WID:	6
Northing	4630779.025
Easting	419396.6542
WR# (map)	25-8991
WR name (map)	54 USU
WR# (POD)	25-1945, 25-8991
WR owner (POD)	USA BUREAU OF RECLAMATION, UTAH STATE UNIVERSITY
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/6/19. Photo shows 50 HP electric pressure pump above stilling well (~ 5 ft. diam) and steel discharge pipe (~ 10 in. diam), power pole and telemetry outside of photo, no intake pipe visible, flow monitored by ultrasonic sensor, flow record rated fair (1989-2019).
Elevation of withdrawal (ft. msl)	End of pipe was submerged during drawdown.
Operational status	Potentially operational

WID:	7
Northing	4630753.435
Easting	419898.519
WR# (map)	25-3382 25-9827
WR name (map)	37 BULLEN FARMS
WR# (POD)	(1) 22-3382, (2) 25-9827, (3) 25-4928
WR owner (POD)	(1) BETTY KNIGHT REVOCABLE TRUST, (2) PACIFICORP, (3) PACIFICORP
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/6/19. Photos show electric pump (covered) and ~6 in. PVC intake extending 32 feet, mesh screen at end buried in sediment, power pole and telemetry outside of photo. UDWRi records indicate diesel pump at this location, flow monitored by ultrasonic flow sensor, record rated fair (1989-2019)
Elevation of withdrawal (ft. msl)	4,410.79
Operational status	Potentially operational

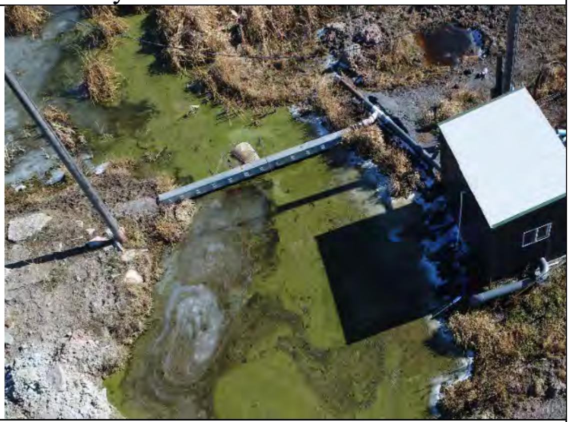
WID:	8
Northing	4631027.751
Easting	420186.9199
WR# (map)	25-3358
WR name (map)	35 J. GOLDEN RIGBY
WR# (POD)	25-9778, 25-10078
WR owner (POD)	TODD N. BALLARD FAMILY TRUST
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/2/19. Photos show two pumps. The left pump (75 HP electric pump) is WID 8, intake pipe (~ 8 in. diam) is underwater but visible near shore and extends out of sight, flow measured by ultrasonic sensor, record rated fair (1989-2019).
Elevation of withdrawal (ft. msl)	End of pipe was submerged during drawdown.
Operational status	Potentially operational

WID:	9
Northing	4631027.54
Easting	420203.2182
WR# (map)	–
WR name (map)	–
WR# (POD)	25-9014, 25-10078, 25-11044, 25-9437, 25-9778
WR owner (POD)	TODD N & NORENE R TRS BALLARD
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/2/19. Photos show two pumps. The right pump (WID 9), visible intake (~ 8 in. diam) at center of photo extends ~ 10 ft. with cage on end and secured to fence posts directly above the intake for WID 8, no flow records available for WID 9.
Elevation of withdrawal (ft. msl)	4,408.05
Operational status	Potentially operational

WID:	10
Northing	4630848.95
Easting	420968.882
WR# (map)	25-9014
WR name (map)	55A TODD BALLARD
WR# (POD)	25-9014, 25-10078, 25-4557, 25-8268, 25-9778,
WR owner (POD)	INNOVASIS PROPERTIES LLC, TODD N. BALLARD FAMILY TRUST
Power source	Electricity
Picture (overview)	
Description:	Surveyed 9/27/19. Photo shows pumps and three steel intake pipes 12–16 in. diam with screens, extending ~ 10 feet into water, adjustable with cable and motor, electric pressure pumps monitored by ultrasonic flow sensors, flow record rated fair 1989–2019.
Operational status	Potentially operational

WID:	12
Northing	4631410.501
Easting	421889.9198
WR# (map)	25-8263
WR name (map)	50 BOB MUNK
WR# (POD)	25-3378, 25-8148, 25-8263, 25-8397
WR owner (POD)	MUNK BROTHERS LLC
Power source	Electricity
Picture (overview)	
Description:	Surveyed 9/27/19. Photo shows pumphouse and dual ~10 in. intakes with adjustable spinning screens, water pumped from stilling basin with intake (left), pumps monitored with ultrasonic flow sensors, flow record rated fair (1989-2019).
Elevation of withdrawal (ft. msl)	4,408.84
Operational status	Potentially operational

WID:	13
Northing	4631724.33
Easting	421727.0464
WR# (map)	25-8268
WR name (map)	51 RUSS SEAMONS
WR# (POD)	25-10149
WR owner (POD)	INNOVASIS PROPERTIES LLC
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/5/19. Photo shows pumphouse and two discharge pipes (one left and one above pumphouse) into pond. Pump collects water from pond to left, excess water flows into pond at right. Photo collected by drone. Flow records are unrated (1991–2019).
Elevation of withdrawal (ft. msl)	Variable, water elevation regulated by control structure at road crossing on Clay Slough.
Operational status	Potentially operational

WID:	14
Northing	4632316.572
Easting	422687.7798
WR# (map)	–
WR name (map)	–
WR# (POD)	25-3367, 25-8272
WR owner (POD)	WILLIAM L. LINDLEY
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/5/19. Photo shows pumphouse and one intake pipe into pond at left. Photo collected by drone, no flow records available.
Elevation of withdrawal (ft. msl)	Variable, water elevation regulated by control structure at road crossing on Clay Slough.
Operational status	Potentially operational

WID:	15
Northing	4630213.717
Easting	421300.0087
WR# (map)	–
WR name (map)	–
WR# (POD)	25-3041, 25-4557
WR owner (POD)	PAUL F CARDON, Norma Seamons
Power source	Electricity
Picture (overview)	
Description:	Surveyed 9/27/19. Photo shows pumphouse and steel intake pipe ~14-16 in. diameter connected to bottom of pump and extending down into screened concrete well. Discharge from pump connected to the back of pump. Pump and intake are functional, no flow records identified.
Elevation of withdrawal (ft. msl)	End of pipe was submerged during drawdown.
Operational status	Potentially operational

WID:	16
Northing	4629088.905
Easting	420071.0167
WR# (map)	25-6262
WR name (map)	42 JOE COWLEY
WR# (POD)	25-6262
WR owner (POD)	CC RANCH FAMILY, LLC
Power source	Propane
Picture (overview)	
Description:	Surveyed 9/27/19. Photo shows 80 HP Ford propane pump connected to ~12 in. steel intake pipe (center of photo). Pump draws from pond at shoreline and filled by 3-foot plastic culvert. Pump controlled by on/off pressure sensor, flow record rated fair (1989-2019).
Elevation of withdrawal (ft. msl)	4,410.22
Operational status	Potentially operational

WID:	17
Northing	4629442.937
Easting	421528.9425
WR# (map)	–
WR name (map)	–
WR# (POD)	25-3031, 25-6975
WR owner (POD)	PAUL F. CARDON
Power source	Electricity
Picture (overview)	
Description:	Photo shows electric pump installed on small concrete base at shoreline and intake pipe (6 in. PVC) to center of photo, flow monitored by telemetry (see antenna near pole). Pump and intake are functional, no flow records identified.
Elevation of withdrawal (ft. msl)	End of pipe was submerged during drawdown.
Operational status	Potentially operational

WID:	18
Northing	4628948.835
Easting	422309.7168
WR# (map)	–
WR name (map)	15B LARRY FALSLEV
WR# (POD)	25-6908, 25-6909
WR owner (POD)	LARRY J AND MARY FALSLEV FAMILY TRUST
Power source	Electricity
Picture (overview)	
Description:	Photo shows antenna and utility box containing 25 HP pump, pipe with gate valve to left of antenna. Survey identified two small 3 in. pipes at bottom of slope to left, assume these are intake, flow monitored by on/off pressure sensor, flow record is unrated (2005–2019).
Elevation of withdrawal (ft. msl)	4,409.14
Operational status	Potentially operational

WID:	19
Northing	4628947.195
Easting	422804.6562
WR# (map)	25-6909
WR name (map)	16 MIKE FALSLEV (PREVIOUS: RULON FLASLEV)
WR# (POD)	25-6908, 25-6909
WR owner (POD)	LARRY J AND MARY FALSLEV FAMILY TRUST
Power source	Electricity
Picture (overview)	
Description:	Surveyed 9/27/19. Photo shows pumphouse and antenna, intake is behind screen to photo left at water surface, pump is 60 HP electric pressure pump monitored with ultrasonic flow sensor, flow record is rated fair (1989–2019).
Elevation of withdrawal (ft. msl)	End of pipe was submerged during drawdown.
Operational status	Potentially operational

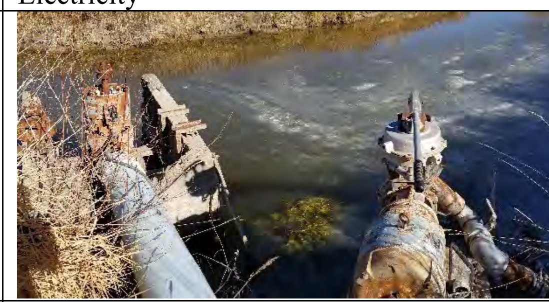
WID:	20
Northing	4628376.699
Easting	422963.025
WR# (map)	25-6320
WR name (map)	22A LARON FALSLEV
WR# (POD)	25-6319, 25-6320
WR owner (POD)	THE FALSLEV INVESTMENT TRUST
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/6/19. Photo shows pumphouse to left and ~14-inch diameter intake pipe in concrete box, small pump and barrel screen to right. Main pump is 10 HP electric flood pump, monitored by on/off pressure sensor, flow record rated fair (1989-2019). No UDWRi record for small pump to right.
Elevation of withdrawal (ft. msl)	End of pipe was submerged during drawdown.
Operational status	Potentially operational

WID:	21
Northing	4627983.57
Easting	422527.8456
WR# (map)	25-6023
WR name (map)	30 J.L. WATTERSON
WR# (POD)	25-6023
WR owner (POD)	JAMES T. WATTERSON REVOCABLE TRUST
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/1/19. Photo shows pumphouse and two intake pipes including 6 in. flexible pipe and screen to left and ~12 steel pipe at center. Pump is 12 HP electric flood pump monitored with on/off pressure sensor, flow record is rated fair (1989-2019)
Elevation of withdrawal (ft. msl)	Small intake pipe (left): 4,407.68 Large intake pipe (center): end of pipe was submerged during drawdown.
Operational status	Potentially operational

WID:	22
Northing	4627729.483
Easting	422757.3993
WR# (map)	–
WR name (map)	–
WR# (POD)	25-4319
WR owner (POD)	NORVAL H. JOHNSON
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/1/19. Photo shows winterized pump and 10-foot section of intake pipe (flexible 8 in. diam) to left of pipe, likely suspended during summer from floating frame (see left of pump). Pump and intake are functional, No flow records identified.
Elevation of withdrawal (ft. msl)	Variable.
Operational status	Potentially operational

WID:	23
Northing	4627122.77
Easting	423173.281
WR# (map)	25-6318
WR name (map)	11 BENSON-BEAR LAKE IRR. CO.
WR# (POD)	25-6318
WR owner (POD)	BENSON-BEAR LAKE IRRIGATION COMPANY
Power source	Electricity
Picture (overview)	
Description:	Surveyed 9/27/19. Photo shows pumphouse, antenna top of pumphouse, and concrete intake throughout structure to center of photo. Pump is 30 HP electric flood pump, measured with 18-inch Parshall Flume, flow record is rated good (1989–2019).
Elevation of withdrawal (ft. msl)	4,410.93
Operational status	Potentially operational

WID:	24
Northing	4626592.70
Easting	423124.012
WR# (map)	–
WR name (map)	–
WR# (POD)	25-4958
WR owner (POD)	GORDON W. RICKS
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/5/19. Photo shows winterized pump and plumbing connection, electric meter box, and 3-inch flexible intake pipe that was removed from water for the year. Pump and intake are functional, no flow records identified.
Elevation of withdrawal (ft. msl)	4,412.72
Operational status	Potentially operational

WID:	25
Northing	4627543.280
Easting	423573.3724
WR# (map)	25-3311
WR name (map)	34 HAROLD FALSLEV (KEVIN FALSLEV)
WR# (POD)	25-7953
WR owner (POD)	HAROLD N. FALSLEV
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/5/19. Photo shows small electric pressure pump (photo right) connected to flexible 4-inch diameter intake in pond. Concrete structure and pipe to photo left are inactive. Pond is filled by diversion ditch off Bear River. Flow monitored by on/off pressure sensor, flow record rated fair (1989-2019)
Elevation of withdrawal (ft. msl)	End of pipe was submerged during drawdown.
Operational status	Potentially operational

WID:	26
Northing	4627612.855
Easting	423568.9593
WR# (map)	–
WR name (map)	–
WR# (POD)	25-3311
WR owner (POD)	HAROLD N. FALSLEV
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/5/19. Photo shows pumphouse, radio antenna (photo left), and adjustable intake with screen (photo right) above small pond. Pump and intake are functional, no flow records identified.
Elevation of withdrawal (ft. msl)	Variable.
Operational status	Potentially operational

WID:	27
Northing	4627894.961
Easting	424014.8437
WR# (map)	–
WR name (map)	–
WR# (POD)	–
WR owner (POD)	–
Power source	Electricity
Picture (overview)	No photo.
Description:	Surveyed 11/5/19. This location was identified from Irrigation District map. Adjacent land owner near pump (per irrigation district map) said the pump has been moved to either WID 26 or WID 27.
Elevation of withdrawal (ft. msl)	None.
Operational status	Non-operational (no pump at site)

WID:	28
Northing	4628240.681
Easting	424424.3195
WR# (map)	–
WR name (map)	–
WR# (POD)	25-6855, 25-6910, 25-6911, 25-6912, 25-6913
WR owner (POD)	NOLAN R. BALLARD
Power source	Electricity
Picture (overview)	
Description:	Surveyed 9/9/27. Photo shows pumphouse only. Pump inside, no visible intake at surface to pump, large pond behind pumphouse filled by diversion from river. Pump and intake are functional, no flow records identified.
Elevation of withdrawal (ft. msl)	None visible
Operational status	Potentially operational

WID:	29
Northing	4628449.335
Easting	424488.5699
WR# (map)	–
WR name (map)	–
WR# (POD)	25-6855, 25-6910, 25-6911, 25-6912, 25-6913
WR owner (POD)	NOLAN R. BALLARD
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/5/19. Photo shows pumphouse adjacent to irrigation pond. General location of this pump on irrigation district map, pump has been removed from house, two metal pipes (4-inch and 1-inch extend into pond), adjacent landowner did not know current location of pump.
Elevation of withdrawal (ft. msl)	None.
Operational status	Non-operational (no pump at site).

WID:	30
Northing	4628158.468
Easting	424794.957
WR# (map)	–
WR name (map)	–
WR# (POD)	25-5977
WR owner (POD)	HAROLD N. FALSLEV
Power source	Electricity
Picture (overview)	
Description:	Surveyed 9/29/19. Photo shows wooden shelter above pump, and flexible pump intake to left of tree, the mount of an old intake is visible to right of tree near grass. Pump and intake are functional, no flow records identified.
Elevation of withdrawal (ft. msl)	End of pipe was submerged during drawdown.
Operational status	Potentially operational

WID:	31
Northing	4628116.326
Easting	425438.0254
WR# (map)	–
WR name (map)	–
WR# (POD)	25-6518, 25-6301
WR owner (POD)	W. LEE REESE, ROBERT E. GRIFFITHS
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/5/20. Photo shows pumphouse and intake pipe attached to float with rotating screen at end of pipe. Photo collected by drone. Pump draws from ditch that drains large pond to north. Pond is filled by diversion from Bear River. Pump and intake appear functional, no flow records identified.
Elevation of withdrawal (ft. msl)	Variable
Operational status	Potentially operational

WID:	32
Northing	4628541.604
Easting	425674.8515
WR# (map)	25-6299
WR name (map)	T01 LEE REESE
WR# (POD)	25-6300
WR owner (POD)	W. LEE REESE REVOCABLE TRUST AND DON REESE REVOCABLE TRUST
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/5/20. Photo shows 20 HP electric flood pump, two intake pipes (~12-inch diameter) in concrete well, power box and radio antenna (upper photo left). Flow is monitored by an on/off pressure sensor, record is rated fair (1989-2019).
Elevation of withdrawal (ft. msl)	End of pipe was submerged during drawdown.
Operational status	Potentially operational

WID:	33
Northing	4629123.139
Easting	425584.5215
WR# (map)	–
WR name (map)	–
WR# (POD)	25-7987
WR owner (POD)	VALLEY VESTA FARMS
Power source	None
Picture (overview)	
Description:	Surveyed 11/5/19. Photo shows shoreline area of the location on irrigation district map where pump should be. Photo collected by drone. No sign of pump, intake pipe, or Power source (i.e. power pole or line) at this location.
Elevation of withdrawal (ft. msl)	None.
Operational status	Non-operational (no infrastructure identified)

WID:	34
Northing	4629184.655
Easting	425510.438
WR# (map)	25-7522
WR name (map)	T03 TOM REESE
WR# (POD)	25-7522
WR owner (POD)	BERT D. REESE AND SONS INC.
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/5/19. Photo shows three irrigation pump, two intake pipes (~10-inch diameter), concrete stilling well, electrical connection and radio antenna (left of power pole). UDWRi records show a single 15 HP electric pressure pump monitored by on/off pressure sensor, flow record rated fair (1989-2019).
Elevation of withdrawal (ft. msl)	End of pipe was submerged during drawdown.
Operational status	Potentially operational

WID:	35
Northing	4629537.039
Easting	425147.0306
WR# (map)	25-4647
WR name (map)	39A WAYNE WATTERSON
WR# (POD)	25-7951, 25-7849
WR owner (POD)	DEE D. REESE
Power source	Diesel fuel
Picture (overview)	
Description:	Surveyed 11/1/19. Photo shows metal intake pipe with perforated end, attached to sealed 50-gallon drum used as a float. Pump is a diesel pressure pump, flow is monitored by an on/off pressure sensor, flow record is rated fair (1989-2019).
Elevation of withdrawal (ft. msl)	Variable
Operational status	Potentially operational

WID:	36
Northing	4629013.692
Easting	425113.7536
WR# (map)	25-6914
WR name (map)	09 JOHN ALLEN
WR# (POD)	25-3264
WR owner (POD)	JOHN E. ALLEN
Power source	Electricity
Picture (overview)	
Description:	Surveyed 9/27/19. Photo shows 12-inch diameter intake pipe connected to pump in pumphouse located off bank (to right of blue barrel) and radio antenna. Intake pipe is adjustable with cable and winch. UDWRi record shows two pumps at this site including 25 HP electric flood and 25 HP electric pressure pumps monitored by ultrasonic flow sensor, record is rated fair (1989-2019)
Elevation of withdrawal (ft. msl)	Variable
Operational status	Potentially operational

WID	37
Northing	4628731.776
Easting	425157.4782
WR# (map)	–
WR name (map)	08A REESE-BALLARD
WR# (POD)	25-6914, 25-6915, 25-6939, 25-7047, 25-7048
WR owner (POD)	JOHN E. ALLEN
Power source	Electricity
Picture (overview)	
Description:	Surveyed 9/27/19. Photo shows pumphouse, radio antenna (right side of roof), and two metal intake pipes (~12 inch diameter, screened at end), Pump is 30 HP electric flood monitored by ultrasonic flow sensor, flow record is rated fair (2005-2019).
Elevation of withdrawal (ft. msl)	End of pipes were submerged during drawdown, screen on left intake pipe was visible.
Operational status	Potentially operational

WID:	38
Northing	4626966.139
Easting	424448.3495
WR# (map)	EX1093 E1093
WR name (map)	EX1 PRESTON, SAUNDERS, JOHNSON
WR# (POD)	25-9343, 25-7196
WR owner (POD)	LEE JOHNSON, MERLIN SAUNDERS
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/5/19. Photo shows wooden shelter above pump, radio antenna and intake pipe (~6-inch diameter) extending ~ 15 feet into pond. Pipe is connected to sealed barrel used as float. Pump is 25-HP electric pressure pump monitored by on-off pressure sensor, flow record is rated fair (1989-2019).
Elevation of withdrawal (ft. msl)	Variable
Operational status	Potentially operational

WID:	39
Northing	4627637.307
Easting	421139.4712
WR# (map)	EX1194
WR name (map)	11C JIM WATTERSON
WR# (POD)	25-7964
WR owner (POD)	JAMES T. WATTERSON
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/6/19. Photo shows connections to two intake pipes (~ 6-inch diameter) that extend 5 – 10 feet from shoreline. Pump is a propane pressure pump, located outside of photo to left, flow monitored by ultrasonic flow sensor, record rated fair (1989-2019).
Elevation of withdrawal (ft. msl)	4.410.11
Operational status	Potentially operational

WID:	40
Northing	4627326.015
Easting	420139.1854
WR# (map)	25-6691 25-9827
WR name (map)	43 BULLEN FARMS
WR# (POD)	25-4928, 25-6691, 25-8368, 25-9827
WR owner (POD)	PACIFICORP, BETTY KNIGHT REVOCABLE TRUST, BULLEN FARMS INCORPORATED
Power source	Diesel fuel
Picture (overview)	
Description:	Surveyed 11/5/19. Photo shows pump (116 HP Deutz Diesel) connected to flexible intake pipe (~10-inch diameter), rotating screen/floating platform in pond, radio antenna with solar panel (right of pump) and fuel tank (left of pump). Pond is filled by large ditch diverting from reservoir. Flow record rated fair (1989-2019).
Elevation of withdrawal (ft. msl)	Bottom of ditch: 4,411.15
Operational status	Potentially operational

WID:	41
Northing	4626549.162
Easting	421296.4135
WR# (map)	EX-581
WR name (map)	11A LEE JOHNSON (KIMBER JOHNSON)
WR# (POD)	25-10015, 25-8346
WR owner (POD)	W. D. JOHNSON, BENSON BEAR LAKE IRRIGATION COMPANY
Power source	Electricity
Picture (overview)	
Description:	Surveyed 11/5/19. Photo shows pump (30 HP electric pressure pump) and two flexible intake pipes (~4 inches diameter, screened at end) extending 10 feet from shoreline, and electrical source with base of antenna. A second pump is located directly behind pump shown, both appear functional. First pump monitored by on/off pressure sensor, flow record rated good (1989-2019), no record for other pump
Elevation of withdrawal (ft. msl)	4,409.25 (intake – large pump), the end of small intake pipe was submerged during drawdown.
Operational status	Potentially operational

WID:	42
Northing	4626516.089
Easting	421497.4178
WR# (map)	25-3379
WR name (map)	36 NORVAL JOHNSON (NICK GALLOWAY)
WR# (POD)	25-3379, 25-3461, 25-3462
WR owner (POD)	NORVAL H. JOHNSON, WILLIAM D. JOHNSON, LEE W. JOHNSON
Power source	Electricity
Picture (overview)	
Description:	Surveyed 9/27/19. Photo shows wooden shelter, pump (40 HP electric pressure pump), intake pipe (~10-inch diameter) connected to rotating screen on float. Flow is monitored by on/off pressure sensor, flow record rated good (1989-2019).
Elevation of withdrawal (ft. msl)	Variable
Operational status	Potentially operational

WID:	43
Northing	4626375.992
Easting	421687.1046
WR# (map)	25-8949
WR name (map)	53 CECIL ARCHIBALD
WR# (POD)	25-8949
WR owner (POD)	CECIL ARCHIBALD
Power source	Electricity
Picture (overview)	
Description:	Surveyed 9/27/19. Photo shows concrete pumphouse, antenna, and steel intake pipe (8-inch diameter) with flex connection, suspended in water by floating barrel. Pipe is screened at end, extends from shoreline ~15 feet, pump is 30 HP electric pressure pump, flow record is rated fair (1989-2019)
Elevation of withdrawal (ft. msl)	Variable
Operational status	Potentially operational

WID:	44
Northing	419803.513
Easting	4631314.44115
WR# (map)	–
WR name (map)	–
WR# (POD)	25-3358
WR owner (POD)	VALJAY RIGBY
Power source	None
Picture (overview)	
Description:	Surveyed 11/5/20. Photo shows abandoned pump and post for electric power connection. Pump has been abandoned. Remnant of intake pipe is on reservoir bed ~ 25 feet from shore.
Elevation of withdrawal (ft. msl)	None.
Operational status	Non-operational (no intake or Power source)

WID:	803
Northing	4627983.08
Easting	424408.5294
WR# (map)	–
WR name (map)	–
WR# (POD)	25-7955, 25-7957, 25-7955
WR owner (POD)	M. L. BALLARD, LARRY J AND MARY FALSLEV FAMILY TRUST
Power source	Electricity
Picture (overview)	
Description:	Surveyed 9/27/19. Photo shows pumphouse, intake pipe (~6-inch diameter to left of concrete), and structure used to adjust intake pipe based on the water surface elevation. No flow records identified.
Elevation of withdrawal (ft. msl)	End of pipe was submerged during drawdown.
Operational status	Potentially operational

WID:	804
Northing	Exact location not GPS (under construction)
Easting	Exact location not GPS (under construction)
WR# (map)	–
WR name (map)	–
WR# (POD)	E5931 (25-11572)
WR owner (POD)	West Cache Irrigation Company (WCIC)
Power source	Unknown
Picture (overview)	No picture available, project is under construction.
Description:	General location is southeast of Newton Recreation Site. Easement was granted by PacifiCorp to WCIC in June 2020 to construct a new pump station.
Elevation of withdrawal (ft. msl)	Under construction
Operational status	Non-operational (under construction)

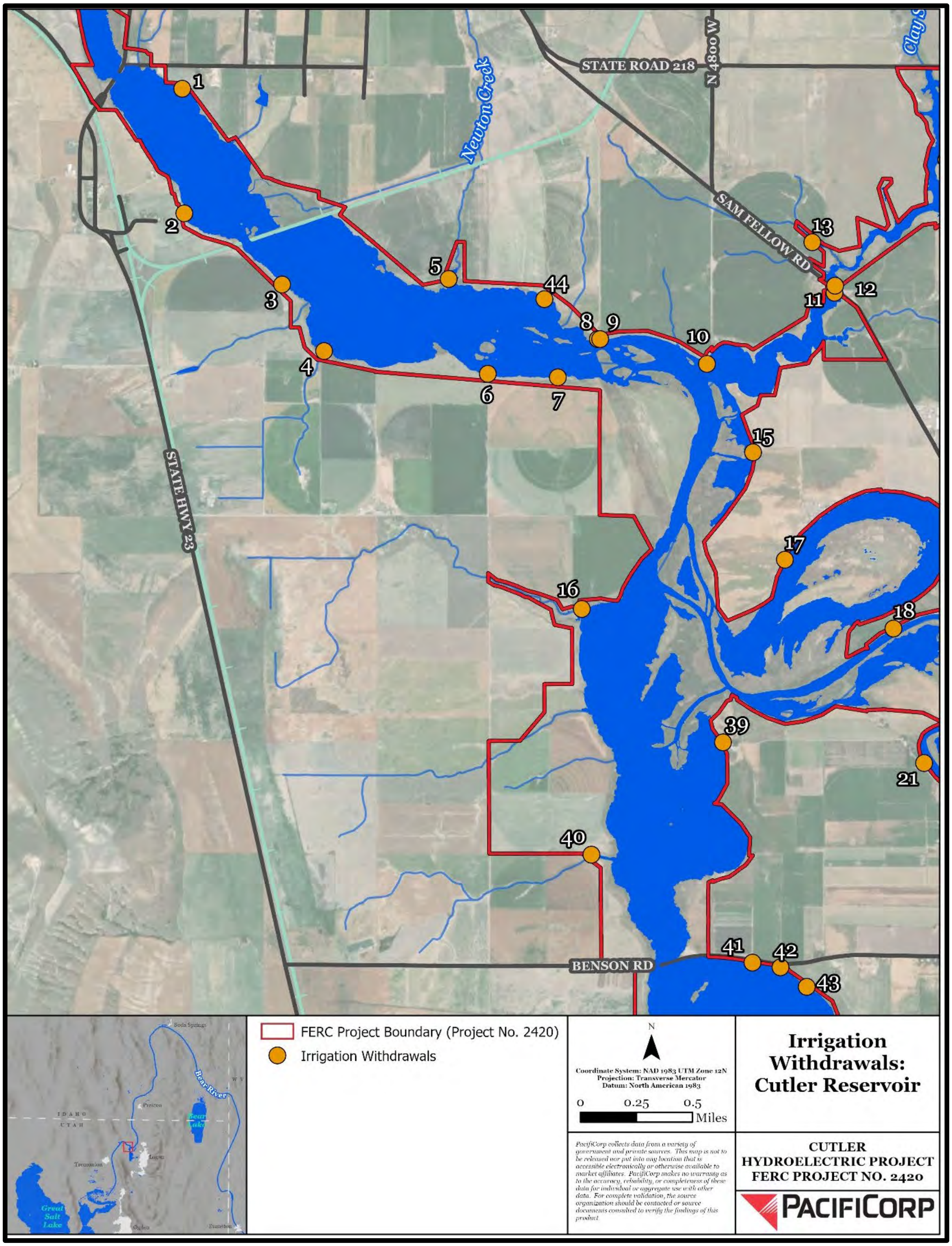


FIGURE 1 **IRRIGATION WATER WITHDRAWAL STRUCTURES LOCATED ON CUTLER RESERVOIR.**

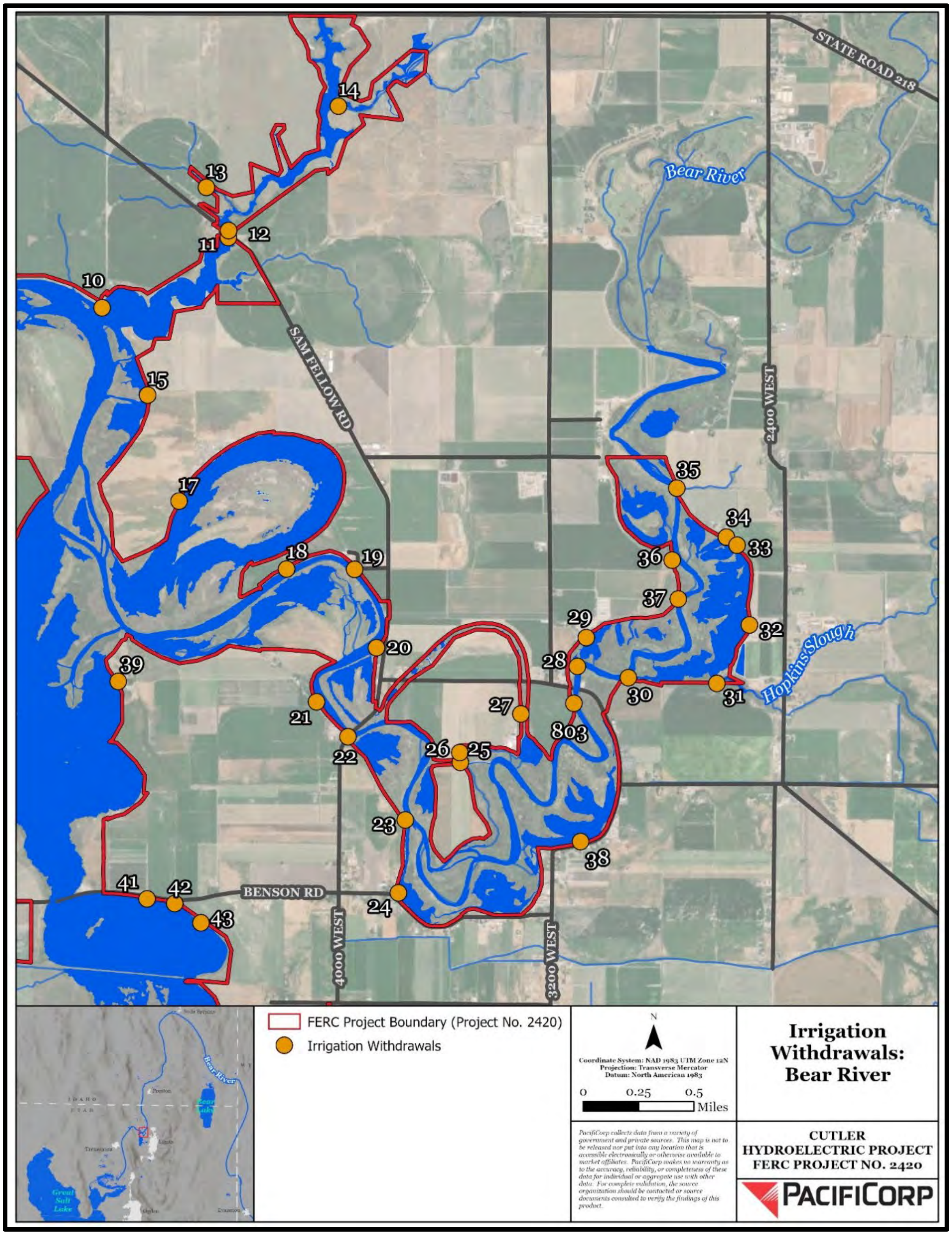


FIGURE 2 IRRIGATION WITHDRAWAL STRUCTURES LOCATED ON THE BEAR RIVER

ATTACHMENT D-2

BANK STABILIZATION PROJECT SURVEYS

INTRODUCTION

This attachment includes field survey results of all bank stabilization projects implemented by PacifiCorp in the FERC Project Boundary for Cutler Reservoir. The results of past monitoring are based on 1) condition of bank stabilization components and their ability to prevent erosion, 2) condition and trend of site vegetation, 3) presence of new or enlarged bank failures, and 4) incidental wildlife use (PacifiCorp 2002). Survey results presented in this attachment are based on the same factors. Maps showing the location of each existing bank stabilization project are found in in Attachment D-3 of this Appendix D.

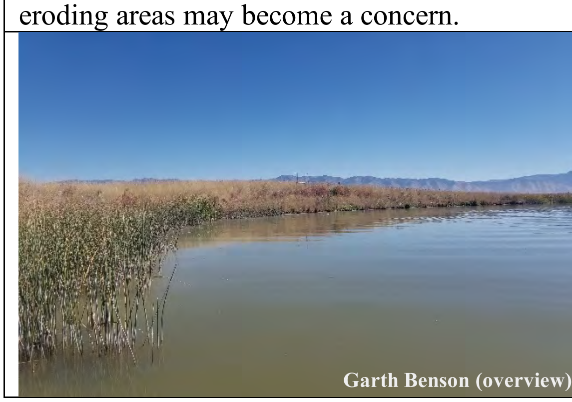
<table>
<tr><td colspan="2">Site Name: Archibald</td></tr>
<tr><td>Construction date: 1995</td><td>Length (ft): 5,358</td></tr>
<tr><td colspan="2">Bank Stabilization type: Gabion baskets (Note that all bank stabilization project types began with car removal, when present, and minimum 2:1 bank sloping.).</td></tr>
<tr><td colspan="2">Existing condition: Emergent vegetation is dense on the upstream half of this site where gabions are relatively close to bank, and less so downstream where gabions are >10 ft. from shore. Emergent zone vegetation is primarily mature cattails with some willow. Phragmites is found on the upstream end of the project (left photo) that transition to cattail. Slope vegetation is primarily herbaceous interspersed with mature shrubs (sage and rabbit brush) and few trees (Russian olive). Grass and weeds cover shoreline slopes on the downstream half of the project where cultivated fields are adjacent to the shoreline. Rock gabion and rip-rap are in good condition throughout the length of the project. Gabion is upright, cage is structurally solid without breaks; visible on upstream end of the project near RR Fishing Bridge (right photo) and submerged on the downstream end. Small recreation (fishing-related) trails to water are visible. Active erosion (~100 ft.) is located adjacent to project, between the upstream end of gabion and the RR Fishing Bridge, characterized by steep, unstable banks with recent sloughing. Project is rated in good condition.</td></tr>
<tr><td>
Archibald (overview)</td><td>
Archibald (detail)</td></tr>
</table>

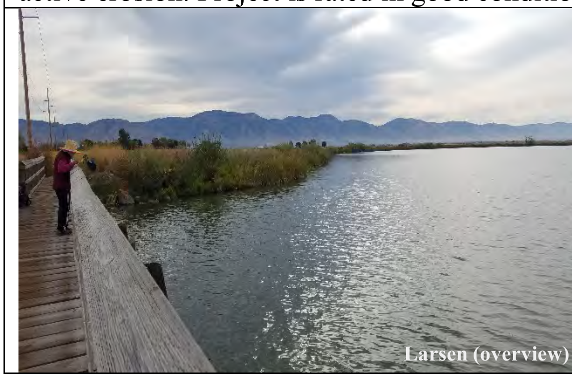
<table>
<tr><td colspan="2">Site Name: Ballard</td></tr>
<tr><td>Construction date: Fall 1997; reconstructed in 2003.</td><td>Length (ft): 1,951</td></tr>
<tr><td colspan="2">Bank Stabilization type: Originally large straw bales only; subsequently reconstructed in fall 2003 with breakwater rock rip-rap (large rock rip-rap placed parallel to and 3-8 feet from the shoreline), willow bundles (placed horizontally), and cattail and hardstem added in the emergent zone.</td></tr>
<tr><td colspan="2">Existing condition: Emergent vegetation is dense through the length of this site. Emergent zone vegetation is primarily cattail and hardstem. Slope vegetation is an equal mix of herbaceous (dense stands of grass) and shrubs (mostly willow) with small amounts of thistle in some areas. Breakwater rock rip-rap is in good condition and visible at shoreline near the middle of the project (see right photo). No active erosion, although old scars on slopes are visible. Project is rated in good condition.</td></tr>
<tr><td>Ballard (overview)</td><td>Ballard (detail)</td></tr>
</table>

<table>
<tr><td colspan="2">Site Name: Benson West</td></tr>
<tr><td>Construction date: 2002</td><td>Length (ft): 552</td></tr>
<tr><td colspan="2">Bank Stabilization type: Breakwater rock rip-rap with toe of slope plantings (willow) and emergent zone cattail/hardstem plantings.</td></tr>
<tr><td colspan="2">Existing condition: Emergent zone vegetation consists primarily of cattails in large groups. Vegetation is healthy with new growth in colonies found in shallow shoreline areas (see right photo). Slope vegetation is a mix of healthy species of shrub (primarily willow with one Russian olive) and herbaceous grasses that stabilize low banks in the area. Limited numbers of thistle were also observed. Bank and shoreline integrity are good with some user-created trails cutting through the vegetation that provide fishing access to shoreline. These areas are more common on the south end of the project. No active erosion is present but runoff from storm events and snowmelt may occur from user-created trail surfaces. Project is rated in good condition.</td></tr>
<tr><td>
Benson West (overview)</td><td>
Benson West (detail)</td></tr>
</table>

Site Name: Canyon J Benson	
Construction date: Fall 1996	**Length (ft):** 1,215
Bank Stabilization type: Slope plantings (willow) and rock rip-rap (smaller rock placed directly on shoreline).	
Existing condition: No emergent vegetation was observed at this site. Slope vegetation is primarily a dense mixture of willow and other shrubs with a few thistle. Dense grass understory occurs beneath shrubs and adds to slope stability. Vegetation cover is dense throughout the project. Rip-rap is visible along the shoreline in some locations but is mostly submerged at normal reservoir elevations. During the drawdown, extensive smaller riprap extending ~15 ft. from the shoreline was observed on the downstream end of this project. No evidence of active erosion was observed although eroding segments occur just upstream of the site (right photo). Project is rated in good condition.	
 Canyon J Benson (overview)	 Canyon J Benson (detail)

Site Name: G. Benson South	
Construction date: 1999	**Length (ft):** 1,518
Bank stabilization type: Cars removed during summer 1999. Breakwater rock rip-rap placed adjacent to shoreline (large rock placed several feet out into water to form a quietwater zone for the emergent plantings) followed by slope plantings (willow) and hardstem/cattails in the emergent zone during fall 1999.	
Existing condition: Emergent vegetation primarily consists of cattail with some hardstem. Vegetation is healthy and increasing in some areas. Slope vegetation is primarily herbaceous grass with few willow or other shrubs, following willow mortality from non-target spray by County. Rip-rap is in place along the shoreline and colonized by some emergent vegetation. Bank stability remains high. No sign of active erosion were observed. Project is rated in good condition.	
 G Benson South (overview)	 G Benson South (detail)

Site Name: Garth Benson	
Construction date: 1998	**Length (ft):** 1,704
Bank Stabilization type: Rip-rap (smaller rock placed directly on the shoreline) and slope planting. Rock placed in 1998 followed by shrub plantings.	
Existing condition: Emergent vegetation is limited in some areas of the project. Where it does occur, vegetation is a mixture of healthy cattail and hardstem. Emergent vegetation is moving into shallow areas at some locations (left photo). Slope vegetation is primarily a dense cover of herbaceous grass. Riprap is present and colonized by upslope herbaceous vegetation at some locations (right photo). Two areas of shoreline that did not get original riprap treatment are now showing some signs of active erosion at this site includes one segment (75 ft.) near the middle of the project and another segment (50 ft.) near the downstream end of the project. The emergent zone at the eroding segment near the middle of the project is being colonized by hardstem and cattails growing on slumped bank material. Overall, project is rated in good condition, although eroding areas may become a concern.	
 Garth Benson (overview)	 Garth Benson (detail)

Site Name: Larsen	
Construction date: 1996	**Length (ft):** 1,855
Bank Stabilization type: Rock rip-rap (smaller) placed directly on shoreline with slope planting (willow).	
Existing condition: Emergent vegetation is dense and well-established for the entire project and could be increasing. Slope vegetation is comprised of shrub species at many locations including a range of willow age classes. Herbaceous grass is present as understory where space allows. No user-created recreation trails observed in slope areas. Rip-rap is generally not visible but still present at some locations based on observations made during the 2019 drawdown. No sign of active erosion. Project is rated in good condition.	
 Larsen (overview)	 Larsen (detail)

Site Name: Middle Roundy	
Construction date: 2000	**Length (ft):** 1,330
Activity type: Breakwater rock rip-rap and slope plantings (willow). Cattail and hardstem planted in November 2000; additional shrubs and willow bundles (placed in a trench at the toe of the slope, running parallel to the shoreline) also planted.	
Existing condition: Emergent vegetation includes a mixture of hardstem and *Phragmites* (concentrated in the upstream/north end), few cattails are present. Emergent vegetation appears to be increasing where water depth allows but most cover is complete. Upslope vegetation is dominated by herbaceous grass with shrubs occurring in the upper portion of the bank slope. No sign of active erosion. Project is rated in good condition.	
 Middle Roundy (overview)	 Middle Roundy (detail)

Site Name: Near Check Dam 12	
Construction date: 2001	**Length (ft):** 831
Bank Stabilization type: Breakwater rock rip-rap with willow bundles placed at the toe of the slope and slope plantings (rose and currant).	
Existing condition: Emergent vegetation consists of a mixture of cattail and hardstem. Vegetation is consistent and increasing in extent throughout most of the project. Slope vegetation includes pockets of shrub (willow) near the shoreline mixed with herbaceous grass and some thistle. Slope vegetation cover is complete (i.e. no bare areas). Breakwater rocks were observed at the downstream (north) end of project during the 2019 drawdown. A few low-elevation (<5 ft.) bank segments were noted to have minor undercutting where emergent vegetation was absent. No slumping, cracking, or signs of instability or active erosion were observed at these locations. This project is rated in good condition.	
 Near Check Dam 12 (overview)	 Near Check Dam 12 (detail)

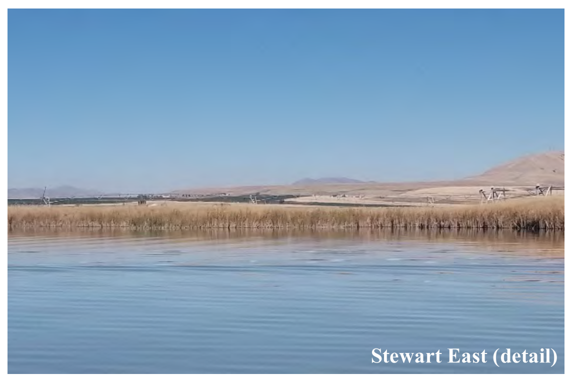
Site Name: Roundy Pump	
Construction date: 2000	**Length (ft):** 1,697
Bank Stabilization type: Breakwater rock rip-rap, emergent zone vegetation, willow bundles, and slope plantings (rose and currant). Rock, willow, hardstem, cattail, and shrubs placed fall 2000.	
Existing condition: Emergent vegetation includes cattail and hardstem as separate stands and as mixed cover. Emergent vegetation is consistent in most areas with gaps appearing along the upstream end of the project. Slope vegetation is primarily herbaceous grass with shrubs (some willow). Vegetation cover is complete over the length of the project. Breakwater rocks were observed throughout the project during the 2019 drawdown and are visible at times during the irrigation season (right photo). No sign of active erosion was observed in the project although one eroding bank segment (~40 ft.) occurs immediately upstream of where the breakwater rock begins. Project is rated in good condition.	
 Roundy Pump (overview)	 Roundy Pump (detail)

<table>
<tr><td colspan="2">Site Name: RR Trail North</td></tr>
<tr><td>Construction date: 2000</td><td>Length (ft): 3,338</td></tr>
<tr><td colspan="2">Bank Stabilization type: Rebuilt earthen dike (former RR crossing over reservoir near Benson Marina) with breakwater rock rip-rap, willow bundles, and slope plantings. Rocks placed by July 2000; planting occurred in late 2000 including willow bundles, cattail, and hardstem in the emergent zone areas; rose and currant shrubs on the slopes.</td></tr>
<tr><td colspan="2">Existing condition: Emergent vegetation is dense and comprised of a mix of cattail, hardstem, and other marsh vegetation with limited Phragmites. Emergent zone vegetation is mostly contiguous with little new spread. Slope vegetation is primarily herbaceous with larger shrubs on the slopes on the west end of the site and on the east end where good willow (toe of the slope) and upslope growth was observed. Breakwater rocks continue to protect the shoreline and are visible just above the water surface at normal reservoir elevations (right photo). Rock and cobble material are colonized by emergent zone vegetation in most areas. No active erosion observed at any location. Project is rated in good condition.</td></tr>
<tr><td>
RR Trail North (overview)</td><td>
RR Trail North (detail)</td></tr>
</table>

Site Name: RR Trail South	
Construction date: 2000	**Length (ft):** 5,856
Bank Stabilization type: Rebuilt earthen dike (former RR crossing over reservoir near Benson Marina) with breakwater rock rip-rap, willow bundles, and slope plantings. Rocks placed by July 2000; planting occurred in late 2000 including willow, cattail, and hardstem in the emergent zone areas; rose and currant shrubs on the slopes.	
Bank Stabilization condition: Emergent zone vegetation is generally dense along the full length of the project including a mix of cattail and hardstem with large shrubs (willow, rose, and currant) on the east end of the site and primarily cattail emergent zone vegetation on the west end of the project, along with a small patch of *Phragmites*. Slope vegetation on the east end of the project is primarily woody shrubs. Vegetation on the west end is a mixture of herbaceous marsh grass and shrubs. Breakwater rock rip-rap provides consistent cover and protection from erosion. Small boulders used as breakwater rock are visible just above the water surface near the shoreline (right photo) for most of the project. No active erosion identified. Project is rated in good condition.	
 RR Trail South (overview)	 RR Trail South (detail)

Site Name: RR Trail West	
Construction date: 2000	**Length (ft):** 1,200
Bank Stabilization type: Breakwater rock rip-rap, emergent zone planting (hardstem/cattail), and willow bundles planted in a trench at the toe of the slope. Willows planted following rock placement in November 2000.	
Existing condition: Emergent vegetation is a mixture of cattail and hardstem. Vegetation is consistent through the length of the project. Slope vegetation is primarily shrubs with some herbaceous grass understory. Willow are found at the waters' edge with other shrub species located further upslope. Vegetation cover is complete (i.e. no bare areas). No active erosion identified. Project is rated in good condition.	
 **RR Trail West (overview)** RR Trail West (overview)	 **RR Trail West (detail)**

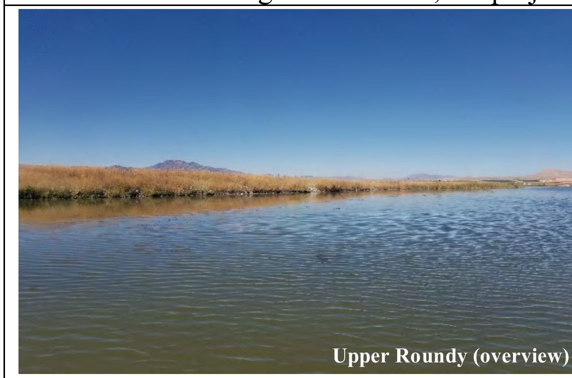
Site Name: Spring Creek	
Construction date: 1996	**Length (ft):** 618
Bank Stabilization type: Large rock rip-rap, placed directly at the toe of the river bank; no associated plantings.	
Existing condition: Emergent vegetation provides a moderately dense cover of herbaceous grass mixed with some cattail. Extent of vegetation is limited to sloped material that reduces water depth and provides substrate for emergent grass. Slope vegetation is mostly herbaceous grass with one mature willow tree and few small shrubs. Rip-rap is visible at the water surface (right photo) and continues to maintain protection from erosion and promote bank stability on the outside of the channel meander. No erosion was identified in the project although an eroding bank segment is located immediately upstream of the project. The project is rated in good condition.	
 Spring Creek (overview)	 Spring Creek (detail)

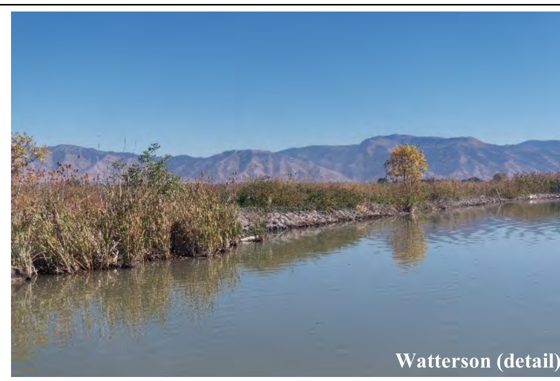
<table>
<tr><td colspan="2">Site Name: Stewart East</td></tr>
<tr><td>Construction dates: 1996; rebuilt in 2011</td><td>Length (ft): 3,110</td></tr>
<tr><td colspan="2">Bank Stabilization type: Concrete barrier (covering 76 feet of total project length) and large straw bales (originally); later re-construction was breakwater rock, willow bundles, and slope plantings (rose and currant).</td></tr>
<tr><td colspan="2">Existing condition: Straw bank protection failed after being placed in 1996 (concrete barrier held but was only used in a small portion of the bank). New bank stabilization efforts were implemented in 2011 including breakwater rock, emergent zone cattail/hardstem plantings, willow bundles, and slope plantings (rose and currant) and renamed W. Larsen East and West to distinguish the new segments in the database. Existing emergent vegetation is a consistent cover of cattail or hardstem on the east side of the site. Emergent vegetation does not exist in the middle (north) section of the site where the concrete barrier was installed (original project). Pockets of cattail are found on the far west end of the site. Slope vegetation is herbaceous with few shrubs. Cover is mostly sparse on the east and west side; landscaped lawn (behind the parallel concrete barrier) provide complete cover in the middle section of the project. Adjacent landowner has planted three rows of trees near the top of slope and east of landscaped area (but outside the PacifiCorp Project Boundary) that extends parallel to the reservoir for 350 ft. Breakwater rock was visible for most of the project during the 2019 drawdown and provides good shoreline projection. No active erosion identified. Project is rated in good condition.</td></tr>
<tr><td>
Stewart East (overview)</td><td>
Stewart East (detail)</td></tr>
</table>

<table>
<tr><td colspan="2">Site Name: Stewart West</td></tr>
<tr><td>Construction date: Originally 1996; later rebuilt in late 2004.</td><td>Length (ft): 1,520</td></tr>
<tr><td colspan="2">Bank Stabilization type: Large straw bales (originally); subsequently breakwater rock rip-rap with cattail/hardstem emergent zone plantings and toe of slope plantings (willow).</td></tr>
<tr><td colspan="2">Existing condition: Emergent vegetation is moderately dense cattail for most of the project length. A pocket of hardstem and marsh grass occurs in the emergent zone near the middle of the project. The extent of emergent vegetation is maintaining or slowly increasing based on the age class and condition of observed species. Slope vegetation includes a sparse cover of herbaceous grass. No weeds or invasive species were observed on slopes or in the emergent zone. No willows were observed at this project. Breakwater rock rip-rap is located throughout the project but is visible at the upstream (~60 ft.) and downstream (~90 ft.) ends of the project and continues to prevent erosion. No active erosion was identified. Project is rated in good condition.</td></tr>
<tr><td>
Stewart West (overview)</td><td>
Stewart West (detail)</td></tr>
</table>

<table>
<tr><td colspan="2">Site Name: Stewart West Middle</td></tr>
<tr><td>Construction date: 2001 (re-construction following failure of original hay bales)</td><td>Length (ft): 1,441</td></tr>
<tr><td colspan="2">Bank Stabilization type: Originally large hay bales placed at the toe of the slope; replaced by breakwater rock rip-rap, emergent zone and willow plantings (toe of the slope).</td></tr>
<tr><td colspan="2">Existing condition: Site was originally part of 1996 Stewart West project but was re-constructed in 2001 after original site failure; new name reflects new treatment in database. Emergent zone vegetation is primarily mature cattail but mixed with Phragmites along each end of the project where width of emergent zone increases. Vegetation is healthy. Upslope vegetation is primarily herbaceous with one large group of shrubs (willow) located at upstream end of project. Slope cover is less dense in the middle portion of the project where banks are relatively steep compared to other project slopes. Some breakwater rock is visible (right photo) and mixed with much of the emergent vegetation, providing a stable base for growth. One eroding segment (~5 ft) noted, possibly due to surface runoff channel. All other areas stable. Project is rated in good condition.</td></tr>
<tr><td>
Stewart West Middle (overview)</td><td>
Stewart West Middle (detail)</td></tr>
</table>

<table>
<tr><td colspan="2">Site Name: Stewart West West</td></tr>
<tr><td>Construction date: 2001 (re-construction following failure of original hay bales)</td><td>Length (ft): 985</td></tr>
<tr><td colspan="2">Bank Stabilization type: Originally large hay bales placed at the toe of the slope; replaced by breakwater rock rip-rap, emergent zone and willow plantings (toe of the slope).</td></tr>
<tr><td colspan="2">Existing condition: Site was originally part of 1996 Stewart West project but was re-constructed in 2001 after original site failure; new name reflects new treatment in database. Emergent vegetation is moderately dense cattail throughout the length of the project. Early growth Phragmites is mixed with cattail at some locations and currently limited to a few individual stems (i.e. no dense clumps). Although cattail growth is consistent, total cover does not appear to be increasing and could be crowded by Phragmites in the future. Slope vegetation is dominated by herbaceous grass; no shrubs observed. Breakwater rock rip-rap is located throughout but visible at the downstream end (110 ft.) of the site, protecting the shoreline. No active erosion identified. Project is rated in good condition.</td></tr>
<tr><td>
Stewart West West (overview)</td><td>
Stewart West West (detail)</td></tr>
</table>

<table>
<tr><td colspan="2">Site Name: Upper Roundy</td></tr>
<tr><td>Construction date: 1999</td><td>Length (ft): 2,442</td></tr>
<tr><td colspan="2">Bank Stabilization type: Rock rip-rap (smaller), placed directly on shoreline, no revegetation.</td></tr>
<tr><td colspan="2">Existing condition: Emergent vegetation is primarily cattail and occurs as a mixture with hardstem at some locations. Extent of vegetation is limited to upstream and downstream areas; no emergent vegetation is found in the middle of the site. Slope vegetation is moderately dense herbaceous grass mixed with teasel (right photo). Wildlife trails (Canada goose) cut through the shoreline vegetation at some locations for access to water. Shoreline banks are low elevation and ~1 ft. high or less. Small rock rip-rap covers the full length of the project and functions well in most locations as a barrier to shoreline erosion. A few segments with vertical bank exposure were noted in the middle segment (~560 ft.) of the project where emergent vegetation does not occur. Bank stability is good (i.e. no sloughing or cracks were observed) but potential erosion remains a concern from this segment. Overall, the project is rated in good condition.</td></tr>
<tr><td>
Upper Roundy (overview)</td><td>
Upper Roundy (detail)</td></tr>
</table>

<table>
<tr><td colspan="2">Site Name: Watterson</td></tr>
<tr><td>Construction date: 1993</td><td>Length (ft): 3,988</td></tr>
<tr><td colspan="2">Bank Stabilization type: Gabion baskets.</td></tr>
<tr><td colspan="2">Existing condition: Emergent vegetation is predominately cattail, with some hardstem and Phragmites. Emergent vegetation is growing in front of and behind rock gabions. No emergent vegetation occurs in a segment (~550 ft.) near the middle of the project. Phragmites occurs in dense groups that appear to be expanding in several areas. Cattail growth is primarily good but decadent stands were observed behind the gabion at some locations. Slope vegetation is a dense mixture of herbaceous and shrub species including minor amounts of thistle and other weeds. The gabion structure is visible where it isn't covered with heavy vegetation (right photo). The structure has tipped in some locations. This is particularly evident at the upstream end of the site. Active erosion is occurring just upstream of where the gabion begins. No active erosion was identified at the site. Project is rated in good condition.</td></tr>
<tr><td>
Watterson (overview)</td><td>
Watterson (detail)</td></tr>
</table>

ATTACHMENT D-3

SHORELINE AND BANK EROSION MAP BOOK

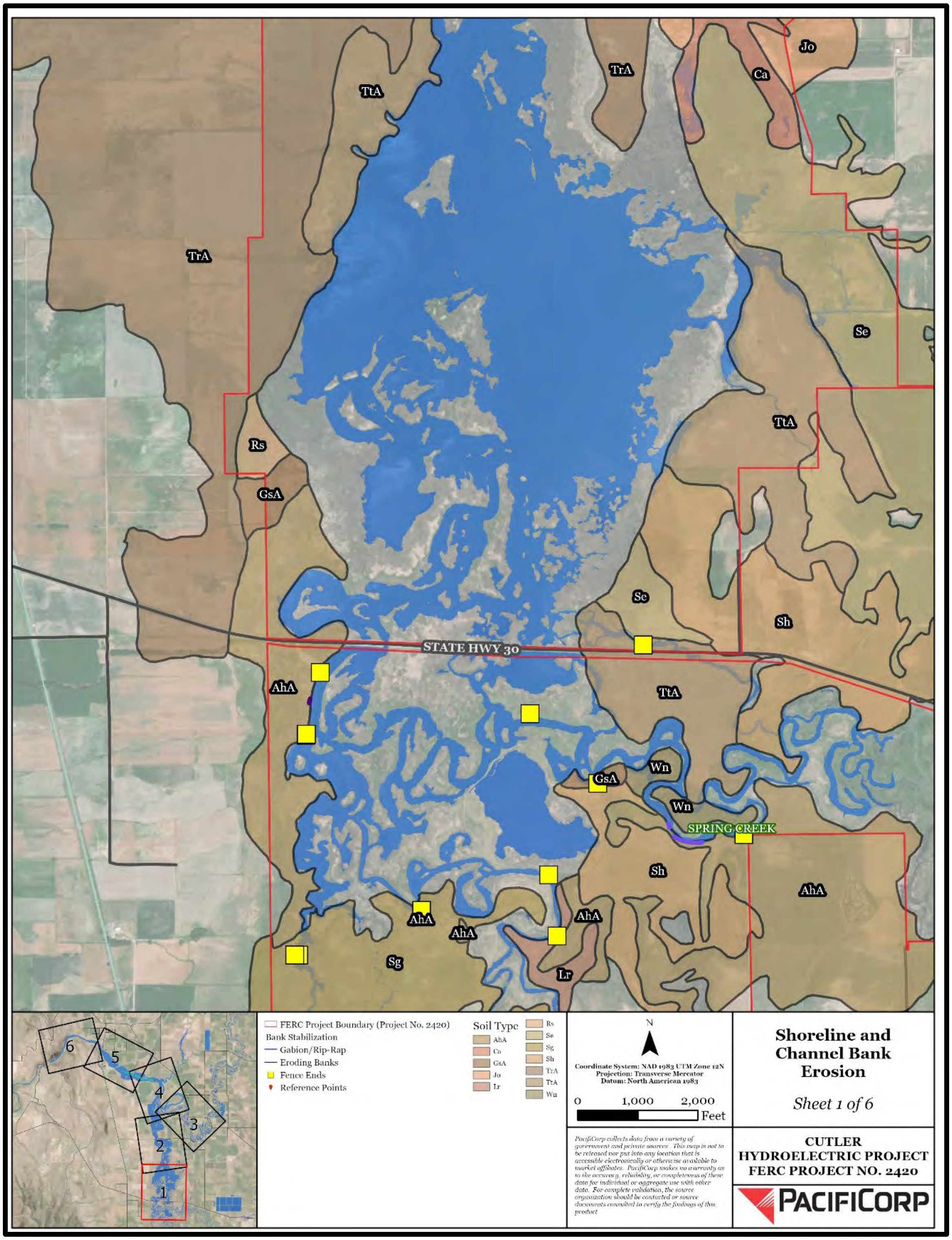


FIGURE D3-1. SOIL TYPES AROUND SEGMENTS OF SHORELINE/CHANNEL BANK EROSION AND BANK STABILIZATION PROJECTS FROM SOUTH MARSH TO 0.5 MILE DOWNSTREAM OF RR FISHING BRIDGE (NOT SHOWN).

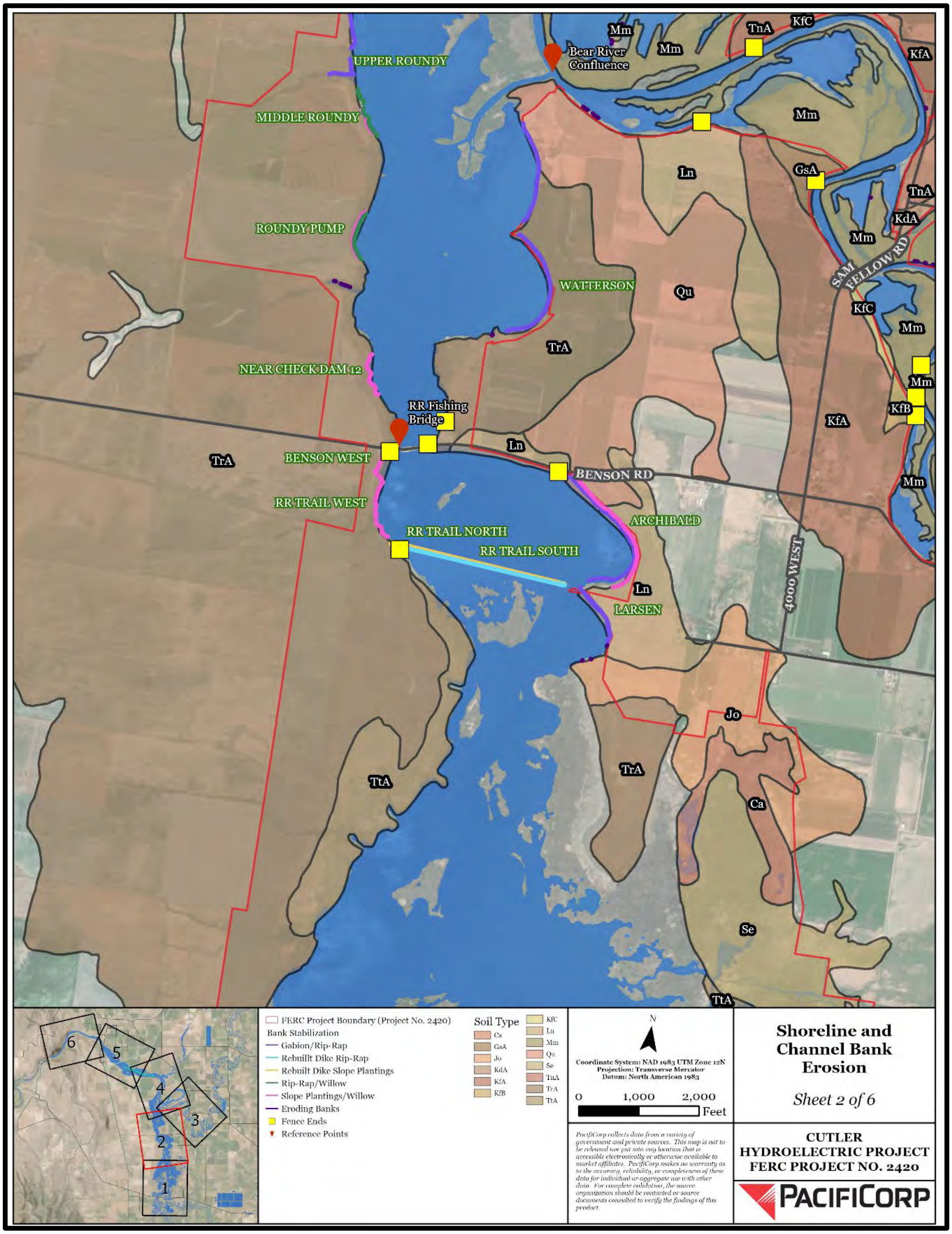


Figure D3-2. SOIL TYPES AROUND SEGMENTS OF SHORELINE/CHANNEL BANK EROSION AND BANK STABILIZATION PROJECTS FROM UPSTREAM OF RR FISHING BRIDGE TO BEAR RIVER CONFLUENCE.

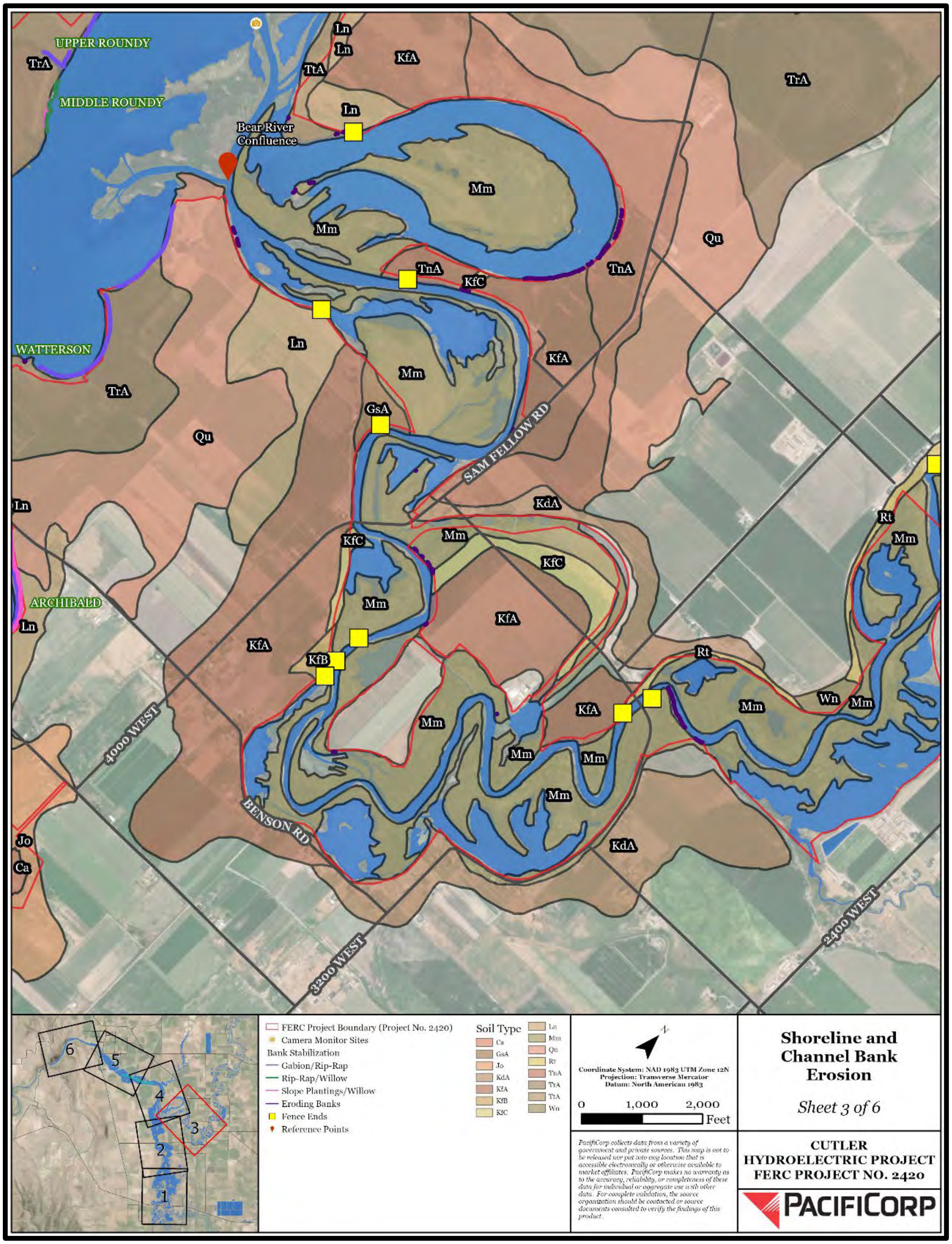


FIGURE D3-3. SOIL TYPES AROUND SEGMENTS OF SHORELINE/CHANNEL BANK EROSION AND BANK STABILIZATION PROJECTS FROM BEAR RIVER CONFLUENCE TO FERC PROJECT BOUNDARY.

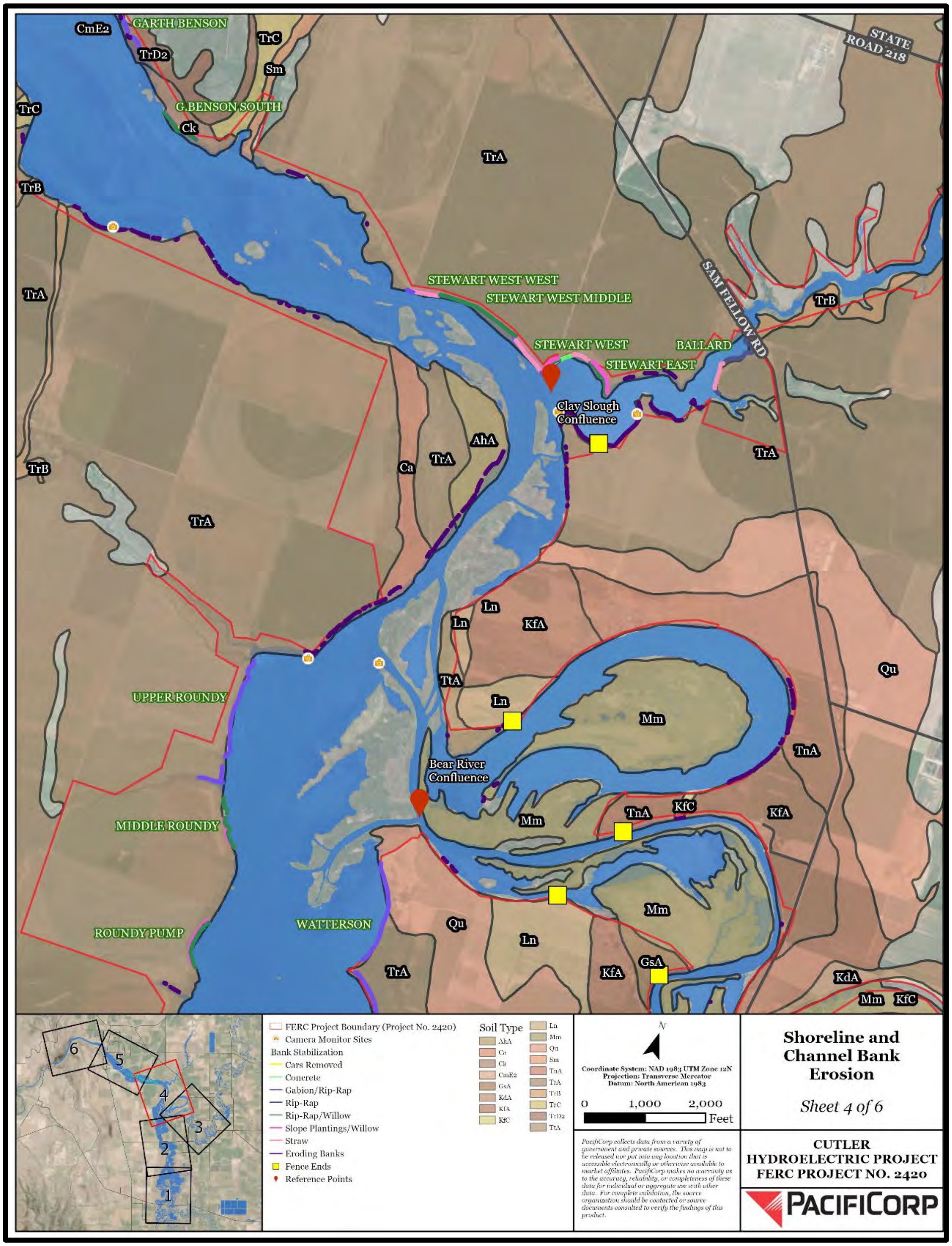


FIGURE D3-4. SOIL TYPES AROUND SEGMENTS OF SHORELINE/CHANNEL BANK EROSION AND BANK STABILIZATION PROJECTS FROM BEAR RIVER CONFLUENCE TO 1,000' UPSTREAM OF UPR RAILROAD BRIDGE (NOT SHOWN).

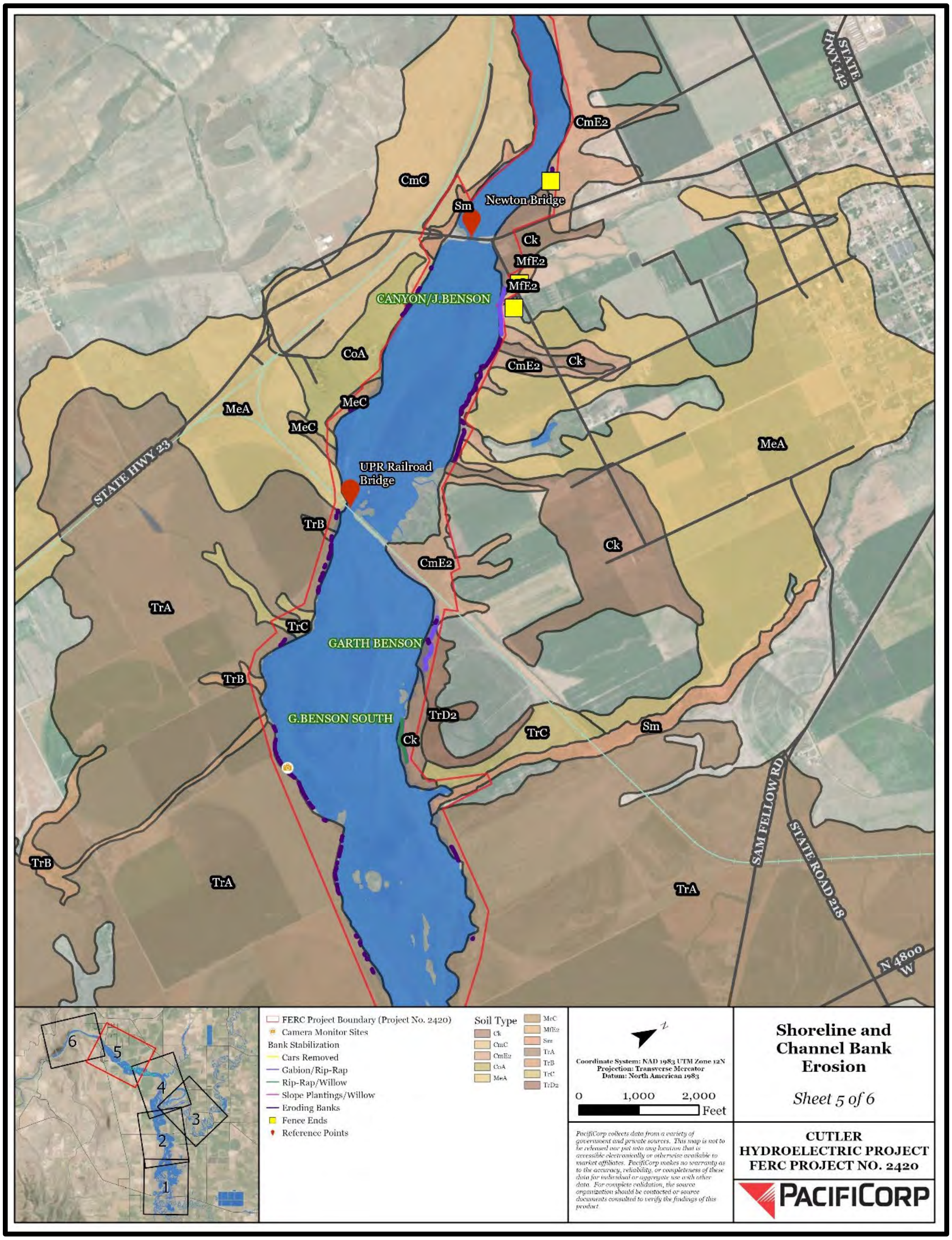


FIGURE D3-5. SOIL TYPES AROUND SEGMENTS OF SHORELINE/CHANNEL BANK EROSION AND BANK STABILIZATION PROJECTS FROM DOWNSTREAM OF CLAY SLOUGH (NOT SHOWN) TO NEWTON BRIDGE.

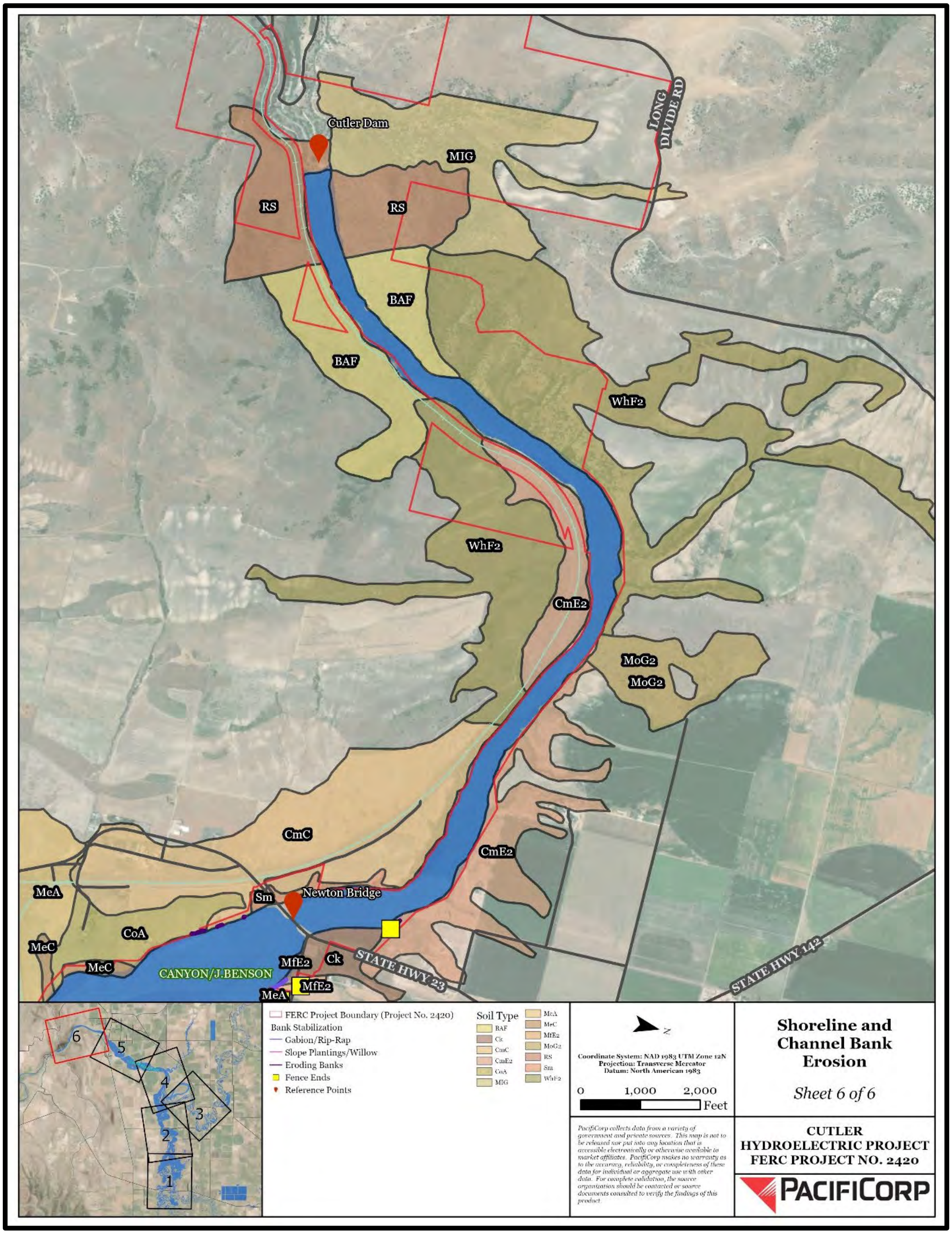
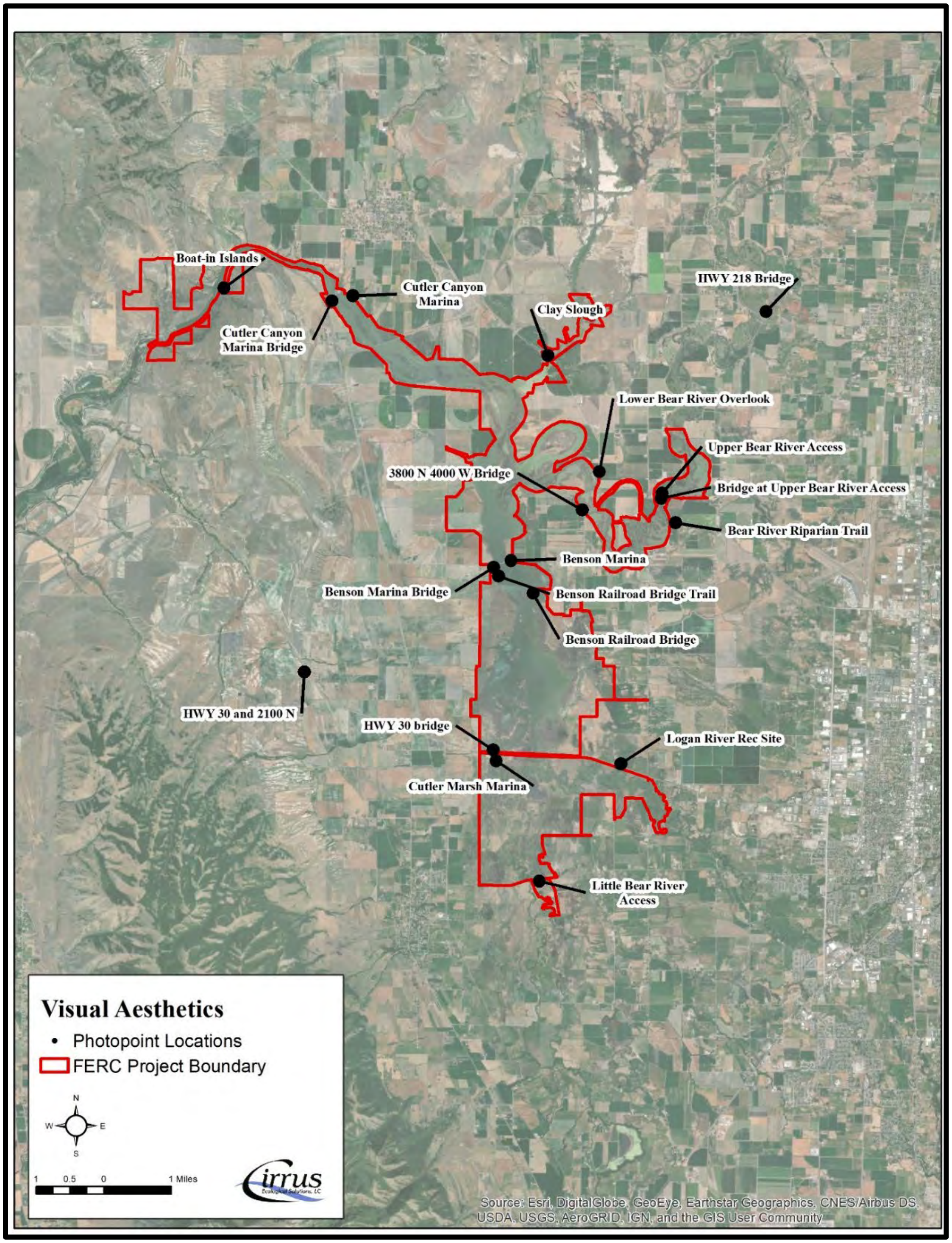


FIGURE D3-6. SOIL TYPES AROUND SEGMENTS OF SHORELINE/CHANNEL BANK EROSION AND BANK STABILIZATION PROJECTS FROM NEWTON BRIDGE TO CUTLER DAM.

ATTACHMENT D-4

PHOTOPOINTS



MAP D-1. PHOTOPOINT LOCATIONS.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet.

Note: November 1, 2019, drawdown.
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-1. LITTLE BEAR RIVER ACCESS PHOTO PAIR, LOOKING DOWNSTREAM.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: Note: November 1, 2019, drawdown.
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-2. LOGAN RIVER RECREATION SITE, LOOKING DOWNSTREAM.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: Note: November 1, 2019, drawdown.
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-3. HIGHWAY 30 BRIDGE, DOWNSTREAM SIDE, LOOKING EAST.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown.
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-4. HIGHWAY 30 BRIDGE, UPSTREAM SIDE, LOOKING EAST.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown.
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-5. CUTLER MARSH MARINA (PANORAMA VIEW CENTERED SOUTH).

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-6. BENSON RAILROAD BRIDGE, DOWNSTREAM SIDE LOOKING EAST.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-7. BENSON RAILROAD BRIDGE, LOOKING UPSTREAM AND SOUTHWEST.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-8. BENSON RAILROAD BRIDGE TRAILHEAD, LOOKING UPSTREAM AND SOUTHEAST.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-9. BENSON MARINA BRIDGE, UPSTREAM SIDE LOOKING WEST.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-10. BENSON MARINA BRIDGE, DOWNSTREAM SIDE LOOKING WEST .

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-11. BENSON MARINA (PANORAMA VIEW, CENTERED WEST, DOWNSTREAM TO THE RIGHT).

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-12. HIGHWAY 218 BRIDGE, UPSTREAM SIDE, LOOKING WEST, AMALGA, UTAH.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-13. HIGHWAY 218 BRIDGE, DOWNSTREAM SIDE, LOOKING WEST, AMALGA, UTAH.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-14. UPPER BEAR RIVER ACCESS, LOOKING WEST, UPSTREAM TO THE RIGHT.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-15. UPPER BEAR RIVER ACCESS BRIDGE, UPSTREAM SIDE, LOOKING EAST.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-16. UPPER BEAR RIVER ACCESS BRIDGE, DOWNSTREAM SIDE, LOOKING WEST.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-17. BEAR RIVER RIPARIAN TRAIL, VIEW OF RIVER OXBOW, LOOKING SOUTHWEST.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

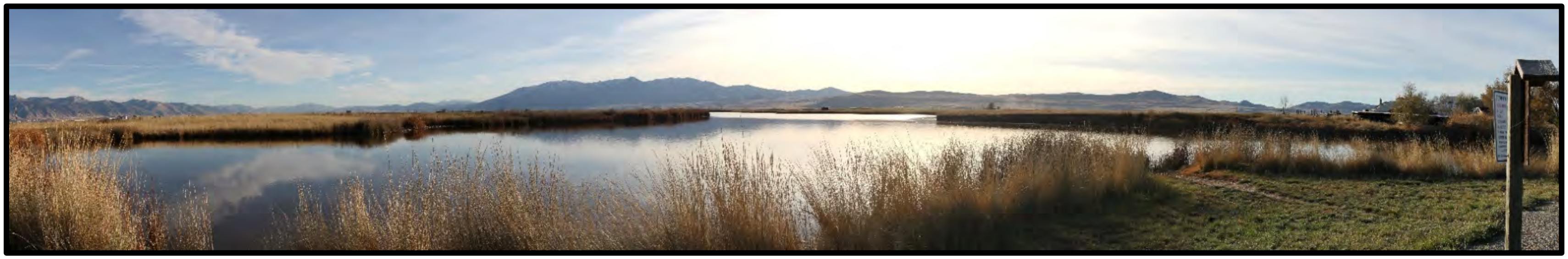
Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-18. 3800 N 4000 W (RIVERSIDE) BRIDGE, DOWNSTREAM SIDE, LOOKING DOWNSTREAM, BENSON, UTAH.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-19. LOWER BEAR RIVER OVERLOOK, PANORAMA VIEW, CENTERED WEST.



Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-20. CLAY SLOUGH ACCESS, DOWNSTREAM, PANORAMA VIEW CENTERED WEST.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-21. SAM FELLOW ROAD AT CLAY SLOUGH , UPSTREAM SIDE LOOKING NORTH.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-22. HIGHWAY 23 (NEWTON) BRIDGE, UPSTREAM SIDE, PANORAMA VIEW CENTERED EAST.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-23. HIGHWAY 23 (NEWTON) BRIDGE, DOWNSTREAM SIDE, PANORAMA VIEW CENTERED WEST.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-24. CUTLER CANYON MARINA, PANORAMA VIEW CENTERED SOUTHWEST, UPSTREAM TO THE LEFT.

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-25. SOUTH BOAT-IN ISLAND FROM SOUTH SIDE, LOOKING NORTH (WHEELON DAM SUBMERGED IN BASELINE PHOTO).

Note: October 24, 2019, baseline.
Elevation at Cutler Dam 4,407.3 feet

Note: November 1, 2019, drawdown
Elevation at Cutler Dam 4,392.4 feet.

FIGURE D-26. HIGHWAY 30 AND 2100 N, MENDON, UTAH (OVERVIEW PANORAMA, CENTERED WEST).

APPENDIX E
FISH AND AQUATIC INITIAL STUDY REPORT

FISH AND AQUATIC RESOURCES INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT (FERC NO. 2420)

Prepared for:

PacifiCorp
Salt Lake City, UT

Prepared by:

SWCA®
ENVIRONMENTAL CONSULTANTS

February 2021

Fish and Aquatic Resources Initial Study Report

Cutler Hydroelectric Project

(FERC No. 2420)

Prepared for:

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February 2021

FISH AND AQUATIC RESOURCES
INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

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CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

1.0 INTRODUCTION

PacifiCorp is owner, operator, and the Federal Energy Regulatory Commission (FERC) licensee for the Cutler Hydroelectric Project (FERC No. 2420) (Project). The Project is located on the Bear River and several tributaries in Cache Valley, Utah, between the Wasatch and Wellsville Mountains. Cutler Dam is located in Box Elder County; however, most of the Project reservoir lies within Cache County. The Project reservoir is formed at the confluence of Spring Creek and the Bear, Logan, and Little Bear Rivers. PacifiCorp operates the Project under a 30-year license issued by FERC on April 29, 1994; the current license will expire on March 31, 2024. PacifiCorp initiated the formal relicensing process utilizing the Integrated Licensing Process (ILP) by filing the Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on March 29, 2019.

The relicensing process involves cooperation and collaboration amongst PacifiCorp, as licensee, stakeholders including state and federal resource agencies, state and local governments, non-governmental organizations (NGO), and interested individuals. PacifiCorp coordinated with stakeholders, that included federal and state agencies, NGOs, Native American tribes, and tribal organizations, throughout the study scoping process, public meetings, workshops, scoping meetings, and a site visit. These meetings facilitated the identification of study needs to be addressed. Study scoping occurred from March 2019 through February 2020, when FERC issued the Study Plan Determination. PacifiCorp, FERC, and stakeholders identified the need for a fish and aquatic resources study during the study scoping process.

2.0 PROJECT NEXUS AND RATIONALE FOR STUDY

The Fish and Aquatic Resources Study Plan was prepared to evaluate the environmental conditions, including potential changes in operations, of the Project for FERC relicensing. Operation of the Project may have potential direct and indirect effects on fish and aquatic resources.

The rationale for this study is:

- Future operations may increase levels of reservoir fluctuations and the width of the reservoir operating band. Such actions may affect the aquatic organisms and their habitat.
- Information is lacking on benthic invertebrates and mollusks regarding their presence and potential exposure to future Project operations.

3.0 STUDY OBJECTIVES

The goal of this study is to determine the status of aquatic organisms and their habitat and characterize the benthic invertebrate and mollusk community within the Project Area; to evaluate the effects of the fall 2019 reservoir drawdown on the aquatic community; and to relate potential Project operational changes and the resultant effects on the aquatic community within the reservoir.

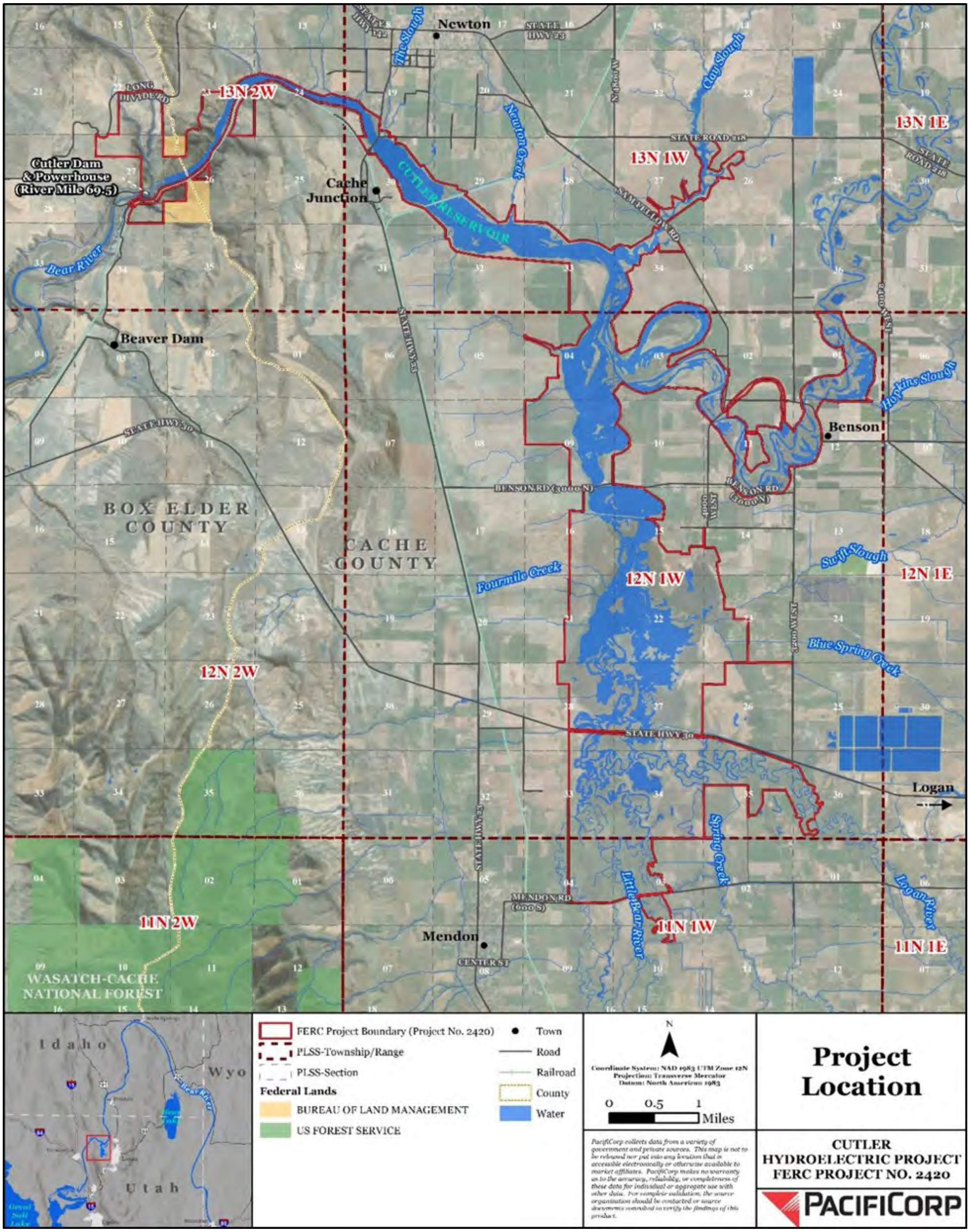
Objectives for this study are:

- Summarize existing information on the aquatic organisms and their habitat residing in the Cutler Reservoir and its tributaries, and the Bear River up to 2-miles downstream of Cutler Dam.
- Determine potential effects of the fall 2019 reservoir drawdown on fish, mollusks, and macroinvertebrates and their habitat in Cutler Reservoir (e.g., stranding/displacement).
- Based on observations during the fall 2019 reservoir drawdown, determine potential effects of future Project operations on resident fish, macroinvertebrate, and mollusk habitat in Cutler Reservoir.
- Provide information for National Environmental Policy Act (NEPA) analysis of the affected environment.

The FERC-approved Revised Study Plan (RSP) includes an objective to evaluate the effects of PacifiCorp's potential proposed operations; however, this information is not included in the Initial Study Report (ISR). It will be presented in the Draft License Application (DLA), which will be submitted in 2021. In addition, the study objectives state that the goal of the study is to evaluate the effects of the fall 2019 reservoir drawdown on the aquatic community. The following clarification is warranted with regard to this objective: the fall 2019 reservoir drawdown does not simulate potential proposed Project operations. The drawdown reduced the Cutler Reservoir elevation to 4,389.99 feet, which is likely much lower than expected future Project operations. Accordingly, caution should be exercised in reviewing study results regarding potential effects of drawdown events on the aquatic community. However, the objective to collect data on fish, mollusks, and macroinvertebrates and their habitat in the reservoir during the drawdown event was met. The data collected during the drawdown event will help determine potential effects of proposed Project operations as simulated by the calibrated 2-deminsional (2D) hydraulic model.

3.1 STUDY AREA

The study area for aquatic resources contains all Project features (encompassing the Project Boundary) (Figure 3-1), which extends, for the purposes of characterization and analysis, from the edge of the Project Boundary and within the reservoir zone of influence of each major tributary to the reservoir. The study area also includes the Bear River for 2-miles downstream of the dam.



Source: PacifiCorp 2018

FIGURE 3-1 FERC PROJECT BOUNDARY

4.0 METHODS

4.1 EXISTING INFORMATION ON THE FISHERIES RESOURCE

Existing information on the fisheries resources in the study area was collected and summarized. In addition, the Utah Division of Wildlife Resources (UDWR) completed an electrofishing survey of the Bear River downstream of Cutler Dam in June 2019, and a mollusk survey of the reservoir during the 2019 fall drawdown. The UDWR fisheries work completed on the Bear River will serve to establish the current fishery community downstream of the Project and is included in Section 5.0 of this ISR.

4.2 AQUATIC COMMUNITY SAMPLING DURING THE FALL 2019 RESERVOIR DRAWDOWN

The Cutler Reservoir drawdown occurred in the fall 2019 to obtain light detection and ranging (LiDAR) and bathymetry data of the reservoir. The drawdown provided a unique opportunity to sample the aquatic community. Sampling during the drawdown included observations of fish isolation, benthic macroinvertebrate collection, and mollusk surveys.

4.2.1 FISH ISOLATION

Observation of fish isolation observations were recorded in each of the reservoir units except Bear River Unit which, because of its riverine nature and defined channel, was not likely to have isolation areas during the drawdown. Location of reservoir isolation pools were identified and georeferenced.

The exposed reservoir bottom sediments are composed of very fine silt and clay at the surface and are virtually impossible to access by foot. During the fall 2019 drawdown, a Marsh Master (semi-floating tracked vehicle) and an aerial drone were used to survey isolated pools along the perimeter of each reservoir unit. An ArcGIS Collector tracked the Marsh Master and georeferenced each pool that contained live or dead fish. The size of each isolation pool was estimated, and number of fish estimated along with species and size when possible. Also, documented was the location of all isolated pools that did not contain fish. Locations not accessible by a Marsh Master were documented using an aerial drone. The drone photographed those pools to verify presence or absence of fish with zoom photography, and georeferenced the pool location.

4.2.2 RAPID BIOASSESSMENT OF BENTHIC MACROINVERTEBRATES

A bioassessment of benthic macroinvertebrates was conducted to inform an effects determination of future Project operations on this community by looking for differences in the community structure between the pre-drawdown state and stages of drawdown at the reservoir.

Benthic macroinvertebrates were sampled consistent with Rapid Bioassessment protocols (David et al. 1998). Samples were collected before and during the fall 2019 drawdown of Cutler Reservoir. Fieldwork to select transect sites was conducted prior to the drawdown on October 3, 2019. Survey transects were established in each of the reservoir units, as identified in the 2018 Cutler Hydroelectric Project Resource Management Plan Five-year Monitoring Report (PacifiCorp 2018). These units are the South Marsh Unit (Unit 1), North Marsh Unit (Unit 2), Reservoir Unit (Unit 3), Bear River Unit (Riverine Unit), and Cutler Canyon Unit (Unit 4) (Figure 4-1). The Rapid Bioassessment methodology is designed for small rivers and shallow reservoirs, and is not applicable to large rivers, such as the Bear River; therefore, per the RSP, the Bear River Unit was not sampled.

Benthic Macroinvertebrate Index (BMI) samples were collected along the same transects established in each reservoir unit for the water quality study (Table 4-1). Three to seven transects were established for each of the reservoir units (depending on the unit size) prior to the drawdown and numbered consecutively in each unit. Transects were selected based on representativeness of the unit, accessibility during the drawdown, and further were not expected to be dewatered during the drawdown. Transects selected are shown in Figure 4-1 and listed in Table 4-2. Using the number assigned to each transect, a random number generator (Random Number Generator 2020) was used to make a selection along the transect for the primary sampling site and a secondary site, with the secondary site established as a back-up in case the primary site could not be sampled or did not seem suitable prior to the drawdown.

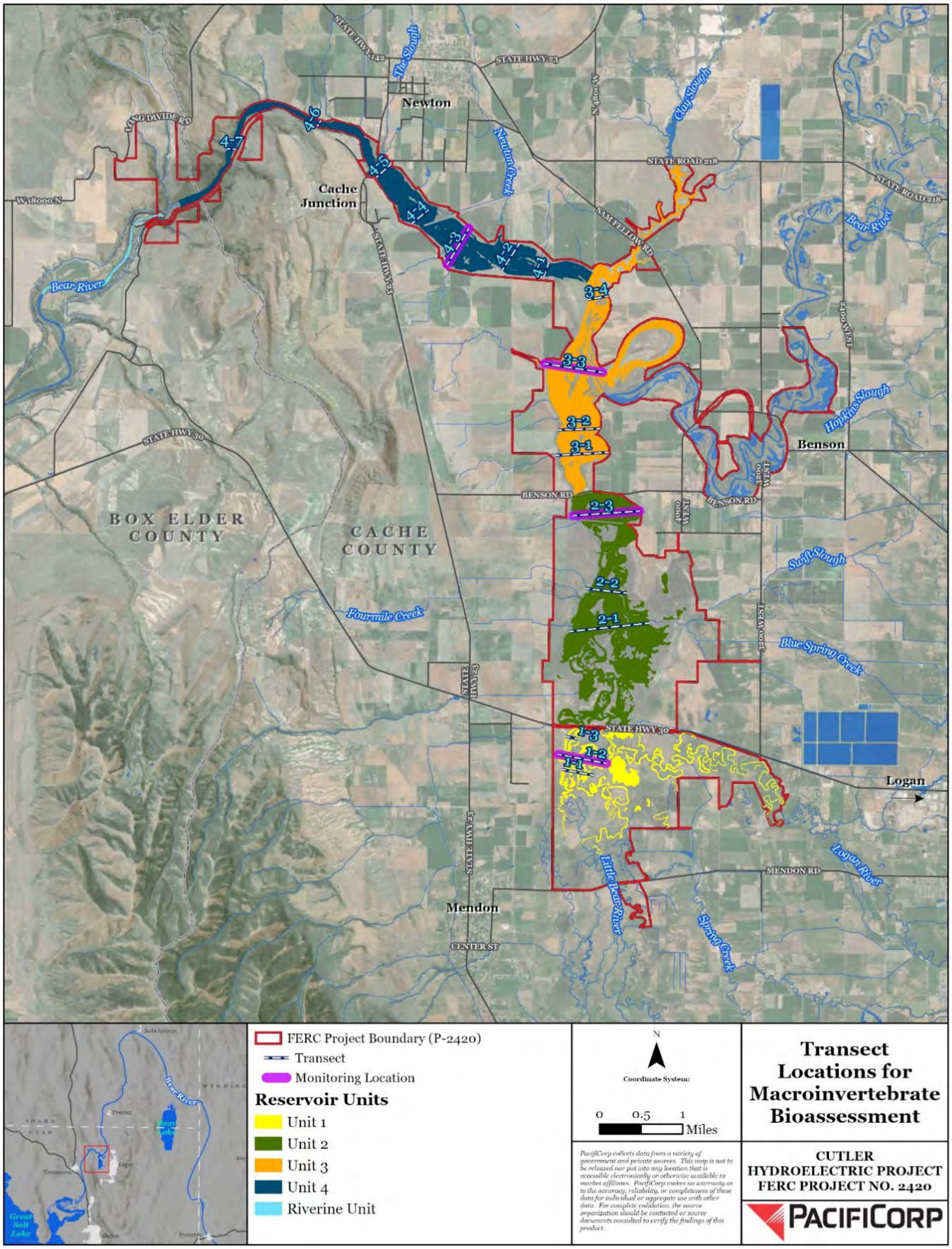


FIGURE 4-1 TRANSECT LOCATIONS AND RANDOMLY SELECTED TRANSECTS (PURPLE) FOR MACROINVERTEBRATE BIOASSESSMENT

TABLE 4-1 SAMPLING LOCATIONS ON CUTLER RESERVOIR

TRANSECT	NUMBER OF SAMPLES ALONG TRANSECT
South Marsh Unit	4
North Marsh Unit	4
Reservoir Unit	4
Cutler Canyon Unit	4
Bear River downstream of Cutler Dam	1

TABLE 4-2 TRANSECTS RANDOMLY SELECTED FOR WATER QUALITY AND BENTHIC SAMPLING

UNIT	TRANSECT	PRIMARY RANDOM SELECTION	SECONDARY RANDOM SELECTION
South Marsh	1-1	0	0
South Marsh	1-2	X	0
South Marsh	1-3	0	X
North Marsh	2-1	0	0
North Marsh	2-2	0	X
North Marsh	2-3	X	0
Reservoir Unit	3-1	0	0
Reservoir Unit	3-2	0	X
Reservoir Unit	3-3	X	0
Reservoir Unit	3-4	0	0
Canyon Unit	4-1	0	X
Canyon Unit	4-2	0	0
Canyon Unit	4-3	X	0
Canyon Unit	4-4	0	0
Canyon Unit	4-5	0	0
Canyon Unit	4-6	0	0
Canyon Unit	4-7	0	0

Note: Unit is the first number and transect is the second number, e.g., *Unit* 1-*Transect* 1

4.2.3 FRESHWATER MOLLUSK SURVEY

During the drawdown in November 2019, a team of 6 to 10 people from UDWR surveyed shorelines and accessible portions of the reservoir bed to collect mollusk specimens. The UDWR team specifically assessed the presence the native California Floater (*Anodonta californiensis*) in the reservoir. The team also searched for non-native bivalves such as the Paper Pondshell (*Utterbackia imbecillis*). UDWR recorded the georeferenced location of native and non-native species, the position relative to reservoir water elevations during the drawdown, sample date, and time. The substrate of locations with pooled water were raked to determine the existence, if any, of specimens noting whether the specimens encountered were alive or dead. Shell samples of deceased specimens were retained.

4.3 MODIFICATIONS TO METHODS

The original study plan, required foot surveys, seine larger pools, and return fish to the main reservoir. However, once the reservoir was in the drawdown state, it was apparent that the sediment was too muddy (and the mud too deep, up to 2 feet) to access the isolation sites by foot. Therefore, a Marsh Master was used to access stranded areas and make determinations without leaving the vehicle. The Marsh Master could not reach a few of the sites, so an aerial drone was used to observe these sites, check for fish presence, take photographs, and georeference each site.

The original study plan for the benthic macroinvertebrate bioassessment, required that the organisms be identified to genus. However, the Bureau of Land Management (BLM)/Utah State University (USU) National Aquatic Monitoring Center (USU Bug Lab) follows regional protocols that identify organisms to a standardized Operational Taxonomic Unit (OTU) (Cuffney et al. 2007).

5.0 RESULTS

This section organizes the results by methods listed in the study plan.

5.1 FISH, BENTHIC MACROINVERTEBRATES AND AQUATIC COMMUNITY EXISTING INFORMATION

5.1.1 FISHERIES

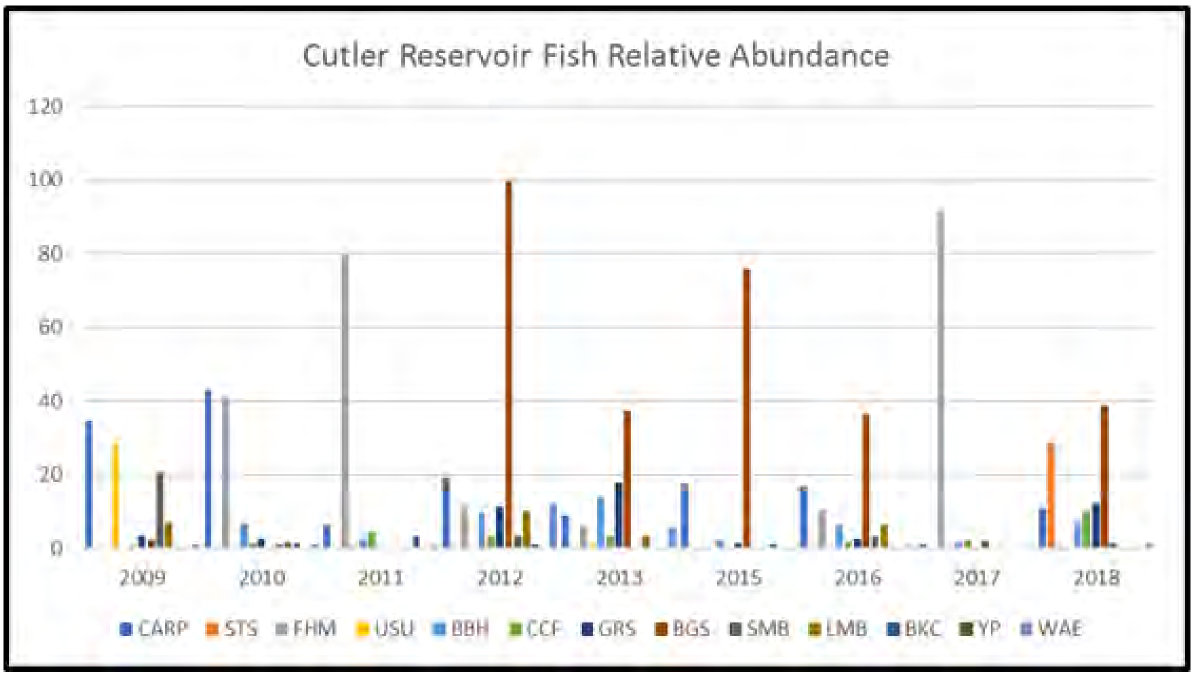
Fish species present in the reservoir include game fish and non-game fish, and are dominated by non-native species, including Common Carp (*Cyprinus carpio*), Fathead Minnow (*Pimephales promelas*), Spottail Shiner (*Notropis hudsonius*), Utah Sucker (*Catostomus ardens*), Black Bullhead (*Aeiurus melas*) or Brown Bullhead (*Ameiurus nebulosus*), Channel Catfish (*Ictalurus punctatus*), Green Sunfish (*Lepomis cyanellus*), Bluegill Sunfish (*Lepomis macrochirus*), Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*Micropterus salmoides*), Black Crappie (*Pomoxis nigromaculatus*), Yellow Perch (*Perca flavescens*), and Walleye (*Sander vitreus*) (UDWR 2018; Sigler and Sigler 1996).

A description of each of these species, their food habits, and biological information is provided in PacifiCorp's PAD (PacifiCorp 2019). Other fish species that have either been present in the Bear River upstream of Cutler Reservoir or downstream of Cutler Dam but are not currently known to occur in the study area are Bonneville Cutthroat Trout (*Oncorhynchus clarki utah*), Bluehead Sucker (*Catostomus discobolus*), and Northern Leatherside Chub (*Lepidomeda copei*). Bonneville Cutthroat Trout are known to occur in the Logan River, Blacksmith Fork River, Cub River (a tributary of the Bear River), and upstream sections of the Bear River in Idaho and Wyoming (USFWS 2001) but have not been documented in Cutler Reservoir or mainstem Bear River downstream of Cutler Dam in recent years (last known observation was 2008) (USFWS 2001).

Bluehead Sucker were historically found in the Bear River drainage but currently are not known to be present in Cutler Reservoir or downstream of the dam (UDWR 2019; 2016). The Northern Leatherside Chub is native to the Bear River, but its numbers are greatly reduced and threatened in much of its native habitat (UDWR 2009; Sigler and Sigler 1996). The Northern Leatherside Chub prefers cool riverine habitat. There is a historic record of Northern Leatherside Chub in the

Logan River near Cutler Reservoir (USFWS 2011) but currently they are considered extirpated and not known to exist in the Project Area.

Since 2009, the USU classes, Watershed Sciences 3110 and Aquatic Ecology Practicum 4510: Fish Diversity Laboratory, have participated in a fisheries assessment activity in Cutler Reservoir. Relative abundance estimates for each species has been developed using student data from these USU classes. Relative abundance estimates provide a snapshot in time for each year since 2009, illustrating which species are present and which of those are the dominant species (Figure 5-1).



Source: USU 2018

Note: CARP = Common Carp, STS = Spottail Shiner, FHM = Fathead Minnow, USU = Utah Sucker, BBH = Black Bullhead, CCF = Channel Catfish, GRS = Green Sunfish, BGS = Bluegill Sunfish, SMB = Smallmouth Bass, LMB = Largemouth Bass, BKC = Black Crappie, YP = Yellow Perch, WAE = Walleye.

FIGURE 5-1 RELATIVE ABUNDANCE OF FISH SPECIES SAMPLED IN CUTLER RESERVOIR 2009–2018

These data indicate that the three most dominant species are Bluegill Sunfish, Fathead Minnow, and Common Carp. Spottail Shiners appeared for the first time in 2018 and were noted as the second-most prevalent species that year. Spottail Shiners were stocked in Oneida Reservoir in 1986 but were not collected until 2018 by the USU class. The dominant species vary from year to year, which may reflect actual high and low age-class survival trends; however, there could be an artificial factor created by having different students with differing skill levels collecting these data each year. Nonetheless, the data are valuable pieces of information to assist managers with assessing the health of the Cutler Reservoir fish community at regular intervals. According to Budy et al. (2011) no fishes have been stocked in Cutler Reservoir since 1990, indicating the resident fish reproduce naturally. Budy et al. (2011) related water conditions in Cutler Reservoir to the viability of three popular sport fish: Walleye, Channel Catfish, and Black Crappie. Walleye, Crappie, and Channel Catfish displayed growth rates at the upper range of reported values for these species. Budy et al. (2011) also noted that fish diversity is relatively high for a western reservoir. The authors, based on their modeling results, rated the reservoir at a mid-level degree of biological condition and degree of stress compared to a purported state of high stress and severe degradation (Budy et al. 2011). While Walleye experience eutrophic conditions with high temperatures and low dissolved oxygen and demonstrate negative growth during the warm summer months, more tolerant species, Black Crappie and Channel Catfish, appear to be largely unaffected. Since the fish community is dominated by Carp, this species plays an important role in restructuring the ecology of the aquatic community in Cutler Reservoir (Budy et al. 2006).

UDWR conducted a survey of the fishery in Bear River downstream of Cutler Dam on June 26 and 27, 2019 using electrofishing equipment. The main purpose of the survey was to determine the presence/absence of Bluehead Sucker and Northern Leatherside Shiner in the lower Bear River; both species are native to the Bear River. No native fish were captured during the survey; further, UDWR stated that there is no native fishery remaining in either Cutler Reservoir, or the Bear River downstream of Cutler (UDWR 2019). Species that were captured included Northern Leopard Frog (*Lithobates pipiens*), Channel Catfish, Common Carp, Smallmouth Bass, Green Sunfish, Bluegill Sunfish, Black Crappie, Common Logperch (*Percina caprodes*), Walleye, Brown Trout (*Salmo trutta*), and Fathead Minnow.

5.1.2 BENTHIC MACROINVERTEBRATES

There are few data sources on benthic macroinvertebrates prior to the Five-year Monitoring Report of 2003 to 2007 (PacifiCorp 2008). In the report, it was noted that an assessment of stream benthic macroinvertebrates conducted by Utah Division of Water Quality (UDWQ) determined that the sections of the Little Bear River and Spring Creek near Cutler Reservoir were impaired, based on biological criteria. The impairment is related to the absence of 48 percent and 41 percent of the species (for Little Bear River and Spring Creek, respectively) expected to occur at that site based on the streams' natural, geomorphic, and watershed characteristics (UDWQ 2008).

Data on benthic macroinvertebrates in Cutler Reservoir were collected by USU students. Benthic macroinvertebrate biomasses in the open sediments of Cutler Reservoir were observed to be very low (Dees 2007; Stoller 2007). Total macroinvertebrate biomass and density in Swift Slough was 42 percent and 50 percent, respectively, compared to the Logan River site, the least impaired site in the Cutler Reservoir system. Samples collected in Swift Slough, the location where effluent from Logan City is returned to the watershed, exhibited very low biomass of benthic invertebrates compared to other reservoir (Dees 2007; Stoller 2007). Macroinvertebrate populations in Cutler Reservoir were determined to be dominated by oligochaetes (worms) and chironomids (non-biting midges) (Dees 2007; Stoller 2007). Both taxa are relatively tolerant of eutrophic conditions although oligochaetes are substantially more tolerant. A review of the diet requirements of bird species commonly found around Cutler Reservoir (Cornell University 2008; Kaufman 1996) indicates numerous species depend on chironomids as part of their diet. Eutrophication and associated low dissolved oxygen are known to affect the quality and quantity of macroinvertebrates, a key food resource for many birds and fishes (PacifiCorp 2019).

As eutrophication becomes more severe, the chironomid community tends to decrease in numbers with corresponding increases in oligochaetes (Wetzel 2001). The dominance of oligochaetes in Swift Slough indicates advanced eutrophic conditions with low dissolved oxygen concentrations.

Based on the available macroinvertebrate data, bird and fish foraging on benthic invertebrates in the open water sections of the reservoir could be limited by low prey density (Wurtsbaugh and Lockwood 2007). Wurtsbaugh and Lockwood (2007) suggested that additional macroinvertebrate data are required to determine if this condition extends to other parts of Cutler Reservoir and to look for the presence of populations of macroinvertebrates such as Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (collectively EPT taxa). EPT taxa are generally the least tolerant of eutrophic conditions (Wang, et al. 2007).

Budy et al. (2006) reported finding EPT taxa in several fish diet samples so there is at least a presence in parts of the reservoir. Existing information on benthic macroinvertebrates in the Bear River downstream of Cutler Dam was not available, and therefore has not been included in this report. PacifiCorp will continue to search for study reports on benthic macroinvertebrates in the Bear River downstream of Cutler Dam prior to submittal of the DLA. Study reports, if available, will be included in the DLA.

5.2 AQUATIC COMMUNITY INVESTIGATIONS DURING THE 2019 RESERVOIR DRAWDOWN

Information was gathered on three aquatic communities during the fall 2019 drawdown at Cutler Reservoir: fish, benthic macroinvertebrates, and mollusks. The results are provided for each of these communities in this section.

5.2.1 FISH COMMUNITY

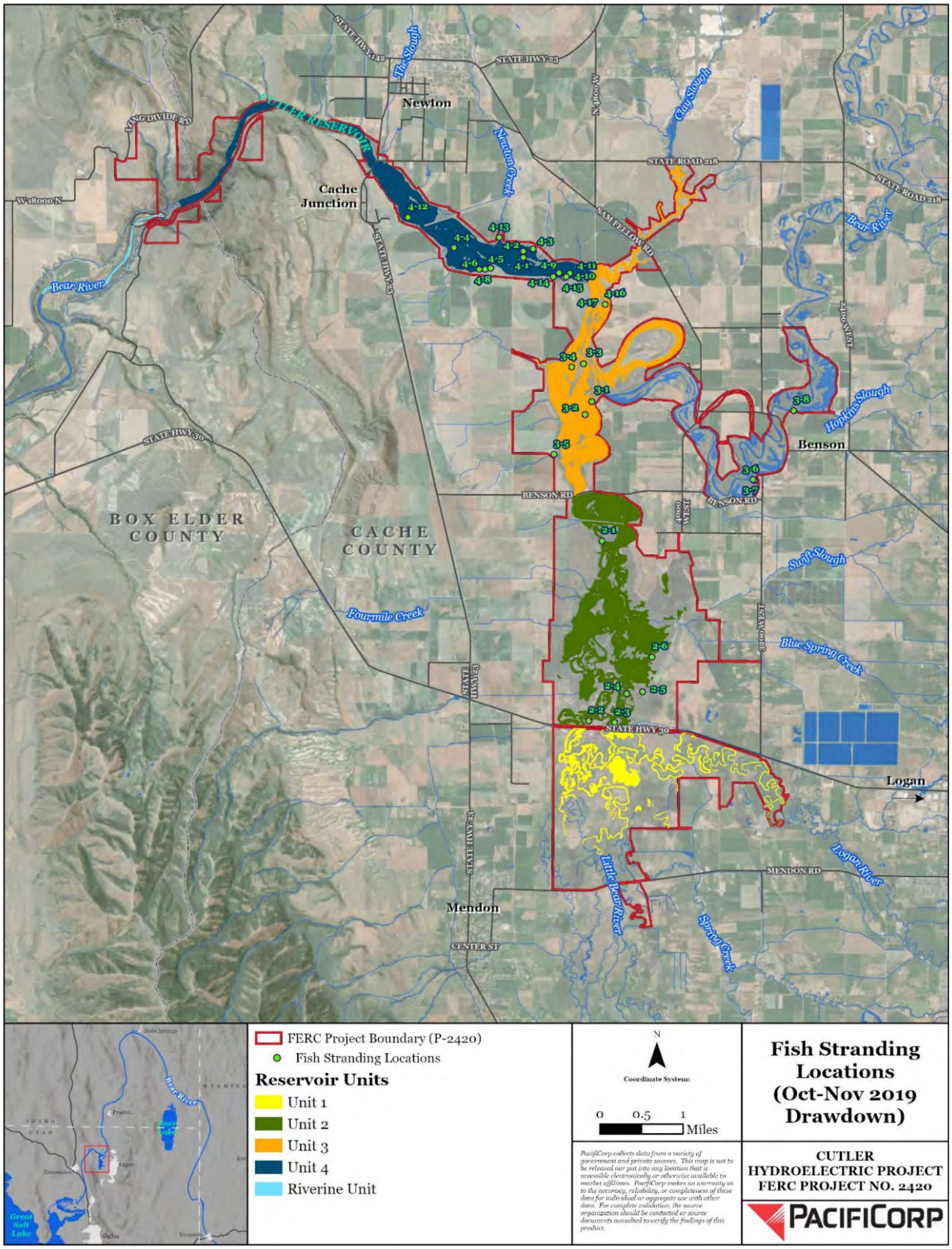
Cutler Reservoir was divided into four units for the fish isolation investigation (Figure 5-2). Field crews investigated 31 sites using a Marsh Master where accessible and a drone for inaccessible sites. The following information was recorded at each potential isolation location: number of fish, species of fish, estimated fish lengths, and approximate depth of isolation area. These areas were identified as 'potential' because the proposed reservoir operating range had not been established. Table 5-2 lists the number of sites surveyed for potential fish isolation, date and time of observation during the drawdown, coordinates of the location, and recorded data. Photos of potential fish isolation sites are provided in Attachment E-1. The fish isolation surveys were completed at reservoir elevations lower than PacifiCorp anticipates for normal year-round operations. Fish isolation surveys during the drawdown occurred between elevations 4,389.89 and 4,392.01 feet above mean sea level (msl), as measured at the Cutler Dam. Potential isolation locations identified during the drawdown were compared to the calibrated 2D hydraulic model inundation boundaries for proposed normal (elevation 4,407.5 to 4,406.5) and extended (elevation 4,406.5 to 4,405.0) operating ranges (Attachment E-1). Proposed operations are discussed in detail in Section 3.0 of the ISR. The 2D hydraulic model assumes the elevation fluctuation events in normal operating ranges occurring 85 percent of the time and 15 percent of the time for the extended operating range. It is important to note that potential isolation pools identified during this study are a snapshot in time. Given the fine nature of the reservoir sediments, the bottom sediments are likely to experience annual redistribution with varying inflows. That said, this study provides a fair representation of the overall quantity and characterization of potential fish isolation pools during reservoir fluctuations, within either normal or extended operating ranges. This study observed some fish stranded in isolated pools during the November 2019 drawdown. Very few fish were observed within these pools and an even smaller fraction of those fish were dead. In addition, most locations where fish isolation was observed during the drawdown event are not exposed in the proposed operating elevation ranges.

TABLE 5-1 SITES SURVEYED FOR POTENTIAL FISH ISOLATION DURING THE NOVEMBER 2019 CUTLER RESERVOIR DRAWDOWN

SITE ID	DATE	TIME	LATITUDE	LONGITUDE	NO. FISH	FISH LENGTH (INCHES)	SPECIES
2-1	11/4	12:10	41.7786339364027	-111.949030541678	>2	3 to 4	Unk
2-2	11/4	14:05	41.7472751718773	-111.95166045669	>2	1 to 2	Unk
2-3	11/4	14:23	41.7470188619326	-111.945576251713	>10	13	LMB, BGS, TP
2-4	11/4	14:59	41.752070878663	-111.942857518472	4	1 to 8	CCF
2-5	11/4	15:17	41.7524636733001	-111.939201133618	1	3	Unk
2-6	11/4	15:39	41.7584911317152	-111.937023941662	12	2 to 3	BGS
3-1	11/5	10:09	41.8029561598776	-111.951736031955	1	24	CRP
3-2	11/5	10:18	41.8006486947926	-111.953317436961	>4	1.5	Unk
3-3	11/5	13:25	41.8095108349527	-111.95373880522	>7	1 to 3	BGS, CCF
3-4	11/5	14:03	41.8089128786234	-111.956481599836	2	6 to 8	CCF, Unk
3-5	11/6	9:55	41.7936522483029	-111.960430422247	>6	2 to 3	Unk
3-6	11/8	11:42	41.789542194	-111.913598694	Unk	Unk	Unk
3-7	11/8	11:43	41.789676194	-111.913911889	Unk	Unk	Unk
3-8	11/8	12:01	41.801735417	-111.904632972	Unk	Unk	Unk
4-1	11/6	11:42	41.8278848064918	-111.968099273352	2	4 to 5	CCF
4-2	11/6	11:57	41.828998694983	-111.964908493395	1	1	TP
4-3	11/6	12:05	41.8294757949143	-111.965833087096	15	1	Unk
4-4	11/6	13:36	41.8294777186675	-111.984264285311	1	8	CCF
4-5	11/6	14:01	41.8257767865896	-111.978291983469	>4	1.5 to 8	CCF
4-6	11/6	14:07	41.8257706950217	-111.97694895361	2	3 to 10	CCF
4-7	11/6	14:12	41.825944805194	-111.976006178007	>6	1.5	Unk
4-8	11/6	14:16	41.8260281248484	-111.975631963216	1	15	CRP
4-9	11/7	11:05	41.8246277252048	-111.961040276815	>6	1	BGS
4-10	11/7	14:33	41.8252873185529	-111.959709416433	>15	1.5 to 3	BGS, Unk
4-11	11/7	14:49	41.8252896849107	-111.957174841419	4	1.5	Unk
4-12	11/7	8:07	41.834672917	-111.995104694	*	*	*
4-13	11/6	9:47	41.8313517780001	-111.973765222	*	*	*
4-14	11/6	15:03	41.824510306	-111.958481861	*	*	*

SITE ID	DATE	TIME	LATITUDE	LONGITUDE	NO. FISH	FISH LENGTH (INCHES)	SPECIES
4-15	11/6	15:04	41.8246424720001	-111.957995028	*	*	*
4-16	11/6	15:12	41.819926583	-111.948856222	*	*	*
4-17	11/6	15:13	41.8199301390001	-111.948857278	*	*	*

Note: Unk = unknown; BGS = Bluegill Sunfish; CCF = Channel Catfish; CRP=Common Carp; LMB = Largemouth Bass; TP=tadpole.
*- Sites 4-12 through 4-17 were surveyed by drone and observations of depth, fish numbers and sizes were not attainable



Source: PacifiCorp 2019

FIGURE 5-2 POTENTIAL FISH ISOLATION LOCATIONS IDENTIFIED DURING THE NOVEMBER 2019 CUTLER RESERVOIR DRAWDOWN

TABLE 5-2 POTENTIAL FISH ISOLATION LOCATIONS IN RELATION TO PROPOSED OPERATING RANGE ELEVATIONS

SITE	EXPOSED AT INUNDATION BOUNDARY ELEVATION 4407.5 FEET	EXPOSED AT INUNDATION BOUNDARY ELEVATION 4406.5 FEET	EXPOSED AT INUNDATION BOUNDARY ELEVATION 4405.0 FEET	EXPOSED DURING DRAWDOWN EVENT AND WITHIN PROPOSED OPERATING RANGE ELEVATIONS
2-1	No	No	Yes	Yes**
2-2	No	Yes	Yes	No**
2-3	No	No	No	No**
2-4	No	No	No	No**
2-5	No	Yes	Yes	No**
2-6	No	No	No	No**
3-1	Yes*	Yes	Yes	Yes**
3-2	Yes*	Yes	Yes	Yes**
3-3	No	No	No	Yes**
3-4	No	No	No	No**
3-5	Yes*	Yes	Yes	Yes**
3-6	No	Yes	Yes	Unk
3-7	No	No	No	Unk
3-8	N/A*	N/A	N/A	N/A
4-1	No	No	Yes	Yes**
4-2	No	Yes	Yes	Yes**
4-3	No	Yes	Yes	Yes**
4-4	No	No	No	No**
4-5	No	No	No	No**
4-6	No	No	No	No**
4-8	No	No	Yes	Yes**
4-9	Yes*	Yes	Yes	Yes**
4-10	No	Yes	Yes	Yes**
4-11	No	Yes	Yes	Yes**
4-12	No	No	No	Unk
4-13	No	No	Yes	Unk
4-14	No	No	No	Unk
4-15	Yes*	Yes	Yes	Unk
4-16	Yes*	Yes	Yes	Unk
4-17	Yes*	Yes	Yes	Unk

* Site is exposed above the reservoirs high elevation mark or is outside of the modeled area (i.e., the zone of influence from proposed operations) but that was not known at the time of data collection.
** Stranded fish were observed.

5.2.2 RAPID BIOASSESSMENT OF BENTHIC MACROINVERTEBRATES

A baseline Rapid Bioassessment sample collection was performed the week of October 14, 2019, prior to the drawdown period. Beginning on October 16, 2019, a field team of three began sampling Transect 2-3 in the North Marsh Unit. Samples were collected using either a kick-net to scoop along the bottom or an Eckman dredge, depending on the depth. Each method sampled approximately 0.046 square meters with two kick-net scoops or two Eckman dredge grabs collected at each sample site on every transect. Each sample was rinsed clean and most of the detritus removed (except for filamentous green algae) to assure the team that enough organisms were collected. Any detritus, rocks, wood, or other media were thoroughly cleaned and rinsed to remove any organisms clinging to those pieces. In addition, the samples were washed through a 250-micron sieve to remove silt and mud such that the sample was as clean as possible for processing in the lab. All samples were preserved in 95 percent isopropanol and taken to USU Bug Lab to sort and identify organisms. Organisms were sorted to family and assigned to a standardized Operational Taxonomic Unit (OTU) (Cuffney et al. 2007).

Pre-drawdown benthic samples were collected on October 16 and 17, 2019 (Table 5-3). Benthic samples during the drawdown were collected November 4 and 5, 2019 (Table 5-4). The pre-drawdown benthic samples were collected at or near full pool (4,407.5 feet above msl). The benthic sampling during the drawdown occurred between 4,389.89 and 4,392.01 feet above msl as measured at the Cutler Dam. The benthic samples during the drawdown were taken at lower reservoir elevations than PacifiCorp anticipates for normal year-round operations. Each sample bottle contained specimens from either two Eckman dredges or two kick-net scoops, both of which were estimated to sample an area of 0.046 square meters. Site 4-3-4 was not sampled during the drawdown because the site was dewatered.

Overall, more than 29,000 macroinvertebrates were collected prior to the reservoir drawdown. Of those, the families in greatest numbers were the aquatic earthworms (16,043) followed by non-biting midge flies (9,422 of subfamily Chironominae and 1,928 of subfamily Tanypodinae). The greatest numbers of earthworms and midges were found in the Reservoir Unit (Unit 3).

During the drawdown, the number of macroinvertebrates captured were considerably higher than in the pre-drawdown survey (41,326) (Table 5-4). As in the pre-drawdown state, the primary families were the same, but totals were higher for aquatic earthworms (19,326) and the non-biting midge Chironominae (17,630). Similarly, invertebrates were grouped by common names following David et al. (1998) in a comparison of pre-drawdown and post-drawdown densities (Table 5-5 and Table 5-6). Pre- and post-drawdown invertebrate densities were further compared using mean values per transect (Table 5-7 and Table 5-8). David et al. (1998) suggests organizing invertebrate data by benthic guilds for analysis of the two conditions (Table 5-9 and Table 5-10).

TABLE 5-3 DENSITY OF MACROINVERTEBRATES* FROM BENTHIC SAMPLES COLLECTED FROM CUTLER RESERVOIR PRIOR TO 2019 DRAWDOWN (OCTOBER 16 AND 17, 2019)

OTU	COMMON NAME	SAMPLE SITE (UNIT-TRANSECT-SAMPLE SITE)																TOTAL
		1-2-1	1-2-2	1-2-3	1-2-4	2-3-1	2-3-2	2-3-3	2-3-4	3-3-1	3-3-2	3-3-3	3-3-4	4-3-1	4-3-2	4-3-3	4-3-4	
Nemata	Nematode Worm	22	109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	130
Other Oligochaeta	Aquatic Earthworm	674	2,935	6,522	0	130	0	0	1,304	435	717	0	348	2,022	1,065	478	0	16,043
Acari	Water Mite	22	87	109	0	0	0	0	0	22	152	0	22	196	87	0	0	565
Lepidoptera	Butterflies/Moths	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	22
Dubiraphia	Beetle	22	22	43	0	0	0	0	0	0	0	0	22	0	22	0	0	130
Ceratopogonidae	Biting Midge	0	87	239	0	0	0	0	0	0	0	0	43	0	0	0	0	370
Chironominae	Non-biting Midge	174	609	1,000	43	150	470	280	522	609	804	283	717	304	1,087	696	1,935	9,422
Orthocladiinae	Non-biting Midge	65	196	22	43	20	0	0	0	0	0	0	22	22	0	22	0	411
Tanypodinae	Non-biting Midge	43	435	1,174	22	10	0	70	65	0	22	0	0	43	65	0	0	1,928
Callibaetis	Mayfly	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenis	Mayfly	0	0	22	0	30	0	10	0	0	0	0	0	0	0	0	0	62
Corixidae	Water Boatman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidostoma	Caddisfly	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gammarus	Freshwater Shrimp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asellidae	Freshwater Isopod	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	22
Pisidiidae	Freshwater Mollusk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		1,022	4,478	9,130	130	340	470	360	1,891	1,065	696	283	1,174	2,609	2,326	1,196	1,935	29,105

Note: * quantity per square meter
** Operational Taxonomic Unit

TABLE 5-4 DENSITY* OF MACROINVERTEBRATES FOUND IN THE BENTHIC SAMPLES COLLECTED DURING THE 2019 CUTLER RESERVOIR DRAWDOWN (NOVEMBER 4 AND 5, 2019)

OTU**	Common Name	Sample Site (Unit-Transect-Sample Site)																Total
		1-2-1	1-2-2	1-2-3	1-2-4	2-3-1	2-3-2	2-3-3	2-3-4	3-3-1	3-3-2	3-3-3	3-3-4	4-3-1	4-3-2	4-3-3	4-3-4	
Nemata	Nematode Worm	0	22	43	0	0	0	0	0	0	0	0	22	0	0	0	–	87
Other Oligochaeta	Aquatic Earthworm	0	3,587	1,370	0	87	217	2,304	609	5,696	717	87	4,522	130	0	0	–	19,236
Acari	Water Mite	0	130	130	43	43	43	283	0	1,043	152	174	22	0	22	0	–	2,087
Lepidoptera	Butterflies/ Moths	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	0
Dubiraphia	Beetle	0	22	109	43	0	0	0	0	0	0	0	0	0	0	0	–	174
Ceratopogonidae	Biting Midge	43	22	22	0	0	0	0	0	0	0	0	0	0	0	0	–	87
Chironominae	Non-biting Midge	217	696	826	891	2,543	2,022	848	2,261	1,217	804	2,261	783	0	2,261	0	–	17,630
Orthocladiinae	Non-biting Midge	0	0	22	43	22	0	22	87	0	0	0	43	0	0	0	–	239
Tanypodinae	Non-biting Midge	0	413	65	109	65	152	109	174	109	22	174	0	0	0	0	–	1,391
Callibaetis	Mayfly	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	–	22
Caenis	Mayfly	0	0	0	0	0	0	0	87	0	0	0	0	0	0	0	–	87
Corixidae	Water Boatman	0	0	22	0	0	22	0	0	22	0	22	0	0	0	0	–	87
Lepidostoma	Caddisfly	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	–	22
Gammarus	Freshwater Shrimp	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	–	22
Asellidae	Freshwater Isopod	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	0
Pisidiidae	Freshwater Mollusk	0	0	0	43	0	0	0	0	0	0	22	0	0	0	0	–	65
Total		261	4,891	2,609	1,174	2,761	2,457	3,587	3,217	8,130	1,696	2,739	5.391	130	2,283	0	–	41,326

Note: *quantity per square meter
**OTU = operational taxonomic unit

TABLE 5-5 MACROINVERTEBRATE GROUPS AND DENSITIES* COMBINED BY SAMPLE SITE PRIOR TO 2019 CUTLER RESERVOIR DRAWDOWN

COMMON NAME (ORDER)	SAMPLE SITE (UNIT-TRANSECT-SAMPLE SITE)															
	1-2-1	1-2-2	1-2-3	1-2-4	2-3-1	2-3-2	2-3-3	2-3-4	3-3-1	3-3-2	3-3-3	3-3-4	4-3-1	4-3-2	4-3-3	4-3-4
Worms (Oligochaeta)	696	3,043	6,522	0	130	0	0	1,304	435	130	0	348	2,022	1,065	478	0
Water Mite (Arachnida)	22	87	109	0	0	0	0	0	22	22	0	22	196	87	0	0
Butterflies/Moths (Lepidoptera)	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0
Beetle (Insecta)	22	22	43	0	0	0	0	0	0	0	0	22	0	22	0	0
Midges(Insecta)	283	1,326	2,435	109	180	470	360	587	609	543	283	783	370	1,152	717	1,935
Mayflies (Ephemeroptera)	0	0	22	0	30	0	0	0	0	0	0	0	0	0	0	0
Water Boatman (Insecta)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caddisfly (Trichoptera)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shrimp (Amphipoda)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sowbug (Isopoda)	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0
Clams (Mollusca)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: *quantity per square meter

TABLE 5-6 MACROINVERTEBRATE GROUPS AND DENSITIES* COMBINED BY SAMPLE SITE DURING THE NOVEMBER 2019 CUTLER RESERVOIR DRAWDOWN

COMMON NAME (ORDER)	SAMPLE SITE (UNIT-TRANSECT-SAMPLE SITE)															
	1-2-1	1-2-2	1-2-3	1-2-4	2-3-1	2-3-2	2-3-3	2-3-4	3-3-1	3-3-2	3-3-3	3-3-4	4-3-1	4-3-2	4-3-3	4-3-4*
Worms (Oligochaeta)	0	3,609	1,413	0	87	217	2,304	609	5,696	717	87	4,544	130	0	0	–
Water mite (Arachnida)	0	130	130	43	43	43	283	0	1,043	152	174	22	0	22	0	–
Butterflies/moths (Lepidoptera)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–
Beetle (Insecta)	0	22	109	43	0	0	0	0	0	0	0	0	0	0	0	–
Midges (Insecta)	261	1,130	935	1,043	2,630	2,174	978	2,522	1,326	826	2,435	826	0	2,261	0	–
Mayflies (Ephemeroptera)	0	0	0	0	0	0	0	87	22	0	0	0	0	0	0	–
Water boatman (Insecta)	0	0	22	0	0	22	0	0	22	0	22	0	0	0	0	–
Caddisfly (Trichoptera)	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	–
Shrimp (Amphipoda)	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	–
Sowbug (Isopoda)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–
Clams (Mollusca)	0	0	0	43	0	0	0	0	0	0	22	0	0	0	0	–

Note: *Not sampled – dewatered
*quantity per square meter

TABLE 5-7 MACROINVERTEBRATE MEAN DENSITIES* FOR EACH TRANSECT PRIOR TO CUTLER RESERVOIR DRAWDOWN IN OCTOBER 2019

COMMON NAME	TRANSECT 1-2	TRANSECT 2-3	TRANSECT 3-3	TRANSECT 4-3**
Worms	2,565.25	358.5	228.5	891.5
Water mite	54.5	0	16.5	70.75
Butterflies/moths	0	0	0	5.5
Beetle	21.75	0	5.5	5.5
Midges	1,038.25	399.25	554.5	1,043.5
Mayflies	5.5	0	0	0
Water boatman	0	0	0	0
Caddisfly	0	0	0	0
Shrimp	0	0	0	0
Sowbug	5.5	0	0	0
Clams	0	0	0	0

Note: *quantity per square meter
**Corrected for missing data.

TABLE 5-8 MACROINVERTEBRATE MEAN DENSITIES* FOR EACH TRANSECT DURING THE CUTLER RESERVOIR DRAWDOWN IN NOVEMBER 2019

COMMON NAME	TRANSECT 1-2	TRANSECT 2-3	TRANSECT 3-3	TRANSECT 4-3**
Worms	1,255.5	804.25	27.61	43.33
Water Mite	75.75	92.25	347.75	14.67
Butterflies/Moths	0	0	0	0
Beetle	43.5	0	0	0
Midges	842.25	2,076	1,353.25	753.67
Mayflies	0	21.75	5.5	0
Water Boatman	5.5	5.5	11	0
Caddisfly	0	5.5	0	0
Shrimp	0	0	5.5	0
Sowbug	0	0	0	0
Clams	0	0	5.5	0

Note: *quantity per square meter
**Corrected for missing data.

TABLE 5-9 PERCENTAGE CONTRIBUTION OF BENTHIC GUILDS TO THE TOTAL BENTHIC COMMUNITY IN CUTLER RESERVOIR GROUPED BY TRANSECT LOCATION PRIOR TO THE DRAWDOWN IN OCTOBER 2019

METRIC	TRANSECT 1-2	TRANSECT 2-3	TRANSECT 3-3	TRANSECT 4-3*
No. of Groups	6	3	4	5
EPTs (%)	0.15	0.99	0	0
Worms (%)	69.5	47.3	28.3	44.2
Dominants (%)	97.6	100	97.2	95.9
Diptera (%)	28.1	52.6	68.9	51.7
Insects (%)	0.9	0.99	0.68	0.27

Note: EPT = Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)
*Corrected for missing data.

TABLE 5-10 PERCENTAGE CONTRIBUTION OF BENTHIC GUILDS TO THE TOTAL BENTHIC COMMUNITY IN CUTLER RESERVOIR GROUPED BY TRANSECT LOCATION DURING THE DRAWDOWN IN NOVEMBER 2019

METRIC	TRANSECT 1-2	TRANSECT 2-3	TRANSECT 3-3	TRANSECT 4-3*
No. of Groups	5	6	7	3
EPTs (%)	0	0.91	0.12	0
Worms (%)	56.5	26.8	61.4	5.3
Dominants (%)	94.3	95.8	91.7	98.1
Diptera (%)	37.9	69.1	30.2	92.8
Insects (%)	2.2	1.1	0.37	0

Note: EPT = Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)
*Corrected for missing data.

During the drawdown, the number of benthic macroinvertebrate groups increased for Transects 2-3 and 3-3 and decreased for Transects 1-2 and 4-3. Most notably the percent of worms decreased in Transects 1-2, 2-3, and 4-3 but increased in Transect 3-3. The exact opposite was true for Diptera, where the percentages increased for Transects 1-2, 2-3, and 4-3 but decreased in Transect 3-3.

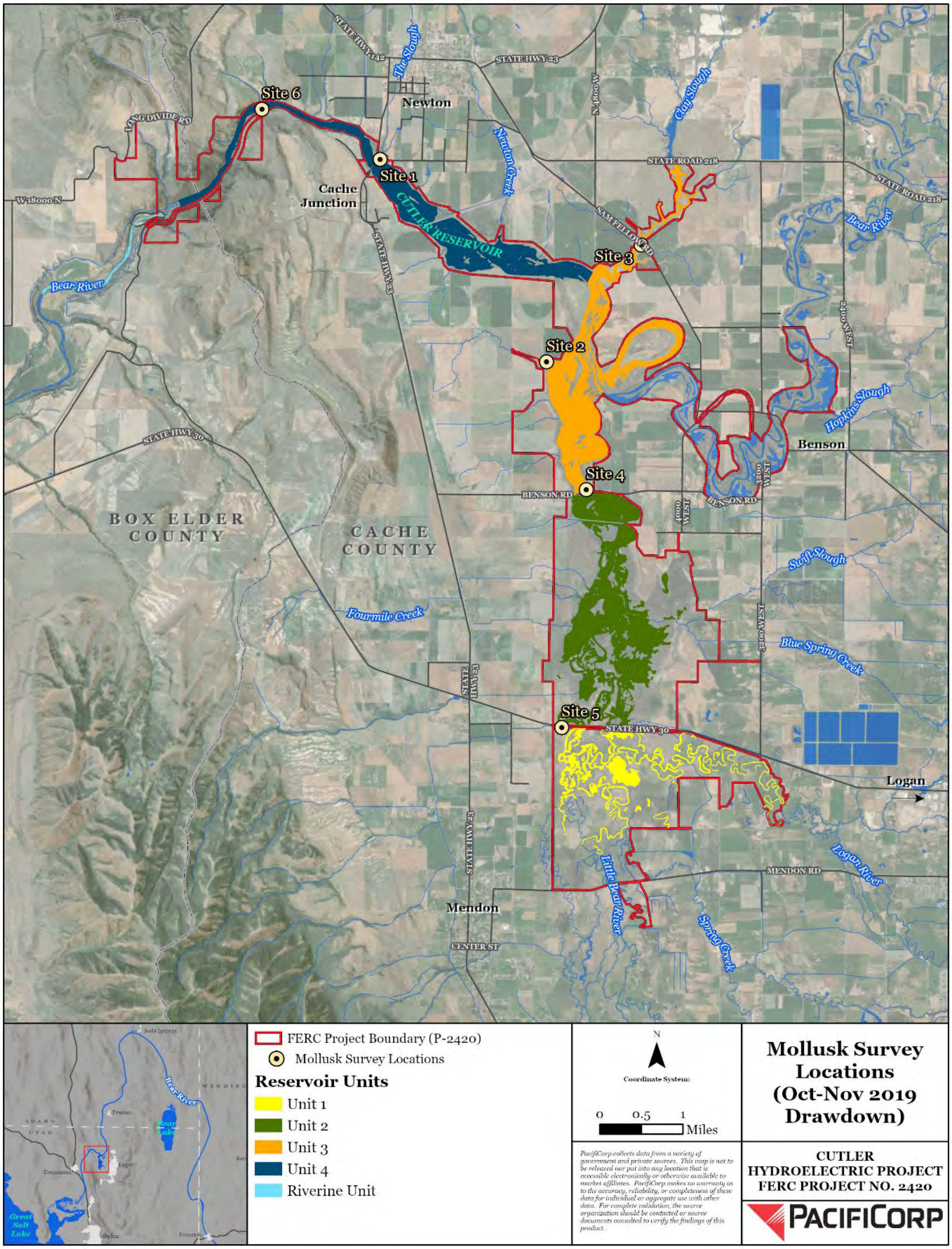
Benthic macroinvertebrate densities were not significantly different ($p \leq 0.05$) between the pre-drawdown and during drawdown sampling events with the exception of Transects 2 and 3. The Student t-test demonstrated significantly different results between Transect 2-3 before drawdown and during the drawdown ($p=0.02$) and Transect 3-3 before and during the drawdown ($p=0.2$). There were other notable differences although not statistically significant due to the high degree of variability. For example, the density of worms decreased from 2,565 individuals per square meter before the drawdown to 1,256 individuals per square meter during the drawdown.

Overall, the differences between the pre-drawdown condition and during the drawdown were mainly in densities and distribution. However, there were greater numbers observed in Units 2 and 3 during the drawdown, which can be attributed to sediment disturbance and invertebrate drift during the water elevation change going from full pool to the full 2019 drawdown.

5.2.3 FRESHWATER MOLLUSK SURVEY

The UDWR performed mollusk surveys on October 28, November 4, and November 8, 2019 (Figure 5-3) for six sites. On October 28, 2019, the UDWR team surveyed Site 1 (Figure 5-3) and discovered 55 (47 live/8 dead) Paper Pondshells located in approximately 2 feet of water with a silt/mud substrate. Site 2 produced no mollusks; however, the substrate did not appear to be suitable for mussels. On November 4, 2019, the UDWR team surveyed Site 3 and discovered 23 (8 live/15 dead) Paper Pondshells located in silt/mud substrate near the channels and at Site 4 272 (37 live/235 dead) Paper Pondshells were discovered in the silt/mud flats. The final survey on November 8, 2019 at Site 5, the UDWR team discovered 10 dead Paper Pondshells and 3 California Floaters that appeared to have expired much earlier than the drawdown period. The California Floater shells were in a riffle with approximately 6 inches of silt/mud and a hardened bottom. The UDWR team revisited Site 1 because the reservoir had reached its lowest point where the team found 5 California Floater shells in habitat similar to Site 5. They also found several smaller specimens. The field crew also surveyed Site 6 where UDWR found four dead Paper Pondshells (Figure 5-3).

Although some stranding and mortality of Paper Pondshell and a small number of California Floaters was observed, these observations occurred at reservoir elevations that are lower than the potential future operating range, and are not considered detrimental to the mussel community, according to UDWR (2019).



Source: PacifiCorp 2019

FIGURE 5-3 UDWR AQUATIC MOLLUSK SURVEY LOCATIONS

6.0 SUMMARY

The current outcome of study fieldwork as presented in this ISR satisfies the content and methods approved by FERC's Study Plan Determination and fills the data gaps for aquatic resources identified by FERC in Scoping Document 1 and Scoping Document 2.

Specifically, this study work identifies minimal temporary changes to aquatic habitat for fish and macroinvertebrates (including aquatic mussels) in Cutler Reservoir in relation to potential proposed Project operations.

This study data will allow analysis of the potential effects of future Project operations on aquatic habitat for resident (almost completely non-native) fish and macroinvertebrates in Cutler Reservoir. Analysis of potential effects of future proposed Project operations will be provided in the DLA. No additional or future studies are proposed.

7.0 REFERENCES

Budy, P., M. Baker, and S.K. Dahle. 2011. Predicting fish growth potential and identifying water quality constraints: A spatially-explicit bioenergetics approach. *Environmental Management* 48:691. https://doi.org/10.1007/s00267-011-9717-1

Budy, P., K. Dahle, and G. Thiede. 2006. *An Evaluation of the Fish Community of Cutler Reservoir and the Bear River Above the Reservoir with Consideration of the Potential for Future Fisheries Enhancement.* 2005 Annual Report to the Utah Department of Environmental Quality, Division of Water Quality.

Cornell University. 2008. Birds of North America Online. Available at: https://birdsoftheworld.org/bow/home Accessed July 18, 2020.

Cuffney, T.F., M.D. Bilger, and A.M. Haigler. 2007. Ambiguous taxa: effects on the characterization and interpretation of invertebrate assemblages. Journal of North *American Benthological Society* 26(2):286–307.

David, S.M., K.M. Somers, R.A. Reid, R.J. Hall, and R.E. Girard. 1998. Sampling protocols for the rapid bioassessment of streams and lakes using benthic macroinvertebrates. Ontario, Canada: Queen's Printer for Ontario.

Dees, T. 2007. Effects of wastewater treatment plant discharge on benthic invertebrate communities in Cutler Reservoir. In *Comparison of chemical and biological characteristics in Cutler Reservoir (Utah) near the inflows of the Logan River and the Logan Wastewater Treatment Plant*, edited by W.A. Wurtsbaugh and R. Lockwood. Aquatic Ecology Practicum Class Report, College of Natural Resources, Utah State University.

Kaufman, K. 1996. *Lives of North American Birds*. New York: Houghton Mifflin.

PacifiCorp. 2018. *Cutler Hydroelectric Project Resource Management Plan 5-year Monitoring Report 2013-2017.* PacifiCorp, Salt Lake City, Utah. https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/hydro/cutler/03282018_Cutler_RMP-5yr_Monitor.pdf

PacifiCorp. 2018. Cutler Hydroelectric Project FERC Project No. 2420. Maps created in 2018.

PacifiCorp. 2019. Cutler Hydroelectric Project FERC No. 2420 Pre-Application Document Volume I – Main Document. March 2019.

Random Number Generator. 2020. Available at: https://www.google.com/search?source=hp&ei=3as1X5OTJdjE0PEP28uRuAQ&q=random+number+generator. Accessed July 28, 2020.

Sigler, W.F., and J.W. Sigler. 1996. *Fishes of Utah: A Natural History*. University of Utah Press, Salt Lake City, Utah.

Stoller, J. 2007. Benthic invertebrate biomass and densities in Cutler Reservoir near the inflow of the Logan River and the Logan Wastewater Treatment Plant. In *Comparison of chemical and biological characteristics in Cutler Reservoir (Utah) near the inflows of the Logan River and the Logan Wastewater Treatment Plant*, edited by W.A. Wurtsbaugh and R. Lockwood. Aquatic Ecology Practicum Class Report, College of Natural Resources, Utah State University.

U.S. Fish and Wildlife Service (USFWS). 2001. *Status Review for Bonneville Cutthroat Trout (Oncorhynchus clarki utah)*. Portland, Oregon, and Denver, Colorado: U.S. Fish and Wildlife Service Regions 1 and 6.

U.S. Fish and Wildlife Service (USFWS). 2011. Endangered and threatened wildlife and plants; 12-month finding on a petition to list Northern Leatherside Chub as endangered or threatened. 76 FR 63443.

Utah Division of Water Quality (UDWQ). 2008. *Utah's 2008 Integrated Report*. Salt Lake City: Utah Division of Water Quality.

Utah Division of Wildlife Resources (UDWR). 2009. Rangewide Conservation Agreement and Strategy for Northern Leatherside. Utah Division of Wildlife Resources, Publication No. 9-11. Salt Lake City, Utah.

Utah Division of Wildlife Resources (UDWR). 2016. Conservation and Management Plan for Three Fish Species in Utah. Addressing needs for Roundtail Chub (*Gila robusta*), Bluehead Sucker (*Catostomus discobolus*), and Flannelmouth Sucker (*Catostomus latipinni*s). Utah Division of Wildlife Resources, Salt Lake City, Utah.

Utah Division of Wildlife Resources (UDWR). 2019. Field report of electrofishing survey on the Bear River downstream of Cutler dam. Utah Division of Wildlife Resources, Ogden, Utah.

Utah State University (USU). 2018. *Watershed Science Annual Class Reports on the Fishery in Cutler Reservoir - Excel spreadsheet.* Logan City: Utah State University.

Wang, L., D.M. Robertson, and P.J. Garrison. 2007. Linkages between Nutrients and Assemblages of Macroinvertebrates and Fish in Wadable Streams: Implication to Nutrient Criteria Development. *Environmental Management* 39:194–212. https://doi.org/10.1007/s00267-006-0135-8.

Wetzel, R.G. 2001. *Limnology: Lake and River Ecosystems*. 3rd ed. San Diego Academic Press.

Wurtsbaugh, W.A. and R. Lockwood (eds). 2007. *Comparison of limnological characteristics in Cutler Reservoir (Utah) near the inflows of the Logan River and the Logan Wastewater Treatment Plant.* Aquatic Ecology Practicum Class Report, College of Natural Resources, Utah State University.

ATTACHMENT E-1

POTENTIAL FISH ISOLATION SITE IMAGES

UNIT 2 POTENTIAL ISOLATION SITE IMAGES

PHOTO E-1: SITE 2-1 SURVEYED FOR POTENTIAL FISH ISOLATION

PHOTO E-2: SITE 2-2 SURVEYED FOR POTENTIAL FISH ISOLATION

PHOTO E-3: SITE 2-3 SURVEYED FOR POTENTIAL FISH ISOLATION

PHOTO E-4: SITE 2-4 SURVEYED FOR POTENTIAL FISH ISOLATION

PHOTO E-5: SITE 2-5 SURVEYED FOR POTENTIAL FISH ISOLATION

PHOTO E-6: SITE 2-3, LIVE LARGEMOUTH BASS

PHOTO E-7: SITE 2-3, LIVE BLUEGILL SUNFISH JUVENILE

PHOTO E-8: SITE 2-3, LIVE TADPOLE

UNIT 3 POTENTIAL ISOLATION SITE IMAGES

PHOTO E-9: SITE 3-1 SURVEYED FOR POTENTIAL FISH ISOLATION

PHOTO E-10: SITE 3-2 SURVEYED FOR POTENTIAL FISH ISOLATION

PHOTO E-11: SITE 3-3 SURVEYED FOR POTENTIAL FISH ISOLATION

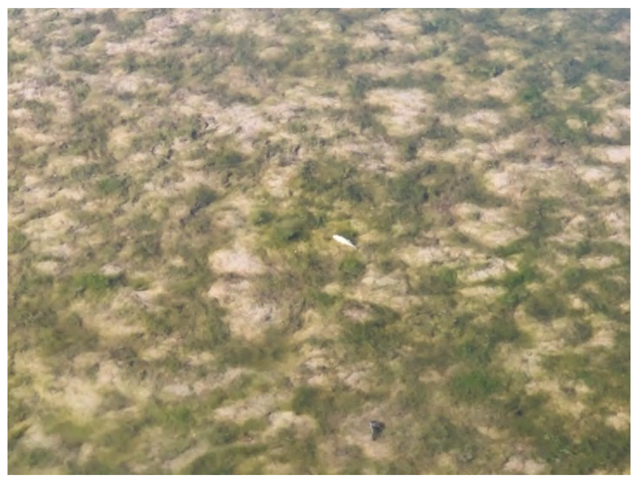


PHOTO E-12: SITE 3-3, DEAD BLUEGILL SUNFISH

PHOTO E-13: SITE 3-4 SURVEYED FOR POTENTIAL FISH ISOLATION

PHOTO E-14: SITE 3-5, DRONE VIEW OF POTENTIAL FISH ISOLATION SITE

PHOTO E-15: SITE 3-6, DRONE VIEW OF POTENTIAL FISH ISOLATION SITE

PHOTO E-16: SITE 3-7, DRONE VIEW OF POTENTIAL FISH ISOLATION SITE

PHOTO E-17: SITE 3-8, DRONE VIEW OF POTENTIAL FISH ISOLATION SITE

UNIT 4 POTENTIAL ISOLATION SITE IMAGES


PHOTO E-18: SITE 4-1 SURVEYED FOR POTENTIAL FISH ISOLATION


PHOTO E-19: SITE 4-1, DEAD CHANNEL CATFISH


PHOTO E-20: SITE 4-2 SURVEYED FOR POTENTIAL FISH ISOLATION


PHOTO E-21: SITE 4-3 SURVEYED FOR POTENTIAL FISH ISOLATION


PHOTO E-22: SITE 4-3, LIVE UNKNOWN JUVENILE FISH


PHOTO E-23: SITE 4-4, DEAD CHANNEL CATFISH

Figures 1–11, below, illustrate fish isolation sites observed during the 2019 drawdown event in relation to inundation boundaries for the proposed normal operating range (4,407.5- 4,406.5 feet, 85 percent of the time) and proposed extended range (elevation 4,407.5-4,405.0, 15 percent of the time). The pink line shows the boundary at elevation 4,405.0 feet, the black line shows the boundary at elevation 4,406.5 feet, and the blue line shows the boundary at elevation 4,407.5 feet.

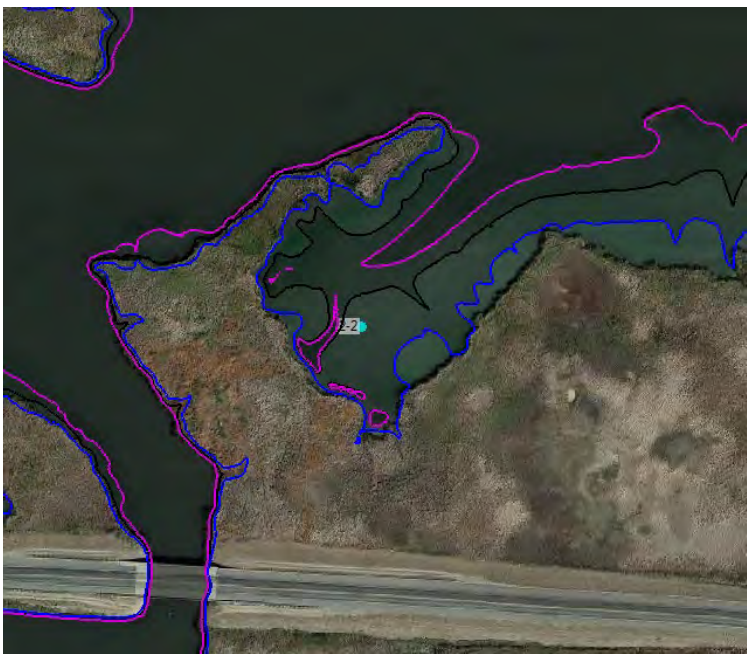


FIGURE E-1: SITE 2-2

FIGURE E-2: SITE 2-5

FIGURE E-3: SITE 2-1

FIGURE E- 4: SITE 3-5

FIGURE E- 5: SITE 3-1 & SITE 3-2

FIGURE E-6: SITE 3-6

FIGURE E-7: SITE 4-16

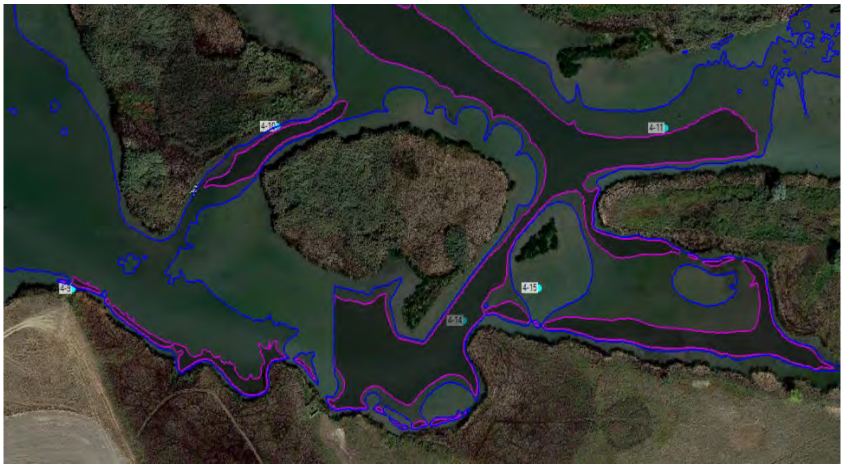


FIGURE E-8: SITES 4-9, 4-10, 4-11, AND 4-15

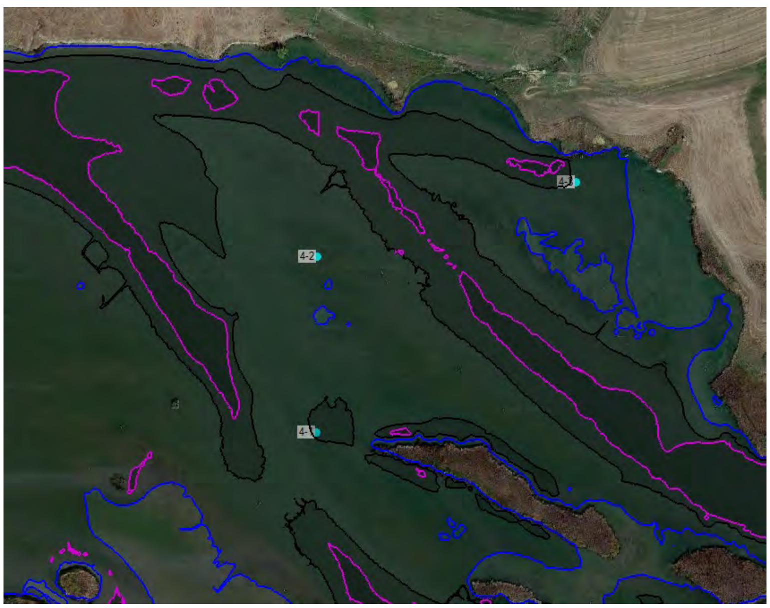


FIGURE E-9: SITES 4-1, 4-2, AND 4-3

FIGURE E-10: SITE 4-13

FIGURE E-11: SITE 4-8

APPENDIX F
WATER QUALITY INITIAL STUDY REPORT

WATER QUALITY INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT

(FERC NO. 2420)

Prepared for:

PacifiCorp
Salt Lake City, Utah

Prepared by:

SWCA ENVIRONMENTAL CONSULTANTS

February 2021

WATER QUALITY
INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT

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WATER QUALITY INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

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WATER QUALITY INITIAL STUDY REPORT

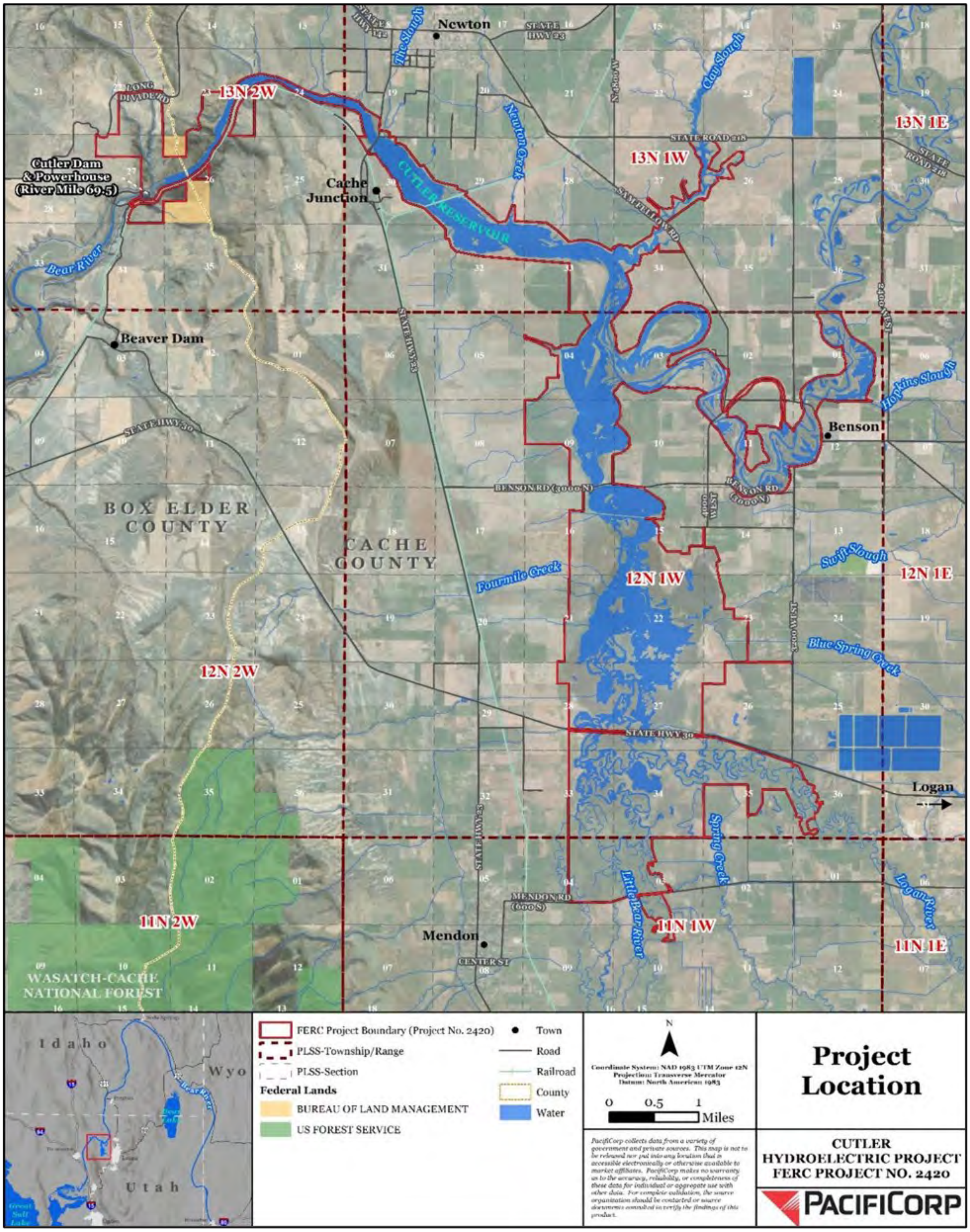
CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

1.0 INTRODUCTION

PacifiCorp is the owner, operator and the Federal Energy Regulatory Commission (FERC) Licensee for the Cutler Hydroelectric Project (FERC No. 2420) (Project). The Project is located on the Bear River and several tributaries in Cache Valley, Utah, between the Wasatch and Wellsville Mountains. Cutler Dam is located in Box Elder County, and most of the Project reservoir lies within Cache County. The Project reservoir is formed at the confluence of Spring Creek and the Bear, Logan, and Little Bear Rivers (Figure 1-1). PacifiCorp operates the Project under a 30-year license issued by FERC on April 29, 1994; the current license will expire on March 31, 2024. PacifiCorp initiated the formal relicensing process utilizing the Integrated Licensing Process (ILP) by filing the Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on March 29, 2019.

The relicensing process involves cooperation and collaboration amongst PacifiCorp, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGOs), and interested individuals. PacifiCorp coordinated with stakeholders that included federal and state agencies, NGOs, and Native American tribes and tribal organizations, throughout the study scoping process, public meetings, workshops, scoping meetings, and a site visit. These meetings facilitated the identification of study needs to be addressed. Study scoping occurred in March 2019 through February 2020 when FERC issued the Study Plan Determination. PacifiCorp, FERC, and stakeholders identified the potential need for a water quality study during the study scoping process.



Source: PacifiCorp 2018

FIGURE 1-1 CUTLER PROJECT LOCATION MAP

2.0 PROJECT NEXUS AND RATIONALE FOR STUDY

The water quality study is part of the overall Cutler Relicensing Study Plan to evaluate the environmental conditions, and future Project operations, for FERC relicensing. Continued operation of the Project may have direct, indirect, and/or cumulative effects on water quality resources. Comments from FERC staff and stakeholders on the Preliminary Study Plan (PSP) requested that PacifiCorp utilize a two-phased approach to the water quality study. To address comments on the proposed Water Quality Study Plan, PacifiCorp modified the PSP to include a two-phased study plan approach.

Phase 1 is a synthesis of all existing water quality data for Cutler Reservoir, with the addition of new water quality data gathered during the fall 2019 drawdown. This report presents the results of the Phase 1 study and discusses whether there are outstanding data gaps that may warrant data collection in 2021 (Phase 2).

The rationale for this study consists of:

- The uncertainty regarding how future Project operations may affect water quality within the FERC Project Boundary and downstream of Cutler Dam; increased levels of reservoir fluctuations that may potentially affect water quality, especially turbidity, the total phosphorus (TP) released from the reservoir sediments, and dissolved oxygen (DO).
- Determining the effects of the fall 2019 reservoir drawdown on water quality, specifically, TP, total suspended solids (TSS), and DO and how to relate this information to potential effects of future operations.
- Water quality information from past monitoring efforts by PacifiCorp, Utah State University (USU), Utah Division of Water Quality (UDWQ), and the City of Logan, as well as a DO and water quality study performed by Ecosystems Research Institute (ERI). In addition, there are numerous entities managing the five major total maximum daily load (TMDL) designations in the Bear River basin that implemented monitoring requirements. However, because several entities collected and stored data separately, a

synthesis of all existing data, including additional data collected during the fall 2019 drawdown, is needed to provide a more comprehensive understanding of water quality conditions in Cutler Reservoir and the surrounding aquatic environment, including the 2-mile reach of the Bear River downstream of Cutler Dam.

3.0 STUDY OBJECTIVES

The goal of this study was to characterize water quality within the reservoir and zone of influence in the main tributaries, including the Bear River reach up to 2 miles downstream of Cutler Dam, or as adjusted given additional information from the hydraulics study.

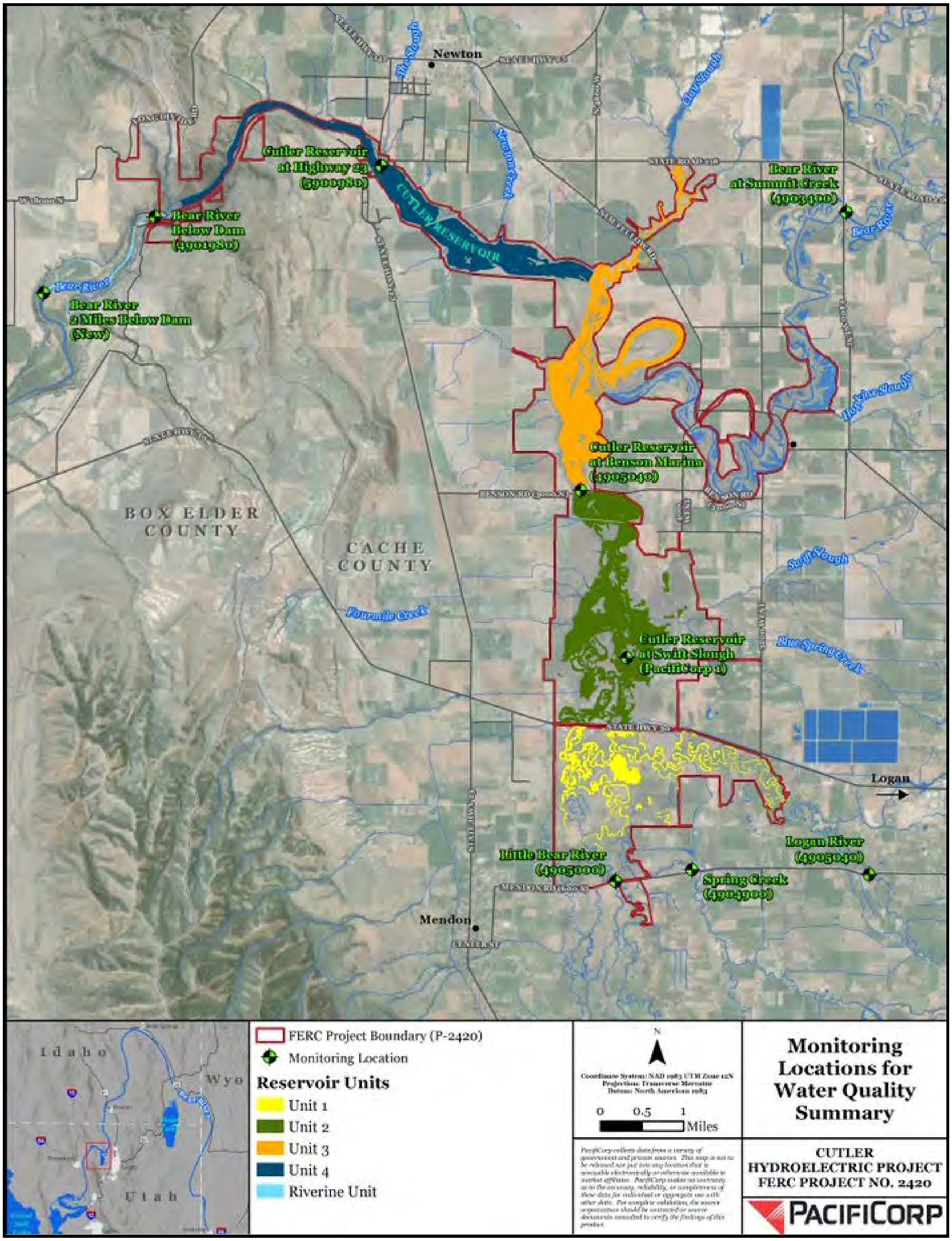
Specific objectives were as follows:

- Determine potential effects of continued and future Project operations on water quality of Cutler Reservoir and the Bear River downstream of Cutler Dam
- Determine the effects of the fall 2019 drawdown on water quality in the reservoir and downstream of Cutler Dam and relate those effects to future operations
- Synthesize existing water quality information, including PacifiCorp's 5-year Water Quality Monitoring Reports (PacifiCorp 2018), USU publications, UDWQ's periodic water quality monitoring, ERI's data set, information from the city of Logan, and the 2010 TMDL Study (SWCA 2010), to characterize the overall Cutler Reservoir water quality environment
- Describe the relationship between nutrients and aquatic weed growth
- Provide recommendations to address identified water quality issues
- Provide information for National Environmental Policy Act (NEPA) analysis of the affected environment

Although the Revised Study Plan (RSP) included objectives to evaluate effects of PacifiCorp's potential proposed operations on water quality resources, provide recommendations to address problems, and provide information for NEPA analysis, this information is not included in the Initial Study Report (ISR). It will be evaluated in the Draft License Application (DLA), which will be submitted in 2021.

3.1 STUDY AREA

The study area for water quality contains all Project features (encompassed by the Project Boundary) (Figure 3-1) and extends, for the purposes of characterization and analysis, from the edge of the Project Boundary up each major tributary within the reservoir zone of influence. The study area also includes the Bear River up to 2-miles downstream of the dam. PacifiCorp's water quality monitoring sites are provided in Figure 3-1.



Source: PacifiCorp 2018

FIGURE 3-1 PROJECT BOUNDARY MAP AND WATER QUALITY MONITORING LOCATIONS

4.0 METHODS

4.1 PHASE 1 – COLLECTION OF PHOSPHORUS AND DISSOLVED OXYGEN SAMPLES DURING THE FALL 2019 DRAWDOWN

To allow for direct comparison of data collected over the past 23-plus years, as well as for the purpose of analyzing the proposed operations, 2019 drawdown sampling transects were established along transects previously used for PacifiCorp's monitoring reports. These transect locations are the same as those used for the benthic macroinvertebrate assessment described in the Fish and Aquatics Study Plan and ISR (PacifiCorp 2021, in progress).

Table 4-1 lists the transect locations and number of samples per transect. Figure 4-1 provides the location of all transects identified and the transects that were selected for sampling.

The PacifiCorp reservoir management units are delineated as the South Marsh Unit, North Marsh Unit, Reservoir Unit, and Cutler Canyon Unit. Additional sampling locations were located on the Bear River downstream of Cutler Dam at the Collinston Bridge and 2-miles downstream of Cutler Dam at the Boy Scouts' Camp Fife. To establish sampling transects, between three and seven georeferenced transects were identified and consecutively numbered in each of the reservoir units (depending on the unit size) before the drawdown (Table 4-2). The main criteria for these transects were that they be representative of the unit where they were established, be accessible during the drawdown, and not be dewatered during the drawdown. Using the last digit of the number assigned to each transect, a random number generator (Google 2020) was used to make a selection for the primary sampling site and for a secondary site, with the secondary site established as a backup should the primary site not be sampled at drawdown.

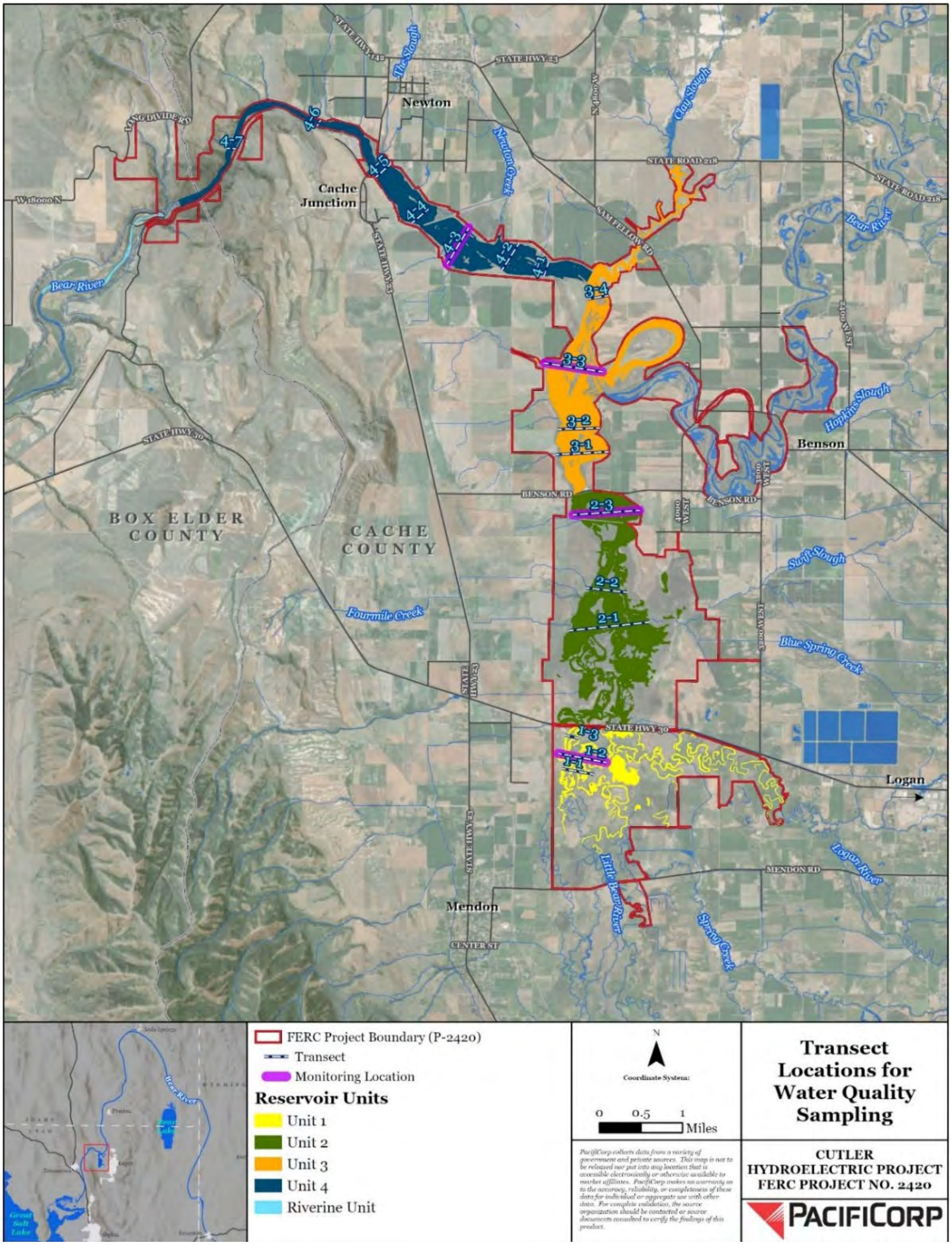
TABLE 4-1 SAMPLING LOCATIONS ON CUTLER RESERVOIR

Transect	Number of Samples along Transect
South Marsh Unit	4
North Marsh Unit	4
Reservoir Unit	4
Cutler Canyon Unit	4
Bear River downstream of Cutler Dam	1
Bear River 2 miles below Cutler Dam	1

TABLE 4-2 TRANSECTS RANDOMLY SELECTED FOR WATER QUALITY AND BENTHIC SAMPLING

Unit	Transect*	Primary Random Selection	Secondary Random Selection
South Marsh	1-1		
South Marsh	1-2	X	
South Marsh	1-3		X
North Marsh	2-1		
North Marsh	2-2		X
North Marsh	2-3	X	
Reservoir	3-1		
Reservoir	3-2		X
Reservoir	3-3	X	
Reservoir	3-4		
Cutler Canyon	4-1		X
Cutler Canyon	4-2		
Cutler Canyon	4-3	X	
Cutler Canyon	4-4		
Cutler Canyon	4-5		
Cutler Canyon	4-6		
Cutler Canyon	4-7		

Note: * For transect designations, first number refers to “unit,” and second number refers to “transect.”



Source: PacifiCorp 2018 Note: Highlighted in purple

FIGURE 4-1 MAP OF ALL TRANSECTS IDENTIFIED INCLUDING SPECIFIC TRANSECTS SELECTED FOR WATER QUALITY SAMPLING

4.2 PHASE 1 – SYNTHESIZE EXISTING WATER QUALITY DATA

PacifiCorp collected and analyzed water quality in Cutler Reservoir and four tributaries at intervals required by the license (quarterly every year for three years, and then quarterly every five years) since 1996 (PacifiCorp 2020, 2013, 2008, 2002). All data from these monitoring reports were summarized in the Cutler Reservoir 2018 Five-year Monitoring Report (PacifiCorp 2018). Since 1979, UDWQ monitored water quality in the Bear River and Cutler Reservoir; however, much of the data has not been summarized or provided in a regular reporting cycle but was provided in a number of USU reports (e.g., Budy, et al. 2011; Wurtsbaugh and Lockwood 2007. In addition, the TMDL study (SWCA 2010) provides a rich source of information regarding point and non-point sources and documents the annual nutrient loading into Cutler Reservoir.

The USU reports, Master's theses, Doctoral dissertations, and faculty publications, provide a good data set of all the existing data (e.g., Budy, et al. 2011; Wurtsbaugh and Lockwood 2007) for a side-by-side comparison of similar sampling sites used in past data collection efforts. ERI collected a DO data series from 2005 to 2007 for Swift Foods at a number of locations that could be correlated with PacifiCorp sampling locations. Ecosystems Research, Inc. DO data are recorded in 15-minute intervals and the data are condensed to June through September, when temperatures are highest, to evaluate the worst-case scenarios for temperature and DO.

If sufficient congruency between the various existing reports and studies was identified, trend graphs were incorporated in the synthesis in an attempt to document change in water quality conditions over the past several decades. The collective data were analyzed across seasons at sites that correspond with PacifiCorp's sampling sites. Existing reports reviewed as part of the synthesis are annotated below:

PacifiCorp 5-year Monitoring Report. 2018.

Per the Cutler FERC license, PacifiCorp began collecting water quality data in 1996. Chemical parameters included nutrient concentrations of phosphorus (total and orthophosphate) and nitrogen as nitrate (NO_3), nitrite (NO_2), ammonia (NH3), and total Kjeldahl nitrogen (TKN). Physical parameters included temperature, TSS, specific conductivity, pH, and DO values. The samples were collected during five hydroperiods (1996–1998, 2000–2003, 2008, 2013, and 2018). The 2018 report includes all the previous water quality data collected where comparisons are made at each of eight monitoring sites per year.

Budy, P., M. Baker and S.K. Dahle. 2011.
Dr. Budy and two other researchers collected water quality information, fish, plankton, and benthic macroinvertebrate data and used this information to assess fish performance in the highly eutrophic Cutler Reservoir environment. Water quality data collected during this study included temperature, conductivity, TSS, pH, salinity, turbidity, and DO. In addition, the team collected data on secchi depth, TKN, nitrate-nitrite, ammonia, TP, dissolved phosphorus, and soluble reactive phosphorus.

Wurtsbaugh, W.A. and R. Lockwood [eds]. 2007.
Logan City wastewater treatment plant discharge information was collected and compared with the fisheries, planktonic, and benthic macroinvertebrate communities with that of the Logan River where it enters Cutler Reservoir. Water quality information collected included TP, DO, temperature, pH, chlorophyll *a*, and turbidity.

In addition, due to comments from the BRCC on the PSP, existing literature regarding phosphorus concentrations in waterbodies was evaluated to determine its relationship to aquatic vegetation production.

4.3 PHASE 1 – SEDIMENT CHARACTERIZATION

The modeling crew collected core samples of reservoir sediments and water samples. The samples were analyzed for the presence and concentration of nutrients, metals, and/or contaminants that may be stirred up and released into the water column during periodic drawdowns under potential future Project operations. TP, dissolved TP, and orthophosphate data from the sediment core analysis is incorporated into this Water Quality Report.

5.0 RESULTS

5.1 PHASE 1 – COLLECTION OF PHOSPHORUS AND DISSOLVED OXYGEN SAMPLES DURING THE FALL 2019 DRAWDOWN

Data were collected during the fall 2019 drawdown to provide a more complete understanding of current water quality conditions in Cutler Reservoir and the surrounding aquatic environment, including the 2-mile reach of the Bear River downstream of Cutler Dam.

On October 16, 2019 prior to the reservoir drawdown, a field crew of three began sampling Transect 2-3 in the North Marsh Unit. Samples for TP, dissolved phosphorus total (DPT), and orthophosphate were collected at sub-surface for each of the four transect sites. In addition, temperature, and DO were measured in situ using a Hanna HI 9829 multi-parameter water quality sampling probe. Because the field crew was also collecting benthic samples at the sites (benthic samples are included in the Fish and Aquatics Study Report), the crew was careful to first take water quality samples and water depth measurements prior to disturbing the bottom sediments. Transect 3-3 was also sampled on October 16. Transects 1-2 and 4-3 were sampled on October 17, 2019; river sites downstream of Cutler Dam were sampled on October 18, 2019.

TP, DPT and orthophosphate were processed at ERI's analytical laboratory in Logan, Utah. All water samples were kept on ice and transferred to the lab within 24 hours of collection. These procedures occurred one week prior to reservoir drawdown and were repeated November 4-6, 2019, following drawdown to the reservoir's lowest elevation. The analyses were performed in accordance with Utah Rule R444-14 and the TNI standard 2009, Section 5.10. The analytical methods followed Rice, et al. (2017) and specifically utilized 2540D for TSS, 4500-PE for orthophosphate, 4500-PB for DPT, and 4500-PB for TP.

Water quality data for the reservoir drawdown were analyzed using the Microsoft Excel t-test to test for significant difference between pre-drawdown samples and those collected during the drawdown by transect location. The hypothesis tested was that there is no significant difference, by transect, between the two sampling periods using the probability standard of $p \leq 0.05$.

Raw data are presented in Table 5-1for pre-drawdown conditions (October 16–18, 2019) and in Table 5-2 for conditions during the drawdown (November 4–6, 2019) at the reservoir's lowest level. Most sites were sampled under both conditions, except for Site 4-3-1, which was observed to be dry during the drawdown. Reservoir elevations at Cutler Dam were at full pool during the pre-drawdown conditions and at elevation 4,392.01 feet on November 4; elevation 4,389.89 feet on November 5; and elevation 4,390.89 feet on November 6. The lab analysis of the water samples passed the quality control measures with no quality control errors and no data qualifiers.

By unit, average water temperatures were lower during the drawdown than before the drawdown (Figure 5-1), with the differences perhaps more related to weather and time of year. Average DO levels were lower during the drawdown than before the drawdown (Figure 5-2) but were still compliant with state standards and well within support levels for aquatic life. In contrast, TSS levels were higher during the drawdown than before the drawdown, except for Site 1-2-1 (Figure 5-3). Orthophosphate levels were lower during the drawdown, except that Site 1-2-1 was 0.2 milligrams per liter (mg/L) higher (Figure 5-4). Dissolved phosphorus (Figure 5-5) and TP (Figure 5-6) average levels were mixed. For sites downstream of Cutler Dam (Collinston and Camp Fife), DO levels were higher before the drawdown, and the various phosphorus levels were higher during the drawdown.

The results of the 2019 fall drawdown demonstrated minimal effects in terms of nutrient releases and resultant diminished DO (Table 5-3). Oxygen depletion appeared to occur at the reservoir sites, but reductions could be simply a result of temperature or decaying vegetation and decomposition (Siriwardana et al. 2018) and not a result of the drawdown. Even though there was not a reliable test for significance, DO levels were higher during the drawdown at the two reservoir outflow sites. Two factors could have contributed to these differences: 1) air and water temperature decreased considerably between sampling before the drawdown and sampling during the drawdown, which would allow for an increased capacity for DO, and 2) spilling over the normally submerged dam occurred at the old Wheelon Dam site and at the reservoir outfall gate that caused aeration and, thus, increased DO downriver.

TSS levels were generally higher during the drawdown than before the drawdown, with a significant difference at Transect 4-3. There was an obvious increase in TSS levels between sampling before and during the drawdown due to the release of sediments into suspension during the drawdown. That is, disturbance and erosion of bottom sediments occurred when the reservoir was lowered by approximately 11 feet at the dam, which is the maximum mechanical limit of the reservoir, creating a cutting action by drawing down water elevation and increasing downstream flow velocity.

Finally, the concentration of orthophosphate was significantly decreased at Site 4-3 during the drawdown. This is counterintuitive since, with increased TSS, the various states of phosphorus concentrations would likely be higher. This would be especially true at the Transect 4-3 where TSS would likely be cumulative, but that was not the case.

In conclusion, there are some water quality effects demonstrated when the Cutler Reservoir was drawn down approximately 11 feet from full pool at the dam. However, it is possible, with reservoir elevation changes that are smaller in magnitude, that the effects would likely be undetectable.

TABLE 5-1 WATER QUALITY DATA COLLECTED IN CUTLER RESERVOIR IN OCTOBER 2019, PRIOR TO DRAWDOWN

TRANSECT	SITE	DATE	TIME	DO (%)	DO (MG/L)	WATER TEMPERATURE (°C)	TSS (MG/L)	OP (MG/L)	DP (MG/L)	TP (MG/L)	WATER DEPTH (FEET)
1-2	1	10/17/2019	1:42 PM	131.8	12.13	10.58	82.90	0.02690	0.0325	0.1000	1.25
1-2	2	10/17/2019	2:10 PM	115.4	11.22	10.21	2.58	0.00801	0.0105	0.0234	2.5
1-2	3	10/17/2019	2:40 PM	114.1	11.03	9.11	4.90	0.00735	0.0087	0.0259	3.5
1-2	4	10/17/2019	3:15 PM	118.8	11.3	9.02	5.38	0.01030	0.0103	0.0234	5.5
2-3	1	10/16/2019	10:17 AM	135	13.5	8.7	13.90	0.02640	0.0319	0.0612	4
2-3	2	10/16/2019	11:37 AM	145	13.5	9.33	7.19	0.02970	0.0209	0.0407	4
2-3	3	10/16/2019	12:30 PM	134	13.1	9.57	14.00	0.03040	0.0465	0.0556	2.75
2-3	4	10/16/2019	2:03 PM	150.9	14.54	9.94	12.40	0.10100	0.1110	0.1410	3.75
3-3	1	10/16/2019	4:50 PM	141.4	12.8	12.69	7.45	0.12700	0.1350	0.1590	4
3-3	2	10/16/2019	4:30 PM	147.2	13.5	12	8.87	0.14500	0.1570	0.1840	6
3-3	3	10/16/2019	4:05 PM	143.2	13.1	11.65	7.20	0.10300	0.1200	0.1470	2.75
3-3	4	10/16/2019	3:02 PM	108	10.6	9.74	11.10	0.01180	0.0135	0.0339	8.5
4-3	1	10/17/2019	11:05 AM	109.4	10.63	9.3	19.40	0.05600	0.0593	0.0915	2.5
4-3	2	10/17/2019	10:20 AM	107.4	10.27	9.54	9.09	0.05760	0.0599	0.0891	3.5
4-3	3	10/17/2019	9:45 AM	105	10.09	9.26	14.70	0.05730	0.0673	0.0959	3
4-3	4	10/17/2019	9:10 AM	105.6	10.24	8.93	15.30	0.06220	0.0642	0.0940	6
Collinston		10/18/2019	8:40 AM	104.1	10.05	9.37	29.30	0.05300	0.0530	0.1110	1
Camp Fife		10/18/2019	8:59 AM	97.1	9.47	9.48	22.5	0.05200	0.0557	0.121	1

Note:
DO dissolved oxygen
DP dissolved phosphorous
OP orthophosphate
TP total phosphorus
TSS total suspended solid

TABLE 5-2 WATER QUALITY DATA COLLECTED IN CUTLER RESERVOIR, NOVEMBER 2019 DURING DRAWDOWN

TRANSECT *	SITE	DATE	TIME	DO (%)	DO (MG/L)	WATER TEMPERATURE (°C)	TSS (MG/L)	OP (MG/L)	DP (MG/L)	TP (MG/L)	WATER DEPTH (FEET)
1-2	1	11/5/2019	2:55 PM	96.2	10.12	6.62	26.10	0.0245	0.0381	0.0703	2
1-2	2	11/5/2019	3:15 PM	86.00	8.94	6.67	16.90	0.00865	0.0142	0.0284	4
1-2	3	11/5/2019	3:45 PM	84.9	9.02	6.48	16.70	0.0172	0.0196	0.0284	2.5
1-2	4	11/5/2019	4:00 PM	84.8	8.97	6.32	15.60	0.00996	0.013	0.0308	3
2-3	1	11/5/2019	10:00 AM	67.6	7.84	2.71	57.90	0.0169	0.0306	0.0545	1
2-3	2	11/5/2019	10:21 AM	80.6	9.26	2.47	35.70	0.0241	0.0281	0.0971	1
2-3	3	11/5/2019	10:45 AM	76.2	7.99	5.76	19.50	0.0195	0.0275	0.0527	0.29
2-3	4	11/5/2019	11:20 AM	82.7	9.17	3.71	6.87	0.0212	0.0263	0.0387	2
3-3	1	11/4/2019	2:04 PM	105.9	10.75	7.47	5.76	0.137	0.148	0.1660	1
3-3	2	11/4/2019	2:31 PM	79.4	8.83	4.34	7.50	0.121	0.136	0.1500	3
3-3	3	11/4/2019	2:55 PM	123.1	11.86	9.58	15.70	0.0767	0.0741	0.1040	1
3-3	4	11/4/2019	3:31 PM	86.7	9.58	4.56	10.00	0.00956	0.0184	0.0308	6
4-3	1 *										
4-3	2	11/4/2019	12:35 PM	93.6	10.08	5.27	16.80	0.0535	0.0666	0.0940	1
4-3	3	11/4/2019	1:25 PM	90.1	9.97	4.16	34.10	0.0552	0.0622	0.1010	4
4-3	4	11/4/2019	11:20 AM	78.9	9.01	3.96	46.00	0.0545	0.0629	0.1340	1
Collinston		11/6/2019	3:12 PM	96.6	10.25	5.95	224.00	0.0565	0.0681	0.2830	1
Camp Fife		11/6/2019	3:26 PM	85.2	8.89	5.92	148.00	0.0558	0.0785	0.2980	1

Note: * Transect dry
DO dissolved oxygen
DP dissolved phosphorous
OP orthophosphate
TP total phosphorus
TSS total suspended solid

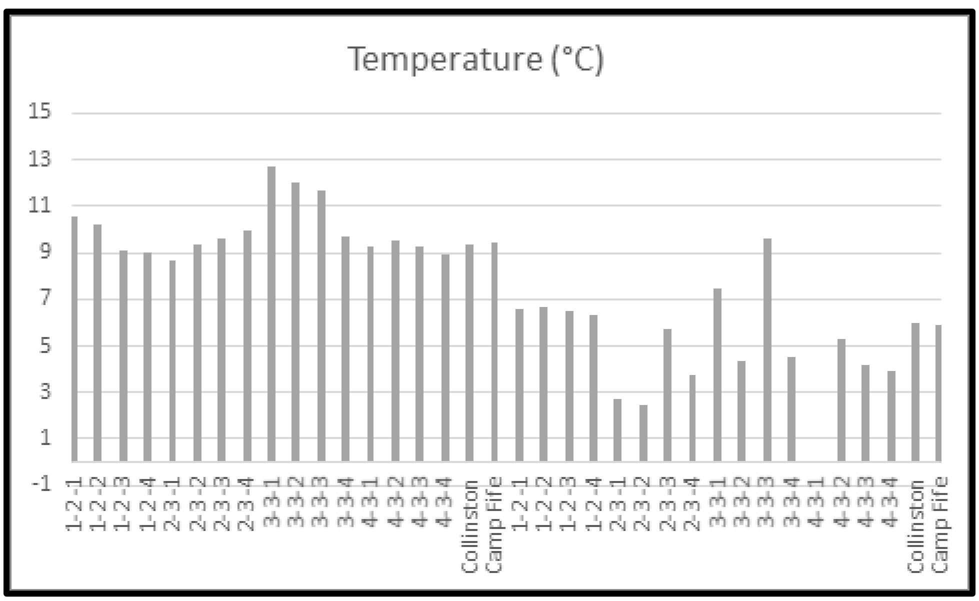
Statistical analysis using the Microsoft Excel t-test one-tailed, paired function yielded the results shown in Table 5-3. Site 4-3-1 was dropped from the t-test because the site was dry and not sampled during the drawdown. Because the river sites downstream of Cutler Dam were only sampled in one location at each site, this violates assumptions of the t-test; therefore, these data are reported but were dropped from the analysis of significant differences.

In general, there were no significant differences among the data, except for water temperature and DO at all sites but Site 4-3, and for TSS and orthophosphate at Site 4-3 only.

TABLE 5-3 PROBABILITIES THAT WATER QUALITY DATA COLLECTED IN CUTLER RESERVOIR WERE SIGNIFICANTLY DIFFERENT BEFORE DRAWDOWN THAN DURING DRAWDOWN ($P = 0.05$)

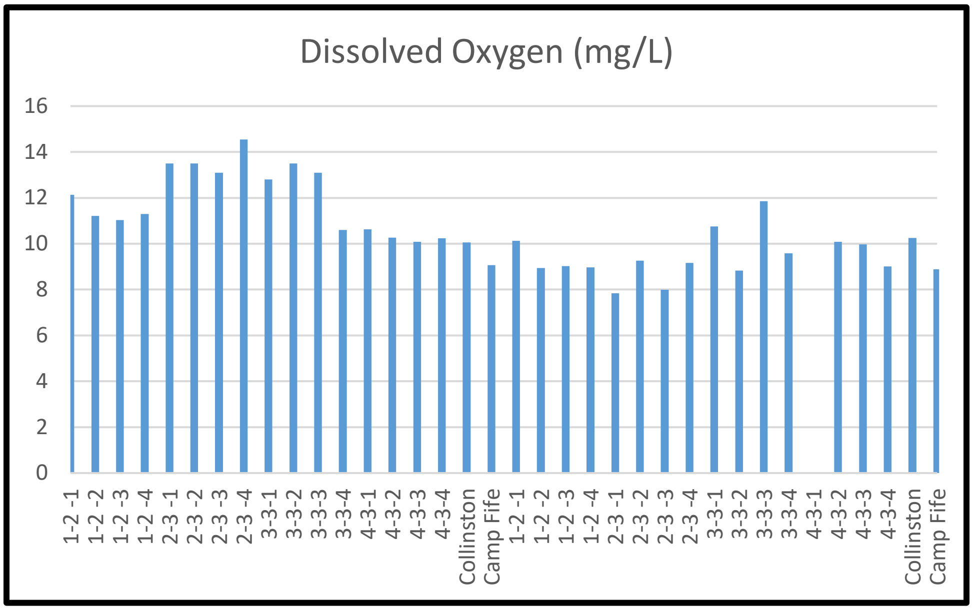
SITE TRANSECT	TEMPERATURE	DO	TSS	TP	DISSOLVED PHOSPHORUS	ORTHOPHOSPHATE
1-2	0.000	0.001	0.382	0.434	0.253	0.387
2-3	0.000	0.000	0.077	0.305	0.136	0.097
3-3	0.006	0.026	0.330	0.349	0.394	0.402
4-3	0.120	0.384	0.046	0.127	0.485	0.025

Note:
DO dissolved oxygen
DP dissolved phosphorous
TSS total suspended solid



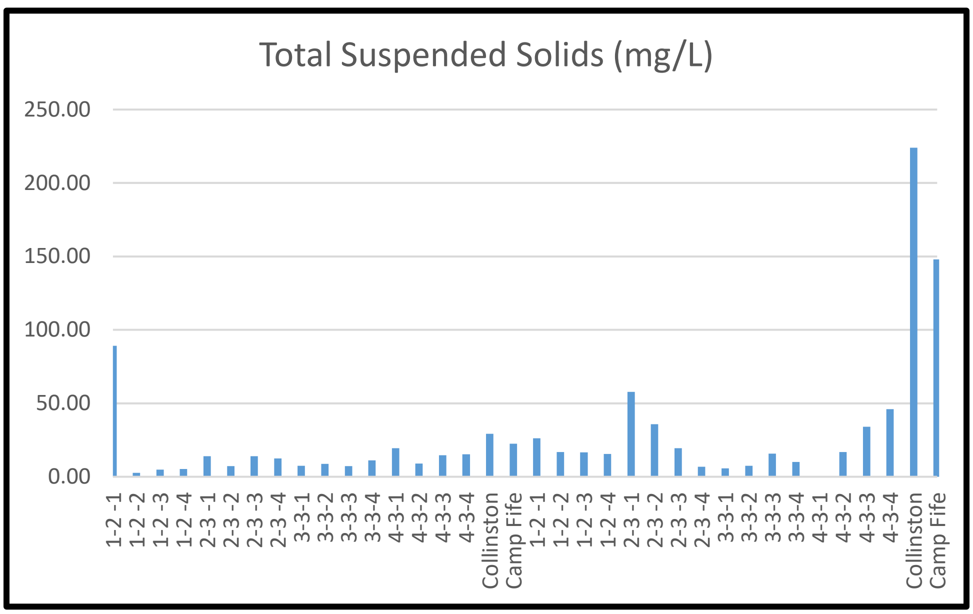
Note:
October 16-18, 2019, left half of graph- prior to drawdown
November 4–6, 2019, right half of graph-during drawdown

FIGURE 5-1 WATER TEMPERATURES COLLECTED AT CUTLER RESERVOIR SITES BEFORE AND DURING DRAWDOWN



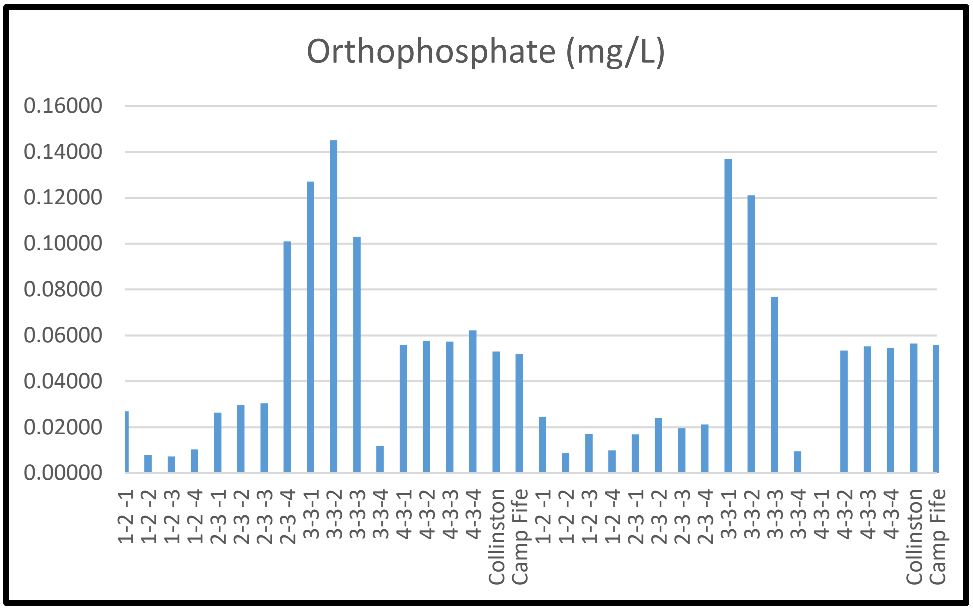
Note:
October 16-18, 2019, left half of graph- prior to drawdown
November 4–6, 2019, right half of graph-during drawdown

FIGURE 5-2 DISSOLVED OXYGEN COLLECTED AT CUTLER RESERVOIR SITES BEFORE AND DURING DRAWDOWN



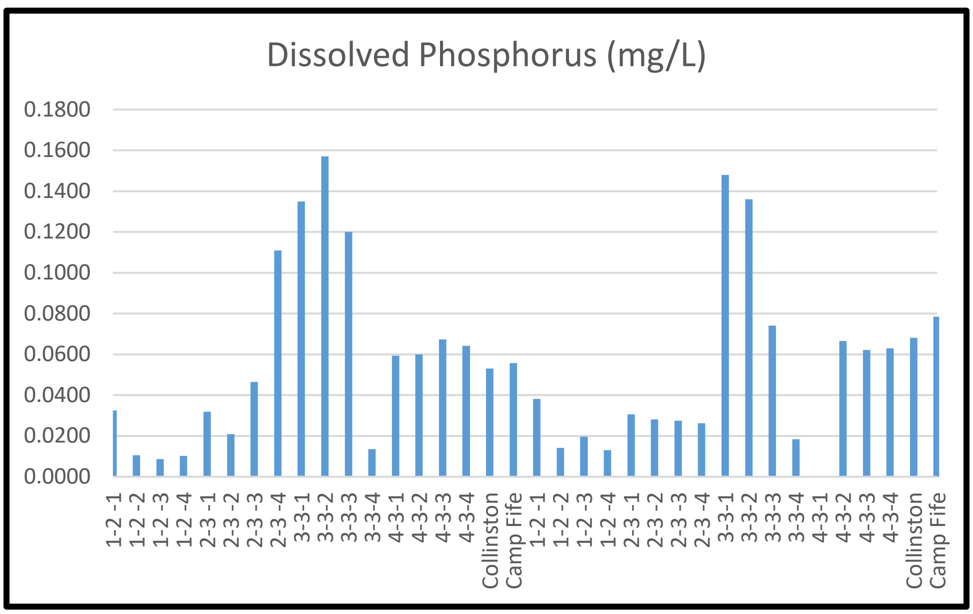
Note:
October 16-18, 2019, left half of graph- prior to drawdown
November 4–6, 2019, right half of graph-during drawdown

FIGURE 5-3 TOTAL SUSPENDED SOLIDS COLLECTED AT CUTLER RESERVOIR SITES BEFORE AND DURING DRAWDOWN



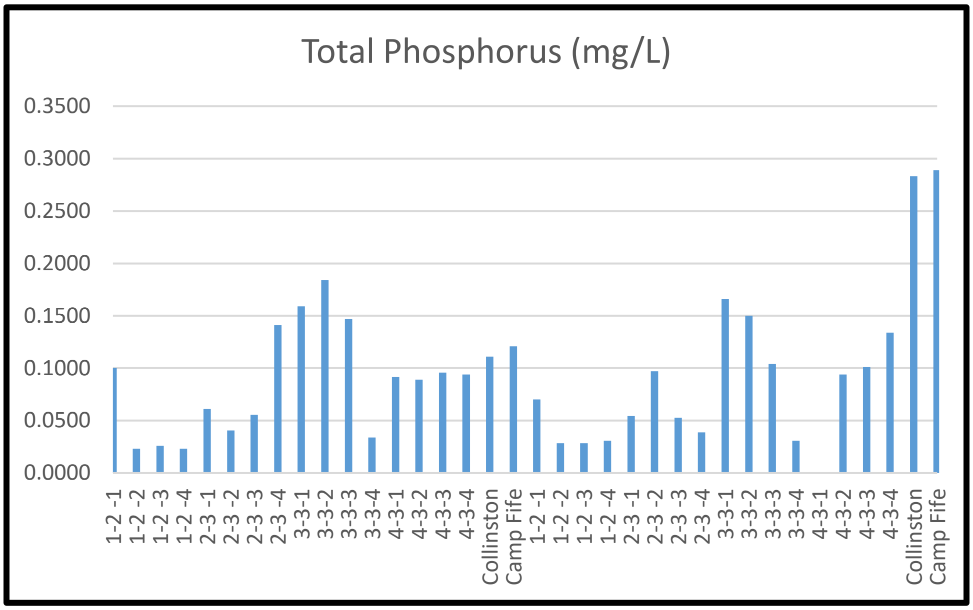
Note:
October 16-18, 2019, left half of graph- prior to drawdown
November 4–6, 2019, right half of graph-during drawdown

FIGURE 5-4 ORTHOPHOSPHATE RESULTS COLLECTED AT CUTLER RESERVOIR SITES BEFORE AND DURING DRAWDOWN



Note:
October 16-18, 2019, left half of graph- prior to drawdown
November 4–6, 2019, right half of graph-during drawdown

FIGURE 5-5 DISSOLVED PHOSPHORUS COLLECTED AT CUTLER RESERVOIR SITES BEFORE AND DURING DRAWDOWN



Note:
October 16-18, 2019, left half of graph- prior to drawdown
November 4–6, 2019, right half of graph-during drawdown

FIGURE 5-6 TOTAL PHOSPHORUS COLLECTED AT CUTLER RESERVOIR SITES BEFORE AND DURING DRAWDOWN

5.2 PHASE 1 – EXISTING WATER QUALITY DATA

Water quality information from past monitoring efforts by PacifiCorp, USU, UDWQ, and the city of Logan, as well as a DO and water quality study performed by ERI, were reviewed and the pertinent data organized in summary tables that are presented in this section. The data was used for direct comparisons with data collected by PacifiCorp over the past 23-plus years, and data from all the available sources, collected at the same (or closely adjacent) reservoir water quality sampling stations used for PacifiCorp's monitoring reports. These data were synthesized into a cohesive, comprehensive review of existing water quality information for Cutler Reservoir and its tributaries in Section 5.2.1.

5.2.1 PACIFICORP MONITORING

Following issuance of the current 1994 FERC license (FERC No. 2420), PacifiCorp initiated a water quality monitoring program as required by the license under the Cutler Resource Management Plan (Cutler RMP). The Cutler RMP outlines specific requirements for wildlife habitat improvements; agricultural lease modifications; buffer establishment for grazing and agricultural activities; bank stabilization; recreation site improvements; and other natural resource projects and monitoring, including water quality monitoring. Water quality monitoring initially was required quarterly and annually (1996–1998 and 2000–2003) but, subsequently, quarterly at 5-year intervals (PacifiCorp 2020, 2013, 2008, 2002). A water quality study, intended for inclusion in the 2023 Five-year Monitoring Report, was completed in 2018 and is currently available on PacifiCorp's website[1]. A final water quality monitoring data collection and report under the current license is planned for 2023.

Data during each sampling period were collected seasonally during initial efforts. To understand more about water quality in the reservoir, beginning in 2008, PacifiCorp added additional sampling to cover seasonal baseflow conditions, spring runoff, and storm conditions. An annual average was developed by combining data from all hydrologic conditions. For comparison with other entities' sampling efforts, this ISR uses PacifiCorp's annual averages (Table 5-4).

TABLE 5-4 AVERAGE WATER QUALITY OBSERVATIONS IN THE CUTLER RESERVOIR SYSTEM DURING HYDROPERIODS/ YEARS AS MEASURED BY PACIFICORP

HYDROPERIOD	1996–1998	2000–2003	2008	2013	2018	ANNUAL MAXIMUM	ANNUAL MINIMUM
Water Temperature (ºC)							
Logan River	7.5	7.7	9.5	8.9	8.8	9.5	7.5
Little Bear River	9.2	9.6	11.2	10.1	9.5	11.2	9.2
Spring Creek	9.5	9.8	8.4	10.1	11.0	11.0	8.4
Cutler Reservoir south of Swift Slough	–	–	14.1	12.2	10.5	14.1	10.5
Cutler Reservoir at Benson Marina	11.7	11.4	13.6	12.3	11.7	13.6	11.4
Bear River at Summit Creek	9.9	9.8	12.2	11.5	10.6	12.2	9.8
Cutler Reservoir at Highway 23	–	–	16.0	12.0	11.1	16.0	11.1
Bear River below Cutler Dam	10.4	11.3	13.9	12.7	10.4	13.9	10.4
pH Level							
Logan River	8.0	8.1	8.5	8.3	8.2	8.5	8.0
Little Bear River	8.0	8.0	8.5	8.2	8.3	8.5	8.0
Spring Creek	7.9	7.9	8.4	8.2	8.2	8.4	7.9
Cutler Reservoir south of Swift Slough	–	–	8.9	8.3	8.4	8.9	8.3
Cutler Reservoir at Benson Marina	8.3	8.2	8.8	8.5	8.6	8.8	8.2
Bear River at Summit Creek	8.1	8.0	8.7	8.5	8.6	8.7	8.0
Cutler Reservoir at Highway 23	–	–	8.9	8.6	8.6	8.9	8.6
Bear River below Cutler Dam	8.1	8.0	8.6	8.5	8.6	8.6	8.0

[1] https://www.pacificorp.com/energy/hydro/cutler.html

HYDROPERIOD	1996–1998	2000–2003	2008	2013	2018	ANNUAL MAXIMUM	ANNUAL MINIMUM
Total Coliform Concentration (organisms/100 mL) No Standard							
Logan River	281	407	245	1,586	>2,419.6*	>2,419.6	281
Little Bear River	860	448	325	1,926	>2,419.6	>2,419.6	325
Spring Creek	2,537	1,278	205	>2,419.6	>2,419.6	>2,419.6	205
Cutler Reservoir south of Swift Slough	–	–	410	1,356	>2,419.6	>2,419.6	410
Cutler Reservoir at Benson Marina	1,702	115	84	1,275	>2,419.6	>2,419.6	84
Bear River at Summit Creek	499	208	220	1,476	>2,419.6	>2,419.6	208
Cutler Reservoir at Highway 23	–	–	103	1,723	>2,419.6	>2,419.6	103
Bear River below Cutler Dam	237	246	167	2,211	>2,419.6	>2,419.6	167
*2,419.6 is a detection limit							
Nitrate as N (mg/L) UDWQ Standard 4 mg/L							
Logan River	0.345	0.248	0.288	0.584	0.300	0.584	0.248
Little Bear River	1.278	0.715	0.493	0.881	0.868	1.278	0.493
Spring Creek	5.089	4.786	4.800	1.840	2.448	5.089	1.840
Cutler Reservoir south of Swift Slough	–	–	0.050	0.696	0.608	0.696	0.050
Cutler Reservoir at Benson Marina	0.722	0.497	0.677	0.414	0.405	0.722	0.405
Bear River at Summit Creek	0.814	0.642	0.585	0.436	0.701	0.814	0.436
Cutler Reservoir at Highway 23	–	–	0.088	0.328	0.769	0.769	0.088
Bear River below Cutler Dam	0.829	0.562	0.592	0.360	0.547	0.829	0.360
TKN as N (mg/L) No Standard							
Logan River	–	–	–	0.250	0.333	0.333	0.250
Little Bear River	–	–	–	0.618	0.455	0.618	0.455
Spring Creek	–	–	–	0.428	0.671	0.671	0.428
Cutler Reservoir south of Swift Slough	–	–	–	0.575	0.712	0.712	0.575
Cutler Reservoir at Benson Marina	–	–	–	0.882	0.870	0.882	0.870
Bear River at Summit Creek	–	–	–	0.452	0.431	0.452	0.431
Cutler Reservoir at Highway 23	–	–	–	0.625	0.619	0.625	0.619
Bear River below Cutler Dam	–	–	–	0.775	0.699	0.775	0.699
TP Concentration (mg/L) For Cutler standard is 0.07 mg/L for the No. reservoir and 0.009 mg/L for the So. reservoir							
Logan River	0.0217	0.0129	0.0483	0.0250	0.0250	0.0483	0.0129
Little Bear River	0.0893	0.0891	0.0833	0.0250	0.1150	0.1150	0.0250
Spring Creek	–	–	–	0.0250	0.1642	0.1642	0.0250
Cutler Reservoir south of Swift Slough	–	–	0.0900	0.0250	0.0988	0.0988	0.0250

HYDROPERIOD	1996–1998	2000–2003	2008	2013	2018	ANNUAL MAXIMUM	ANNUAL MINIMUM
Cutler Reservoir at Benson Marina	0.1734	0.1832	0.1615	0.0477	0.1820	0.1832	0.0477
Bear River at Summit Creek	0.1163	0.0765	0.0533	0.0250	0.0383	0.1163	0.0250
Cutler Reservoir at Highway 23	–	–	0.1497	0.0250	0.0951	0.1497	0.0250
Bear River below Cutler Dam	0.1308	0.1134	0.1167	0.0250	0.1130	0.1308	0.0250
DO Concentration (mg/L) UDWQ Standard NLT 5.5 mg/L							
Logan River	9.5	10.9	9.8	8.3	8.1	10.9	8.1
Little Bear River	8.6	9.8	9.2	8.4	7.7	9.8	7.7
Spring Creek	8.4	9.2	8.9	8.2	7.2	9.2	7.2
Cutler Reservoir south of Swift Slough	–	–	13.1	7.7	9.0	13.1	7.7
Cutler Reservoir at Benson Marina	9.4	10.4	8.7	8.5	8.6	10.4	8.5
Bear River at Summit Creek	8.9	9.8	8.8	8.4	8.5	9.8	8.4
Cutler Reservoir at Highway 23	–	–	9.9	8.7	9.3	9.9	8.7
Bear River below Cutler Dam	8.9	9.8	10.5	9.4	9.9	10.5	8.9
Turbidity (NTU/FNU) UDWQ Standard 10 NTU increase over ambient							
Logan River				10.28	8.45	10.28	8.45
Little Bear River				25.64	28.825	28.825	25.64
Spring Creek				36.44	40.818	40.818	36.44
Cutler Reservoir south of Swift Slough				33.00	32.60	33.00	32.60
Cutler Reservoir at Benson Marina				38.85	37.30	38.85	37.30
Bear River at Summit Creek				135.175	31.275	135.175	31.275
Cutler Reservoir at Highway 23				43.72	33.20	43.72	33.20
Bear River below Cutler Dam				45.675	32.925	45.675	32.925
TSS Concentration (mg/L) No Standard							
Logan River				5.10	8.445	8.445	5.10
Little Bear River				19.96	28.825	28.825	19.96
Spring Creek				26.64	40.818	40.818	26.64
Cutler Reservoir south of Swift Slough				99.25	32.6	99.25	32.6
Cutler Reservoir at Benson Marina				22.875	37.3	37.3	22.875
Bear River at Summit Creek				17.10	31.275	31.275	17.10
Cutler Reservoir at Highway 23				30.32	33.20	33.20	30.32
Bear River below Cutler Dam				30.8	32.925	32.925	30.8

Source: PacifiCorp 2008-2018

Note: ºC = degrees Celsius; mL = milliliter; N = nitrogen; TKN = total Kjeldahl nitrogen; NTU = nephelometric turbidity unit; FNU = formazin nephelometric unit; NLT=not less than

5.2.1.1 WATER TEMPERATURE

Average annual temperatures in the Cutler Reservoir system during the five hydroperiods were highest in 2008 and 2013 (following local, regional, and global trends) and lowest during the 1996–1998 period (Table 5-5). Highest temperatures occurred at Highway 23 (16.0 degrees Celsius [°C]), Swift Slough (14.1°C), Benson Marina (13.6°C), and Bear River below Cutler Dam (13.9°C) (PacifiCorp 2020, 2013, 2008, 2002).

5.2.1.2 pH

As presented in Table 5-4, 39 percent of the samples exceeded a pH of 8.4, with a maximum value of 8.9 at both Swift Slough and Highway 23 sites. Generally, pH levels in the reservoir system were found to be alkaline (greater than 7.0) in nature (PacifiCorp 2020, 2013, 2008, 2002).

5.2.1.3 TOTAL COLIFORM

Average total coliform concentrations during baseflow conditions varied through time but were generally higher in 2018 than in previous years (Table 5-5). Average total coliform concentrations across sites were greater than the detection limit of 2,419.6 organisms/100 milliliters (mL). The next highest levels occurred in 2013. Of the 53 total coliform samples collected across sites in 2018, all had concentrations exceeding the upper detection limit of 2,400 organisms/100 mL (PacifiCorp 2020). The cause of the overall increase in total coliform concentrations observed in 2018 is unclear, but may be related to the ongoing discharge of Logan and Cache Valley wastewater to Cutler Reservoir; a new wastewater tertiary treatment system is scheduled to come online that is intended to ameliorate some of the nutrient and coliform input issues that the reservoir currently experiences.

5.2.1.4 NUTRIENTS

TP data collected in 2018 show an overall increase across all sites from data collected in 2013 (Table 5-5). TP concentration increased between 2013 and 2018, ranging from a 93 percent increase at Cutler Reservoir south of Swift Slough to a 51 percent increase at Bear River at Summit Creek (PacifiCorp 2020). It is important to note that 92 percent of the 2013 TP results were below the detection limit of 0.05 mg/L, which is a deviation from the overall trend in TP concentrations from previous monitoring efforts by PacifiCorp. This anomalous data was noted in the 2013 and 2018 reports, but no explanation for it has been identified (Refer to 2013 and 2018 Water Quality Reports, 2018 Cutler 5-year Report, and as a 2018 stand-alone report for additional detail [PacifiCorp 2020; 2018]). However, comparing 2018 data with the hydroperiods other than 2013, the levels are not substantially different, although for some years, the TP levels are greater than those for 2018.

Nitrate-nitrogen concentrations varied from one site to another in 2018 but generally remained about the same as, or were slightly higher than, the concentrations in 2013 (Table 5-5). Total nitrogen in the Cutler Reservoir system during baseflow conditions was higher in 2013 than in 2018 at the southern (upstream) monitoring sites and lower in 2013 from Cutler Reservoir at Benson Marina to the Bear River downstream of the dam. Note that total nitrogen was not collected before 2008.

5.2.1.5 DISSOLVED OXYGEN

DO measurements were taken during all water quality sampling events, except during summer baseflow and the fall storm in 2008 due to equipment failure and during the fall storm in 2013 at the Cutler Reservoir south of Swift Slough site due to inaccessibility. Additionally, the data suggest equipment failure during the 2013 summer baseflow sampling event and the 2018 winter baseflow; thus, these values were not used to calculate summary statistics. DO values were generally high downstream of Cutler Dam and throughout the Cutler Reservoir system at all sampling times, but highest during fall baseflow. The lowest values recorded were at Spring Creek and Little Bear River during 2018, at Cutler Reservoir at Benson Marina in 2008, and at Cutler Reservoir south of Swift Slough in 2013. However, these minimum values are considered protective of fisheries.

5.2.1.6 TURBIDITY AND TOTAL SUSPENDED SOLIDS

Turbidity is often reported in nephelometric turbidity units (NTUs) or formazin nephelometric units (FNUs), which represent the degree to which light is scattered in water. Before 2013, the field meters used to measure turbidity recorded values as NTUs. Turbidity units were changed to FNUs in 2013 and 2018 with the use of a new meter.

Turbidity at monitoring sites was measured during all hydroperiods in 2013 and in 2018. The data show that, in general, average conditions showed the highest turbidity at the Cutler Reservoir sites compared with tributary sites. However, the highest value occurred during the 2018 runoff at Bear River at Summit Creek, with a turbidity value of 135.75 NTUs. This high reading was most likely because of erosion occurring in Summit Creek during runoff.

TSS samples were collected during all hydroperiods in 2013 and in 2018. In general, TSS concentrations follow a similar seasonal trend as turbidity, with the highest values collected during runoff or storm conditions. These results suggest that storms have the potential to increase TSS more than turbidity in this system, which can result in higher nutrient inputs. Turbidity and TSS were closely correlated at most sites, as would be expected.

5.2.2 UTAH STATE UNIVERSITY STUDIES

USU gathered Cutler Reservoir and the surrounding area water quality information for years. The data are presented in annual class field exercise reports, master's theses or PhD dissertations, USU Press publications, and peer-reviewed articles for various professional journals.

Budy et al. (2007) characterized Cutler Reservoir in 2006 as well mixed, with stratification rarely occurring. The authors surmised that the shallow depths and wind-driven current restricted the formation of strata in the reservoir, and because of this, DO concentrations were not limiting and water temperatures were generally tolerable for the reservoir sport fishes. Nutrient concentrations and resultant phytoplankton biomass were deemed to be on the high side and at similar levels throughout the reservoir, except in the reservoir units influenced by the southern tributaries (the South Marsh and North Marsh units). The southern tributaries exhibited very high nitrate-nitrite levels and very low chlorophyll *a*. Budy et al. (2007) found that E. coli (*Escherichia coli*) concentrations were highest in the Bear River just upstream of Cutler Reservoir; two to three times greater than other sampling sites. Using their results, Budy et al. (2007) classified Cutler Reservoir as eutrophic due to chlorophyll *a* concentration, mesotrophic due to nitrogen concentration and that the system is phosphorus limiting for phytoplankton growth, with a high nitrogen/phosphorus ratio of 500 to 1.

The main sources of nutrient inputs upstream of Cutler Reservoir are irrigation returns, animal feeding operations (AFO) and concentrated animal feeding operations (CAFO) (SWCA 2010: Budy et al 2007). More than 389 AFOs/CAFOs, representing 37,000 cattle (SWCA 2010), exist along the Bear River upstream of Cutler Reservoir. The mainstem Bear River courses through a broad floodplain dotted with pasturelands, grazing, and dairy operations, with over 50 percent of the total landscape categorized as agricultural use and two-thirds of that land irrigated (Budy et al. 2007). Logan City's wastewater treatment lagoons discharge into Swift Slough and contribute over 89 percent of the TP load in the Swift Slough (SWCA 2010). The cities of Logan, Smithfield, Hyde Park, North Logan, Providence, and River Heights convey their sewage to the Logan facility. In addition, all septic system waste is hauled to the Logan facility. These cities make up over 70 percent of the population in the valley (Budy et al. 2007). Spring Creek, Little Bear River, and Logan River are sources of high levels of nutrient inputs. Spring Creek has high E. coli levels, excess nitrogen and phosphorus, high water temperatures, and low DO. Little Bear River and Spring Creek both have undergone TMDL determinations, but the impact of water quality improvements has not been evaluated.

Budy et al. (2007) reported that, in 2006, water temperatures in the late summer ranged from 21.5°C at the surface in their site in Swift Slough to 17°C at the bottom (2.0 meters) at the southern tributaries site. They stated that DO readings were suitable for fish for all sites and all depths ranging from 21.5 mg/L in the southern tributaries to 7.2 mg/L at their sampling site near the Highway 23 bridge.

Budy et al. (2007) found the lowest counts of E. coli at the Highway 23 site and the highest counts per 100 mL at Clay Slough, Swift Slough, the southern tributaries, and Bear River upstream of the reservoir.

Budy et al.'s 2011 bioenergetics study is a culmination of several years of investigations attempting to link fish performance to thermal habitat stability. Reference was made to the 2010

UDWQ TMDL study (SWCA 2010), which had the overall goal to restore and maintain water quality to a level that protects and supports the designated beneficial uses for Cutler Reservoir.

Budy et al. (2011) analyzed water temperature, specific conductance, total dissolved solids (TDS), pH, salinity, turbidity, DO, secchi depth, TKN (NO_3-NO_2 and ammonium [NH_4]), TP, soluble reactive phosphorus (SRP), dissolved phosphorus, and chlorophyll *a*.

Water quality sampling was collected seasonally (Table 5-5). DO conditions did not appear to be limiting fish (DO > 4 mg/L). On July 30, 2006, thermal imaging revealed that reservoir-wide temperatures ranged from 18°C to 34°C. The reference fish species used for their performance analysis were Channel Catfish (*Ictalurus punctatus*), Black Crappie (*Pomoxis nigromaculatus*), and Walleye (*Sander vitreus*). Channel Catfish growth potential peaked at 29°C, Black Crappie growth potential peaked at 22°C, and Walleye peaked at17°C to 20°C.

The southern tributaries (Little Bear River and Logan River) were found to provide cooler water to the reservoir in the summer. However, thermal imaging performed in July 2006 revealed that the southern reservoir (equivalent to PacifiCorp's Unit 1; also, the shallowest area of the reservoir) was the warmest segment of Cutler Reservoir.

TABLE 5-5 CUTLER RESERVOIR SEASONAL WATER QUALITY VALUES

	PacifiCorp Equivalent	Conductivity (µS/cm)	NO_3-NO_2 (ppb)	TP (ppb)	Chlorophyll a (µg/L)	Water Temp (°C)	WRT (days)	Minimum DO (mg/L)
Spring Season								
Segment 1	Unit 4	323.0	174.0	148.0	14.96	18.03	1.73	7.69
Segment 2	Unit 4	331.8	194.0	150.0	11.19	17.57	1.56	6.26
Segment 3	Unit 3	284.7	124.0	213.0	9.033	17.53	1.20	7.14
Segment 4	Unit 2	243.0	81.0	71.0	2.121	15.06	2.17	7.55
Segment 5	Unit 1	248.6	229.0	95.0	3.156	13.13	0.15	7.58
Mean		286.2	160.4	135.4	8.091	16.26	1.36	7.24
Standard deviation		41.0	58.4	55.2	5.422	2.10	0.76	0.59
Summer Season								
Segment 1	Unit 4	586.7	4.0	223.0	53.83	25.59	41.01	6.80

	PACIFICORP EQUIVALENT	CONDUCTIVITY (µS/CM)	NO_3-NO_2 (PPB)	TP (PPB)	CHLOROPHYLL A (µG/L)	WATER TEMP (°C)	WRT (DAYS)	MINIMUM DO (MG/L)
Segment 2	Unit 4	592.7	2.0	227.0	61.67	26.53	36.98	4.55
Segment 3	Unit 3	539.5	2.0	246.0	48.88	26.37	28.53	4.90
Segment 4	Unit 2	417.7	38.0	215.0	64.83	24.39	51.49	4.58
Segment 5	Unit 1	500.2	1,881.0	228.0	17.2	20.62	3.55	6.10
Mean		527.4	385.4	227.8	49.28	24.70	32.31	5.39
Standard deviation		71.9	836.2	11.4	19.01	2.43	18.07	1.01
Fall Season								
Segment 1	Unit 4	547.3	675.0	175.5	23.02	11.17	4.20	7.20
Segment 2	Unit 4	570.7	727.0	147.0	18.81	10.60	3.79	9.90
Segment 3	Unit 3	494.2	704.0	235.0	20.04	11.03	2.92	12.12
Segment 4	Unit 2	314.0	165.0	56.5	3.177	9.79	5.28	12.21
Segment 5	Unit 1	428.0	2,093.0	162.0	4.733	9.10	0.36	8.49
Mean		470.8	872.8	155.2	13.96	10.34	3.31	9.98
Standard deviation		103.4	720.9	64.5	9.275	0.88	1.85	2.21

Source: Budy et al. 2011
Note: µS/cm = microsiemens per centimeter; ppb = parts per billion; µg/L = micrograms per liter; WRT = water residence time

Nitrate-nitrite levels ranged from 194 to 2,093 parts per billion (ppb), with the two highest readings occurring in Segment 5 (equivalent to PacifiCorp's Unit 1, Figure 5-1) in the summer and fall. Total phosphorus (TP) levels across the three seasons observed by Budy et al. (2011) were highest in Segment 3 (equivalent to PacifiCorp's Unit 3), ranging from 213 to 246 ppb. Finally, minimum DO levels were recorded in Segments 1 and 2 (equivalent to PacifiCorp's Unit 4) and ranged from 4.55 to 7.20 mg/L (Budy et al. 2011).

USU undergraduate science classes have used Cutler Reservoir to learn field data collection techniques and how to interpret results. The many papers developed and vetted by USU faculty and graduate students have consistently stated that the results and conclusions of the students' work must be reviewed cautiously because the fieldwork was conducted on a single day and most of the analytical methods were new to the students. Regardless, *in situ* measurements recorded by reliable instruments and qualified lab analysis provide raw data that are useful, and this technical report incorporates the actual data as a snapshot of water quality conditions in Cutler Reservoir. This information helps to evaluate water quality in the reservoir and any changes or static conditions.

In 2007, a USU water quality class collected water quality samples to compare the Logan River inflow with the city of Logan Wastewater Treatment Plant (WWTP) (Table 5-6) (Wurtsbaugh and Lockwood 2007).

TABLE 5-6 SUMMARY OF DATA COLLECTED BY UTAH STATE UNIVERSITY WATERSHED AND AQUATIC CLASSES IN 2007 THROUGH 2009

YEAR/LOCATION	TOTAL PHOSPHORUS (MG/L)	CHLOROPHYLL *A* (MG/L)	TOTAL NITROGEN (MG/L)	TEMPERATURE (°C)	DO (MG/L)
2007 (Logan River)	0.001	NA	NA	12.0–16.0	8.0–15.0
2007 (WWTP)	0.536	0.024	NA	8.0–16.0	< 1.0–11.0
2008 (near WWTP)	0.82	0.0022	1.27	NA	Minimum of 3.3
2009 Sites 1, 2, 3, 4 (Benson Marina)	0.149 (Site 1) 0.347 (Site 3B)	0.0192 (Site 4) 0.0656 (Site 2)	0.732 (Site 3) 0.966 (Site 1)	15.6 (Site 1) 17.1 (Site 3B)	7.6 (Site 3) 10.2 (Site 1B)
2009 Sites 5, 6, 7, 9 (Swift Slough)	0.065 (Site 7) 0.85 (Site 6)	0.0033 (Site 9) 0.105 (Site 6)	1.325 (Site 5) 1.757 (Site 6)	13.0 (Site 6A) 14.8 (Site 7)	5.9 (Site 6) 11.9 (Site 7)
2009 Site 8 (Valley View)	0.137	0.005	2.219	13.5	10.5
2009 Site 10 (Bear River inflow)	0.094	0.0229	NA	16.4	8.7
2009 Sites 11, 12, 13, 14 (Clay Slough)	0.043 (Site14) 0.159 (Site 11)	0.0389 (Site 14) 0.0457 (Site 11)	0.753 (Site 11) 0.843 (Site 14)	16.8 (Site 11) 17.5 (Site 12)	8.8 (Site 13) 9.5 (Sites 11 and 12)
2009 Cache Junction (Highway 23)	0.181	0.0406	0.698	16.1	7.4

Note: NA = not available
C Centigrade
mg/L milligrams per liter
WWTP Wastewater treatment plant

The goal of an USU aquatic ecology class was to compare Cutler Reservoir near the Logan WWTP to Dingle Marsh at Bear Lake in September 2008 (Abbott et al. 2009). While the comparative studies were interesting, only their WWTP data were useful for this report (Table 5-6).

A notable USU aquatic practicum report was published in 2009 (Mears and Wurtsbaugh 2009). For this report, sampling was expanded and much more thorough within the Cutler Reservoir with comparisons to Dingle Marsh (Table 5-6). Again, while data from Dingle Marsh is interesting, the information was not included in this report.

5.2.3 UTAH DEPARTMENT OF WATER QUALITY DATA AND TMDL STUDY FINDINGS

UDWQ has been collecting water quality data on the Middle Bear River and Cutler Reservoir for over 20 years on a rotational basis. Reports are available for previous monitoring efforts. The most current monitoring effort is scheduled for 2020 and is not included in this report. In addition, UDWQ conducted a TMDL study for the Middle Bear River (including Cutler Reservoir) in 2010 (SWCA 2010).

Of all the studies and monitoring that has occurred on the Bear River and Cutler Reservoir, perhaps the most important and relevant water quality management action is UDWQ's TMDL study (SWCA 2010). That study identified excessive TP and low DO as pollutants of concern and developed target levels for the TMDL study area. The following impaired beneficial uses were identified:

- Class 3B: Protected for warmwater species of game fish and other aquatic life, including the necessary aquatic organisms in their food chain
- Class 3D: Protected for waterfowl, shorebirds, and other water-oriented wildlife not included in Class 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain

The TMDL study identified a myriad of point and nonpoint watershed sources in the Middle Bear River:

- Canal discharge and return flow from lands irrigated with municipal WWTP effluent

- Stormwater runoff
- On-site wastewater treatment systems (septic systems)
- AFOs and CAFOs
- Runoff from agricultural and pasturelands
- Cattle in streams, riparian areas, and reservoir shoreline
- Runoff from forested lands
- Runoff from rangelands
- Seasonal internal reservoir sources
- Pipes discharging into Cutler Reservoir and tributaries
- Stream erosion and reservoir shoreline erosion
- Natural background sources

In addition, two new regulated point sources were identified as the Logan Regional WWTP and the Fisheries Experiment Station. The TMDL study listed all the TMDLs existing in 2010 within the Bear River watershed, including Spring Creek TMDL, Cub River TMDL, Little Bear TMDL, Little Bear River/Hyrum Reservoir TMDL, and the Idaho Bear River TMDL. These TMDLs encompass 19 regulated point sources that are primarily industrial, agricultural, and municipal sources.

Data from the 2010 TMDL study are summarized in Table 5-7.

TABLE 5-7 UDWQ SUMMARY OF WATER QUALITY OBSERVATIONS IN THE CUTLER RESERVOIR SYSTEM, 1995 AND 2006

	11-YEAR AVERAGE	11-YEAR MAXIMUM	11-YEAR MINIMUM
TP (mg/L)			
Bear River Inflow	0.09	0.30	0.01
Northern Reservoir	0.13	0.48	0.03
Northern Inflow	0.40	1.55	0.03
Southern Reservoir	0.33	1.49	0.04
Southern Inflow	0.25	1.98	Non-detect
Chlorophyll 'a'(µg//L)			
Bear River Inflow	18.9	33.0	5.6
Northern Reservoir	21.9	61.7	1.2
Northern Inflow	43.0	43.0	43.0
Southern Reservoir	24.5	48.9	3.1

	11-YEAR AVERAGE	11-YEAR MAXIMUM	11-YEAR MINIMUM
Southern Inflow	10.9	64.8	1.0
Nitrate + Nitrite (mg/L)			
Bear River Inflow	0.62	1.63	0.05
Northern Reservoir	0.41	1.80	0.0
Northern Inflow	0.04	0.06	0.0
Southern Reservoir	0.26	1.23	0.0
Southern Inflow	1.15	5.35	0.02
TSS (mg/L)			
Bear River Inflow	44.1	220.0	4.0
Northern Reservoir	36.7	180.0	4.0
Northern Inflow	60.1	320.0	4.0
Southern Reservoir	31.4	143.0	2.0
Southern Inflow	25.8	163.0	0.5

Source: SWCA 2010

5.2.3.1 TOTAL PHOSPHORUS

The threshold value for TP is listed by UDWQ as 0.07 mg/L for the northern reservoir and 0.09 mg/L for the southern reservoir (SWCA 2010). Greater than half of the TP levels in the Middle Bear River exceeded the threshold value (SWCA 2010). TP levels were greater than 1.5 mg/L in the Little Bear River and Spring Creek, in part due to the upstream meat-processing operations and resultant effects. In the northern part of Cutler Reservoir, the highest summer concentrations, at 0.66 mg/L, occurred in Clay Slough, in part due to the cheese-making plant and other agricultural effects from upstream operations.

5.2.3.2 CHLOROPHYLL *A*

In the Cutler Reservoir TMDL Report (SWCA 2010), the summary data averages do not reflect the more extreme chlorophyll *a* levels recorded at Clay Slough in August and September 2004: 1,262 micrograms per liter (µg/L) and 554 µg/L, respectively.

5.2.3.3 NITRATE-NITRITE

Nitrate-nitrite concentrations were highest in the southern tributary inflow for the 11-year period (SWCA 2010). Southern tributary inflow included Swift Slough, Spring Creek, Little Bear River, and Logan River. The maximum recorded level, at 1,160 mg/L, occurred in the southern tributaries on September 2, 2005 (Table 5-8).

5.2.3.4 TOTAL SUSPENDED SOLIDS

TSS levels were highest in the Northern tributary inflow, which includes Clay Slough and Bear River inflows. The maximum level of TSS, at 2,780 mg/L, was recorded on the Bear River downstream of Cutler Dam on November 16, 1993 (Table 5-8).

TABLE 5-8 WATER QUALITY OBSERVATIONS IN THE CUTLER RESERVOIR SYSTEM, 1983 TO 2006 AND INCLUDED IN UTAH DEPARTMENT OF WATER QUALITY'S DATABASE.

	23-YEAR MINIMUM	23-YEAR MAXIMUM	LOCATION/DATE*	23-YEAR AVERAGE
Phosphorus as P (mg/L)	0.0	257.0	Benson Bridge 9/2/2005	1.67
Orthophosphate (mg/L)	0.0	2.10	Logan Lagoons 9/8/2004	0.12
P-soluble (mg/L)	0.0	0.15	Southern tributaries 10/3/2006	0.05
Nitrogen as ammonia (mg/L)	0.0	192.70	Logan Lagoons 9/5/1984	3.18
TKN (mg/L)	0.0	1,173.0	Clay Slough 9/2/2005	11.63
Nitrogen-nitrate (mg/L)	0.01	126.8	Bear River, west of Fairview 6/12/1990	1.27
Nitrite-nitrate (mg/L)	0.0	1,160	Southern tributaries 9/2/2005	9.18
Nitrite as NO_2 (mg/L)	0.0	0.97	Spring Creek 12/17/03	0.03
Total inorganic nitrogen (mg/L)	0.03	10.79	Spring Creek 12/13/2000	1.59
Chlorophyll *a* (µg/L)	0.0	1,262	Clay Slough 8/4/2004	33.6

	23-YEAR MINIMUM	23-YEAR MAXIMUM	LOCATION/DATE*	23-YEAR AVERAGE
Total coliform (organism/100 mL)	0.0	99,999,000	Clay Slough 7/11/2000	124154.08
Fecal coliform (organisms/100 mL)	0	88,888,000	E.A. Miller effluent 4/11/2000	56,008.47
DO (mg/L)	0.0	22.3	**Low** at Richmond Lagoons 4/30/1985	8.7
pH	4.1	10.8	Low-Bear River, west of Richmond 11/27/1984 High-Hyrum WWTP 1/12/1989	8.12
Temperature (°C)	-0.24	31.93	E.A. Miller effluent 8/15/2002	12.78
Conductivity (µmhos/cm)	0.17	7790	Clay Slough 1/14/2004	923.18
Total dissolved solids (mg/L)	0.2	4,672	Clay Slough 11/14/2004	578.64
TSS (mg/L)	0.0	2,780	Bear River below dam 11/16/1993	50.21
Turbidity (NTU)	0.1	630.0	E.A. Miller effluent 1/28/1999	29.10

Note: Locations are shown for the maximum value recorded, except where noted. µmhos/cm = micromhos per centimeter.
*Location/Date applies to the maximum values unless specified.

PacifiCorp obtained water quality data from UDWQ's Ambient Water Quality Monitoring System (AWQMS) that has been collected by the state since the 2010 TMDL. This data is summarized in Table 5-9.

TABLE 5-9 WATER QUALITY OBSERVATIONS IN THE CUTLER RESERVOIR SYSTEM, FROM 2009 TO 2019

	10-YEAR MINIMUM	10-YEAR MAXIMUM	LOCATION/DATE*	10-YEAR AVERAGE	STANDARD DEVIATION
Phosphorus as total P (mg/L)	0.02	0.47	Benson Bridge 10/21/2015	0.11	0.06
Temperature (°C)	0.00	27.20	Benson Bridge 8/29/2018	25.11	5.68
TSS (mg/L)	1.0	219.0	Bear River Access 8/13/2015	39.6	0.06
pH	6.60	9.20	Bear River Access 10/29/2014	8.31	0.29

	10-YEAR MINIMUM	10-YEAR MAXIMUM	LOCATION/DATE*	10-YEAR AVERAGE	STANDARD DEVIATION
Total coliform (organism/100 mL)	270.9	2,419.57	Benson Bridge 7/18/2019	875.7	450.5
Nitrogen (mg/L)	0.271	1.62	Benson Bridge 4/15/2015	0.63	0.33
DO (mg/L)	4.5	13.1	Benson Bridge 8/12/2014	8.98	1.55
Turbidity (NTU)	6.2	68.5	Benson Bridge 9/26/2019	23.3	20.46

Note: Locations are shown for the maximum value recorded, except where noted.
* Location/Date applies to the maximum values unless specified.

5.2.4 LOGAN WASTEWATER EFFLUENT

The city of Logan published a draft wastewater treatment master plan in 2015. The plan presents historical effluent water quality data from 2007 through 2012 for ammonia, biological oxygen demand (BOD), TSS, and TP.

The UDWQ listed Cutler Reservoir as an impaired water body because of low DO and TP loading. Subsequent to approval of the TMDL by the U.S. Environmental Protection Agency (USEPA) in February 2010, UDWQ allocated TMDL requirements to individual point sources, which resulted in limitations for TP from the Logan WWTP effluent and a requirement to upgrade the treatment facilities to include secondary treatment before discharging. The current facility, a series of wetland lagoons constructed in opposition to UDWQ recommendations *circa* 2000 (Pers. Com. Mike Allred [UDEQ] to Eve Davies [PacifiCorp]), is not capable of meeting new discharge requirements for phosphorus. Subsequently, a requirement to meet chronic ammonia levels, DO, and BOD was added to the National Pollutant Discharge Elimination System (NPDES) permit (Table 5-10).

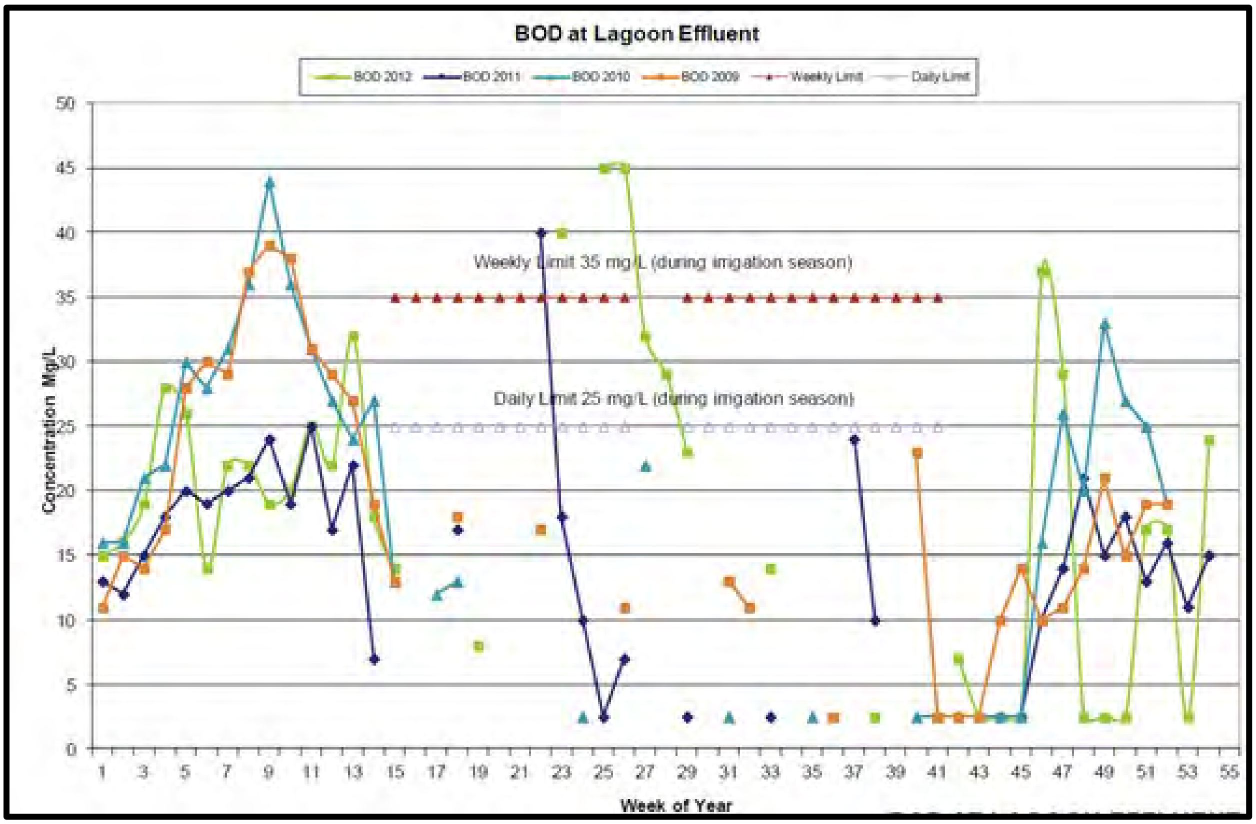
TABLE 5-10 WATER QUALITY EFFLUENT LIMITS OF LOGAN WASTEWATER TREATMENT PLANT

EFFLUENT CONSTITUENT	ACUTE			CHRONIC		
	STANDARD	LIMIT	AVERAGING PERIOD	STANDARD	LIMIT	AVERAGING PERIOD
Ammonia (mg/L)						
Winter	Varies with Temperature	6.0	1 Hour	Varies with temperature and pH	1.3	30 days
Spring		7.0			2.6	
Summer		5.0			3.0	
Fall		8.0			3.0	
Minimum DO (mg/L)	3.0	5.0	Instantaneous	5.5	5.5	30 days
BOD (mg/L)	None	25	7 days	None	35	30 days

Source: City of Logan 2015
Notes: mg/L milligrams per liter
DO dissolved oxygen
BOD biological oxygen demand

The city of Logan operates the constructed wetland lagoon system that provides primary wastewater treatment for Logan and the surrounding communities of Hyde Park, Nibley, North Logan, Providence, River Heights, and Smithfield; these communities are participating in the WWTP upgrade. Originally, the facility was scheduled to be completed in 2017, but the revised completion date is now estimated to be 2022. Graphs (Figure 5-7 through Figure 5-10) illustrate several sewage lagoon component effluent levels (City of Logan 2015).

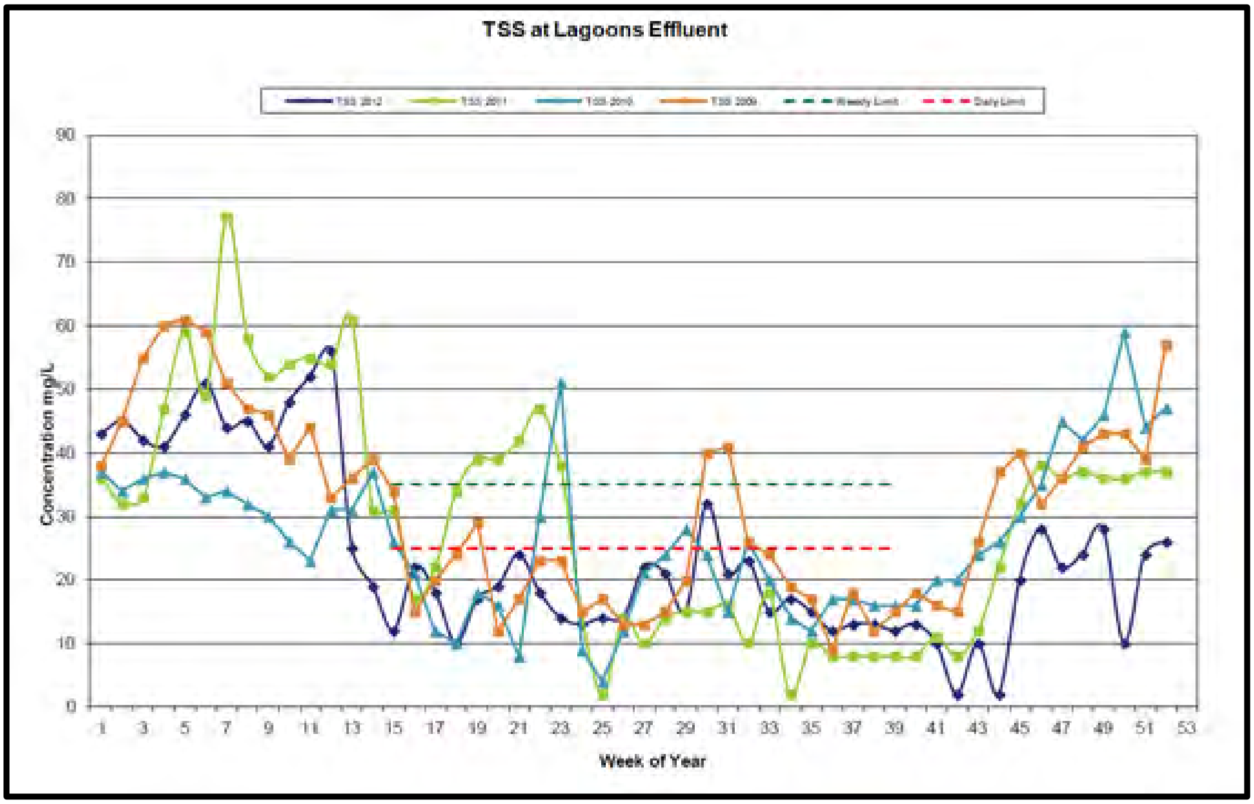
Figure 5-7 illustrates sampled concentrations of BOD in the WWTP lagoon effluent from 2009 through 2012. The regulated daily limit and weekly limit for BOD during the irrigation season is 25 mg/L and 35 mg/L, respectively. These limits were met for most years during the irrigation season, except in 2011 and 2012 when both the daily and weekly limits were exceeded in late June and July. Large volumes of WWTP effluent are utilized by local irrigators for flows during the irrigation season, rather than diverting additional water from the tributaries to Cutler Reservoir. These effluent flows (sometimes referred to as ‘traded’ water which is substituted for additional river diversions) are strictly regulated to only occur during the irrigation season, so that effluent flows do not enter Cutler Reservoir. This effluent water should be completely utilized on lands surrounding the reservoir. However, inexplicably and relatively frequently (at least annually, sometimes more often), the locked gate that historically allowed Logan wastewater to be drained directly to the lower Logan River and into Cutler Reservoir is found open. This allows effluent to discharge to Cutler Reservoir without going through the regulated, measured, appropriate path, thus lowering the levels of input attributed to the Logan WWTP, and increasing Cutler's nutrient degradation issues. When observed by PacifiCorp staff, the issue was brought to the attention of UDWQ.



Source: City of Logan 2015

FIGURE 5-7 LOGAN WASTEWATER TREATMENT PLANT SEWAGE LAGOON EFFLUENT BIOLOGICAL OXYGEN DEMAND CONCENTRATIONS 2009 THROUGH 2012

Similarly, TSS levels are regulated during the irrigation season, with daily and weekly limits of 25 mg/L and 35 mg/L, respectively (Figure 5-8). These limits were exceeded multiple times during the irrigation season across all years sampled.

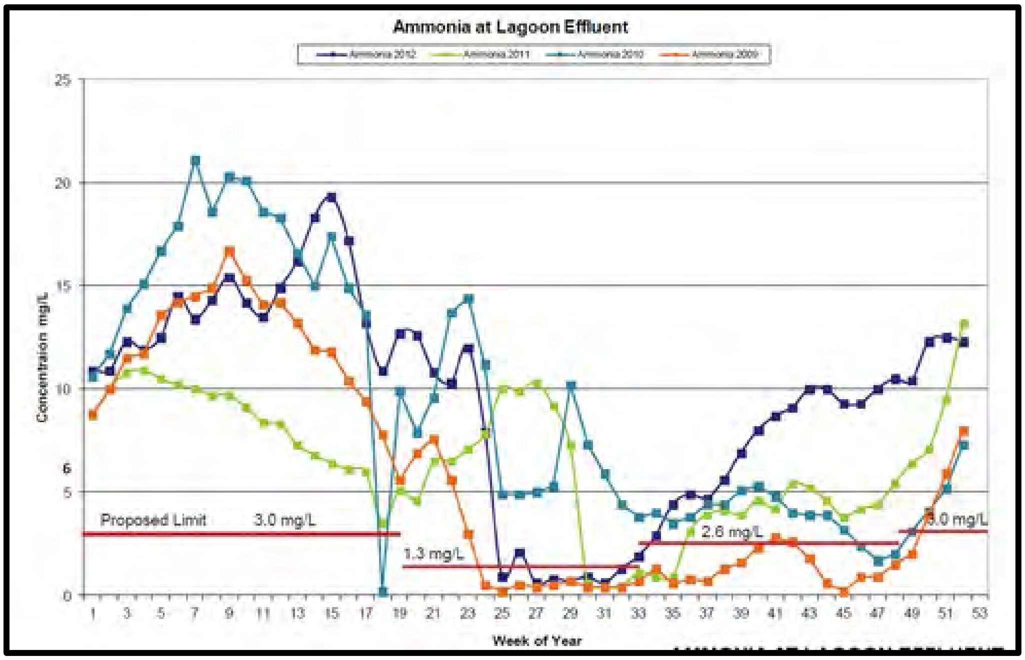


Source: City of Logan 2015

FIGURE 5-8 LOGAN WASTEWATER TREATMENT PLANT SEWAGE LAGOON EFFLUENT TOTAL SUSPENDED SOLIDS CONCENTRATIONS, 2009 THROUGH 2012

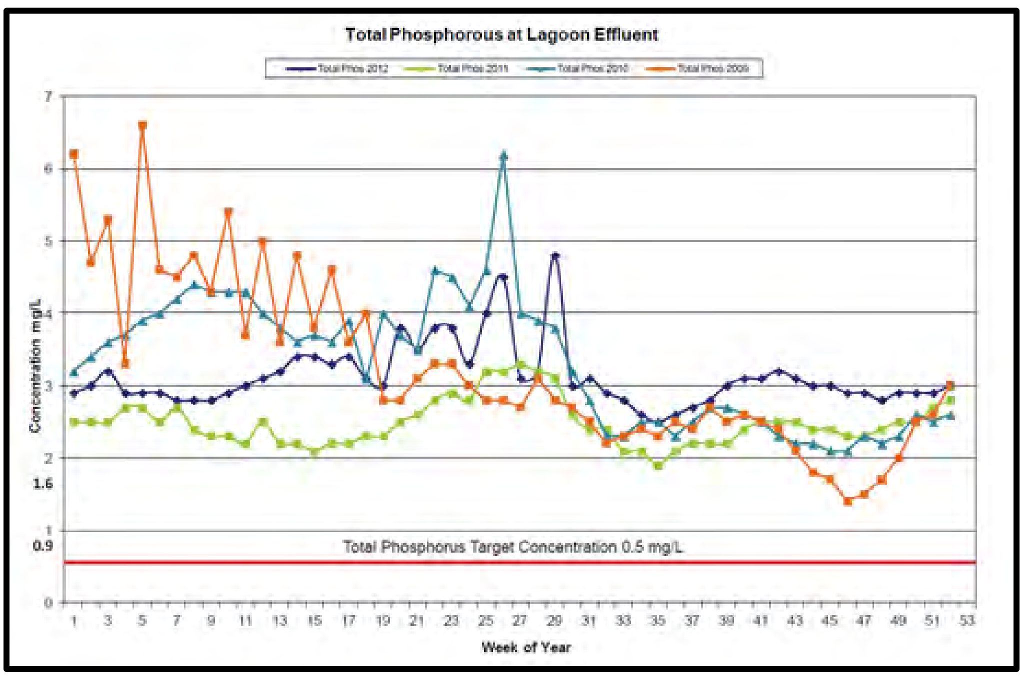
Limits for the WWTP lagoon effluent ammonia have been proposed but not yet implemented (Figure 5-9). These limits are 3.0 mg/L until mid-May, 1.3 mg/L through mid-August, 2.6 mg/L through the end of November, and 3.0 mg/L through December. These levels were exceeded most of the time, except for summer and fall 2009 and summer 2012.

TP is limited within the WWTP lagoon effluent to 0.5 mg/L throughout the entire year (Figure 5-10). Observed TP levels in the sewage lagoon effluent exceeded the regulated limit each year between 2009 and 2012, ranging from 3 to 12 times higher than the imposed limits.



Source: City of Logan 2015

FIGURE 5-9 LOGAN WASTEWATER TREATMENT PLANT SEWAGE LAGOON EFFLUENT AMMONIA CONCENTRATIONS, 2009 THROUGH 2012



Source: City of Logan 2015

FIGURE 5-10 LOGAN WASTEWATER TREATMENT PLANT SEWAGE LAGOON EFFLUENT TOTAL PHOSPHORUS CONCENTRATIONS, 2009 THROUGH 2012

5.2.5 ECOSYSTEMS RESEARCH INSTITUTE

ERI conducted water quality and DO monitoring for a client in 2005 through 2007 and provided some unpublished data for this analysis. DO data were collected continuously at 15-minute intervals at four reservoir marsh sites; Little Bear Marsh (LBM), Spring Creek Marsh (SCM), Logan River Marsh (LRM), and Sewage Discharge Marsh (SDM). LBM and the SDM are included in the FERC Project Boundary for Cutler; however, SCM and LRM were not included because they are not within the FERC Project Boundary (Figure 4-1). These sites include some of the more prominent tributaries to the reservoir and recreation areas, including Valley View, Swift Slough, Benson Marina, Clay Slough, Cache Junction, Bear River, Little Bear River, and Spring Creek.

Although water quality sampling occurred year-round for this study, DO data from the summer months, when temperatures are the highest and DO fluctuates the most, were specifically selected for this technical report to illustrate worst-case conditions. The data for the four marsh sites are summarized in Table 5-11 and illustrated in Attachment F-1, Figures F-1 through F-33.

TABLE 5-11 DISSOLVED OXYGEN DATA COLLECTED AT FOUR MARSH SITES ON CUTLER RESERVOIR, 2005 THROUGH 2007

DATE RANGE	LITTLE BEAR MARSH DO (MG/L)	SPRING CREEK MARSH DO (MG/L)	LOGAN RIVER MARSH DO (MG/L)	SEWAGE DISCHARGE MARSH DO (MG/L)
8/1 to 8/7/2005	Average 2.90 Maximum 7.41 Minimum 0.0	Average 5.32 Maximum 8.81 Minimum 0.0	Average NA Maximum NA Minimum NA	Average 0.12 Maximum 10.93 Minimum 0.0
8/22 to 8/25/2005	Average 7.2 Maximum 8.74 Minimum0.0	Average 13.12 Maximum 17.31 Minimum 0.0	Average 7.93 Maximum 10.25 Minimum 0.0	Average 7.41 Maximum 15.93 Minimum 0.0
6/6 to 6/16/2006	Average 7.23 Maximum 9.5 Minimum 5.89	Average 6.41 Maximum 13.96 Minimum 5.91	Average 7.29 Maximum 8.58 Minimum 6.19	Average 9.13 Maximum 14.25 Minimum 8.29
7/1 to 7/7/2006	Average 10.64 Maximum 19.42 Minimum 5.77	Average 7.16 Maximum 10.58 Minimum 3.99	Average 8.10 Maximum 14.64 Minimum 1.98	Average 8.64 Maximum 14.45 Minimum 4.4
7/31 to 8/7/2006	Average 10.7 Maximum 21.99 Minimum 5.62	Average 7.86 Maximum 11.48 Minimum 5.75	Average 7.39 Maximum 11.18 Minimum 5.10	Average 8.61 Maximum 17.92 Minimum 5.49
6/30 to 7/2/2007	Average 8.57 Maximum 19.34	Average 4.65 Maximum 9.85	Average 8.42 Maximum 19.85	Average 8.59 Maximum 26.82

DATE RANGE	**LITTLE BEAR MARSH DO (MG/L)**	**SPRING CREEK MARSH DO (MG/L)**	**LOGAN RIVER MARSH DO (MG/L)**	**SEWAGE DISCHARGE MARSH DO (MG/L)**
	Minimum 6.24	Minimum (-0.86)	Minimum (-1.86)	Minimum 19.21
7/2 to 7/30/2007	Average 6.16 Maximum 14.60 Minimum 3.53	Average 4.87 Maximum 6.68 Minimum 2.77	Average 8.43 Maximum 20.49 Minimum 1.37	Average 5.46 Maximum 12.80 Minimum 0.09
8/14 to 8/21/2007	Average 7.49 Maximum 14.58 Minimum 4.8	Average 6.03 Maximum 8.52 Minimum 3.88	Average 7.85 Maximum 15.10 Minimum 3.07	Average 6.30 Maximum 13.56 Minimum 2.43

Note: DO dissolved oxygen
mg/L milligrams per liter

ERI also collected samples to analyze concentrations of TP, orthophosphate, turbidity, ammonia (NH_3), nitrate + nitrite (NO_3+NO_2), NO_2, and TSS. These data were collected approximately monthly at the same marsh sites as the DO sampling, beginning September 2005 and ending August 2007 (Attachment F-1, Table 5-12). The highest average concentrations occurred at the SCM sampling site across the board, with turbidity being an exception. Most of the lowest minimum concentrations occurred at the SDM sampling site.

TABLE 5-12 ECOSYSTEMS RESEARCH INSTITUTE MONTHLY WATER QUALITY DATA COLLECTED AT FOUR MARSH SITES ON CUTLER RESERVOIR, 2005 THROUGH 2007

SITE	TP (MG/L)	ORTHOPHOSPHATE (MG/L)	TURBIDITY (NTU)	NH_3 (MG/L)	NO_3+NO_2 (MG/L)	NO_2 (MG/L)	TSS (MG/L)
Little Bear Marsh							
Average	0.234	0.161	18.029	0.159	1.501	0.020	38.276
Maximum	0.746	0.636	44	1.293	4.472	0.049	73.7
Minimum	0.057	0.012	2.3	0.032	0.145	0	6
Spring Creek Marsh							
Average	0.294	0.213	15.9	0.194	1.994	0.024	43.465
Maximum	0.847	0.755	38	1.464	5.099	0.053	83.6
Minimum	0.038	0.028	2.3	0.037	0.42	0	6
Logan River Marsh							
Average	0.071	0.018	12.735	0.053	0.241	0.006	35.370
Maximum	0.58	0.521	39	0.409	4.495	0.024	80.6
Minimum	0.127	0.034	4.6	0.039	0.083	0.006	17
Sewage Discharge Marsh							
Average	0.189	0.110	17.595	0.090	0.760	0.010	42.505
Maximum	0.371	0.254	29	0.358	2.167	0.027	91
Minimum	0.04	0.013	1.8	0.022	0.007	0	2

Note:

mg/L milligrams per liter
NH3 Ammonia
NO_3 Nitrate
NO_2 Nitrite
NTU Nephelometric Turbidity Unit
TP Total Phosphorus
TSS Total Suspended Solids

5.2.6 RELATIONSHIP BETWEEN NUTRIENTS AND AQUATIC WEED GROWTH – LITERATURE REVIEW

The following is a summary of publications and peer-reviewed scientific articles related to nutrients in reservoirs and water conveyance systems and how nutrient levels are related to aquatic vegetative growth. Additional details regarding the specific issues for the Cutler Reservoir system are provided in Section 5.3, below; analysis and strategic suggestions to address the negative effects of plant overgrowth in constructed water conveyance systems will be further addressed in the DLA.

The water system in the western United States includes over 62,140 miles of canals and more than 4.2 million acres of reservoir storage (volume not identified) (Systma and Parker 1999). The U.S. Bureau of Reclamation (Reclamation) alone moves approximately 30 million acre-feet of water per year, with up to 85 percent used to irrigate crop lands (Systma and Parker 1999). The presence of aquatic plants, including rooted macrophytes, reduces storage capacities, blocks screens and pump intakes, and modifies canal features due to decreased canal flow and sedimentation. The cost of aquatic weed control by canal operators is estimated to be $50 million per year in the 17 western states (Systma and Parker 1999). The most common plants are members of the genus *Potamogeton* (commonly known as Pondweed) and the species *Ranunculus aquatilis* (commonly known as White Crowfoot or White-water Buttercup), commonly found in Cutler Reservoir and surrounding tributaries and canals. Several forms of algae (a simple and ancient form of plants without stems, roots, leaves, or vascular tissue, may also be one-celled) can create issues in canals and waterways, as can much larger species, such as Common Reed (*Phragmites australis*) which is spreading throughout the Bear River system, including Cutler Reservoir, and can create both mechanical and ecological concerns in both natural and constructed aquatic conveyance systems.

Treatment strategies are usually conducted using a prescribed schedule with a fast-acting, broad spectrum biocide (Systma and Parker 1999). Systma and Parker (1999) provide a worthwhile discussion of the concept of integrated pest management, or ecologically based pest management, which is based on the knowledge of the biology and ecology of plant species and water systems. Their guide details all the common chemical and mechanical treatments and their toxicity to aquatic organisms other than plants.

Aquatic vegetation management in irrigation canals is mired in complications arising from the connection between natural and artificial systems, multiple beneficial uses, the physical and chemical nature of the water bodies involved, the unique biology of each aquatic plant species, and the constraints of the regulatory climate (Systma and Parker 1999). One of the main guiding regulatory principles is that vegetation management practices that are acceptable in human-made systems may cause serious harm to natural systems.

Rooted aquatic plants must have a sediment base for attachment and nutrient supply. Most nitrogen and phosphorus are obtained from the sediments, with very little captured in the water column. Nitrogen is typically the limiting nutrient in aquatic systems. However, for Cutler Reservoir, phosphorus is the limiting nutrient (SWCA 2010).

One method of biological weed control is the use of Spikerush (*Eleocharis* spp.). This plant species is low growing and has a minimal effect on flow. Slender or Needle Spikerush (*Eleocharis acicularis*) and Dwarf Spikerush (*Eleocharis coloradensis*) have demonstrated the ability to replace Canadian Pondweed (*Elodea canadensis*) and Curly-leaf Pondweed (*Potamogeton crispus*), as well as other *Potamogeton* species (Yeo and Fisher 1970 as cited in Systma and Parker 1999; Yeo and Thurston 1984).

Application of acetic acid to canal bottoms before watering up may be an effective strategy because application of acetic acid at low concentrations can inhibit regrowth and sprouting aquatic plants (Systma and Parker 1999).

Ho-Sub et al. (2007) examined the effect of varying concentrations of TP and total nitrogen on cyanobacterial growth in a shallow, hypereutrophic reservoir. Like the Cutler Reservoir, Ho-Sub et al. (2007) determined that phosphorus, rather than nitrogen, was the key nutrient regulating phytoplankton growth in the reservoir under study and that phytoplankton growth increased with higher nitrogen concentration added.

Any aquatic weed that gains a foothold in a canal can lead to accumulation of sediments, which can create bars and interruption of flow (Reclamation 2017). Aquatic plants spread via seeds or plant fragments (or both) and can enter a canal system via wind, birds, fish, boats and trailers, and anglers (Reclamation 2017). Free-floating aquatic vegetation and fragments of submersed plants can clog irrigation pipes and nozzles and reduce water flow and increase evaporation and seepage (Parker and Comes 1982). Aquatic plant growth can invade the canal footprint, even creating a danger of canal failure if the growth displaces the intended water movement in the system.

Algae and flowering plants form the base of the aquatic food web and are consumed by primary consumers that, in turn, become food to secondary consumers (Parker and Comes 1982). Stems and leaves of aquatic plants serve a whole community of aquatic organisms and are therefore a vital part of a healthy aquatic system. Nitrogen and phosphorus are the two most important nutrients for maintaining the aquatic plant community (and allowing for its overgrowth in some systems), and these elements come from several sources, including sewage effluent, home septic systems, food-producing manufacturers, and agriculture return flows (AERF 2014, Parker and Comes 1982); all of these elements are present at Cutler Reservoir. Phosphorus concentration in water bodies is very important in regulating aquatic macrophyte growth (Boyd 1971). Nitrogen can be a growth limiting factor in freshwater habitats. Floating macrophytes and submerged species with root systems may absorb some nutrients from the water column, but rooted plants are also capable of absorbing nutrients from the sediments.

Macrophyte communities can often amass large amounts of inorganic nutrients early in the growing season, allowing them to compete with phytoplankton for nutrients in the water column. In shallow reservoirs with vast areas of aquatic macrophyte colonies, a large proportion of the available phosphorus is cycled via the vascular plants (Boyd 1971). Once vegetation dies, either by chemical treatment or with winter freezing, a large amount of nutrients taken up by the plants is quickly released back into the water column. Rooted plants have access to a greater concentration of phosphorus in the anaerobic layers in muddy reservoir bottoms than is available in the aerobic water column (Boyd 1971). Boyd (1971) states that the largest amounts of phosphorus in an aquatic system are exchanged in the aquatic system via three mechanisms: 1) between water and the mud substrate, 2) between mud substrate and the rooted macrophytes, and 3) between water and the rooted macrophytes. However, there is also a pathway from rooted macrophytes, whereby phosphorus “leaks” from the anaerobic layer in the substrate through the rooted plants and into the water column. Boyd (1971) also points out that *areas in a water body that are most suitable for rooted aquatic macrophytes will continue to produce macrophytic growth despite management attempts to eradicate them*.

Phosphorus was the primary focus of the 2010 TMDL study (SWCA 2010). The TMDL study identified the following as significant sources of phosphorus loading in the Cutler Reservoir watershed:

- Regulated municipal and industrial sources
- Stormwater runoff from developed areas

- On-site wastewater treatment systems (septic systems)
- AFOs and CAFOs
- Runoff from irrigated and fertilized agricultural lands
- Runoff from pasturelands
- Cattle in streams, riparian areas, and reservoir shoreline
- Runoff from forested lands
- Runoff from rangelands
- Seasonal internal reservoir sources
- Pipes discharging into Cutler Reservoir and tributaries
- Stream erosion and reservoir shoreline erosion
- Atmospheric sources
- Natural background sources

The following information is derived entirely from the 2010 TMDL study (SWCA 2010). Regarding runoff from fields applied with high nutrient waste, two locations were cited as introducing high quantities of phosphorus to Swift Slough (Gossner Foods, cheese processing wastewater) and Clay Slough (Schreiber Foods, manure). There are 386 AFOs and CAFOs within the Cutler Reservoir watershed that contain at least 37,000 cattle (56 percent of the total in the county in 2002). Phosphorus (e.g., for fertilized and irrigated fields) contained in chemical fertilizers and manure is very slow to mineralize. In some cases, more than twice the phosphorus than is needed is added to the soil. This level of phosphorus application exceeds that which can be taken up by plant growth. Therefore, agricultural soils that receive large volumes of phosphorous may be saturated, and once this occurs, it could take hundreds to thousands of years for phosphorous to be depleted (SWCA 2010).

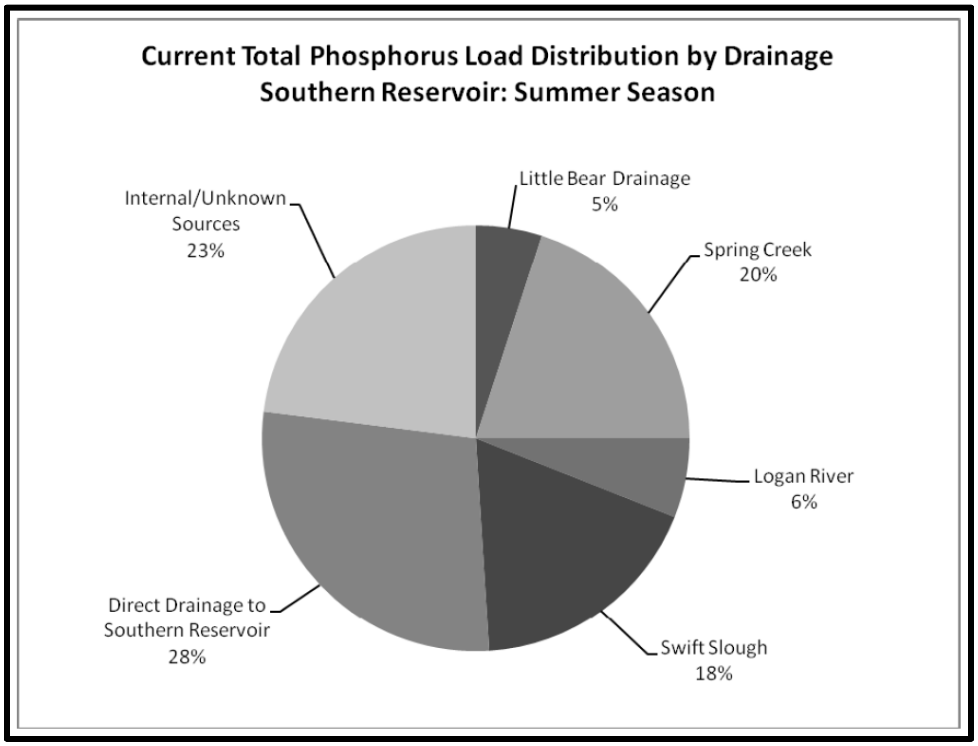
For pasturelands, manure is slow to decompose which can lead to an increased accumulation of soluble phosphorous in an unstable form. The soil in grazing fields is heavily compacted by cattle, such that a higher volume of runoff occurs during storm events that carries with it the soluble phosphorous that eventually enters local water bodies.

Internal reservoir sources of phosphorus include reservoir bottom sediments that contain a significant source of phosphorous that can be released into the water column during storm events that cause erosion, as well as by fish (Carp (*Cyprinus carpio*) spawning and feeding) and animal activity (Cattle [*Bos taurus*], Muskrats [*Ondatra zibethicus*], and Beaver [*Castor*]), as well as recreation (use of propeller-driven boats and jet-skis for hunting, riding, and waterskiing) in the reservoir shallows (noting that over half of the reservoir is less than 2-feet deep, and the vast majority of the reservoir is less than 4-feet deep).

Figure 5-11 through Figure 5-14 illustrates the sources of drainage inputs to the reservoir by location and season. Most of the direct drainage to the reservoir occurs in the southern portion of the reservoir at an estimated rate of 28,922 kilograms (kg) of TP per year. The most notable sources are the Fisheries Experiment Station and the effluent and stormwater discharge from Logan City.

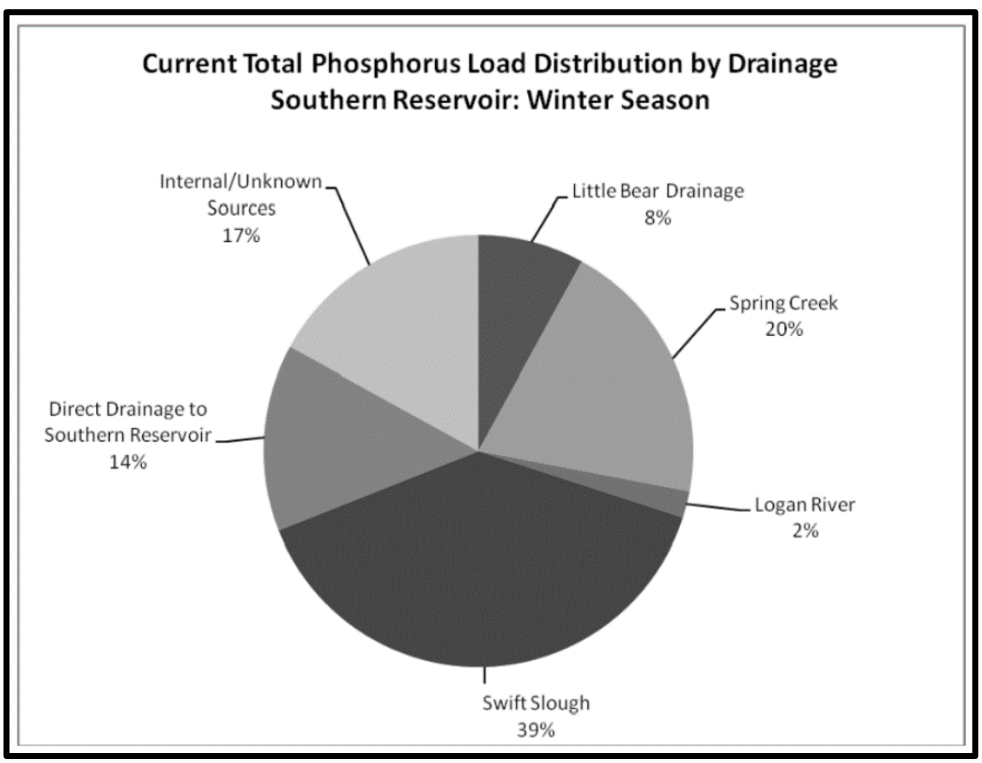
During the summer, the two major sources of phosphorus are direct drainage and internal sources. For the tributaries, Spring Creek and Swift Slough provide the greatest percentage of the phosphorus loading; while, during the winter season, Spring Creek and Swift Slough introduce the greatest amount of phosphorus loading, followed by internal sources and direct drainage.

Clearly, the southern portion of the reservoir provides most of the phosphorus loading to the northern portion of the reservoir during the summer months, followed by the Middle Bear River. The winter phosphorous loading in the northern portion reservoir is relatively the same during the winter season, with the southern portion of the reservoir providing most of the phosphorous input.



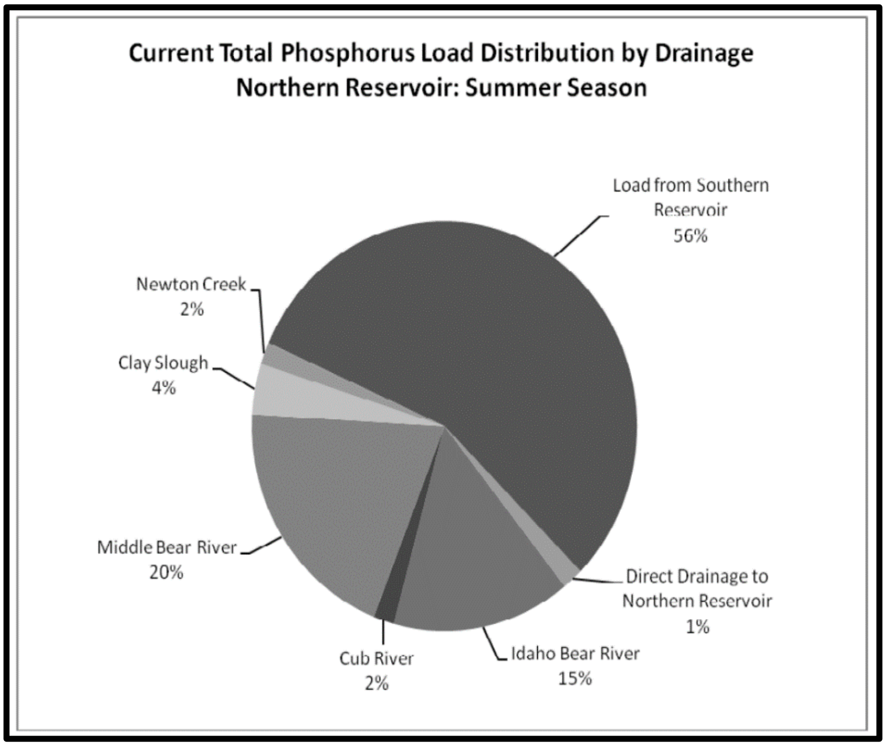
Source: SWCA 2010

FIGURE 5-11 DIRECT SUMMER DRAINAGE TO SOUTHERN RESERVOIR AREA



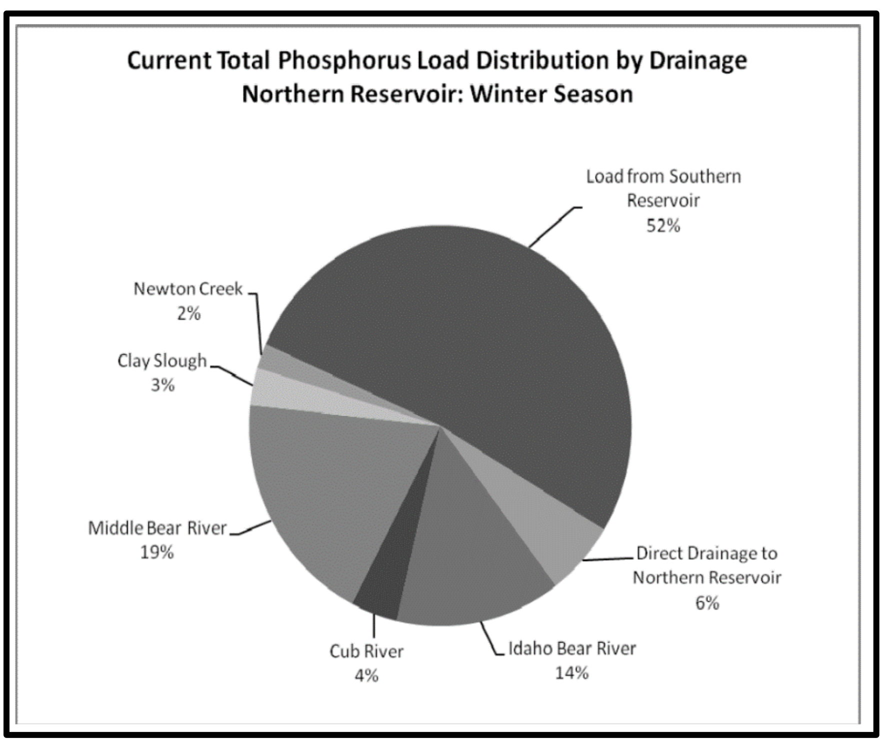
Source: SWCA 2010

FIGURE 5-12 DIRECT WINTER DRAINAGE TO SOUTHERN RESERVOIR



Source: SWCA 2010

FIGURE 5-13 DIRECT SUMMER DRAINAGE TO NORTHERN RESERVOIR



Source: SWCA 2010

FIGURE 5-14 DIRECT WINTER DRAINAGE TO THE NORTHERN RESERVOIR

5.3 SYNTHESIS OF EXISTING WATER QUALITY DATA

Six data sources were used for the synthesis: PacifiCorp, USU research (Budy et al.), USU aquatic classes fieldwork, UDWQ, city of Logan, and ERI (Table 5-13) Not all the previous monitoring efforts were conducted at the same locations, nor are the previously collected data at the same detail level as PacifiCorp's data. However, there is a way to assign the data using the same categories as those created by UDWQ, where sampling locations were designated as Southern Inflows, Southern Reservoir, Northern Reservoir, and Northern Inflows (Table 5-13). Summary tables (Table 5-14 through Table 5-21) allow for comparison of the results from each of the monitoring efforts by sample parameter.

It is important to understand that the water quality parameters measured in Cutler Reservoir over the life of the existing license (from 1996 to present) are entirely driven by the various water quality parameters of the tributary inputs to the reservoir. Such conditions are then slightly modified by reservoir operations as flow moves downstream.

TABLE 5-13 ASSIGNMENTS FOR WATER QUALITY DATA COLLECTED BY MONITORING ENTITIES FOR CUTLER RESERVOIR

ENTITY	LOCATIONS								
UDWQ 1983-2006	Southern Inflow	Southern Inflow	Southern Inflow	Southern Reservoir	Northern Reservoir	Northern Reservoir	Northern Inflow	Reservoir Outflow	Reservoir outflow
UDWQ 2009-2019					Benson Bridge	Clay Slough Confluence	Bear River at Summit Creek		
PacifiCorp	Logan River	Little Bear River	Spring Creek	Swift Slough	Benson	Highway 23	Bear River at Summit Creek	Bear River downstream of dam	
USU—research (Budy et al.)	Segment 5	Segment 5	Segment 5	Segment 4	Segment 3	Segment 1	Segment 2		
USU—aquatic classes fieldwork				Sites 5, 6, 7, 9	Sites 3, 4	Cache Junction	Site 10		
Logan				WWTP effluent					
ERI	LRM	LBM	SCM	SDM					
PacifiCorp fall 2019 drawdown	Unit 1	Unit 1	Unit 1	Unit 2	Unit 3	Unit 4	Unit 3	Bear River downstream of dam	Camp Fife

TABLE 5-14 SUMMARY OF CUTLER RESERVOIR AVERAGE WATER TEMPERATURE

ENTITY	LOCATIONS (°C)								
	Southern Inflow	Southern Inflow	Southern Inflow	Southern Reservoir	Northern Reservoir	Northern Reservoir	Northern Inflow	Reservoir Outflow	Reservoir Outflow
UDWQ 1983-2006			12.7						
UDWQ 2009-2019					27.1	16.68	10.18		
PacifiCorp	8.48	9.92	9.76	12.3	12.14	13.03	10.8	11.74	
USU—research (Budy et al.)			14.28	16.41	18.31	18.26	18.23		
USU—aquatic classes fieldwork	14.0			12.0	16.35	16.1	16.4		
PacifiCorp—pre-drawdown			9.73	9.39		11.52	9.26	9.37	9.48
PacifiCorp—during drawdown			6.52	4.68		6.49	4.46	5.95	5.92

TABLE 5-15 SUMMARY OF CUTLER RESERVOIR AVERAGE TOTAL COLIFORM

ENTITY	LOCATIONS (ORGANISMS/100 ML)								
	Southern Inflow	**Southern Inflow**	**Southern Inflow**	**Southern Reservoir**	**Northern Reservoir**	**Northern Reservoir**	**Northern Inflow**	**Reservoir outflow**	**Reservoir outflow**
UDWQ 1983-2006					1241.0				
UDWQ 2009-2019					1480.5				
PacifiCorp	987.8	1195.8	1772.0	1395.3	1119.2	1415.3	964.6	1056.2	

TABLE 5-16 SUMMARY OF CUTLER RESERVOIR AVERAGE NITRATE-NITROGEN

ENTITY	LOCATIONS (MG/L)								
	Southern Inflow	**Southern Inflow**	**Southern Inflow**	**Southern Reservoir**	**Northern Reservoir**	**Northern Reservoir**	**Northern Inflow**	**Reservoir Outflow**	**Reservoir Outflow**
UDWQ 2009-2019					0.74	0.08	0.809		
PacifiCorp	0.353	0.847	3.792	0.451	0.543	0.395	0.636		

TABLE 5-17 SUMMARY OF CUTLER RESERVOIR AVERAGE TOTAL KJELDAHL NITROGEN

ENTITY	LOCATIONS (MG/L)								
	Southern Inflow	**Southern Inflow**	**Souther n Inflow**	**Southern Reservoir**	**Northern Reservoir**	**Northern Reservoir**	**Northern Inflow**	**Reservoir outflow**	**Reservoir outflow**
UDWQ 1983-2006	3.18				11.63				
PacifiCorp	0.292	0.536	0.549	0.644	0.876	0.622	0.422	0.737	
USU—aquatic classes fieldwork				1.54	0.85	0.698			

TABLE 5-18 SUMMARY OF CUTLER RESERVOIR AVERAGE TOTAL PHOSPHORUS

ENTITY	LOCATIONS (MG/L)								
	Southern Inflow	**Southern Inflow**	**Southern Inflow**	**Southern Reservoir**	**Northern Reservoir**	**Northern Reservoir**	**Northern Inflow**	**Reservoir Outflow**	**Reservoir Outflow**
UDWQ 1983-2006			0.25	0.33		0.13	0.04		
UDWQ 2009-2019					0.156	0.112	0.075		
PacifiCorp	0.0266	0.083	0.0946	0.0713	0.15	0.0899	0.0619	0.0989	
USU—research (Budy et al.)			0.1617	0.1141	0.2313	0.1822	0.1747		
USU—aquatic classes fieldwork	0.001			0.46	0.25	0.181	0.094		
City of Logan	2.0–6.5								
ERI	0.71	0.234	0.294	0.189					
PacifiCorp—pre-drawdown			0.04	0.07	0.13		0.09	0.111	
PacifiCorp—during drawdown			0.16	0.06	0.11		0.13	0.283	

TABLE 5-19 SUMMARY OF CUTLER RESERVOIR AVERAGE DISSOLVED OXYGEN

ENTITY	LOCATIONS (MG/L)								
	Southern Inflow	**Southern Inflow**	**Southern Inflow**	**Southern Reservoir**	**Northern Reservoir**	**Northern Reservoir**	**Northern Inflow**	**Reservoir Outflow**	**Reservoir Outflow**
UDWQ 1983-2006							8.7		
UDWQ 2009-2019					9.01	8.44	9.5		
PacifiCorp	9.32	8.74	8.38	9.93	9.12	9.3	8.88	9.7	
USU—research (Budy et al.)			7.39	8.11	8.05	7.23	6.9		
USU—aquatic classes fieldwork	11.5			8.9	8.9	7.4			
ERI	7.9–8.42	2.9–10.7	4.65–13.12	0.12–9.13					
PacifiCorp—pre-drawdown			11.42	16.66		10.31	12.5	6.62	6.67
PacifiCorp—during drawdown			9.26	8.57		9.69	10.26	10.25	8.89

TABLE 5-20 SUMMARY OF CUTLER RESERVOIR AVERAGE TURBIDITY

ENTITY	LOCATIONS (NTU/FNU)								
	Southern Inflow	**Southern Inflow**	**Southern Inflow**	**Southern Reservoir**	**Northern Reservoir**	**Northern Reservoir**	**Northern Inflow**	**Reservoir Outflow**	**Reservoir Outflow**
UDWQ 2009-2019				18.2		28.57			
PacifiCorp	9.625	27.23	25.75	32.8	38.08	38.46	83.22	39.3	
ERI	12.735	18.029	15.9	17.595					

TABLE 5-21 SUMMARY OF CUTLER RESERVOIR AVERAGE TOTAL SUSPENDED SOLIDS MONITORING FROM ANY OF THE ENTITIES IN TABLE 5-13

ENTITY	LOCATIONS (MG/L)								
	Southern Inflow	**Southern Inflow**	**Southern Inflow**	**Southern Reservoir**	**Northern Reservoir**	**Northern Reservoir**	**Northern Inflow**	**Reservoir outflow**	**Reservoir outflow**
UDWQ 1983-2006			25.80	31.40		36.7	60.1		
UDWQ 2009-2019					42.24		50.85		
PacifiCorp	6.77	24.39	33.73	65.92	30.09	31.76	24.19	31.86	
ERI	35.37	38.28	43.46	42.51					
PacifiCorp—pre-drawdown			25.52	11.87		8.66	14.62	29.3	22.5
PacifiCorp—during drawdown			18.83	29.99		32.3	9.74	224.0	148.0

Water temperature on average is relatively unremarkable for Cutler Reservoir (Table 5-14). An average does not reflect the extremes or the seasonal changes, but temperature is not a focus of most of the monitoring efforts, even though it can have a direct effect on DO, solubility of some nutrients, and primary production. It does appear that water temperatures in the southern units of the reservoir are generally cooler than the northern units.

Other than two observations by UDWQ, PacifiCorp is the only entity that regularly samples and reports total coliform (Table 5-15). The two samples reported by UDWQ from Benson Bridge are similar in scale to PacifiCorp's observation. However, there is no reasonable way to simply make any direct comparison because the samples were collected in different years.

PacifiCorp and UDWQ are the only entities that monitor nitrate-nitrogen on a regular basis (Table 5-16). Nitrogen is commonly found in fertilizers used for lawn and garden care and crop production and occurs naturally in organic form, resulting from decaying vegetation and animal residuals (Oram 2020). Soil bacteria convert the various sources of nitrogen into nitrate, which can be readily absorbed by plants. Nitrate-nitrogen that occurs in groundwater from point sources may be attributable to sewage disposal systems and animal feeding operations, while nonpoint sources are attributable to land use types, such as fertilized cropland, parks, golf courses, and private lawns and gardens (Oram 2020). The two highest sources of nitrate-nitrogen in PacifiCorp's sampling efforts are Little Bear River and Spring Creek, followed by the Bear River at Summit Creek. Over 50 percent of the Little Bear River drainage downstream of Hyrum Reservoir is agricultural (UDWQ 2000). Spring Creek, a small portion of that drainage, enters the Little Bear River just before the confluence with Cutler Reservoir. Approximately 75 percent of the Spring Creek drainage is agricultural land with the majority of the land (95 percent) irrigated. The drainage area includes feedlots, rendering plants, and meat packing plants (UDWQ 2000). In addition, the south fork of Spring Creek receives discharge from the Hyrum WWTP and effluent from a small trout farm. The Utah state standard for nitrate-nitrogen is 4.0 mg/L. PacifiCorp's data show that average data from each sampling site meet the standard; however, the Southern Inflow at Spring Creek barely met the standard. Since these are average values, it is very likely that the nitrate-nitrogen level is regularly exceeded at Spring Creek. In fact, PacifiCorp recorded averages that exceeded the state standard before 2013 but that met the standard in 2013 and 2018.

TKN has been monitored by UDWQ, PacifiCorp, and some USU classes (Table 5-17). TKN is the sum of nitrogen contained in organic substances, ammonia, and ammonium found in soil, water, or sewage effluent (USEPA 2009).

The Utah state standard for total nitrogen is 0.8 mg/L. Most observations by PacifiCorp and the USU classes have been within the standard. However, UDWQ data are several magnitudes higher than the standard and the other measurements taken by PacifiCorp. Perhaps the measurement unit was supposed to be µg/L, but the TMDL data set is not recorded that way on UDWQ's website.

TP is perhaps the most monitored water quality constituent in the Bear River and Cutler Reservoir system. There are several reasons, not the least of which is that the system is phosphorus and nitrogen limiting when it comes to phytoplankton and aquatic macrophyte growth (SWCA 2010). During the most recent TMDL conducted for Cutler Reservoir and the surrounding Bear River, UDWQ identified phosphorus as the primary contributor to water quality exceedances in Cutler Reservoir (SWCA 2010). The Utah state standard for TP is 0.025 mg/L for lakes and reservoirs, but the TMDL study (SWCA 2010) determined 0.07 mg/L and 0.09 mg/L to be the standard limits for the northern and southern reservoir, respectively. Even with a relaxed standard, exceedances were measured by several entities, with the highest levels reaching 2.0 to 6.5 mg/L in the Southern Inflow segment (Table 5-18). The most prominent source of phosphorus loading in the Southern Inflow areas is illustrated by the Spring Creek TMDL, where 67.5 percent of the load comes as point source origins from commercial operations such as EA Miller, Hyrum WWTP, and the Miller Brothers feedlot (UDWQ 2002).

While some of the highest recorded values originate in the Southern Reservoir areas and Southern Inflows, most TP data collected by seven different entities reveal exceedances. A standard of 0.075 mg/L was determined to be the appropriate standard through the TMDL process for the Bear River downstream of Cutler Dam. Of note, the reservoir outflow exceeded the standard for PacifiCorp's most recent (conducted in 2018) average 5-year water quality monitoring period, and before and during the fall 2019 drawdown event.

Low DO is listed as a primary pollutant of concern by UDWQ, and the minimum 1-day value of 3.0 mg/L throughout the water column was established as a target endpoint (SWCA 2010). On average, DO levels meet the criteria (Table 5-19). However, exceedances have been detected by several entities (Table 5-5, Table 5-6, Table 5-8, and Table 5-11). UDWQ noted that DO sags did occur in Cutler Reservoir, especially during the summer months, but that readings less than 3.0 mg/L were a rare occurrence (SWCA 2010).

The Utah state standard for turbidity is no more than a 10-NTU change over ambient conditions. Turbidity is currently less of a concern, given that the focus is turning to TSS. However, monitoring for turbidity is a requirement in PacifiCorp's current license for Cutler Reservoir, so those monitoring efforts will continue through the existing FERC license. On average, most observations by PacifiCorp and others do not appear to exceed the state standards (Table 5-20). Although the average value for the Northern Inflow (Bear River) is 83.22 NTU, the information is not available to relate that value to ambient conditions.

The UDWQ standard for TSS is a daily maximum of 70 mg/L. Most data recorded did not exceed the limit on average. The exception is TSS concentrations during the reservoir drawdown in 2019, when TSS was 29.3 mg/L before the drawdown and 224 mg/L during the drawdown at the Collinston gage site downstream of the dam and 22.5 mg/L before the drawdown and 148 mg/L during the drawdown at the Camp Fife sampling site (Table 5-21). This is likely an expression of the channel-cutting action that occurred at drawdown in which suspended sediments caused elevated TSS levels, and would be expected any time there is a drawdown of this magnitude, but is not expected during normal operation of the Project.

5.3.1 NUTRIENTS AND AQUATIC VEGETATION IN CANALS OWNED AND OPERATED BY THE BEAR RIVER CANAL COMPANY

During the study plan comment period, BRCC specifically requested a literature study of existing information that would inform their management of nuisance aquatic vegetation in their canal system, which is fed by flows from Cutler Reservoir at Cutler Dam. Aquatic vegetation clearly depends on nutrients for growth, as demonstrated by the number of investigations and reports cited in Section 5.2.1.4. Not surprisingly, given the uses and nutrient load carried by every tributary to Cutler Reservoir, there are many sources providing phosphorus to the Cutler Reservoir system. The Cutler Reservoir/Middle Bear River TMDL identified phosphorus as a pollutant of concern. Yet, the TMDL concluded that phosphorus is limiting regarding aquatic plant growth in the reservoir. That said, phosphorus is still present throughout the reservoir in various forms, either in sediments or in living aquatic macrophytes and phytoplankton. Phosphorus is cycling through the system via runoff and various land-based inputs and through plant death, decomposition, and regrowth. The phosphorus loading shown in Figure 5-16 through Figure 5-18 demonstrates an overwhelming phosphorus stream that is, in part, regulated (Cutler Reservoir/Middle Bear River TMDL, Little Bear River TMDL, Spring Creek TMDL). The phosphorus loading in the southern portions of the reservoir then becomes the largest contributor of phosphorus to the northern portions of the reservoir (over 50 percent), and this loading occurs year-round.

Regulation of phosphorus in the Cutler Reservoir system is a perplexing problem: direct inputs from stormwater, sewage effluents, agricultural runoff, irrigation return water, and AFOs are the more visible sources and thus subject to more scrutiny. However, there is a large component of internal unknown sources construed to be from decades of direct input from effluent, high rates of fertilizer application leaching through the soil to the reservoir, and runoff from rangeland/forest land, to name a few. Regulations and load limits, imposed by the Cutler Reservoir/Middle Bear River TMDL, can only be enforced on a relatively small portion of the phosphorus input stream.

A problem exists for canal operators in that high levels of phosphorus inputs, even though phosphorus is still limiting in the basin, will continue to exist and, in turn, will continue to promote aquatic macrophyte and phytoplankton growth. Even if all current phosphorus generation and use in the basin were to cease, the huge amounts that are bound up in the agricultural subsurface soil and the reservoir sediments will continue to leach into Cutler Reservoir and foster nuisance and unwanted plant production for decades. Some reduction in current nutrient loading levels to the reservoir is expected once the new Logan WWTP comes on line which will likely be April or May 2022 (Personal communication, Jim Harps-Logan City Public Works) The new treatment facility will have a new primary and secondary processing pathway but the existing lagoons will be retained to handle high inflows including storm run-off, which typically occur in the spring and summer.

5.4 PHASE 1 - SEDIMENT CHARACTERIZATION

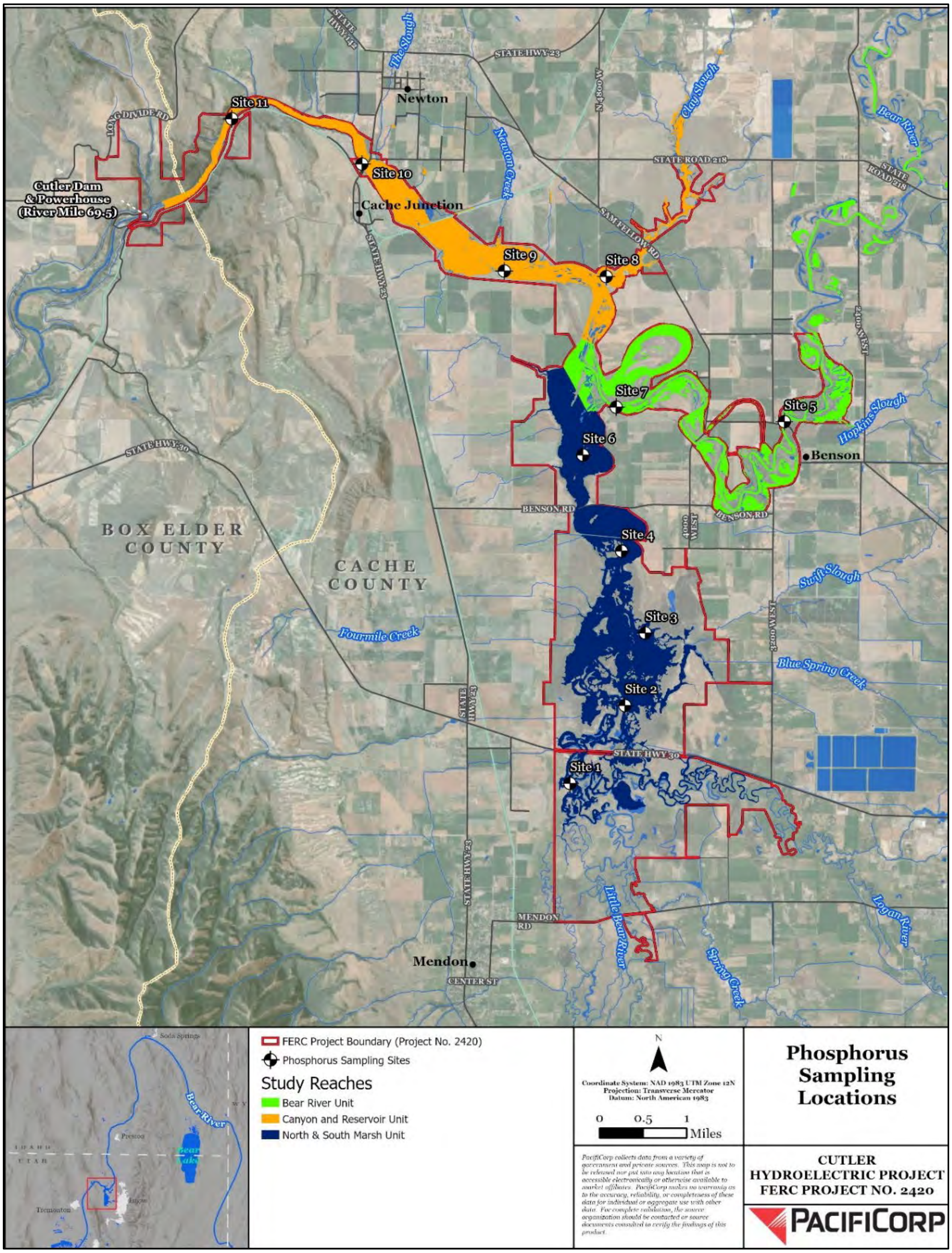
Core samples of reservoir sediments were collected and analyzed for the presence and concentration of nutrients, contaminants, or both, that could be stirred up and released into the water column during periodic drawdowns under potential future Project operations. The key elements of the analysis were the presence of TP, orthophosphate, and dissolved total phosphorus (DTP) in the water column and within the reservoir sediments. Eleven sampling sites were chosen for the sediment study (Figure 5-15).

The work was conducted by the sediment modeling crew and shared with other resource area analyses (refer to the Sediment Analysis Study Plan Methods and ISR Appendix H). This Water Quality ISR Report is neither a complete analysis nor report of the sediment data collected for the Sediment ISR Report. Please refer to that report for more detail and analysis.

Five of the 11 sediment coring sites sampled were selected for the Water Quality ISR because they are in close proximity to past locations and permanent sampling sites used in PacifiCorp's monitoring for the Cutler Project. The preliminary results are shown in Table 5-22 and Table 5-23 and illustrated in Figure 5-15 through Figure 5-20. The most important observations are that TP levels in water and sediment samples collected by the sediment modeling crew were measured at levels that were largely higher than at any recorded in PacifiCorp's previous water quality monitoring datasets. Most of the water samples for TP, DTP, and orthophosphate from the 2020 sediment data collection are higher than those sampled during the most recent 5-year water quality data collection in 2018 by PacifiCorp. In addition, with the exception of DTP in sediments, all other P levels (P, DTP and OP) are higher in the fall and winter levels than during the warmer seasons which is counterintuitive since P concentration is expected to be higher during warmer, lower flow periods.

The sediment core samples collected show a significant amount of accumulation of TP and DTP, tied up in the bottom sediments that could be released into the water column with large reservoir elevation changes. These sediment samples represent TP and DTP stored in the reservoir substrate that could enter the water column if the reservoir bottom is disturbed (e.g., by large reservoir elevation changes). Note that orthophosphate cannot be measured in sediment.

It is not anticipated that normal reservoir operations or proposed operations would create the same issues regarding potential release of contaminants that could occur in the larger magnitude drawdowns such as in fall 2019, but some TP release did occur during that drawdown (Figure 5-6). However, the TP and OP concentrations were magnitudes less than water samples taken in 2020 (Figure 5-16) especially considering the Swift Slough and Benson Marina sites.



Source: PacifiCorp 2018

FIGURE 5-15 SEDIMENT CORING LOCATIONS FOR ANALYSIS OF BOTTOM SEDIMENTS AND ASSOCIATED WATER

TABLE 5-22 SEDIMENT CORE ANALYSIS OF WATER SAMPLES* COLLECTED AT CUTLER RESERVOIR SITES IN 2020

DATE	NORTH MARSH INFLOW	SWIFT SLOUGH	BENSON MARINA	BEAR RIVER ACCESS	HIGHWAY 23 BRIDGE
3/11/12, 2020 TP	0.16	0.70	0.34	0.16	0.19
3/11/12, 2020 OP	0.08	0.58	0.28	0.12	0.15
3/11/12, 2020 DTP	0.13	0.66	0.30	0.14	0.15
6/1/2020 TP	<0.03	<0.03	0.19	<0.03	0.05
6/1/2020 OP	0.07	0.01	0.17	0.02	0.03
6/1/2020 DTP	0.06	0.06	0.16	ND*	0.03
9/1/2020 TP	0.08	0.36	0.12	<0.03	<0.03
9/1/2020 OP	0.03	0.29	0.12	0.01	0.02
9/1/2020 DTP	ND	0.33	0.08	ND	ND
11/1/2020 TP	0.042	0.473	0.161	0.030	0.056
11/1/2020 OP	0.036	0.418	0.146	0.010	0.048
11/1/2020 DTP	0.165	0.650	0.035	0.030	0.030

Note:
*mg/L milligram per liter
*** ND=not detected
OP orthophosphate
DPT dissolved total phosphorus
TP Total phosphorus

TABLE 5-23 SEDIMENT CORE ANALYSIS OF SAMPLES COLLECTED AT CUTLER RESERVOIR SITES IN 2020*

DATE	NORTH MARSH INFLOW	SWIFT SLOUGH	BENSON MARINA	BEAR RIVER ACCESS	HIGHWAY 23 BRIDGE
3/11/12, 2020 TP	773.2	1087.0	1269.0	754.6	698.1
3/11/12, 2020 DTP	0.03	3.12	0.19	0.13	0.09
6/1/2020 TP	704.3	824.6	838.0	653.1	769.1
6/1/2020 DTP	0.44	0.38	0.32	0.07	.18
9/1/2020 TP	660.1	1150	957.7	610.6	731.1
9/1/2020 DTP	0.06	3.71	0.17	0.03	0.04
11/1/2020 TP	680.4	977.8	773.0	642.7	643.4
11/1/2020 DTP	0.08	0.46	0.15	0.03	0.04

Note: * mg/kg
TP Total Phosphorus
DTO Dissolved Total Phosphorus

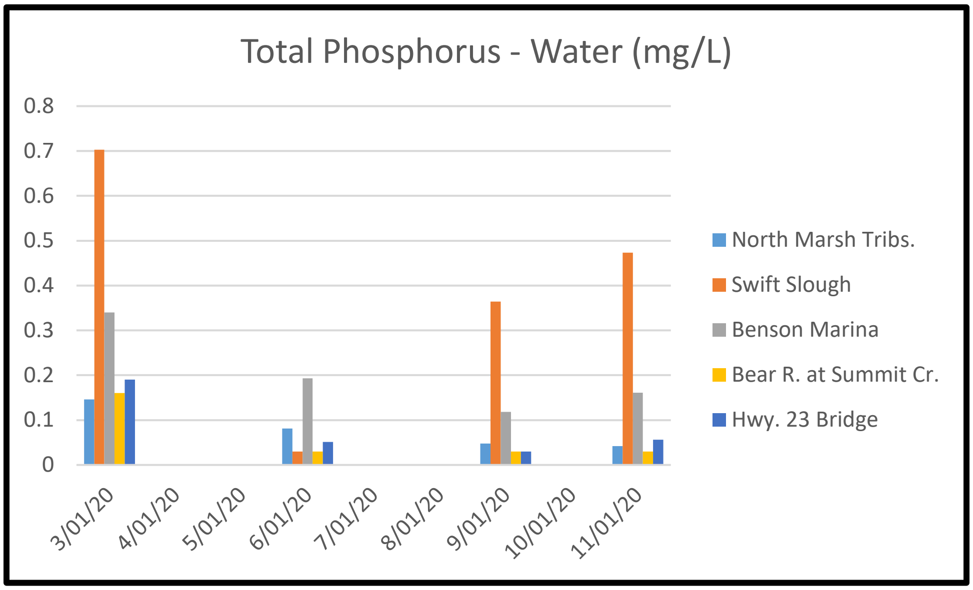


FIGURE 5-16 TOTAL PHOSPHORUS FROM WATER SAMPLES AT FIVE CUTLER RESERVOIR SITES (MARCH, JUNE, SEPTEMBER, NOVEMBER 2020)

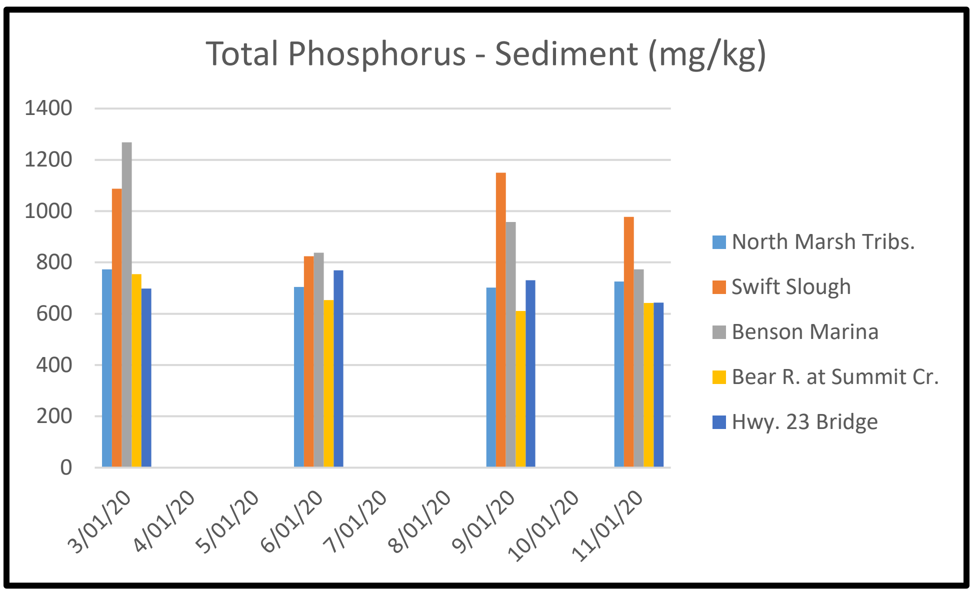


FIGURE 5-17 TOTAL PHOSPHORUS FROM SEDIMENT CORES AT FIVE CUTLER RESERVOIR SITES (MARCH, JUNE, SEPTEMBER, NOVEMBER 2020)

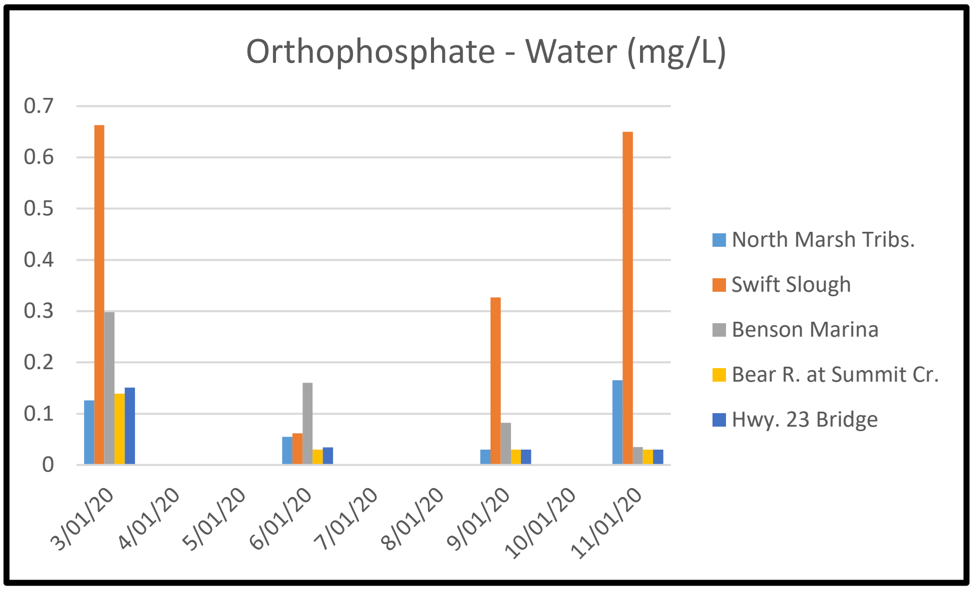


FIGURE 5-18 ORTHOPHOSPHATE FROM WATER SAMPLES AT FIVE CUTLER RESERVOIR SITES (MARCH, JUNE, SEPTEMBER, NOVEMBER 2020)

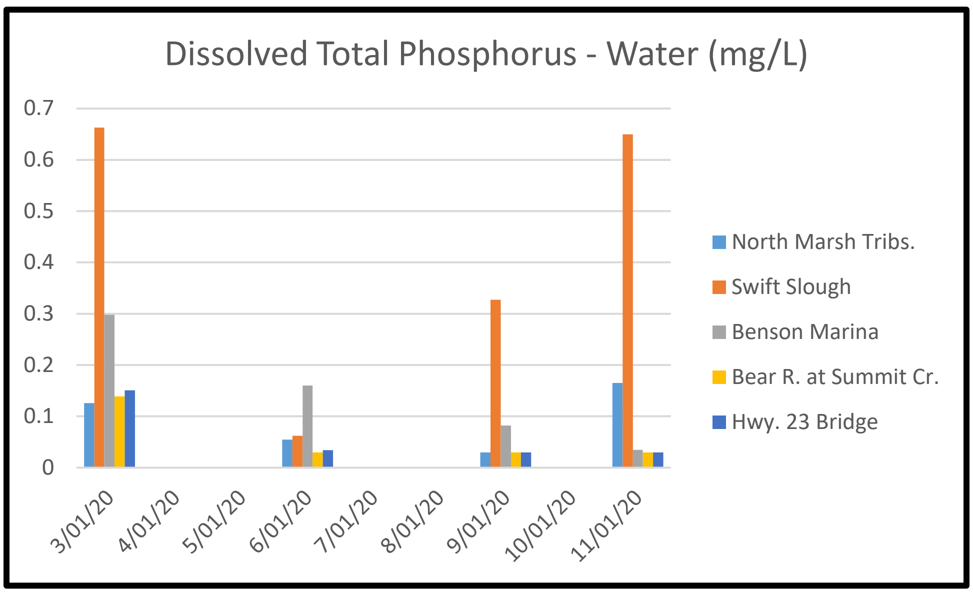


FIGURE 5-19 DISSOLVED TOTAL PHOSPHORUS FROM WATER SAMPLES AT FIVE CUTLER RESERVOIR SITES (MARCH, JUNE, SEPTEMBER, NOVEMBER 2020)

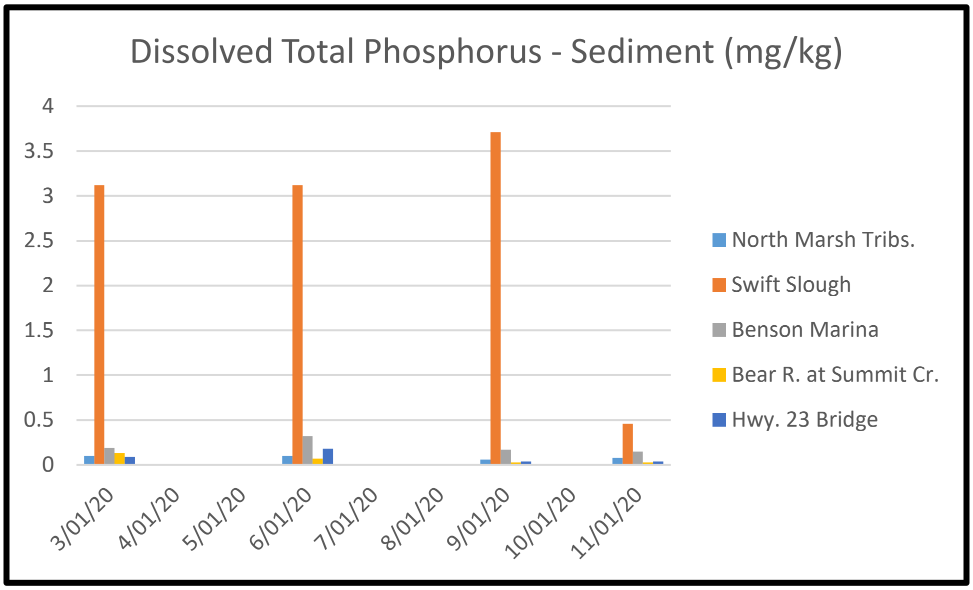


FIGURE 5-20 DISSOLVED TOTAL PHOSPHORUS FROM SEDIMENT CORES AT FIVE CUTLER RESERVOIR SITES (MARCH, JUNE, SEPTEMBER, NOVEMBER 2020)

6.0 SUMMARY

All methods requested in the approved FERC Study Plan Determination were applied and completed in this ISR. There were no new methodologies that were not in the approved RSP. Given the large amount of past and current water quality data, and that UDWQ is collecting new data in 2020, this water quality study filled the data needs identified by PacifiCorp/stakeholders in the RSP, and by FERC in the Study Plan Determination. No additional data gaps emerged and further study of water quality conditions in Cutler Reservoir is not necessary to address the potential effects of continued Project operation. The available data demonstrate that there are very little differences between years and between data collected by different entities. In addition, PacifiCorp will repeat its 5-year water quality monitoring effort in 2023. The only questionable (anomalous and potentially erroneous) existing data are the 2013 TP values reported in the 2018 Water Quality Monitoring Report (PacifiCorp 2020). UDWQ's monitoring in 2020, and TP, OP, and DTP levels measured during the sediment study in 2020, in conjunction with PacifiCorp's future (and final in the current license period) monitoring in three years, should make it even clearer that the 2013 data were anomalous and that data should be disregarded because there is no way to determine the efficacy of the TP sampling performed in 2013; all other monitoring data show concentrations at much higher levels than those observed in 2013.

These study results are sufficient for PacifiCorp to conduct an impact and effects analysis for the DLA once future Project operations are defined; therefore, no additional water quality studies are recommended, and this report concludes the Project's Water Quality Study.

7.0 REFERENCES

Abbott, B., N. Braithwaite, J. Elsner, P. Mason, J. Randal, and D. Epstein. 2009. Comparative Limnological Analysis of Cutler Reservoir and Dingle Marsh with respect to Eutrophication. Aquatic ecology practicum class report. Logan: Watershed Sciences Department, College of Natural Resources, Utah State University.

Aquatic Ecosystem Restoration Foundation (AERF). 2014. *Biology and Control of Aquatic Plants: A Best Management Practices Handbook*. Fort Lauderdale: University of Florida.

Boyd, C.E. 1971. The limnological role of aquatic macrophytes and their relationship to reservoir management. In *Reservoir Fisheries and Limnology*, edited by G.E. Hall, pp. 153-166 Special Publication No. 8. Bethesda, Maryland: American Fisheries Society.

Budy, P., M. Baker, and K. Dahle. 2011. Predicting fish growth potential and identifying water quality constraints: A spatially-explicit bioenergetics approach. *Environmental Management* 2011: 48: Article number 691. https://doi.org/10.1007/s00267-011-9717-1

Budy, P., K. Dahle, and G. Thiede. 2007. *An Evaluation of the Fish Community of Cutler Reservoir and the Bear River above the Reservoir with Consideration of the Potential for Fisheries Enhancement*. Annual report. Salt Lake City: Utah Department of Environmental Quality.

City of Logan. 2015. *Wastewater Treatment Final Master Plan-Final Draft*. Utah: City of Logan.

Google. 2020. Random number generator. https://www.google.com/search?client=firefox-b-1-d&q=random+number+generator. Accessed October 3, 2019.

Ho-Sub, K., S. Hwang, J. Shin, K. An, and C. Yoon. 2007. Effects of limiting nutrients and N:P ratios on the phytoplankton growth in a shallow hypereutrophic reservoir. *Hydrobiologia* 581 (Special Issue: Eutrophication of Shallow Lakes with Special Reference to Lake Taihu, China, edited by B. Qin, Z. Liu, and K. Havens): 255–267.

Mears, J.D., and W.A. Wurtsbaugh (eds.). 2009. Limnological Analyses of Cutler Reservoir and Dingle Marsh with respect to Eutrophication. Aquatic ecology practicum class report. Logan: Watershed Sciences Department, College of Natural Resources, Utah State University.

Oram, B. 2020. Nitrates and nitrites in drinking water groundwater and surface waters. Water Research Center. https://water-research.net/index.php/nitrate. Accessed June 25, 2020

PacifiCorp. 2021 *Fish and Aquatics Initial Study Report for Cutler Reservoir, Utah*. Utah: Salt Lake City. In preparation.

PacifiCorp. 2020. 2018 *Water Quality Analysis and Summary for Cutler Reservoir, Utah*. Stand-alone water quality report prepared for inclusion in the *Resource Management Plan Five-Year Implementation and Monitoring Report: 2018-2022.* Salt Lake City, Utah: SWCA Environmental Consultants.

PacifiCorp. 2018. *Cutler Hydroelectric Project, FERC Project No. 2420, Resource Management Plan Five-Year Implementation and Monitoring Report: 2013-2018*. Prepared for Federal Energy Regulatory Commission, Portland Regional Office, Oregon.

PacifiCorp. 2013. *Water Quality Analysis and Summary for Cutler Reservoir, Utah*. In: *Cutler Hydroelectric Project, FERC Project No. 2420, Resource Management Plan Five-Year Implementation and Monitoring Report: 2013-2017*. Salt Lake City, Utah: SWCA Environmental Consultants.

PacifiCorp. 2008. *Water Quality Analysis and Summary for Cutler Reservoir, Utah*. In: *Cutler Hydroelectric Project, FERC Project No. 2420, Resource Management Plan Five-Year Implementation and Monitoring Report: 2008-2012*. Salt Lake City, Utah: SWCA Environmental Consultants.

PacifiCorp. 2002. *Cutler Hydroelectric Project, FERC Project No. 2420, Resource Management Plan Five-Year Implementation and Monitoring Report: 1995-2002*. Vol. 1. Prepared for Federal Energy Regulatory Commission, Portland Regional Office, Oregon.

Parker, R. and R. Comes. 1982. *Aquatic vegetation management and control*. Pullman: Washington State University and U.S. Department of Agriculture, Agricultural Research Service.

Rice, E.W., R.B. Baird, and A.D. Eaton (eds.). 2017. *Standard Methods for the Examination of Water and Wastewater*. 23rd edition. American Public Health Association, American Waterworks Association, and Water Environment Federation, Washington, D.C.

Siriwardana, C., A.T. Cooray, S. S. Liyanage, and S.M. Koliyabandara. 2018. Seasonal and spatial variation of dissolved oxygen and nutrients in Padaviya Reservoir, Sri Lanka. *Journal of Chemistry* Vol. 2019: Article ID 5405016.

SWCA Environmental Consultants (SWCA). 2010. *Middle Bear River and Cutler Reservoir Total Maximum Daily Load (TMDL)*. Prepared for Utah Division of Water Quality, Salt Lake City.

Systma, M. and M. Parker. 1999. *Aquatic Vegetation in Irrigation Canals: A Guide to Integrated Management*. Oregon: Portland State University, Center for Lakes and Reservoirs Publications and Presentations.

U.S. Bureau of Reclamation (Reclamation). 2017. *Canal Operation and Maintenance: Vegetation*. Denver, Colorado: U.S. Department of the Interior, Bureau of Reclamation Office of Policy, Technical Service Center.

U.S. Environmental Protection Agency (USEPA) 2009. Total nitrogen. U.S. Environmental Protection Agency, National Service Center for Environmental Publications. EPA Publication No. 909R09020. https://www.epa.gov/nscep. Accessed June 30, 2020.

Utah Division of Water Quality (UDWQ). 2002. Spring Creek TMDL. UDWQ, Salt Lake City Utah Division of Water Quality.

Utah Division of Water Quality (UDWQ). 2000. *Little Bear River TMDL*. Salt Lake City: Utah Division of Water Quality.

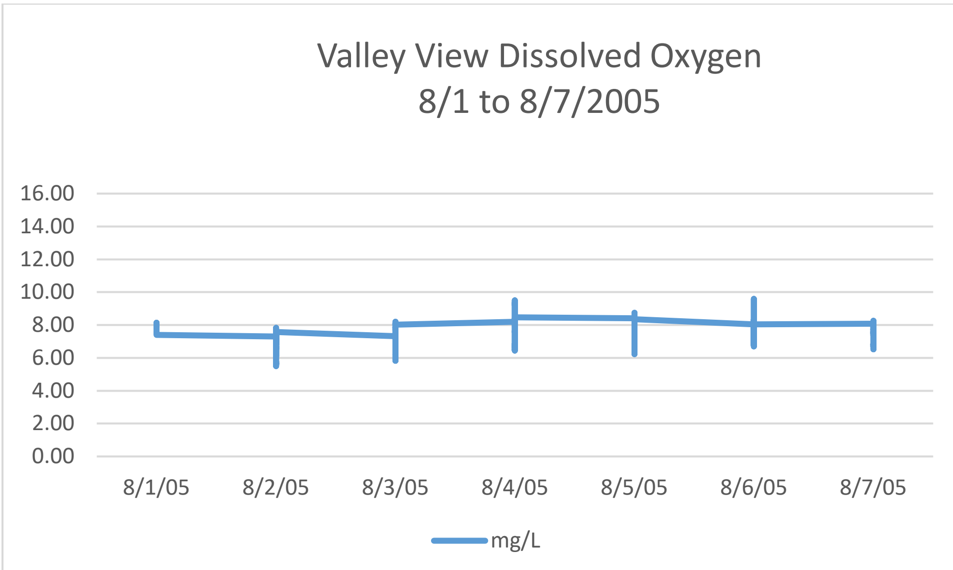
Wurtsbaugh, W.A., and R. Lockwood (eds.). 2007. Comparison of Limnological Characteristics in Cutler Reservoir (Utah) near the Inflows of the Logan River and the Logan Wastewater Treatment Plant*.* Aquatic ecology practicum class report. Logan: College of Natural Resources, Utah State University.

Yeo, R.R. and J.R. Thurston. 1984. The effect of dwarf spikerush (*Eleocharis coloradensis*) on several submersed aquatic weeds. Journal of Aquatic Plant Management – Volume 22:52-56.

ATTACHMENT F-1

FIGURES AND TABLES DERIVED FROM 2005-2007 ERI DATABASE

Attachment F-1 Figures. Dissolved oxygen and water temperature data collected by Ecosystems Research Institute, summer 2005 through 2007.



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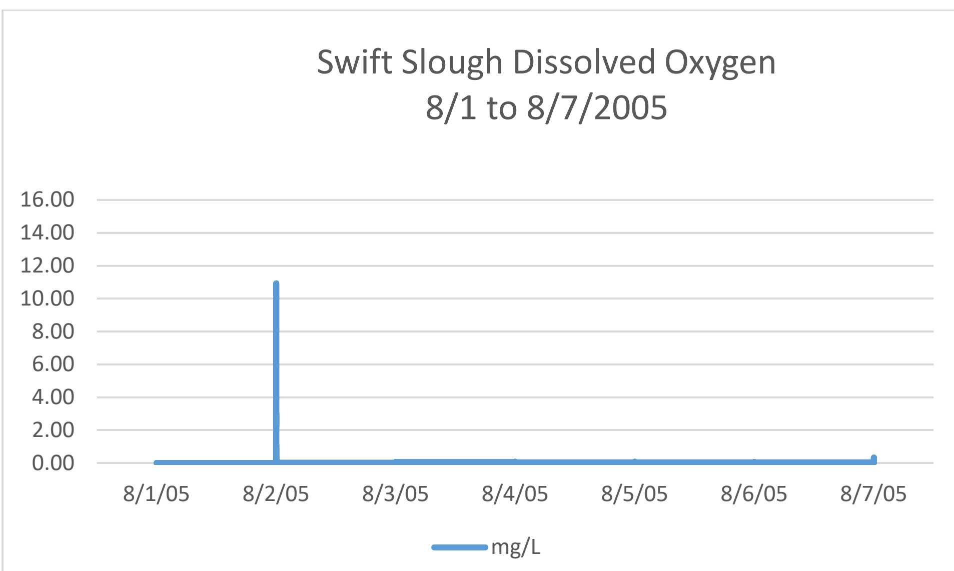

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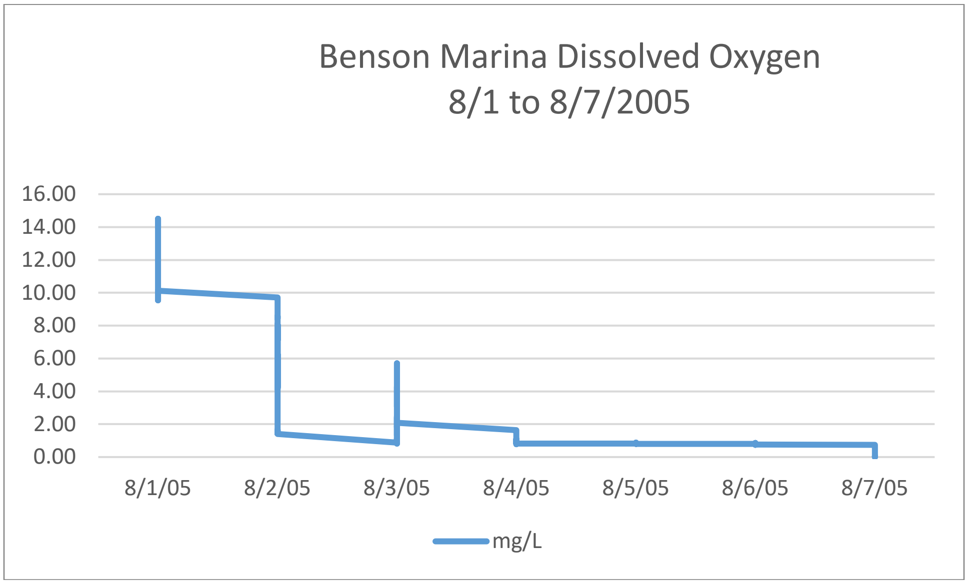

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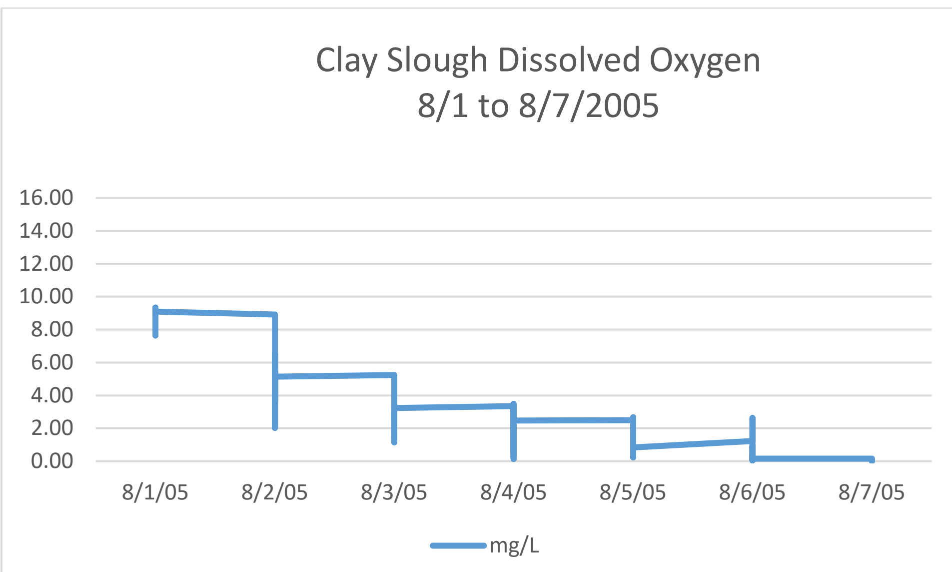

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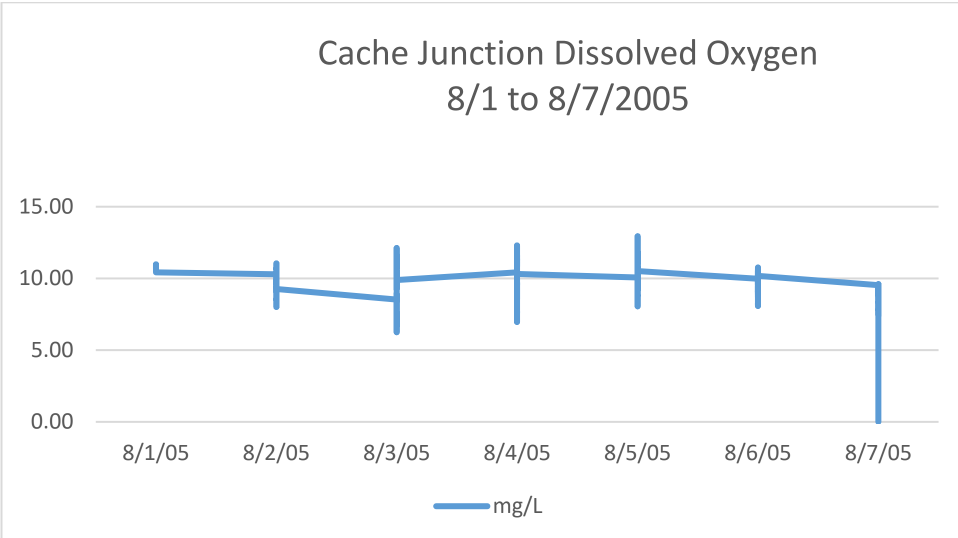

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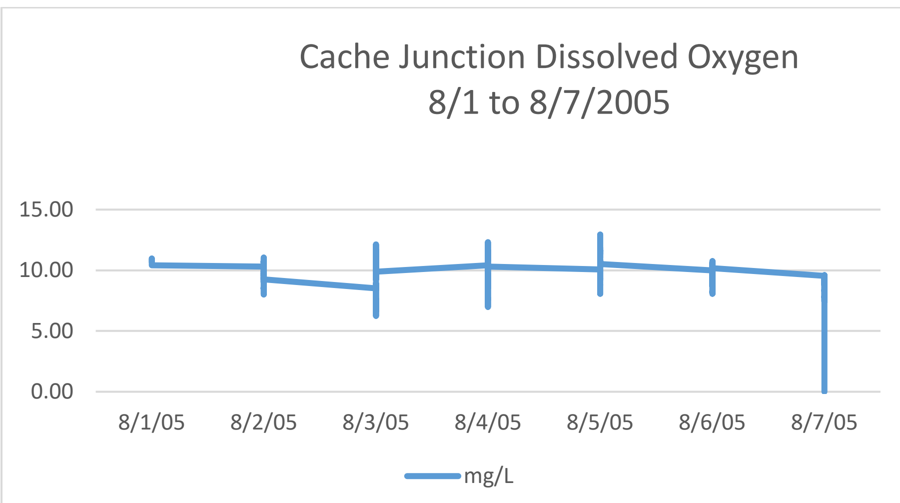

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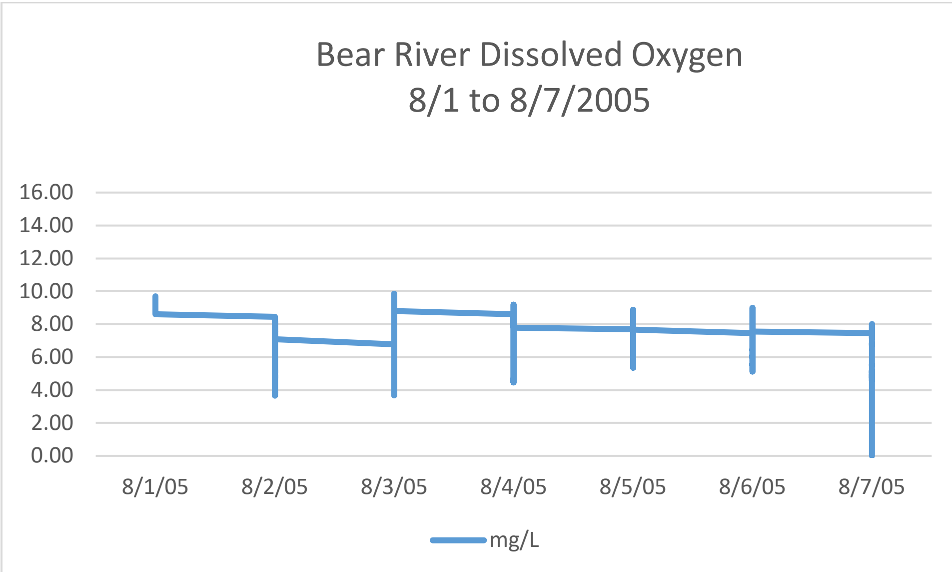

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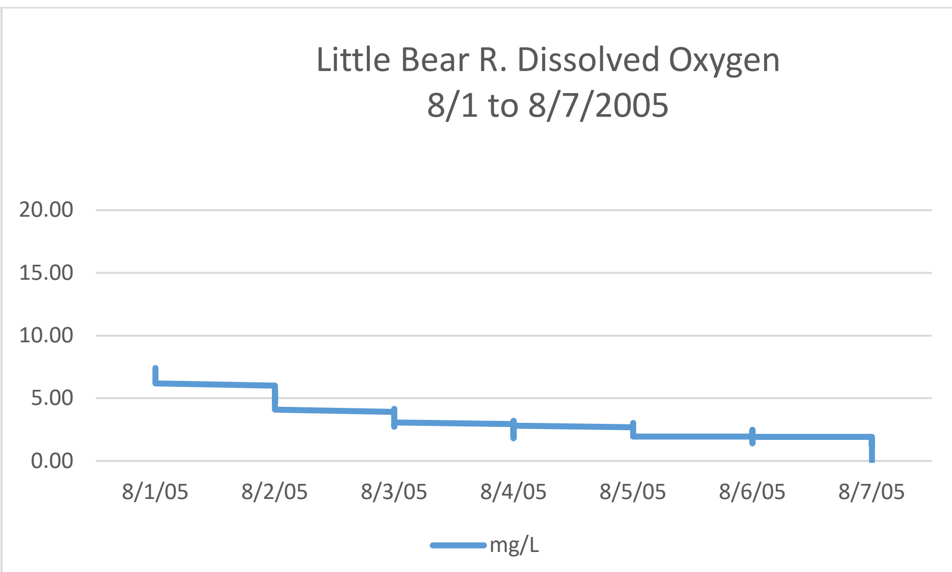

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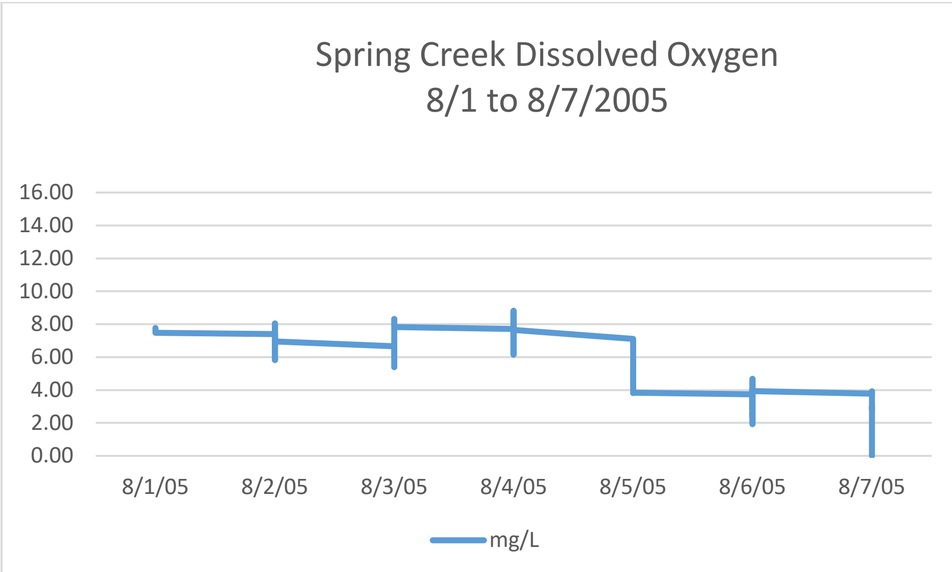

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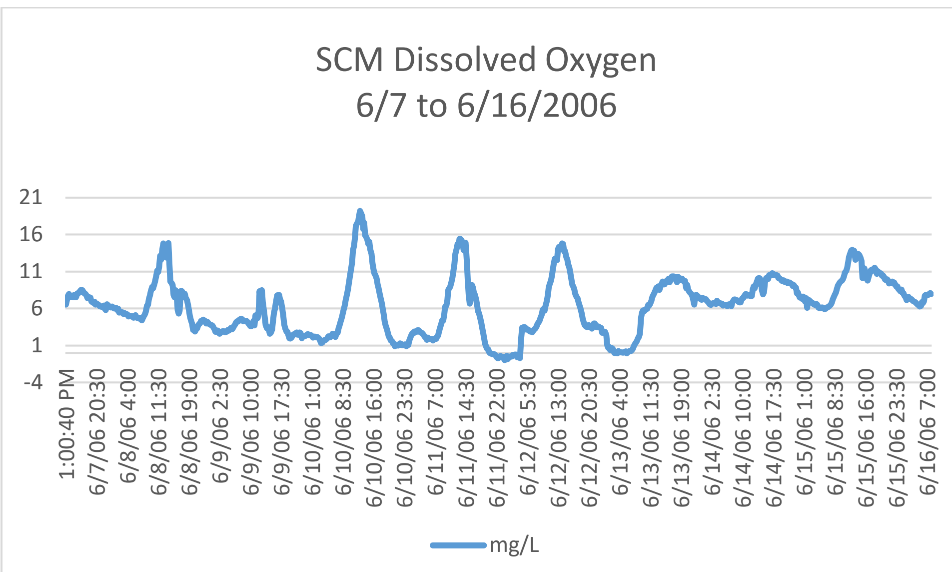

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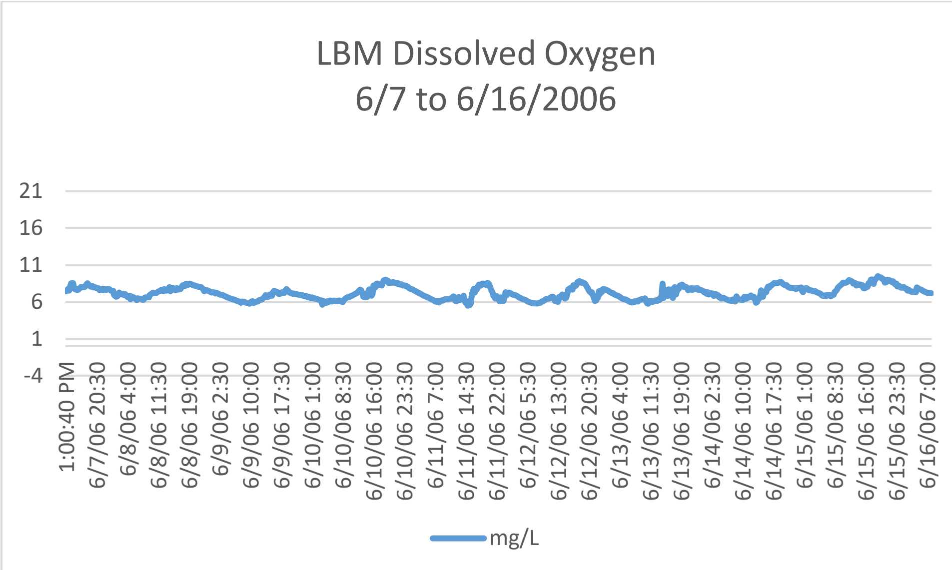

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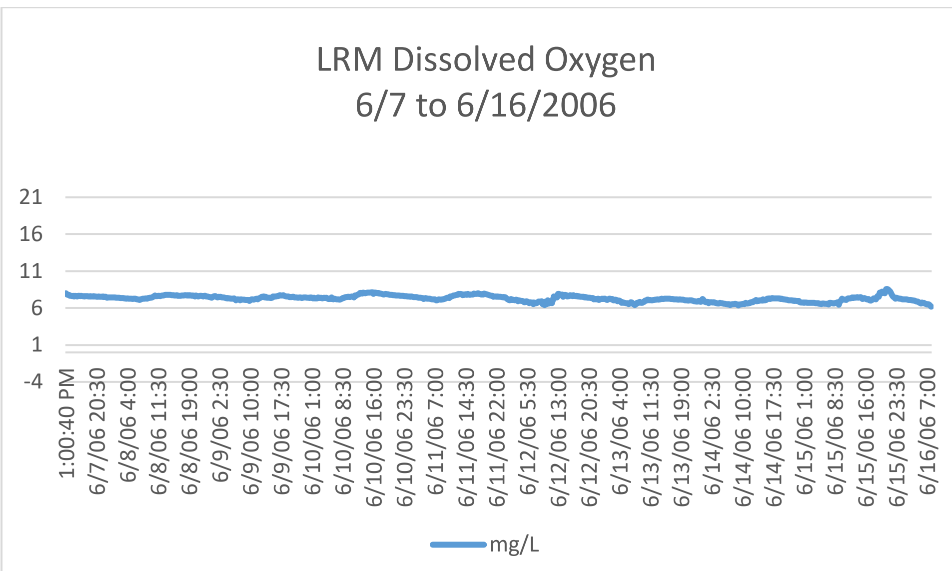

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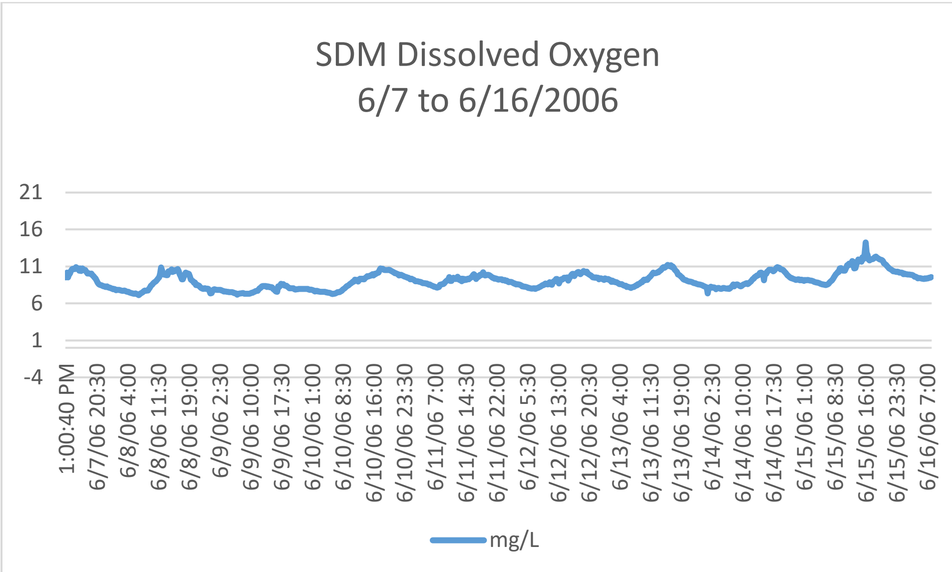

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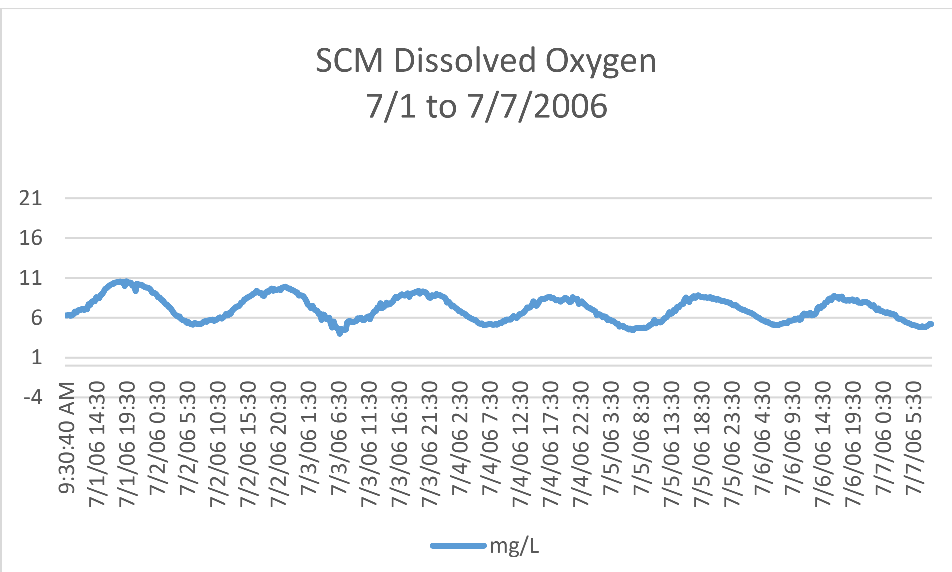

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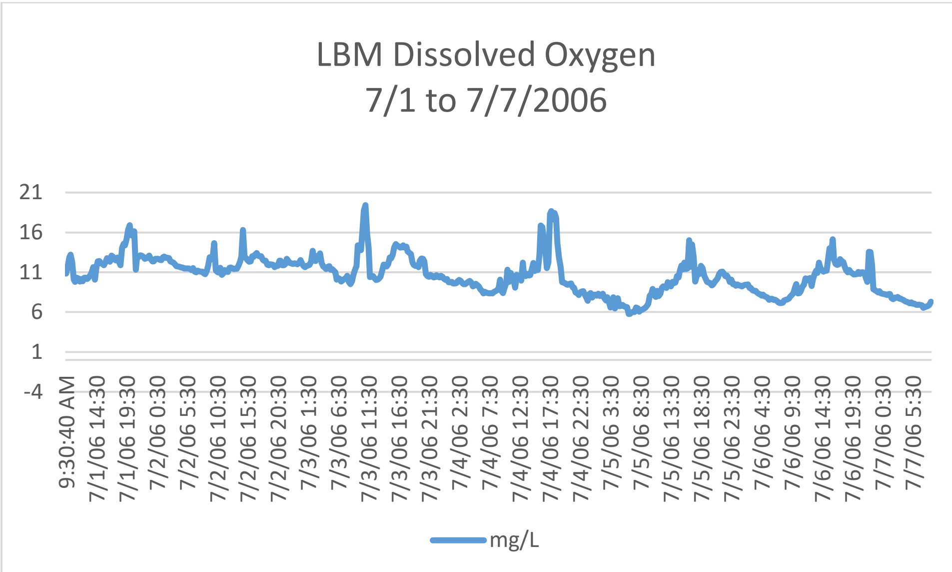

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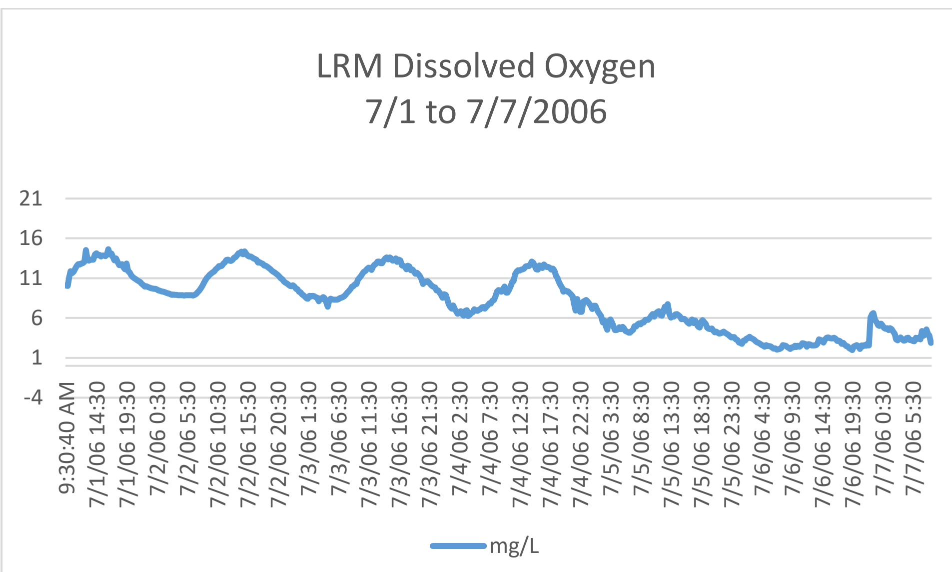

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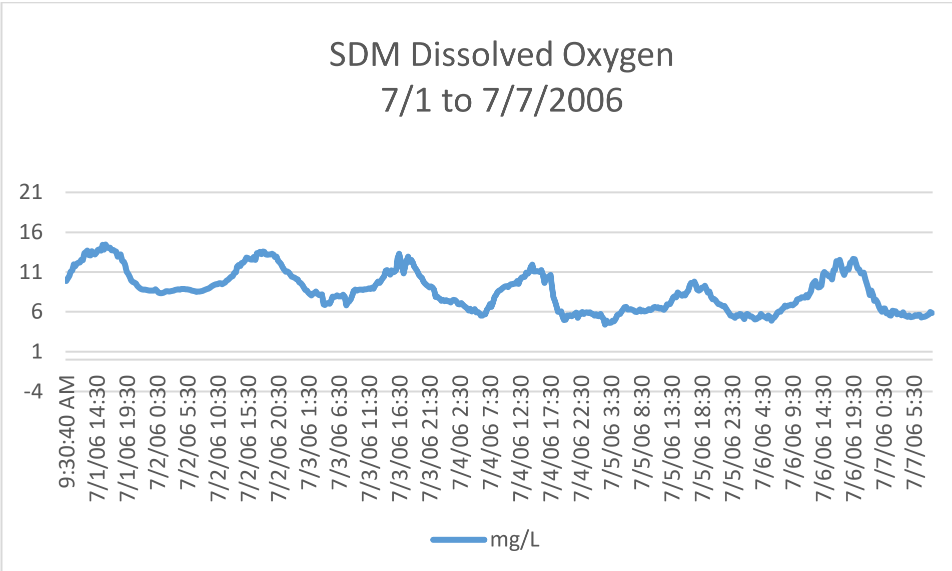

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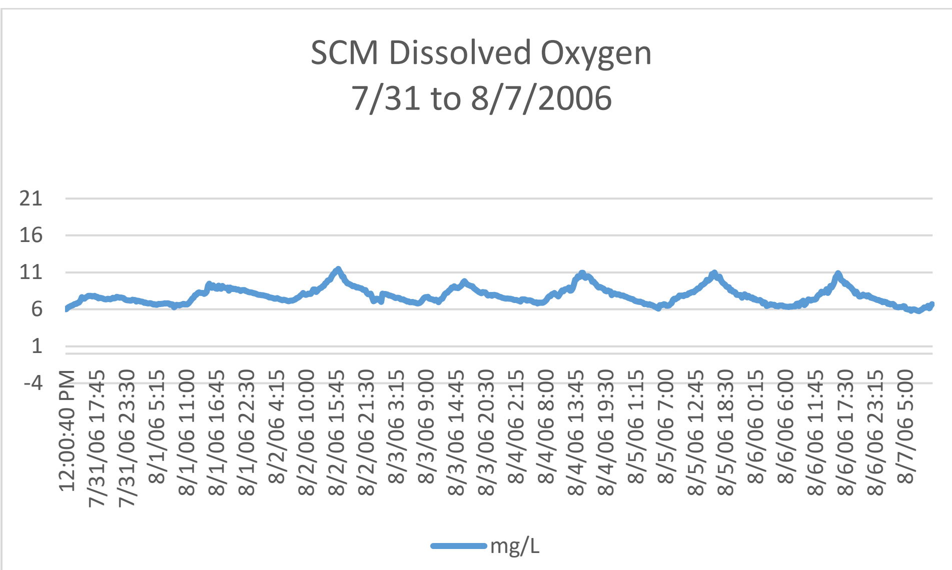

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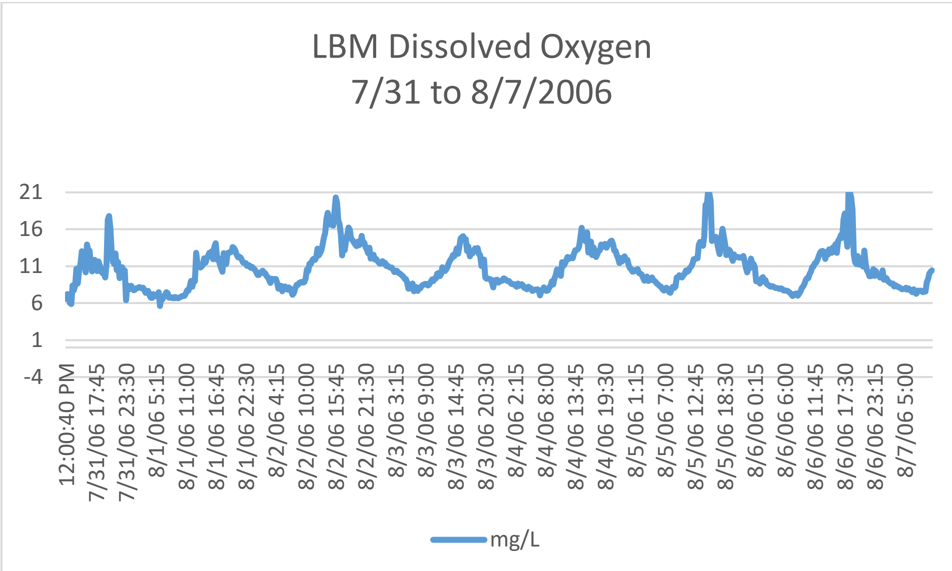

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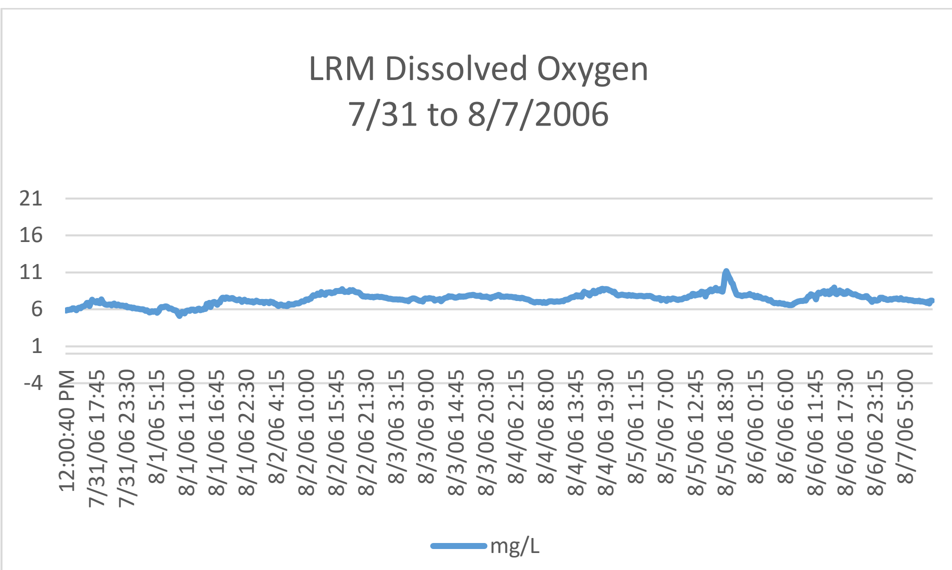

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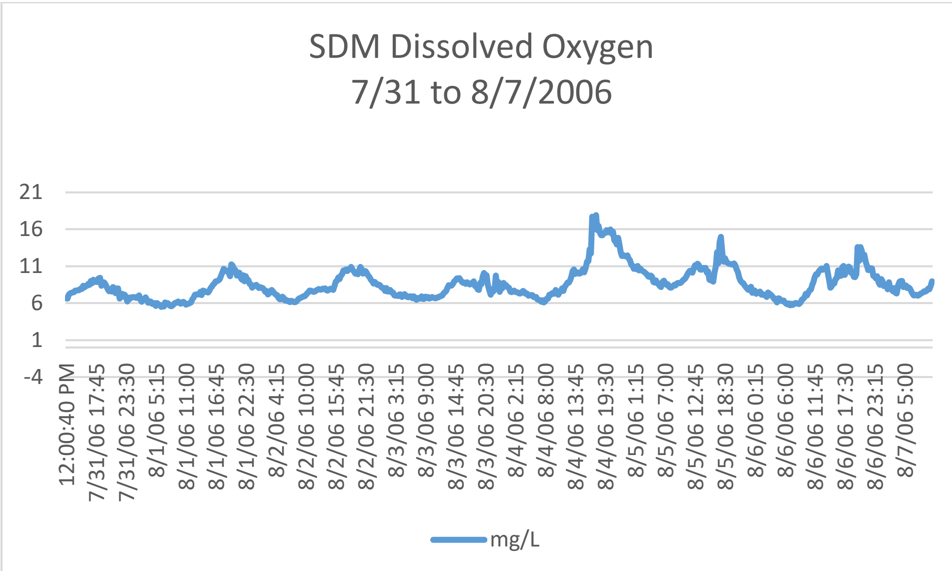

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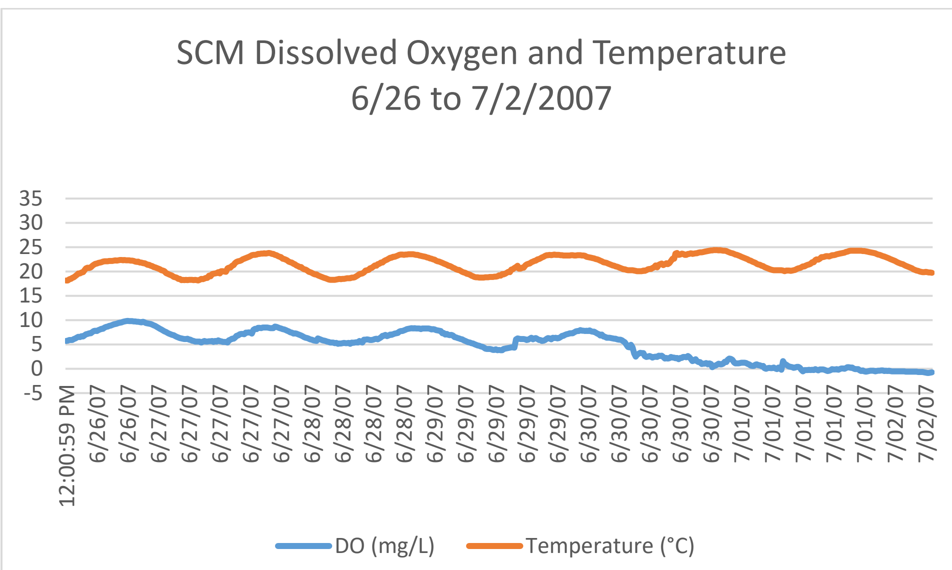

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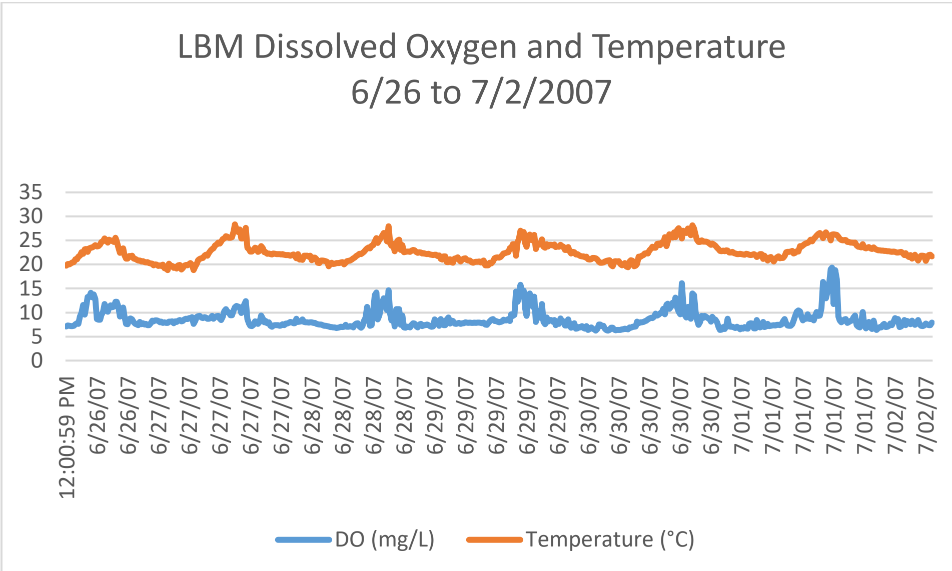

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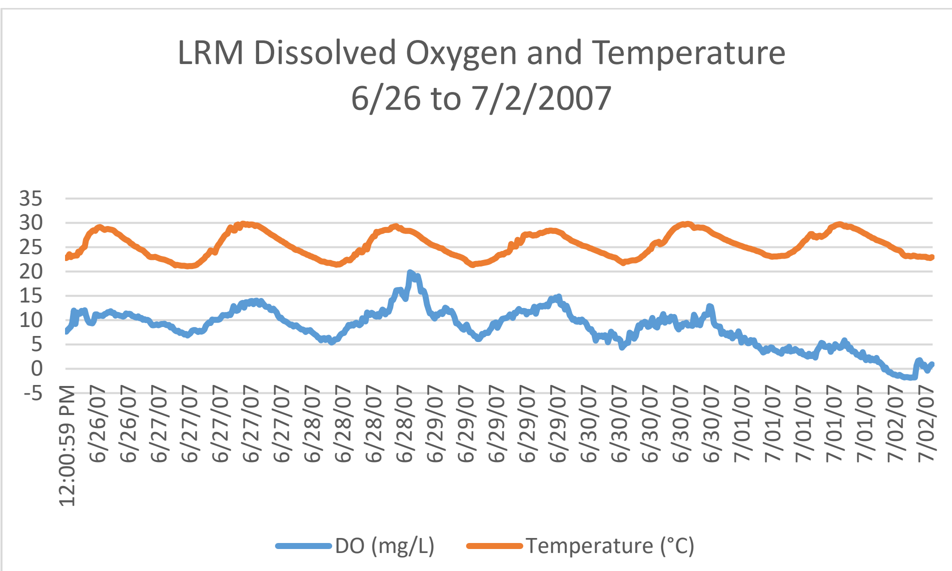

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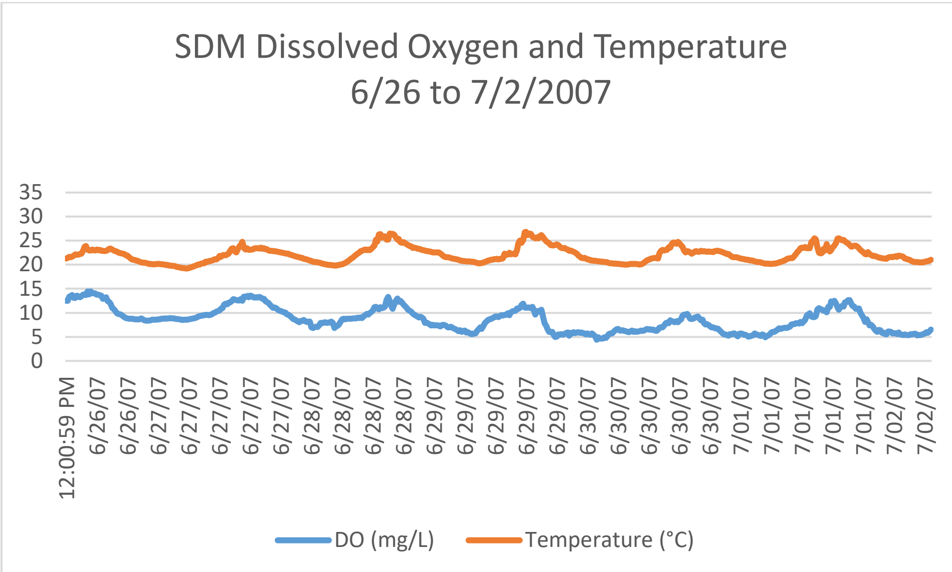

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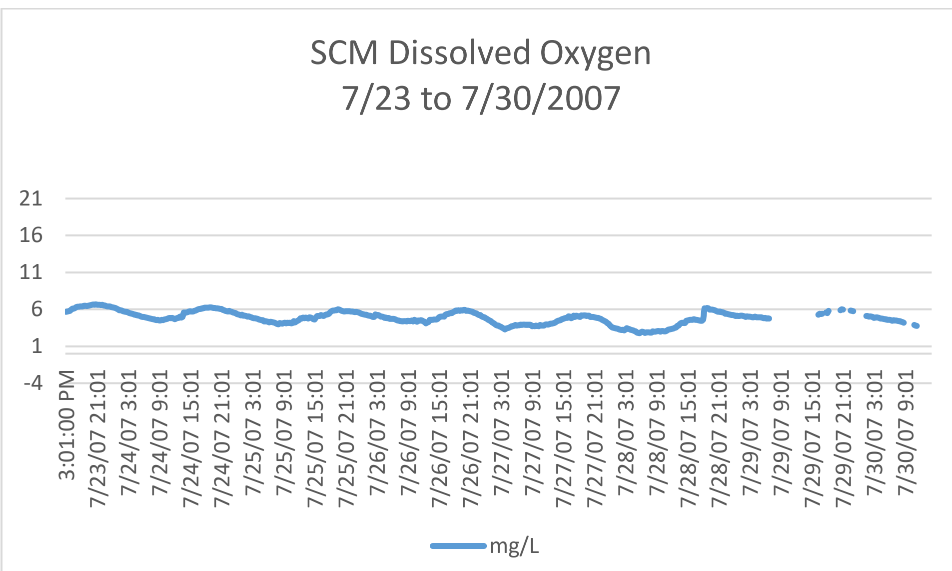

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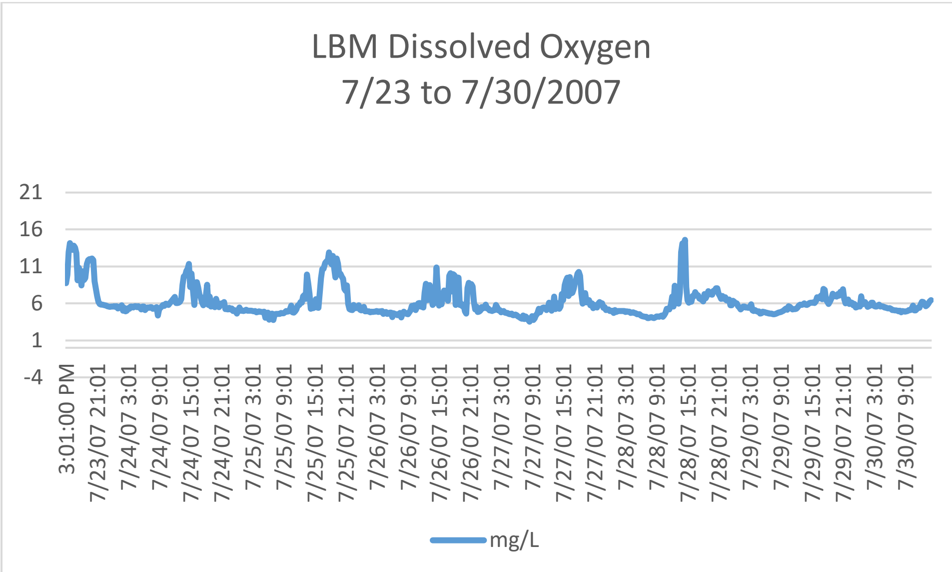

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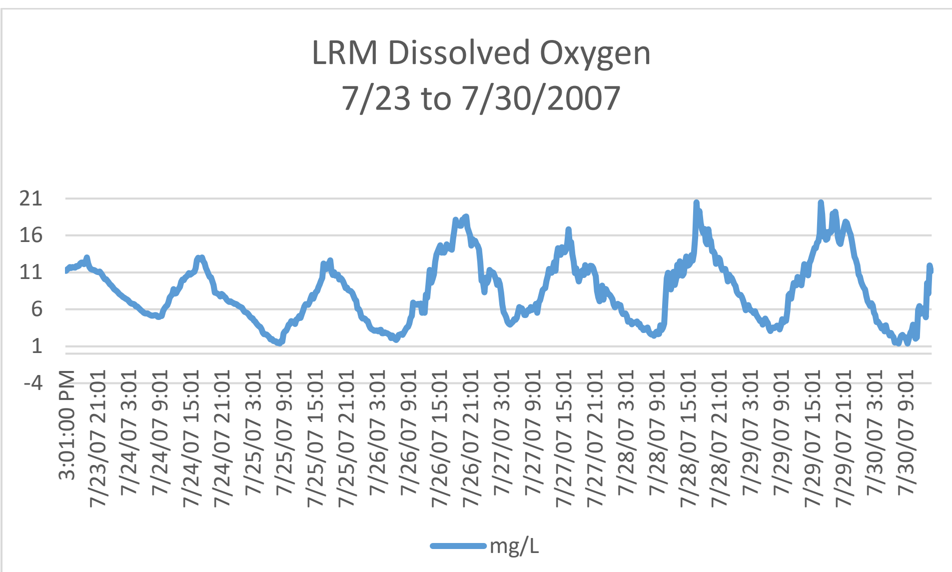

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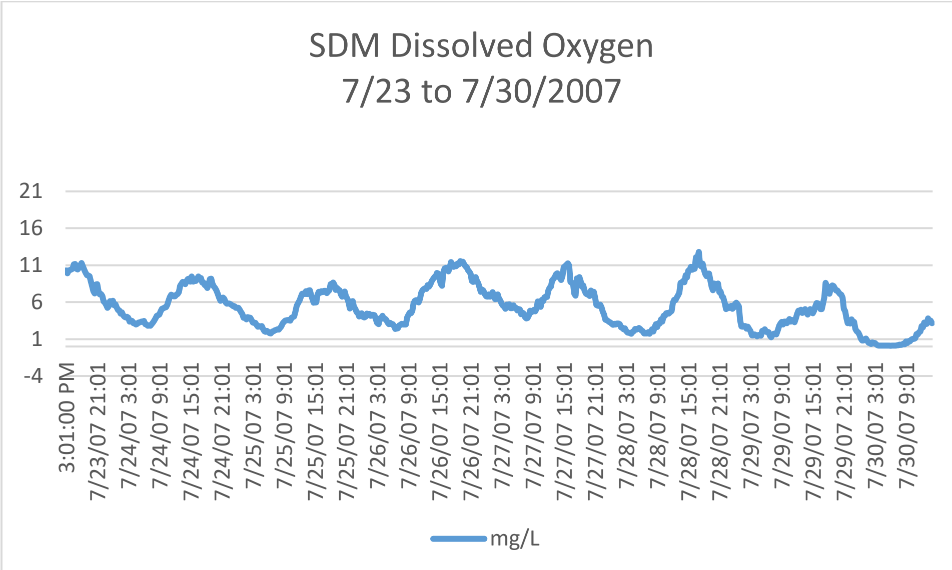

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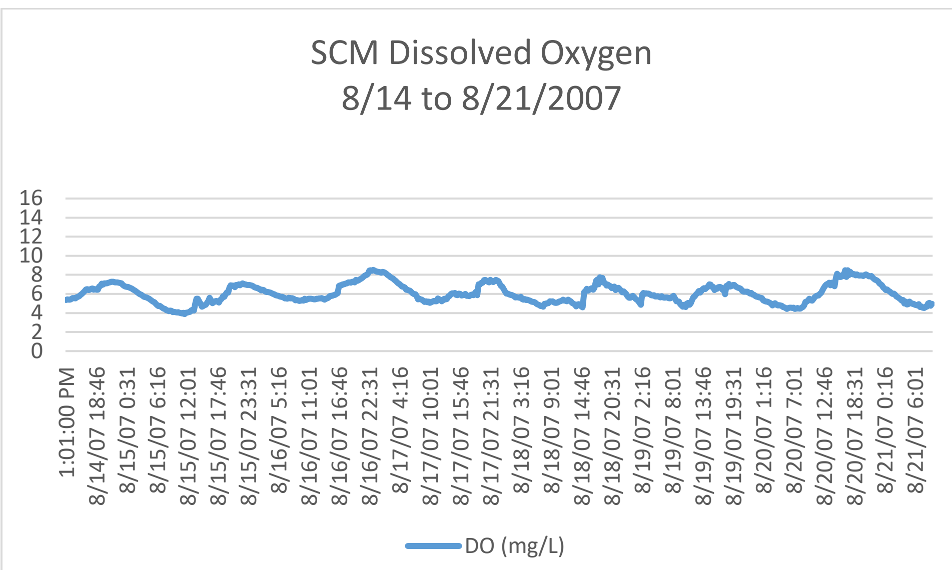

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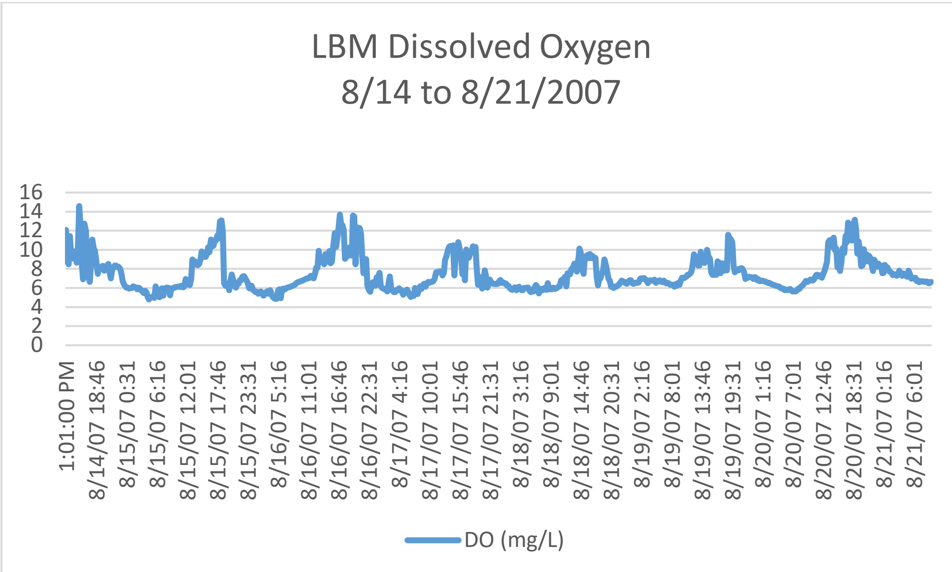

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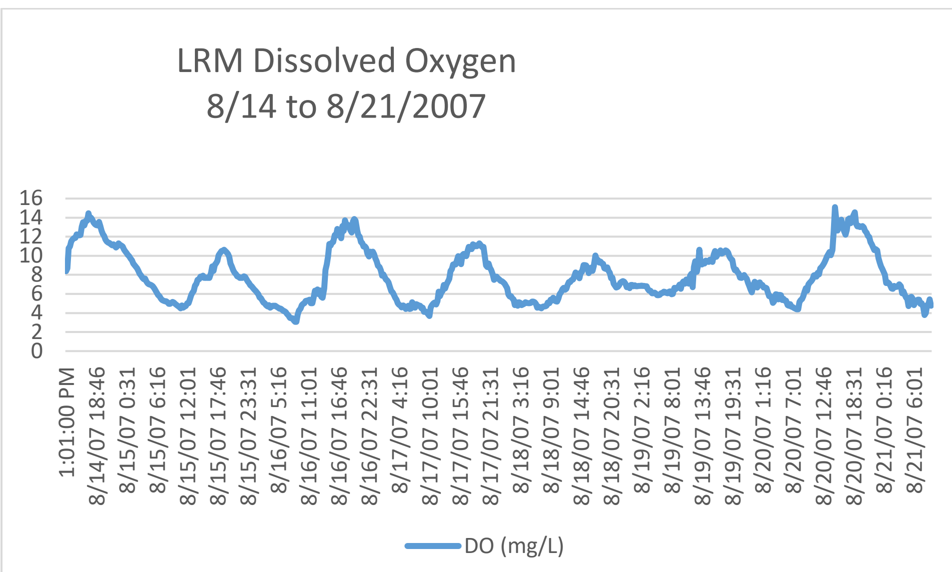

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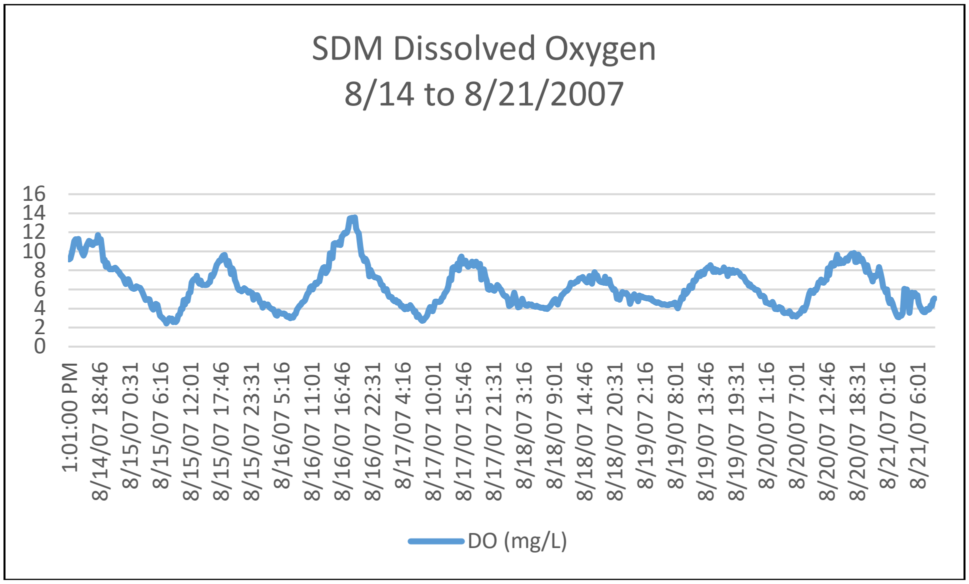
SDM Dissolved Oxygen
8/14 to 8/21/2007
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8/19/07 2:16
8/19/07 8:01
8/19/07 13:46
8/19/07 19:31
8/20/07 1:16
8/20/07 7:01
8/20/07 12:46
8/20/07 18:31
8/21/07 0:16
8/21/07 6:01
DO (mg/L)

Figure F-33.

TABLE F-1. SUMMARY MONTHLY WATER QUALITY DATA COLLECTED AT MARSH SITES ON CUTLER RESERVOIR, 2005 THROUGH 2007

MONTH/YEAR	MARSH SITE	TP (MG/L)	ORTHOPHOSPHATE (MG/L)	TURBIDITY (NTU)	NH_3 (MG/L)	NO_3+NO_2 (MG/L)	NO_2 (MG/L)	TSS (MG/L)
September 2005	LBM	0.398	0.327	8.4	0.035	3.269	0.015	17
	SCM	0.405	0.341	11.0	0.188	2.792	0.016	22
	LRM	0.04	0.02	4.5	0.034	0.362	0.004	7
	SDM	0.248	0.176	18	0.038	0.091	0.003	29
November 2005	LBM	0.35	0.309	2.3	0.198	1.848	0.036	6
	SCM	0.316	0.292	2.3	0.176	2.932	0.035	6
	LRM	0.04	0.03	1.8	0.035	0.379	0.006	2
	SDM	0.197	0.173	3	0.095	1.287	0.022	5
January 2006	LBM	0.242	1.156	36	0.175	0.884	0.016	27
	SCM	0.456	0.319	22	0.409	1.754	0.015	68
	LRM	0.115	0.06	4.3	0.315	0.669	0.004	23
	SDM	0.304	0.231	26	0.235	1.429	0.001	28
February 2, 2006	LBM	0.508	0.378	11	0.359	3.063	0.01	29.4
	SCM	0.515	3.76	8	0.29	2.883	0.011	50.6
	LRM	0.05	0.014	8.4	0.044	0.39	0.037	34.1
	SDM	0.371	0.254	27	0.234	2.167	0.001	80.7
February 28, 2006	LBM	0.172	0.084	13	0.359	0.962	0.019	16.5
	SCM	0.48	0.337	15	0.268	3.118	0.036	72.7
	LRM	0.102	0.01	33	0.039	0.356	0.005	87.9
	SDM	0.158	0.08	16	0.062	1.08	0.017	45.4
April 2006	LBM	0.074	0.012	21	0.034	0.279	0.001	35.4
	SCM	0.219	0.154	14	0.235	1.585	0.022	33.9
	LRM	0.066	0.23	13	0.036	0.328	0.004	30.5
	SDM	0.156	0.098	16	0.063	1.03	0.001	27.3
May 2006	LBM	0.057	0.026	9.2	0.038	0.145	0.005	18
	SCM	0.09	0.052	5.4	0.04	0.527	0.013	11.6
	LRM	0.039	0.018	14	0.037	0.11	0.003	17.9
	SDM	0.068	0.032	9.4	0.037	0.217	0.006	13.8

MONTH/YEAR	MARSH SITE	TP (MG/L)	ORTHOPHOSPHATE (MG/L)	TURBIDITY (NTU)	NH_3 (MG/L)	NO_3+NO_2 (MG/L)	NO_2 (MG/L)	TSS (MG/L)
June 2006	LBM	0.086	0.032	18	0.038	0.353	0.012	34.4
	SCM	0.154	0.065	14	0.038	0.353	0.012	34.4
	LRM	0.049	0.016	14	0.037	0.128	0.003	24.9
	SDM	0.095	0.032	22	0.037	0.245	0.007	49.2
July 7, 2006	LBM	0.177	0.077	3	0.061	1.077	0.032	71.4
	SCM	0.209	0.106	19	0.103	1.316	0.034	53.3
	LRM	0.049	0.013	7.9	0.039	0.209	0.004	24.9
	SDM	0.127	0.034	25	0.039	0.29	0.013	55.1
July 31, 2006	LBM	0.107	0.024	26	0.088	1.085	0.042	54.5
	SCM	0.164	0.078	20	0.088	2.397	0.04	62.1
	LRM	0.101	0.03	19	0.044	0.177	0.007	52.3
	SDM	0.139	0.028	37	0.207	0.359	0.018	86.8
August 2006	LBM	0.118	0.027	44	0.037	0.458	0.027	73.7
	SCM	0.232	0.161	13	0.037	1.958	0.018	37.6
	LRM	0.164	0.007	11	0.04	0.008	0.004	69.1
	SDM	0.152	0.08	11	0.039	1.026	0.016	34.6
September 2006	LBM	0.302	0.26	11	0.037	3.033	0.019	21.1
	SCM	0.31	0.282	14	0.037	3.056	0.018	26.6
	LRM	0.038	0.028	7.7	0.042	0.42	0.006	12.2
	SDM	0.173	0.146	13	0.036	1.601	0.018	17.1
November 2006	LBM	0.204	0.171	9.7	0.096	1.689	0.034	18.6
	SCM	0.293	0.241	7.1	0.141	2.076	0.045	29.7
	LRM	0.057	0.015	3.9	0.045	0.287	0.004	50.4
	SDM	0.177	0.123	8.4	0.045	1.395	0.027	30.2
February 2007	LBM	0.746	0.636	20	1.293	4.742	0.049	60.1
	SCM	0.847	0.755	9	1.464	5.099	0.053	35.6
	LRM	0.05	0.012	3.2	0.063	0.322	0.004	25.3
	SDM	0.225	0.175	4.7	0.358	1.501	0.016	18.1
March 2007	LBM	0.272	0.186	20	0.095	1.935	0	64.6
	SCM	0.28	0.189	24	0.087	2.028	0	39.7

MONTH/YEAR	MARSH SITE	TP (MG/L)	ORTHOPHOSPHATE (MG/L)	TURBIDITY (NTU)	NH_3 (MG/L)	NO_3+NO_2 (MG/L)	NO_2 (MG/L)	TSS (MG/L)
	LRM	0.071	0.019	16	0.058	0.279	0	28.7
	SDM	0.219	0.104	22	0.107	1.255	0	46.4
April 2007	LBM	0.091	0.037	9.4	0.033	0.674	0.004	61.9
	SCM	0.098	0.034	9.6	0.072	0.618	0.009	56.2
	LRM	0.055	0.006	6.1	0.04	0.164	0.004	61.9
	SDM	0.081	0.033	11	0.06	0.418	0.007	32.3
May 2007	LBM	0.124	0.06	19	0.032	0.672	0.013	35.6
	SCM	0.118	0.073	17	0.04	0.774	0.014	26.8
	LRM	0.052	0.015	8.5	0.03	0.173	0.006	13.2
	SDM	0.116	0.035	25	0.037	0.257	0.01	46.5
June 2007	LBM	0.141	0.055	30	0.068	0.747	0.021	54.1
	SCM	0.153	0.073	28	0.082	1.041	0.025	54
	LRM	0.052	0.015	8.5	0.03	1.173	0.006	13.2
	SDM	0.116	0.035	25	0.037	0.257	0.01	46.5
July 2007	LBM	0.164	0.06	36	0.125	0.471	0.019	62.3
	SCM	0.189	0.089	38	0.132	0.772	0.024	67.6
	LRM	0.091	0.007	24	0.032	0.008	0.002	32.6
	SDM	0.248	0.093	12	0.052	0.007	0.002	91
August 2007	LBM	0.126	0.063	25	0.087	0.612	0.016	42.7
	SCM	0.175	0.068	34	0.103	0.62	0.016	83.6
	LRM	0.052	0.003	18	0.036	0.034	0.014	27.4
	SDM	0.269	0.157	29	0.036	0.013	0.002	50.2

Source: ERI 2005-2007

Appendix G
Hydraulic Modeling Initial Study Report

HYDRAULIC MODELING INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT

(FERC NO. 2420)

Prepared for:

PacifiCorp
Salt Lake City, UT

Prepared by:

Kleinschmidt

February 2021

HYDRAULIC MODELING
INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT

(FERC NO. 2420)

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Salt Lake City, UT

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HYDRAULIC MODELING
INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

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INITIAL STUDY REPORT

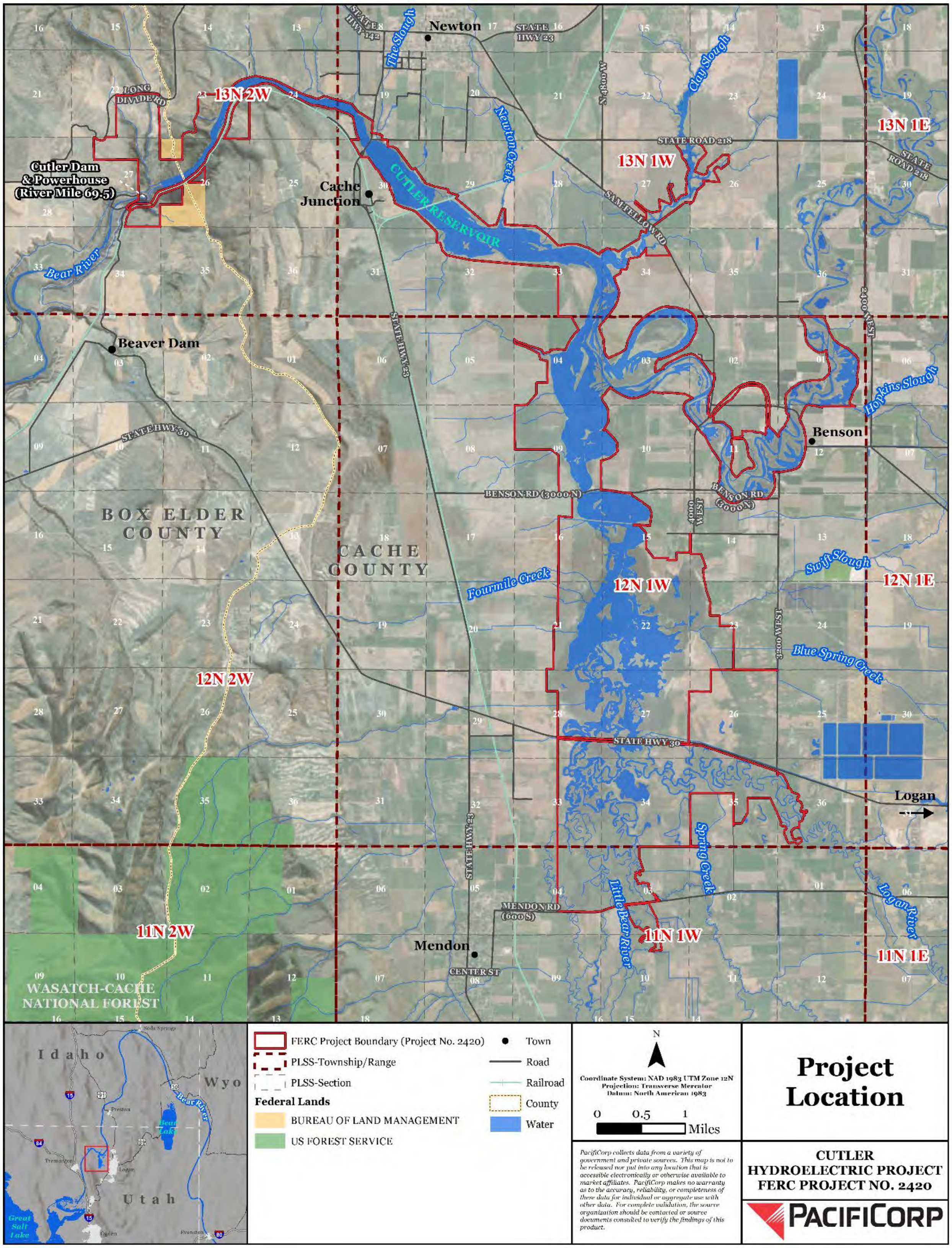
CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

1.0 INTRODUCTION

PacifiCorp is the owner, operator, and Federal Energy Regulatory Commission (FERC) licensee for the Cutler Hydroelectric Project (FERC No. 2420) (Project). The Project is located on the Bear River in Cache Valley, Utah, between the Wasatch and Wellsville Mountains. Cutler Dam is located in Box Elder County; however, most of the Project reservoir lies within Cache County. The Project reservoir is formed at the confluence of Spring Creek and the Bear, Logan, and Little Bear Rivers (Figure 1-1). PacifiCorp operates the Project under a 30-year license issued by FERC on April 29, 1994; the current license will expire on March 31, 2024. PacifiCorp initiated the formal relicensing process utilizing the Integrated Licensing Process (ILP) by filing the Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on March 29, 2019.

The relicensing process involves cooperation and collaboration between PacifiCorp, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. PacifiCorp coordinated with stakeholders throughout the study scoping process, and invited federal and state agencies, NGOs, and Native American tribes and tribal organizations to participate in a public meeting, workshops, scoping meetings, and a site visit. These meetings facilitated the identification of study needs to be addressed. Study scoping occurred in March 2019 through February 2020, when FERC issued the Study Plan Determination. PacifiCorp, FERC, and stakeholders identified the potential need for a hydraulic modeling study during the study scoping process.



Source: PacifiCorp 2018

FIGURE 1-1 CUTLER PROJECT LOCATION MAP

2.0 PROJECT NEXUS AND RATIONALE FOR STUDY

PacifiCorp and stakeholders identified the potential need for a hydraulic modeling study during the study planning process. Potential changes in the operation of the Project could change the way in which the system functions hydraulically, potentially affecting inundation boundaries, flow patterns, sediment transport capacity, and other hydraulic behaviors of Cutler Reservoir. Therefore, it was important to create modeling tools capable of evaluating potential Project operating scenarios and assess their potential effects. In addition, the model established a baseline of existing conditions from which to assess potential hydraulic and sediment impacts associated with potential changes in Project operation.

The hydraulic modeling study was developed to evaluate the existing hydraulic conditions of the Project as well as assess the feasibility and potential impacts that may result from the potential change in future operations as described in the PAD (PacifiCorp 2019).

3.0 REVIEW OF EXISTING INFORMATION

Per the Hydraulic Modeling Study Plan, existing data were reviewed and incorporated into the hydraulic model, as appropriate. The following is an initial list of data sources that were analyzed as part of this study (where data was available, see Section 6.1):

- Hydraulic models within the Project vicinity
- Previous Light Detection and Ranging (LiDAR) and bathymetric surveys
- Bridge and other infrastructure hydraulic data
- U.S. Geological Survey (USGS) and PacifiCorp streamflow gage data
- Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) data

4.0 STUDY OBJECTIVES

The purpose of the hydraulic modeling study was to develop and collect data for calibration of both 1-dimensional (1D) and 2-dimensional (2D) hydraulic models to be used for hydraulic and sediment transport analysis. Both 1D and 2D hydraulic models of the Project were developed as part of the study process following preliminary LiDAR and bathymetric data collection that occurred during the fall 2019 drawdown. This included portions of the Bear River upstream and downstream of the reservoir. A calibrated hydraulic model was used to predict impacts to the hydraulics and sediment transport in order to inform potential changes to Project operations.

4.1 STUDY AREA

Per the Revised Study Plan (RSP) (Section 3.3.4), the study area for the hydraulic modeling effort (Model Boundary) originally included a preliminary estimate of an additional 2 miles beginning at the powerhouse and continuing downstream on the Bear River. As noted in the RSP, if the hydraulic modeling efforts demonstrated that downstream effects were likely to change as a result of potential future Project operations, then the downstream analysis reach length would be changed to correlate with the model findings (see RSP Section 3.3.4). As such, the final Model Boundary for the hydraulic modeling effort included all facilities within the Project Boundary, as well as a 1.5-mile reach of the Bear River downstream of the Project Boundary beginning at the powerhouse. The additional 1.5-mile reach length was based on engineering judgment and aimed to capture the change in sediment transport within the Bear River downstream of the dam.

5.0 METHODS

To accomplish the goals and objectives of this study, PacifiCorp implemented a variety of data review and collection methods to compile structural, spatial, terrain, and hydrologic data sets for the Project. These data sets were used as inputs and calibration data for the U.S. Army Corps of Engineers (USACE) HEC-RAS hydraulic model. The calibrated models were used to develop an understanding of the existing hydraulic and sediment transport conditions, and then used to estimate the potential changes from potential future Project operations in the hydraulic conditions, sediment transport capacity, and water surface elevations (WSE), as well as address questions posed for other resources. At this time, there are no mitigation alternatives officially proposed by PacifiCorp or other stakeholders. Therefore, no mitigation alternatives were modeled as part of this study.

More specific details on the method, timing, and execution of the data collection effort are provided in Section 5.1, and in the Drawdown Elevation and Model Calibration Data Acquisition Plan (DEMCDAP), which was prepared for the fall 2019 drawdown.[1] Details on the methods, timing, and execution of the sediment data collection are provided in the Sediment Initial Study Report (Appendix H).

5.1 DATA COLLECTION

Updated LiDAR data were collected during the fall 2019 drawdown of the reservoir to create a detailed terrain surface of the exposed reservoir bed that was then used for hydraulic model development. A detailed sonar bathymetry survey was made both before and after the 2019 drawdown event to supplement the areas of the reservoir bed that were still inundated at the maximum drawdown and were therefore not able to be surveyed using LiDAR. Fifteen self-contained datalogging pressure transducers (PT) were placed within the reservoir to collect WSE (stage) data before and during the drawdown event to supplement the two fixed-elevation gages. These data, along with lateral inundation extents developed from the aerial images collected during the LiDAR survey, were used to calibrate the hydraulic model by comparing the observed

[1] Available upon request.

elevation and inundation data to the computed results of the hydraulic model. Sediment core samples, suspended sediment concentrations, and depth to bedrock (where feasible) were collected before, during, and after (depending on the component) the fall 2019 reservoir drawdown. These data were used as sediment transport model parameters as well as for calibration of the sediment transport model. More specific details on the sediment data collection are provided in the Sediment Initial Study Report and the DEMCDAP. Discharge measurements were made on all seven measurable surface water inflow locations within the Model Boundary. These flow data were combined with detailed evaluation of the hydrologic data gathered from surrounding existing USGS stream gages and PacifiCorp stream gages to quantify groundwater contributions and develop inflow hydrographs to the hydraulic model.

5.2 MODEL CONSTRUCTION

Using the updated LiDAR and bathymetry, both 1D and 2D hydraulic models of the Project and the surrounding reaches as defined by the Model Boundary were constructed. Development of the 1D and 2D hydraulic models began with creating a model base geometry, which is defined as 1D cross-sections and 2D mesh areas that represent the reservoir, upstream tributaries, and downstream reaches. Once the base geometry was established, the Cutler Dam structure was added including the dam crest, spillway, gates, canals, and other features significantly affecting system hydraulics. Both the 1D and 2D models include boundary conditions at the Bear River, Logan River, Little Bear River, Spring Creek, Clay Slough, Cutler Dam, and downstream end of the model. The 1D model was used to analyze sediment transport within the reservoir and the 2D model was used to analyze flow behavior, inundation boundaries, and other hydraulic characteristics within the Model Boundary.

5.3 MODEL CALIBRATION

The model was calibrated based on data collected during the fall 2019 reservoir drawdown. Calibration was performed in two phases. First, the model was calibrated based on the hydraulics of the reservoir. This included adjusting hydraulic parameters within the model to reproduce observed WSE and flow recorded at USGS gage locations to reproduce observed discharges through Cutler Dam inundation boundaries within the Model Boundary, and WSE data measured at specific points within the reservoir. Aerial photos collected during the drawdown were used to verify the inundation boundaries. Sediment transport within the reservoir was calibrated in the second phase of model calibration. This included adjusting the hydraulic and reservoir bed parameters to match the estimated sediment loading moving through the system during the drawdown. The sediment load was estimated based on suspended sediment data collected downstream of Cutler Dam and calculating sediment volume lost from the reservoir bed during the drawdown, based on the pre- and post-terrain surfaces developed from the LiDAR and bathymetry. Model stability is often analyzed by examining the Courant numbers within the computational domain. The Courant number[2] can help guide both the necessary cell size and the timestep interval required for a stable and accurate model.

5.4 MODEL IMPLEMENTATION

Once the model was calibrated, it was used to develop an improved understanding of the existing hydraulic, sediment transport, and water quality conditions under current and potential future operating procedures. The calibrated model was used to estimate the results of potential changes in Project operations on channel hydraulics, sediment transport capacity, inundation boundary, and water quality.

Specifically, the calibrated model provided WSE, depths, velocities, and shear stresses anywhere within the Model Boundary. The model also produced an inundation boundary of the reservoir based on the operations at Cutler Dam. The hydraulic/sediment transport model was also able to estimate the total bed sediment mobilized within the reservoir due to changes in the operation of Cutler Dam.

The model will also be useful for evaluating potential changes resulting from proposed future Project operations on other resources and examining the feasibility and effectiveness of possible mitigation alternatives proposed by PacifiCorp or other stakeholders.

[2] The Courant number is the residence time of water within a model cell divided by the computation interval.

5.5 MODIFICATIONS TO METHODS

The following modifications were made to the data collection methods described in Section 5.1:

- The aerial imagery collected during the 2019 drawdown event was compromised and thus could not be used as part of this study. The aerial imagery was intended to be used to verify the hydraulic modeling results, specifically the inundation boundary of the reservoir at the time the photos were taken. Given that these aerial images could not be used, on-the-ground site photos collected at 1-minute intervals at 13 sites around the reservoir were used to verify the model results. This method is discussed further in Section 6.4.2.

There were no other modifications made to the methods approved in the FERC Study Plan Determination.

6.0 RESULTS

Cutler Reservoir was drawn down in the fall of 2019 to obtain LiDAR and bathymetry data of the reservoir. Data collected during the drawdown event were used, in part, to develop a hydraulic model to evaluate a range of alternatives for future Project operations and to help inform other studies (e.g., Hydraulic Modeling and Sediment). The drawdown was conducted during fall of 2019 due to irrigation delivery and pumping and seasonal-based constraints, and to gather critical information prior to study implementation in 2020. In addition, the drawdown event provided a unique opportunity to simulate a range of potential Project operational conditions (however, note that the simulations were later determined to not be correlated with the drawdown as conducted and were therefore not used) and collect data on resources in those conditions. Therefore, for several resources, preliminary studies and/or data collection were initiated during the fall 2019 drawdown period, October 25 to November 16, 2019.

6.1 REVIEW OF EXISTING INFORMATION

This Study Report 1) reviewed and incorporated existing or recently collected information related to spatial, terrain, hydrologic, and sediment data, and hydraulic modeling that has been previously completed in the Project vicinity; and 2) discussed the development of the hydraulic model used to address questions related to the potential changes in Project operations on water quality and quantity, as well as sediment transport and mobilization. In addition to informing other study reports, this modeling effort also informed discussions regarding potential changes to water quantity and water delivery within the Model Boundary.

Existing data were reviewed and incorporated into the hydraulic model, as appropriate. The following is the initial list of data sources that were explored followed by whether any data was found and analyzed as part of this study:

- Hydraulic models of the Project vicinity
    - No additional models within the model boundary were found or used for this study.
- Previous LiDAR and bathymetric surveys

  - Previous LiDAR survey within the model boundary was found but it only included areas outside of the reservoir boundary and that was not useful. No additional bathymetry data was found.
- Bridge and other infrastructure hydraulic data.
  - Bridge plans for the State Highway 30 bridge were used to size the exiting culverts that convey water under State Highway 30.
- USGS and PacifiCorp streamflow gage data.
  - Flow data from the Collinston Gage downstream of Cutler Dam was used as part of model calibration. Flow data from USGS gages 10092700 (Bear River Idaho/Utah State Line), and 10109000 (Logan River above State Dam) were analyzed but the gages were determined to be too far away from Cutler Reservoir to be useful to the study.
- FEMA FIS data.
  - There are no existing FEMA FIS data for the Cutler Reservoir or for the 1.5 miles of the Bear River immediately downstream of Cutler Dam. Thus no FIS data were analyzed as part of this study.

6.2 DATA COLLECTION

Several data sets were collected during the fall 2019 drawdown event and used to develop and calibrate the 2D hydraulic model and 1D sediment transport hydraulic model. The datasets include LiDAR and ground-based imagery, bathymetry of the reservoir bed before and after the 2019 drawdown event was completed, PT readings, WSE, surface inflow discharge measurements, discharge through Cutler Dam, total suspended sediment measurements and sediment bed gradations The collection and application of each dataset is discussed in Section 6.2.1 through Section 6.2.6 and the uncertainty of the data are discussed in Section 6.2.7.

6.2.1 LIDAR SURVEY DATA

A LiDAR survey collected detailed elevation data of the reservoir bed and the surrounding Project Area when the reservoir bed was mostly exposed on November 6, 2019. Areas that remained inundated by the reservoir at the time of the LiDAR collection were identified and supplemented with detailed bathymetric survey in order to delineate the true reservoir bed elevation. See Section 6.2.2 for more details on the post-drawdown bathymetric study.

A Robison 44 manned helicopter equipped with a the RIEGL VUX-1LR LiDAR sensor with survey grade Global Positioning System (GPS) (dual frequency GNSS) attached to a Tyler Mount was used to complete the survey. The helicopter conducted flight passes in a series of data capture segments that covered the overall Model Boundary. The LiDAR sensor is a 7-return laser system that uses full waveform processing. For each measurement pulse, the unit returned a first return (top of vegetation), last return (bare earth), and five intermediate pulses that provide detail on vegetation (branch structure). All return datum were used in the classification. The point density was between 75 to 150 points per square meter.

The LiDAR data sets were merged with the bathymetry survey data collected after the reservoir was refilled and, in combination, were used to create a digital elevation model (DEM). Deliverables included an elevation triangular irregular network (TIN), elevation raster, and the raw point file used to create the terrain surfaces. The output datum was delivered in North American Datum (NAD) 83 (Utah State Plane 1983, Utah North) horizontal datum and North American Vertical Datum (NAVD) 88 vertical datum, US foot. Output data from the hydraulic model were converted to NGVD 29 for use in all technical reports and consistency with PacifiCorp's compliance reporting to FERC.

One of the primary components of both the 1D and 2D hydraulic models is the associated terrain dataset. The terrain dataset was used to create the model geometry and for mapping of final inundation boundaries and other hydraulic output results.

6.2.2 BATHYMETRIC DATA

The bathymetry survey was completed in two stages: the pre-drawdown and the post-drawdown.

The pre-drawdown bathymetric survey took place while the reservoir was between elevations 4407.3 and 4407.8 feet NGVD 29 (full pool). The density of bathymetric sample sites surveyed per cross-section was based on recommendations from the hydraulic engineers responsible for the development of the hydraulic and sediment transport model and is discussed in more detail in the DEMCDAP (see Appendix H).

As discussed in Section 6.2.1, the LiDAR data collected during the drawdown of the reservoir did not provide full coverage of reservoir bed elevations because of the remnant deeper areas that remained inundated. These areas were identified using aerial imagery flown at the time of the LiDAR survey. Once the reservoir had refilled to an elevation of 4407.5 NGVD 29, additional bathymetric data were collected from November 21, 2019 through December 3, 2019 at those locations that remained inundated during the full drawdown event. These additional bathymetric data were merged with the LiDAR data set.

The pre- and post-bathymetric surfaces were the primary data sources used to calibrate the 1D sediment transport model, by comparing the resulting bed profiles from the model to the pre- and post-bathymetric surveys.

6.2.3 PRESSURE TRANSDUCER WSE DATA

WSE data during the drawdown period were monitored using PTs to provide calibration data for the hydraulics of the 1D and 2D models. The PTs were installed before the start of the drawdown and were removed after the reservoir refilled. The PTs offered continuous elevation and depth measurements of the PTs during the drawdown of the reservoir at 15 locations (Figure 6-1). The WSE hydrographs for each of the 15 PT locations during the 2019 drawdown event can be found in Attachment G-5 of this Appendix. Four static WSE measurements were taken at four locations after the reservoir refilled on November 18, 2019. These four locations were used as benchmarks to calculate the corresponding WSE for each PT depth and elevation measurement. WSE measurements were recorded in 15-minute intervals at the 15 locations from 1130 hours on October 24, 2019, until 1630 hours on November 21, 2019.

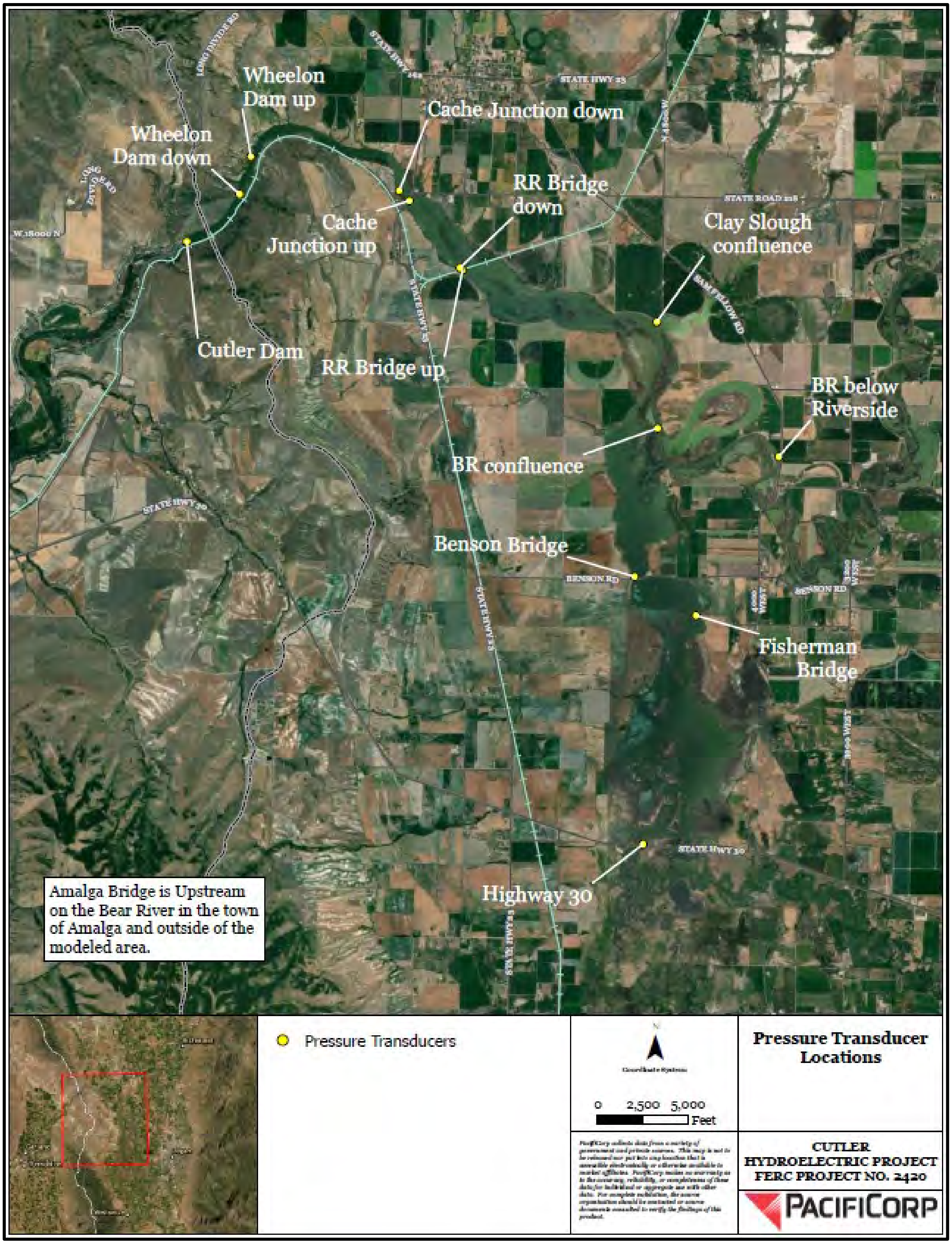


FIGURE 6-1 LOCATIONS OF PRESSURE TRANSDUCERS DURING 2019 DRAWDOWN EVENT

The WSE data were the primary reference to calibrate the 2D hydraulic model by comparing the observed data to the model results at the 15 measurement locations. The WSE data were also used to set the initial WSE in the reservoir during the model simulation as well as setting a WSE hydrograph boundary condition at Cutler Dam to simulate elevations recorded during the drawdown event.

6.2.4 SURFACE INFLOW DATA

Surface inflow data were measured at six sites on November 8, 2019 using an acoustic doppler current profiler (ADCP). The ADCP measurements were processed using the USGS software Eve, and a single inflow value was calculated for each location with the corresponding uncertainty in the measurements. Additionally, the flow at Blue Spring Creek was estimated by visual inspections due to the small quantity of flow in the creek and the uncertainty of the results that would have been produced by the ADCP under these conditions. Table 6-1 shows the measured total inflow and uncertainty at each location.

TABLE 6-1 TOTAL INFLOW AND UNCERTAINTY PERCENTAGE AS MEASURED IN CFS

MEASUREMENT LOCATION	MEASURED TOTAL INFLOW (CFS[1])	UNCERTAINTY (%)
Bear River at Upper Bear River Recreational Site	620	3.8
In-Reservoir under Benson Marina Bridge	462	7.7
Little Bear River at Mendon Road	98.4	6.4
Spring Creek at Mendon Road	52.7	6.6
Logan River at Mendon Road (600 S)	236	5.9
Blue Spring Creek at 3200 W	7 (estimated)	Not Applicable
Logan Wastewater Outflow at 3200 W	32.4	12.6

[1]cfs = cubic feet per second

The total of all inflows in the southern portion of the reservoir upstream and south of the Benson Marina Bridge were calculated to be 426.5 cfs. This indicated that within the southern end of the reservoir upstream of Benson Marina Bridge, an additional 35.5 cfs of groundwater was added to the system to produce the recorded flow of 462 cfs under Benson Marina Bridge. The Cutler Dam Discharge, described in Section 6.2.5, was averaged for November 8, 2019 and was calculated to be 1,090 cfs. The combined flow from the Bear River and flow measured under the

Benson Marina Bridge was calculated to be 1082 cfs, therefore it was deduced that 8 cfs of groundwater was contributed to the system in the reservoir north of Benson Marina Bridge. The outflow conditions were stable at this date with no observed change in reservoir WSE. The inflow conditions around the reservoir were also stable with no precipitation events before or during measurements.

The measured inflow values were used to set inflow values into the reservoir at the corresponding boundary conditions during the model simulation. Adjustments were made to the simulated inflows during model calibration based on the uncertainty in the inflow data as discussed in Section 6.2.7.

6.2.5 CUTLER DAM DISCHARGE DATA

PacifiCorp maintains the Collinston stream gage 880 feet downstream of Cutler Dam in the Bear River and gages in the West and East (Hammond) irrigation canals that record flow measurements at 15-minute intervals. Discharge data for the Collinston gage were used to calculate the flow passing through the powerhouse during the drawdown. The only significant inflow to the Bear River upstream of the Collinston gage is the discharge passing through the powerhouse. Therefore, the recorded hydrograph at the Collinston gage was assumed to be equal to the flow passing through the powerhouse during the drawdown.

6.2.6 SEDIMENTATION DATA

The sediment gradation data were collected from July 20, 2020 through July 30, 2020 to provide inputs for the sediment transport model. Thirty samples from 24 sites were collected to provide sufficient coverage to describe the bed sediment throughout the Model Boundary. A vibrating corer was used to collect samples due to the shallow depths in Cutler Reservoir. The Unified Soil Classification System (USCS) was used to classify particle size. To determine the percentage of grain size, USCS standard sieves were used down to a No. 230 (63 µm sieve). Finer material was classified using a hydrometer. Prior to hydrometer measurements, each sample was tested for percent organic material. Sediment samples with more than 30 percent organic material were not measured for grain size with a hydrometer due to error probability. Sediment sample gradations are provided in Attachment G-1 of this Appendix.

There were no sediment gradation data collected downstream of Cutler Dam. The sediment gradation for this river reach was broadly estimated based on inspection of available site photos and engineering judgement.

Total Suspended Solids (TSS) samples were collected during the drawdown to provide additional inputs for the sediment transport model. Samples were taken at four locations using an ISCO Sampler. Two were collected at separate locations 0.1 and 1 mile downstream of Cutler Dam, respectively. A third sample was collected within the Bear River upstream of Cutler Reservoir, and the last sample was collected within the Logan River near Mendon. Daily samples were taken during the drawdown for the two locations downstream of Cutler and the location within the Bear River. A single TSS concentration of 0.64 mg/L was recorded on November 8, 2019, corresponding to the date inflow was measured for the Logan River during the drawdown. TSS data are provided in Attachment G-2.

6.2.7 UNCERTAINTY IN THE DATASETS

The final DEM used as the terrain layer in the hydraulic model has substantial uncertainty originating from both the LiDAR and the bathymetry surveys. The LiDAR survey was conducted when the reservoir was drawn down to capture the exposed bed in the survey. Because the exposed bed was extremely flat with little to no coloring or texture and saturated with moisture/ice, there was a lack of LiDAR returns in these areas. The bathymetry survey was completed at the normal reservoir pool elevation in an attempt to create redundancy in the elevation data with previous surveys. However, many of the areas that were exposed during the full drawdown are also very shallow and highly vegetated areas of the reservoir at normal pool. Thus, the LiDAR was unable to measure the reservoir bed accurately in those areas. This left some of the gaps in the elevation data unfilled. Using the LiDAR and bathymetric survey data that were successfully acquired, the areas where gaps remained in the reservoir bed data were interpolated using the surrounding areas with verifiable data points.

This level of uncertainty for subsurface terrain data used for hydraulic models is common. The technique used for filling in gaps where terrain data is not present is also common practice. Since the gaps in survey data are strictly within the reservoir, the impacts of this uncertainty in the terrain are limited to the storage of the reservoir and localized hydraulics in these interpolated areas. The hydraulic model still adequately represents the overall hydraulic behavior of the reservoir and is able to replicate measured WSEs and inundation boundaries.

Flow inputs to Cutler Reservoir also have the potential to introduce uncertainty into the hydraulic model. Inflow data were collected once the reservoir was fully drawn down at seven locations. Additionally, the inflow measurement locations were not taken directly at the confluence of the tributaries and the reservoir boundary. Because the discharge measurements were not taken at the reservoir, losses due to infiltration from the measurement locations to the reservoir were not captured. Additionally, groundwater influences over the course of the reservoir drawdown were not adequately measured. Additional assumptions for groundwater influences made in the calibration of the 2D hydraulic model are discussed in more detail in Section 6.3.6.

There was a small amount of uncertainty in locations of the PT WSE data. The PTs were not secured so that they would remain in the same spot during the drawdown. They were able to shift in a 15-foot radius of their installed location over the course of the drawdown. This uncertainty was assumed to have no effect on the analysis as the recorded and model WSE would be acceptably close within a 15-foot radius.

6.3 MODEL CONSTRUCTION

Model geometry for both the 1D and 2D hydraulic models were constructed using the HEC-RAS extension RAS Mapper. All model data is georeferenced to the NAD 83 Utah North State Plane projection. All terrain, structure, and result elevations in the model are originally reported in the NAVD 88 vertical datum. Most of the results presented in this study report have been converted to the NGVD 29 vertical datum for the purpose of consistency throughout the study reports.

6.3.1 DIGITAL TERRAIN DATASET

The digital terrain dataset includes data from two surveys completed during the fall 2019 drawdown: LiDAR and bathymetric, described in more detail in Sections 6.2.1 and 6.2.2, respectively. The LiDAR and bathymetric data were merged and processed into a single DEM as discussed in Section 7.2.1, to be used as the terrain dataset for both the 1D and 2D hydraulic models.

6.3.2 2D HYDRAULIC MODEL BASE GEOMETRY

The 2D geometry consisted of two 2D meshes created in HEC-RAS (Figure 6-2). The first had boundaries encompassing the entire reservoir, including 0.5 miles south of State Highway 30, 5.2 miles of the Bear River from its confluence with the Cutler Reservoir to the Upper Bear River Access, and the reservoir itself downstream to Cutler Dam. The second was the Bear River extending 1.5 miles downstream of the Project powerhouse. The default cell size for the first 2D mesh covering Cutler Reservoir was 200 feet and the default cell size for the second 2D mesh downstream of Cutler Dam was 60 feet. Breaklines, 2D area connections, and refinement regions were added as necessary to properly capture critical terrain details onto the 2D mesh and to provide adequate hydraulic detail. The refinement regions were placed within the Cutler Reservoir 2D mesh and the cell sizes varied from 20 feet to 100 feet (Table 6-2). Additional detail was added to the 2D mesh south of State Highway 30 in order to accurately capture the hydraulics connecting the Logan River to the main reservoir.

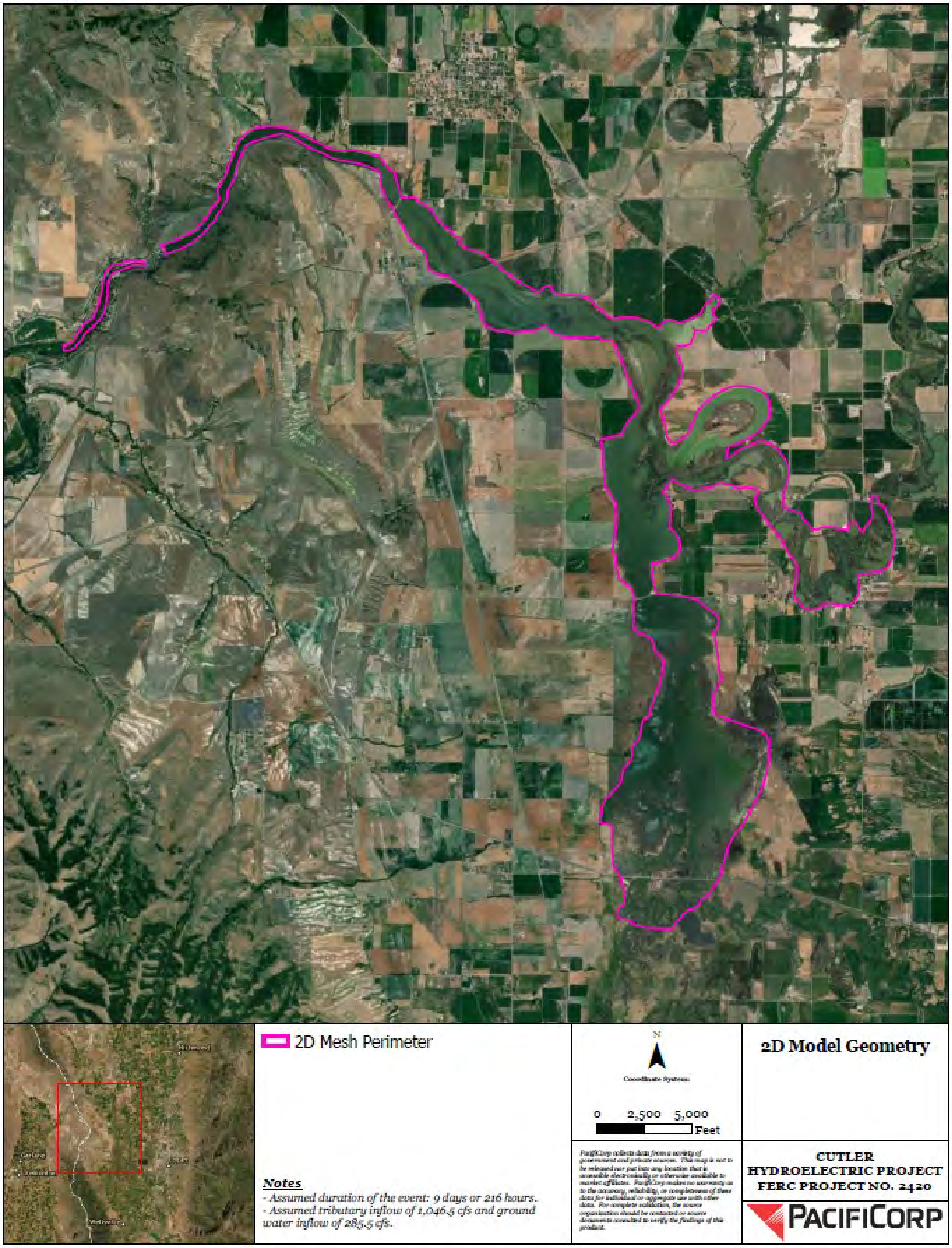


FIGURE 6-2 2D MODEL MESH GEOMETRY

TABLE 6-2 REFINEMENT REGION CELL SIZES OF CALIBRATED MODEL

REFINEMENT RANGE	CELL SIZE (FT)
Cutler Canyon	25
Bear River Channel	60
Cutler Reservoir Channel	100
South Marsh	100
Benson Marina	20
Fishing Bridge	20
Cutler Dam	50
Logan River upstream of State Highway 30	20

6.3.3 1D SEDIMENT TRANSPORT HYDRAULIC MODEL BASE GEOMETRY

The 1D geometry consisted of cross sections sampled using the built-in HEC-RAS Mapper extension derived from the model terrain (Attachment G-10 to this Appendix). Cross-section spacing and orientation were based on the terrain and channel features to fully capture the hydraulics of the reservoir and rivers. Cross-section locations were located to adequately model the changes in geometric features, such as changes in channel slope, cross-section shape, and roughness. Final cross-section spacing ranged from 20 feet to 2300 feet.

6.3.4 MANNING'S ROUGHNESS VALUES

Manning's roughness values ("n" values), the coefficients which represent the roughness or friction applied to the flow by the channel, were assigned based on the reservoir hydraulic conditions as well as calibration of the model. A final "n" value of 0.025 was assigned for the entire modeled area of the Cutler Reservoir and Bear River upstream of Cutler Dam. An "n" value of 0.035 was applied in the Bear River downstream of Cutler (Chow 1959).

6.3.5 STRUCTURE DATA

Physical structures such as bridges, culverts, and the submerged Wheelon Dam have the potential to alter hydraulic movement in the Bear River and Cutler Reservoir. Accordingly, the elevation and dimensions of structures within the inundation boundary of Cutler Reservoir were acquired to construct the hydraulic model. Bridge decks were excluded from the model geometry since flood conditions were not part of the drawdown event or potential Project operations.

Bridge piers were assumed to have minimal effect on the overall model results for the fall 2019 drawdown used for calibration and the proposed Project operations given the low velocities throughout the reservoir and through the bridge openings specifically.

Structure data were acquired for Cutler Dam from plan, elevation, and section drawings provided in CEII-Protected Exhibit F-3.[3] Elevations in Exhibit F-3 are shown in NGVD 29 and were converted to NAVD 88 for the model by adding 3.383 feet. The Cutler Dam crest elevation was taken to be 4,415.383 feet.

Drawings available for the abandoned Wheelon Dam located upstream of Cutler Dam and within the reservoir had an unknown vertical datum that could not be benchmarked to a known reference point; therefore, structure data for Wheelon Dam were assumed from the LiDAR data, and a crest elevation was taken to be 4,401.00 feet. The State Highway 30 culvert data were extracted from the State Highway 30 bridge plans provided by Utah Department of Transportation and were input into the model as 25-foot-wide and 7-foot-tall culverts.

Wheelon Dam and the State Highway 30 culvert crossing were included in the 2D model as 2D area connections. For the 1D model, Wheelon Dam was included as an inline structure and the Highway 30 culvert was modeled as a culvert. Cutler Dam was omitted from the models as the flow moving through the dam was controlled using a WSE hydrograph as described in Section 7.3.5.

6.3.6 BOUNDARY CONDITIONS

Boundary conditions were set to accurately capture the inflow into Cutler Reservoir, the WSE at Cutler Dam, and the outflow from the downstream end of the model. Both the 1D and 2D models included boundary conditions at the Bear River, Logan River, Little Bear River, Spring Creek, Cutler Dam, the Powerhouse Discharge, and the downstream end of the model. Initial model calibration results indicated that there were likely substantial sources of groundwater inflow

[3] Exhibit F contains sensitive and detailed engineering information that, if used incorrectly, may compromise the safety of the Project and those responsible for its proper operation. Members of the public requesting CEII information for the Cutler Project must comply with the Commission's procedures for obtaining access to CEII as required under CFR § 388.113. All public requests for CEII should be made to the Commission's CEII Coordinator.

within the reservoir during the drawdown event. Therefore, groundwater inflow was added as internal boundary conditions at three separate locations in the reservoir to capture the temporal and spatial distribution of groundwater in the reservoir. Inflow hydrographs for each boundary condition for the duration of the drawdown event are shown in Attachment G-3 to this Appendix.

The powerhouse discharge was defined as a flow hydrograph and included as a boundary condition to simulate the drawdown flow passing through Cutler Dam and into the downstream reach of the Bear River. The hydrograph is described in Section 6.2.4. The WSE drawdown hydrograph was taken from the Cutler Dam WSE data described in Section 6.2.3. The boundary condition downstream of Cutler Dam was set to normal depth with a friction slope equal to the bed slope in the Bear River downstream of the dam.

6.3.7 SEDIMENT PARAMETERS

HEC-RAS requires additional parameter inputs for unsteady sediment modeling that capture the physical characteristics of the sediment accumulated in Cutler Reservoir, as well as inflowing sediment into the reservoir. These required parameters include boundary conditions that account for the sediment load flowing into the reservoir from contributing reaches, bed gradations, the maximum depth of erosion, mobile bed limits, the selection of the transport function, sorting method, and fall velocity method, and reservoir water temperature. The parameters are described below in greater detail.

6.3.7.1 BOUNDARY CONDITIONS

Two sediment load series boundary conditions were implemented in the model at the Bear River and Logan River surface inflow locations. Using the TSS data described in Section 6.2.6 and the surface inflows described in Section 6.2.4, sediment load time series were developed for the Bear and Logan River boundary conditions. Given that daily recorded flow data was not available for the entirety of the model simulation and thus a simplified inflow hydrograph based primarily on flow data collected on November 8, 2019 was used for the calibration event, a similar simplified approach was used for the development of the sediment load series. The sediment load series used for the calibration event was based on the sediment load collected on the same day as the flow data (November 8, 2019). Any change to the sediment load series during the calibration event mirrored the change to the inflow hydrograph used during the calibration event. The TSS concentration time series are shown in Attachment G-2 to this Appendix.

6.3.7.2 INITIAL CONDITIONS

The initial conditions are used to define the initial bed gradation throughout the model, the extents of the movable bed limits, the maximum erodible depth, and the minimum elevation of erosion. Bed gradations are described in Section 6.2.6 for the ISCO samples that were taken during the drawdown. The bed gradations were assigned at cross-sections to spatially align with the sample locations. Bed gradations were interpolated between sample locations except in four locations where engineering judgment was used to determine that a uniform bed gradation was more appropriate. No samples were collected in the Bear River upstream of the confluence so site 34 (see Appendix C) was assumed to be an accurate representation of the bed gradation throughout the Bear River upstream of the confluence and was applied to every cross-section in this reach of the model. Wheelon Dam is a significant hydraulic structure in the reservoir that interrupts the continuity of the bed gradations between sample locations. The gradation collected at site 62, approximately 0.25 miles upstream of Wheelon Dam, was applied to all the cross-sections extending from the sample location downstream to Wheelon Dam. The gradation collected at site 58, approximately 0.5 miles downstream of Wheelon Dam, was applied to all the cross-sections extending from the sample location upstream to Wheelon Dam. Site 59 is located approximately 0.25 miles upstream of Cutler Dam and was the most downstream sample taken. The gradation at Site 59 was applied to all the cross-sections extending from the sample location downstream to Cutler Dam. No bed gradations were sampled downstream of Cutler Dam; therefore, the bed gradation of cross sections in the Bear River reach downstream of Cutler dam were assumed based on observation of available field photos and engineering judgment. It was assumed that the bed gradations of the Bear River reach downstream of Cutler Dam have a much coarser composition than the bed gradations within the reservoir. While the Bear River confluence is in the middle of Cutler Reservoir (downstream of the confluence with the Logan and Little Bear rivers and Spring Creek), bed samples within the reservoir were assumed to have a much finer composition than what would be expected in the river.

The maximum extent of the movable bed limits is used to limit the erosion horizontally in the cross-section. This parameter is important for modeling flood events as it allows the model to limit erosion to the main channel. However, the study flow conditions are low-flow events with no inundation of the floodplains, therefore, the movable bed extents were set to the extents of the bank stations to allow for sediment transport in all minor channels or areas conveying flow.

The maximum erodible depth and the minimum elevation of erosion is used to limit the erosion to a known solid boundary, such as bedrock or a constructed channel liner. Bedrock was not reached during ISCO sampling and no indication of erosion to bedrock was observed during the drawdown or by comparing bathymetric surveys. The model only requires the erosion limits to be set using one of the options. Therefore, the maximum depth of 100 feet was applied to every cross-section in the model allowing for ample room for erosion as bedrock was not expected to be reached in the simulation.

The initial conditions for each-cross section in the sediment model are summarized in Attachment G-6 of this Appendix.

6.3.7.3 TRANSPORT PARAMETERS

Transport parameters are used to indicate what transport function, sorting method, and fall velocity method to use for the sediment transportation computations. The transport parameters were used as the main tool for calibrating the sediment model (Table 6-4). All of the parameters have several options for the equations used during the computations. Each method is applicable for specific bed gradations as outlined in the HEC-RAS Hydraulic Reference Manual (USACE 2016). The final transport parameters and the determination of the parameters is discussed in Section 6.4.2 (Table 6-3).

6.3.7.4 WATER TEMPERATURE

Water temperature data were provided as part of the water quality field data and were not collected specifically for this study. Water temperatures during the drawdown ranged from a low of 2.47°C (36.5°F) to 12.69°C (54.8°F). Sediment transport is not sensitive to water temperature so a constant value of 40°F was applied to the model for the duration of the drawdown event.

6.4 MODEL CALIBRATION

The model adjustment and calibration, described below, were based on measured data collected during the fall 2019 drawdown event and analysis of initial model results. All adjustments made to the hydraulic model parameters or geometry were done to produce the most accurate representation of WSEs, inundation boundaries, and drawdown timing, within the model boundary.

6.4.1 MODEL ADJUSTMENTS BASED ON INITIAL RESULTS

Preliminary simulations identified the need for adjustments to both the 1D and 2D models in order to more accurately represent conditions observed during the fall 2019 drawdown event. The following adjustments were made to the models:

- Given that a total discharge hydrograph was recorded passing through Cutler Dam during the 2019 drawdown, the hydraulic model did not need to use detailed gate controls to control the WSE and flow at the dam during the drawdown. Instead, it was assumed that the drawdown could be simulated using a flow hydrograph boundary condition in place of the inline structure. By removing the detailed gate operations during the drawdown event, the complexity of the model and the uncertainty of hydraulic structure parameters were eliminated. However, using this approach revealed additional model limitations including model instability and limited ability to match modeled WSE to observed WSE throughout the reservoir. An alternative approach was selected which controlled the drawdown event using a WSE hydrograph boundary condition at Cutler Dam in lieu of the flow hydrograph boundary condition. The WSE hydrograph was based on WSE data collected from the Cutler Dam PT site as described in Section 5.1. By using a WSE hydrograph boundary condition in the model, instabilities upstream of Cutler Dam were eliminated and the modeled WSE better matched the observed WSE throughout the reservoir, improving calibration and overall model confidence.

- For the portion of the model downstream of Cutler, a flow hydrograph boundary condition was established at the upstream end of the Bear River reach at the powerhouse. The hydrograph matched the measured or assumed drawdown flow through the powerhouse. The powerhouse drawdown flow hydrograph is described in Section 6.3.6.

- Substantial sources of groundwater inflow were documented within the reservoir. The locations of these sources of groundwater were approximated and added as internal boundary conditions.

- No boundary condition was included at Clay Slough because the source of the inflow is completely controlled, and no inflow occurred during the drawdown event.

6.4.2 2D HYDRAULIC MODEL CALIBRATION AND VERIFICATION

The hydraulic model calibration was completed by comparing modeled WSE to the observed WSE in Cutler Reservoir during the 2019 drawdown event at the 15 PT locations. WSE hydrographs were extracted from the model at each of the 15 locations and were plotted versus the observed hydrographs. Hydraulic parameters such as Manning's n values, surface water inflows, and groundwater inflows were modified to reduce the difference between the observed hydrographs from the 2019 drawdown event and modeled hydrographs at each location, until the model was calibrated. Calibrated WSE hydrographs for each of the 15 PT locations are shown in Attachment G-7 of this Appendix.

During calibration of the model, it was found that a significant amount of groundwater was introduced into the system during the event of the drawdown. Without additional groundwater in the model, there was not enough volume available in the reservoir to recharge the canyon section of Cutler that connects the reservoir to the dam. By adjusting the model to account for the additional groundwater in the system, the model was able to recharge the canyon section and more accurately replicate the observed WSE measured during the drawdown. The timing and quantity of groundwater inflow was established through trial and error to produce results most representative of the observed WSE data at the PT locations throughout the reservoir. It was also found that reductions in the Bear River and south inflows were needed to properly model WSE in the Cutler Reservoir and Bear River during the drawdown. These necessary reductions in surface water inflow could be a result of flow measurement error, inaccuracies in the terrain, areas of the reservoir losing water to infiltration, or other inflows or withdrawals that were not accounted for in the hydraulic model. The reductions were removed upon refill of the reservoir to supply the necessary inflow to match recorded WSE in the reservoir. The final groundwater and inflow hydrographs are shown in Attachment G-3 of this Appendix.

In addition to the calibration of the model using PT data collected at 15 locations throughout the reservoir, on-the-ground site photos collected around the reservoir throughout the drawdown event were used to verify the reservoir's inundation boundary generated by the hydraulic model. During the drawdown event, photos were taken at 1-minute intervals at 13 sites throughout the reservoir. These photos were used as a qualitative data points and were visually compared to the resulting inundation boundaries from the hydraulic model overlaid on aerial imagery in order to verify if inundation boundaries matched what was shown in the photo log at the time the photo was taken. Particular attention was paid to five photo site locations near Cutler Marsh, in the southern portion of the reservoir, given that Cutler Marsh contains a significant amount of wildlife habitat that is sensitive to the quantity and timing of exposed shoreline. Attachment G-12 of this Appendix contains a photo log of these sites at two different times during the drawdown, October 26, 2019 and November 4, 2019, and comparisons to inundation boundary results from the hydraulic model at these same times. The results from this comparison verify that the inundation boundaries from the model closely match the photo evidence collected during the drawdown.

A variable timestep interval was selected based on grid cell size, model run time, and model stability. During the drawdown event, there was a sudden increase in the drawdown rate on the morning of October 28, 2019 that extended until the morning of October 29, 2019. This sudden increase in discharge through the dam increased velocities and lowered WSE upstream of Cutler Dam, which increased Courant numbers and caused model instability. For this period of increased velocities, a reduced time step (Table 6-3) was used in order to lower Courant numbers and stabilize the model.

TABLE 6-3 VARIABLE TIMESTEP INTERVALS USED IN CALIBRATED MODEL

SIMULATION PERIOD (DDMMYYYY HH:MM)	SIMULATION TIME STEP (SEC)
24OCT2019 11:30 to 28OCT2019 07:15	20
28OCT2019 11:30 to 28OCT2019 17:00	5
28OCT2019 17:00 to 29OCT2019 05:00	1
29OCT2019 05:00 to 17NOV2019 12:00	20

6.4.2.1 UNCERTAINTY RELATED TO 2D HYDRAULIC MODEL CALIBRATION

The calibration of this hydraulic model was limited by the lack of available inflow data (surface and groundwater) during the drawdown event. The inflow data collected during the drawdown event were limited to a surface flow measurement at a single point in time during the multiple week drawdown and refill event, and groundwater inflow estimates based on subtracting the surface flow measurement from the flow measured within the reservoir at two locations near the upstream end of the reservoir. There are also no nearby reliable flow gages on tributaries to Cutler Reservoir to be confidently used for inflow determination. Without time-related surface and groundwater flow data during the entirety of the drawdown event, it was at first assumed that these measured flows were constant during the event. Results from initial model simulations revealed that with the assumption of constant surface and groundwater inflow, the model was unable to replicate measured WSEs within the reservoir, even when typical calibration parameters (Manning’s Roughness, computation interval) were adjusted within reasonable ranges. Therefore, it was concluded that the assumption of constant surface and groundwater inflow was incorrect, and that groundwater significantly influences reservoir elevations and timing during a drawdown event.

Given the lack of temporal inflow data, and that replication of recorded WSEs was the primary calibration methodology used for this model development, and producing hydraulic model results (including depths, WSEs, and inundation boundaries) for use in other study reports was a primary goal of the Hydraulic Modeling Study Plan, it was determined that varying the surface and groundwater inflows in order to achieve model calibration was appropriate. Groundwater inflow across an area the size of Cutler Reservoir is inherently very difficult to quantify and measure. The dynamics that control groundwater inflow are not the same as those that control surface water inflow. During a reservoir drawdown the magnitude of the fall 2019 event, groundwater inflows could be significant and highly variable. However, it is important to note that the goal of the calibration model was to reproduce observed and provide predicted WSEs, depths, and inundation boundaries for the use in other study reports. Regardless of what groundwater quantities were used for the calibration event, the assumed surface and groundwater amounts used in proposed and existing operational scenarios will have a significant impact on the results (i.e., two reservoir drawdowns to the same elevation with different surface water and groundwater inflow quantities will produce different results).

As long as the assumed groundwater and surface water inflow values are the same for both existing and proposed operational scenarios, the hydraulic model will be able to predict the relative impact that the change in operations will cause to reservoir depths, water surfaces, and inundation boundaries for these assumed inflow conditions.

6.4.3 1D SEDIMENT TRANSPORT HYDRAULIC MODEL CALIBRATION

TSS data collected downstream of Cutler Dam and model output TSS data were intended to be used to calibrate the sediment transport model. However, the results from initial runs of the sediment transport model revealed an overprediction of TSS load downstream of Cutler Dam. Adjustments were made to the model parameters within reasonable ranges in an attempt to converge the model TSS load to the measured TSS load downstream of Cutler Dam, but this was unsuccessful likely because of the dependence of TSS load on accurate inflow data throughout the reservoir and during the entirety of the model simulation. Without sufficient inflow data, matching observed TSS load data with modeled TSS output can be difficult. Therefore, the focus of calibration was shifted to comparing the modeled reservoir bed profiles at the beginning and end of the drawdown to the observed bed profiles extracted from the pre- and post-terrain surfaces. Output TSS data from the sediment transport model were used qualitatively for comparisons of existing and proposed Project operations, as explained further in Section 6.5.

Calibration of the sediment parameters was conducted by testing transport parameters appropriate for the bed composition in the reservoir, as indicated by the HEC-RAS Hydraulic Reference Manual (USACE 2016). Sixteen combinations of sediment transport functions, bed sorting methods, and fall velocity methods were tested to determine the most applicable set to accurately match modeled bed profiles to surveyed bed profiles during the bathymetric surveys. The final selected set is summarized in Table 6-4 below.

TABLE 6-4 SELECTED SEDIMENT TRANSPORT METHODS FOR SEDIMENT MODEL CALIBRATION

TRANSPORT FUNCTION	SORTING METHOD	FALL VELOCITY METHOD
Engelund-Hansen	Copeland (Ex7)	Dietrich

The sediment model calibration was completed using 15 cross sections in the Wheelon Study reach, where bed movement was expected to be the greatest. Using the pre- and post-bathymetry surfaces, bed profiles were extracted at the 15 selected cross sections. These data were used as a calibration data set by comparing the extracted bed profiles to the bed profiles output from the sediment transport model. The resulting bed profiles at the calibration cross sections are shown in Attachment G-8 of this Appendix.

The comparison of the pre- and post- bathymetric surfaces yielded a quantifiable calibration data point which allows for qualitative analyses of changes to the reservoir bottom caused by the different drawdown alternatives. Using this information, the model can identify areas of the reservoir bottom that are subject to higher erosion rates during the drawdown.

6.5 MODEL IMPLEMENTATION

The calibrated hydraulic and sediment transport models were used to develop an improved understanding of hydraulic, sediment transport, and water quality conditions under current and potential future operating procedures. Both 2D Hydraulic and 1D Hydraulic Sediment models were used to simulate the existing Project operations and proposed Project operations (Attachment G-9).

The model geometries, boundary condition location and types, Manning's roughness values, sediment transport functions, and computational timesteps for the proposed Project operational scenarios are identical to those used for the calibration of the drawdown event. The existing and proposed WSE and flow hydrographs used in the model as reservoir controls at Cutler Dam were developed by PacifiCorp to simulate an accurate depiction of the proposed Project operational scenarios. WSE hydrographs at Cutler Dam and Cutler Dam outflow hydrographs for the downstream reach are shown for the operational scenarios in Attachment G-9 of this Appendix. The reservoir surface water inflows were assumed to be the same for the proposed and existing Project operations with a total inflow of 1,090 cfs. The sediment load series for the Logan River and Bear River were modeled as constant applied loads, equal to the average loading for the sample period (0.41 and 16.16 tons/day, respectively). The groundwater inflows were balanced so that the model was stable downstream of Wheelon Dam and flow in the reservoir remained moving in a positive flow direction (upstream to downstream). Groundwater inflow hydrographs for the existing and proposed Project operational scenarios are shown in Attachment G-11 of this Appendix.

6.5.1 2D HYDRAULIC MODEL RESULTS

The 2D hydraulic model results are displayed in a series of map sets for the proposed Project operational scenarios in Attachments G-12 through G-15.

- Inundation Maps – Attachment G-12
- Reservoir Elevations – Attachment G-13
- Minimum Depth Maps – Attachment G-14
- Maximum Velocity Maps – Attachment G-15

6.5.2 1D SEDIMENT TRANSPORT MODEL RESULTS

The 1D sediment transport model results for the existing and proposed operations at selected model cross sections are tabulated in Table 6-5 below. Attachment G-17 details the locations of each of the model cross sections used to extract results. The results indicate that neither of the operational scenarios lead to a significant amount of net bed scour or deposition within the reservoir and that the differences in bed scour/deposition between the existing 1-foot operational scenario and proposed 2.5-foot operational scenario are minimal. The results of the analysis do indicate that the average concentrations of TSS throughout the reservoir would increase for the proposed 2.5-foot drawdown scenario particularly from Clay Slough down to Cutler Dam. This result is reasonable given that a decrease in reservoir stage would result in slightly higher velocities within the reservoir, specifically in the region of the Model Boundary from Clay Slough to Cutler Dam. It is expected that increases to reservoir velocities would increase TSS concentrations given that the bed gradations of Cutler Reservoir are made up of mostly fine sediment. Given that the TSS concentrations within the Model Boundary were unable to be successfully calibrated the individual quantitative TSS concentrations listed in this table have significant uncertainty. However, comparing these TSS concentrations for the existing and proposed operational scenarios qualitatively can be helpful for evaluating potential impacts that the proposed operations may have.

TABLE 6-5 SEDIMENT MODEL RESULTS

XS ID	LOCATION	EXISTING OPERATIONAL RANGE (4407.5 – 4406.5 FT NGVD29)		PROPOSED OPERATIONAL RANGE (4407.5 – 4406.5 FT NGVD29)		DIFFERENCE		
		FINAL BED ELEVATION (FT)	AVG TSS (TONS/DAY)	FINAL BED ELEVATION (FT)	AVG TSS (TONS/DAY)	FINAL BED ELEVATION (FT)	AVG TSS (TONS/DAY)	% INCREASE TSS
1388	Bear River DS Cutler	4266.1	19.9	4266.1	19.0	-0.02	-0.9	-5%
6250	Bear River DS Cutler	4271.8	6.7	4271.7	9.8	-0.04	3.1	46%
8454	Cutler Dam	4369.9	37.7	4369.9	61.7	0.00	23.9	63%
12985	Cutler Caynon	4389.2	42.8	4389.2	70.7	0.00	27.9	65%
14647	Cutler Caynon	4390.5	43.1	4390.5	71.1	0.00	28.0	65%
19155	Cutler Caynon	4391.5	48.2	4391.5	82.2	0.00	34.1	71%
26272	US Cache Junction	4388.0	49.5	4388.0	84.4	0.00	34.9	70%
31291	US Rail Road Bridge	4388.3	52.1	4388.3	90.4	0.00	38.3	74%
36230	Cutler Reservoir	4401.3	57.5	4401.3	103.4	0.00	45.9	80%
43422	Clay Slough	4401.6	62.4	4401.6	108.2	0.00	45.8	73%

3754	Bear River Confluence	4391.5	86.2	4391.5	137.6	0.00	51.4	60%
32102	Bear River Access	4394.6	30.5	4394.6	37.9	-0.02	7.4	24%
57741	Benson Marina	4388.0	3.2	4388.0	7.0	0.00	3.8	118%
69440	Cutler Reservoir	4404.3	5.2	4404.3	11.8	0.00	6.7	129%
79456	US Highway 30	4396.4	23.0	4396.4	43.1	0.00	20.1	87%
84023	South Marsh	4403.1	72.3	4403.1	119.1	0.00	46.8	65%

Based on these model results it can be concluded that increasing the operational range of Cutler Reservoir from 4407.5-4406.5 to 4407.5-4405.0 will not result in a significant increase in bed sediment erosion within the Model Boundary and expected increases in average TSS concentrations would be mostly limited to the Canyon reach of Cutler Reservoir.

6.5.2.1 1D SEDIMENT TRANSPORT PARAMETER SENSITIVITY

In order to verify the model's sensitivity to the sediment transport parameters used for this analysis two additional sets of sediment transport parameters (Table 6-6) were also used to analyze the existing and proposed operational scenarios. The detailed results from this sensitivity analysis can be found in Attachment G-17.

TABLE 6-6 SEDIMENT TRANSPORT PARAMETER SENSITIVITY PARAMETERS

TRANSPORT PARAMETER SENSITIVITY GROUP	TRANSPORT FUNCTION	SORTING METHOD	FALL VELOCITY METHOD
1	Ackers-White	Thomas (Ex5)	Ruby
2	Toffaleti	Copeland (Ex7)	Dietrich

The results from the sensitivity analysis indicate that for the existing and proposed operational ranges described above, changing the sediment transport parameters used in the model do not significantly affect the results. This result increases the confidence in the qualitative conclusions drawn from this analysis.

7.0 SUMMARY

The hydraulic modeling study as presented in this ISR satisfies the content and methods approved by FERC's Study Plan Determination and responds to the data gaps for the various resource areas identified by FERC in Scoping Document 1 and Scoping Document 2. A summary of each respective model, as well as the limitations of these model applications are outlined below.

7.1 2D HYDRAULIC MODEL SUMMARY

The hydraulic results produced from the 2D model accurately represent the existing and proposed operational conditions within the reservoir under the assumed inflow conditions. However, these results are sensitive to the assumed flow inputs within the model, including surface water and groundwater volume and timing. Knowing that the results produced from the model are directly tied to assumed or measured surface and groundwater flow inputs is critical to interpretation of model results. The primary use of this hydraulic modeling tool is to assess the relative differences in reservoir WSEs, depths, and inundation boundaries between different operational scenarios that have similar groundwater and surface water inputs.

7.2 1D SEDIMENT TRANSPORT SCENARIOS MODEL SUMMARY

Sediment modeling has inherent and substantial uncertainties. The results produced by a sediment model of this size and complexity should only be used for comparison purposes (i.e., how operational scenario compare to one another in relative terms). The ability for a sediment transport model of this size and complexity to provide quantitative answers for single operational scenario is neither realistic nor accurate and would require extensive (multi-year) calibration and verification for multiple types of drawdown during different seasons, under different flow conditions, and for different quantities and timing of drawdown. Due to the lack of available bed gradation data downstream of Cutler Dam the quantitative results from this portion of the model carry additional uncertainty. However, the results of the model downstream of Cutler Dam are still helpful when comparing qualitative differences between the two operational scenarios.

This model accomplishes the study objective to produce qualitative sediment results that can be used to determine relative changes in sediment transport capacities and reservoir elevations between the proposed 1-foot operational scenario (normal) and 2.5-foot operational scenario (extended).

7.3 MODEL IMPLEMENTATION LIMITATIONS

The model implementation limitations for these models include:

- Assessing localized hydraulic behavior in areas where the reservoir bed had to be interpolated (no LiDAR returns and no bathymetry).
- Modeling scenarios where groundwater and surface water inflow quantities, locations, and timing are unknown or cannot be assumed.
- Attempting to produce accurate quantitative sediment transport results for a single modeling scenario.

This study was developed to evaluate the existing hydraulic conditions of the Project as well as assess the feasibility and potential impacts that may result from the potential change in future Project operations as described in the PAD (PacifiCorp 2019). Study data include analysis of the potential effects of future Project operations in the Model Boundary. Additional analysis of potential effects of future Project operations will be provided in the Draft License Application. No additional or future studies are proposed.

8.0 REFERENCES

Chow, Ven Te (Chow). 1959. *Open-Channel Hydraulics.* Civil Engineering Series. The Manning Formula. McGraw Hill, Inc. Page 98.

PacifiCorp. 2018. Cutler Hydroelectric Project FERC Project No. 2420. Maps created in 2018.

PacifiCorp. 2019. Cutler Hydroelectric Project Preliminary Application Document (PAD). Published March 2019.

United States Army Corps of Engineers (USACE). 2016. Hydrologic Engineering Center. *HEC-RAS Hydraulic Reference Manual*. Version 5. February 2016. [Online]: https://www.hec.usace.army.mil/software/hec-ras/documentation/HEC-RAS%205.0%20Reference%20Manual.pdf

ATTACHMENT G-1

SEDIMENT SAMPLE GRADATIONS

Soil Type	Size of Soil Type (mm)			Site Gradations (% Finer)									
	Min	Average	Max	Site 1	Site 2	Site 11	Site 17 Depth 1	Site 17 Depth 2	Site 21	Site 26	Site 29	Site 34	Site 35
Clay	0.00	0.00	0.00	28.86	22.50	23.06	31.22	8.80	39.94	23.57	2.49	34.63	18.97
VFM	0.00	0.01	0.01	38.85	29.11	31.25	42.55	10.34	51.00	33.26	2.75	41.39	23.06
FM	0.01	0.02	0.01	48.83	35.73	39.43	53.89	11.89	62.06	42.95	3.00	48.14	27.15
MM	0.02	0.03	0.02	58.81	42.34	47.61	65.22	13.43	73.12	52.64	3.26	54.89	31.25
CM	0.03	0.06	0.05	72.88	52.64	62.24	79.29	16.10	84.35	69.17	4.41	67.61	48.86
VFS	0.06	0.13	0.09	91.87	69.90	86.75	95.86	33.71	94.40	94.13	19.92	89.52	86.87
FS	0.13	0.25	0.18	96.74	82.75	97.75	99.12	88.27	96.35	98.24	72.50	99.26	99.60
MS	0.25	0.50	0.35	97.73	91.41	98.60	99.52	98.63	97.73	98.95	85.31	99.63	99.76
CS	0.50	1.00	0.71	99.60	97.45	99.42	99.94	99.93	99.51	99.90	97.60	99.86	99.93
VCS	1.00	2.00	1.41	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Soil Type	Size of Soil Type (mm)			Site Gradations (% Finer)									
	Min	Average	Max	Site 36	Site 37	Site 39	Site 40	Site 44	Site 45 Depth 1	Site 45 Depth 2	Site 45 Depth 3	Site 47	Site 50
Clay	0.00	0.00	0.00	31.71	48.49	43.28	2.55	3.20	16.57	14.42	32.59	12.93	19.15
VFM	0.00	0.01	0.01	40.54	57.11	51.68	2.66	3.50	24.34	19.03	41.37	18.05	28.51
FM	0.01	0.02	0.01	49.37	65.72	60.07	2.76	3.80	32.11	23.65	50.16	23.18	37.86
MM	0.02	0.03	0.02	58.20	74.33	68.47	2.87	4.11	39.88	28.27	58.94	28.30	47.22
CM	0.03	0.06	0.05	68.60	83.68	77.03	3.19	4.60	56.96	35.63	71.67	42.95	64.43
VFS	0.06	0.13	0.09	83.15	93.59	86.22	13.12	10.54	87.38	52.29	89.05	74.89	91.89
FS	0.13	0.25	0.18	97.42	97.83	93.64	50.31	31.38	96.65	77.90	92.79	96.94	97.63
MS	0.25	0.50	0.35	98.79	99.29	96.38	78.97	64.23	97.88	82.54	94.61	98.52	98.54
CS	0.50	1.00	0.71	99.64	99.89	99.49	95.96	91.40	99.84	90.87	97.53	99.88	99.90
VCS	1.00	2.00	1.41	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Soil Type	Size of Soil Type (mm)			Site Gradations (% Finer)									
	Min	Average	Max	Site 52	Site 53	Site 56 Depth 1	Site 56 Depth 2	Site 58 Depth 1	Site 58 Depth 2	Site 59	Site 62 Depth 1	Site 62 Depth 2	Clay Slough
Clay	0.00	0.00	0.00	13.28	14.42	42.88	2.29	41.98	38.77	47.27	55.55	6.19	37.17
VFM	0.00	0.01	0.01	17.76	19.03	53.95	2.60	52.96	49.53	59.55	66.10	7.57	49.54
FM	0.01	0.02	0.01	22.24	23.65	65.03	2.92	63.95	60.30	71.82	76.65	8.96	61.91
MM	0.02	0.03	0.02	26.72	28.27	76.11	3.23	74.93	71.07	84.10	87.21	10.35	74.28
CM	0.03	0.06	0.05	37.75	37.65	85.97	4.26	84.16	81.37	94.01	95.34	12.47	86.87
VFS	0.06	0.13	0.09	64.86	60.76	93.05	13.72	90.90	90.63	98.79	98.61	16.16	97.90
FS	0.13	0.25	0.18	97.36	93.38	95.98	43.70	97.79	96.26	99.14	99.24	19.40	98.98
MS	0.25	0.50	0.35	99.03	98.40	98.52	83.36	98.96	97.87	99.35	99.44	31.93	99.32
CS	0.50	1.00	0.71	99.77	99.60	99.46	99.45	99.90	99.29	99.62	99.65	68.17	99.92
VCS	1.00	2.00	1.41	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

ATTACHMENT G-2

TOTAL SUSPENDED SOLIDS DATA

Site 1 - Bear River Access		
Collection Date	**Collection Time**	**TSS (mg/L)**
10/25/2019	10:10	2.99
10/26/2019	9:30	6.19
10/27/2019	7:30	7.42
10/28/2019	11:40	12.60
10/29/2019	11:25	4.10
10/30/2019	16:04	9.31
10/31/2019	14:25	6.77
11/1/2019	9:54	5.97
11/2/2019	11:40	6.93
11/3/2019	15:45	16.76
11/4/2019	14:40	28.04
11/5/2019	10:40	11.25
11/6/2019	11:53	6.44
11/7/2019	12:40	9.15
11/8/2019	13:15	8.47
11/9/2019	7:45	6.89
11/10/2019	18:20	13.93
11/11/2019	10:50	12.28
11/12/2019	14:06	10.07
11/13/2019	11:30	4.68
11/14/2019	13:55	9.71
11/15/2019	14:18	7.04
11/16/2019	10:23	7.71
11/17/2019	5:15	19.31
11/18/2019	10:25	8.88

Site 2 - Stilling Basin		
Collection Date	**Collection Time**	**TSS (mg/L)**
10/25/2019	12:24	3.45
10/26/2019	10:16	6.80
10/27/2019	8:25	13.65
10/28/2019	14:40	22.44
10/29/2019	9:14	19.07
10/29/2019	15:00	125.78
10/29/2019	15:00	367.91
10/29/2019	15:00	957.46
10/29/2019	15:00	6414.00
10/29/2019	15:00	673.44
10/30/2019	15:00	151.98
10/31/2019	12:37	112.20
11/1/2019	12:15	74.95
11/2/2019	10:45	248.88
11/3/2019	15:05	663.08
11/4/2019	12:10	193.04
11/5/2019	9:30	173.62
11/6/2019	13:10	157.22
11/7/2019	10:05	167.04
11/8/2019	12:07	119.56
11/9/2019	8:50	73.56
11/11/2019	12:30	96.22
11/11/2019	12:41	91.90
11/12/2019	13:25	63.01
11/16/2019	9:45	24.96
11/17/2019	16:49	26.91

Site 3 - Camp Fife (1)		
Collection Date	Collection Time	TSS (mg/L)
10/25/2019	13:06	6.59
10/26/2019	10:33	24.66
10/27/2019	8:50	10.70
10/28/2019	15:30	12.01
10/29/2019	9:53	12.25
10/30/2019	9:30	893.64
10/31/2019	12:10	137.18
11/1/2019	11:35	80.57
11/2/2019	10:19	158.44
11/2/2019	10:24	522.70
11/2/2019	10:25	876.84
11/2/2019	10:26	1366.36
11/3/2019	14:30	872.68
11/3/2019	14:30	442.92
11/3/2019	14:30	946.32
11/3/2019	14:30	658.56
11/3/2019	14:30	769.36
11/4/2019	11:54	325.56
11/4/2019	11:54	203.70
11/4/2019	11:56	145.34
11/4/2019	11:56	165.70
11/4/2019	11:58	153.44
11/4/2019	12:00	129.50
11/4/2019	12:00	115.52
11/4/2019	12:00	134.00
11/4/2019	12:02	136.36
11/4/2019	12:03	176.96
11/4/2019	12:03	198.76
11/4/2019	12:04	164.14

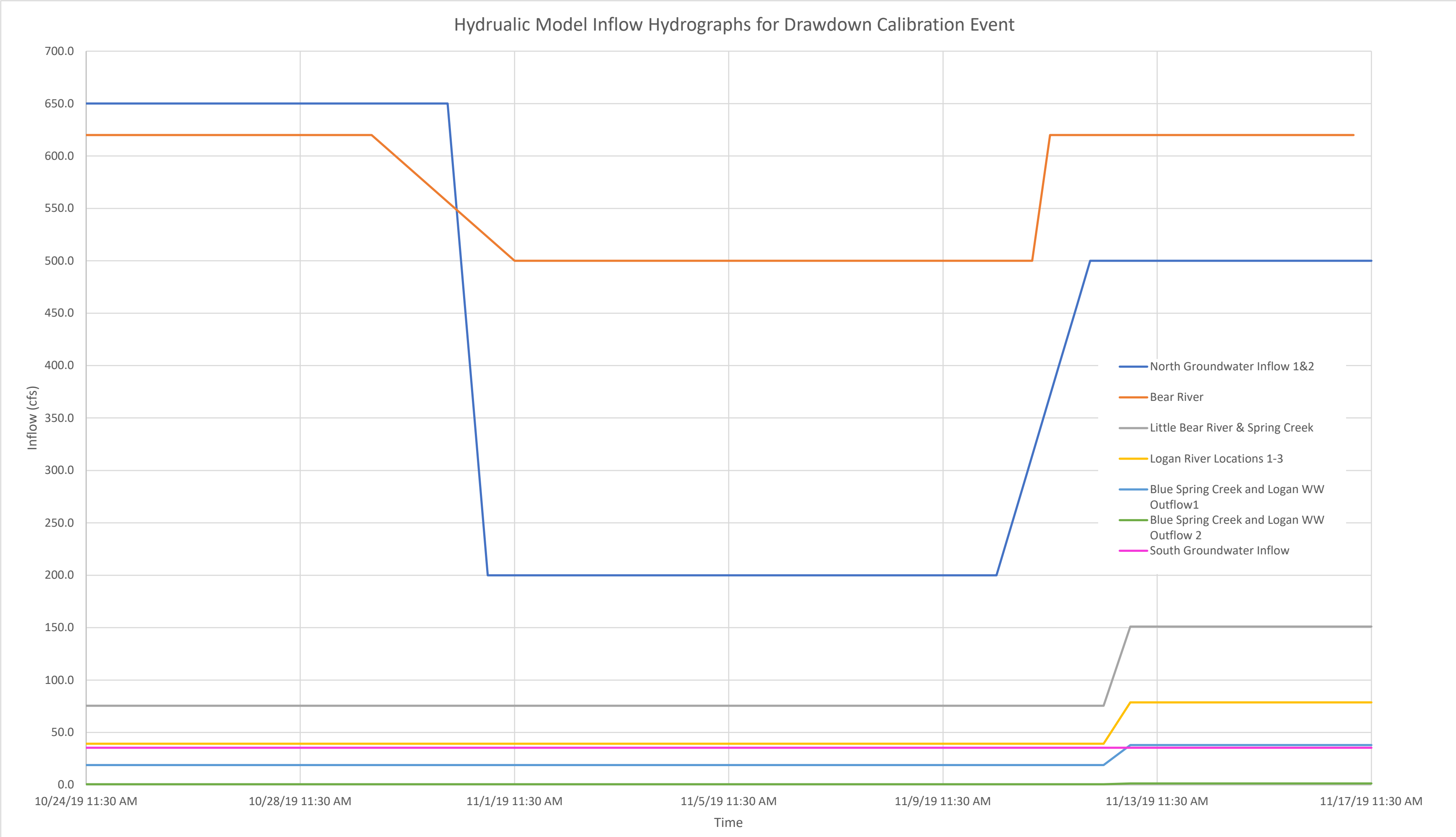
Site 3 - Camp Fife (2)		
Collection Date	Collectio n Time	TSS (mg/L)
11/4/2019	12:03	176.96
11/4/2019	12:03	198.76
11/4/2019	12:04	164.14
11/5/2019	10:12	115.74
11/5/2019	10:12	243.28
11/5/2019	10:10	177.84
11/5/2019	10:10	266.52
11/6/2019	12:40	114.10
11/6/2019	12:32	90.14
11/6/2019	12:33	375.78
11/6/2019	12:38	358.64
11/6/2019	12:45	72.88
11/7/2019	10:35	80.32
11/7/2019	10:35	195.42
11/8/2019	11:15	216.66
11/8/2019	11:17	184.72
11/8/2019	11:19	118.02
11/8/2019	11:22	82.36
11/9/2019	10:00	68.88
11/10/2019	16:15	82.08
11/11/2019	11:49	85.14
11/11/2019	11:45	167.90
11/11/2019	11:46	70.98
11/11/2019	12:15	123.46
11/12/2019	13:33	51.08
11/15/2019	15:15	66.56
11/16/2019	9:37	19.01
11/17/2019	4:35	18.32
11/18/2019	11:45	9.81

ATTACHMENT G-3

INFLOW HYDROGRAPHS BY BOUNDARY CONDITIONS DURING DRAWDOWN

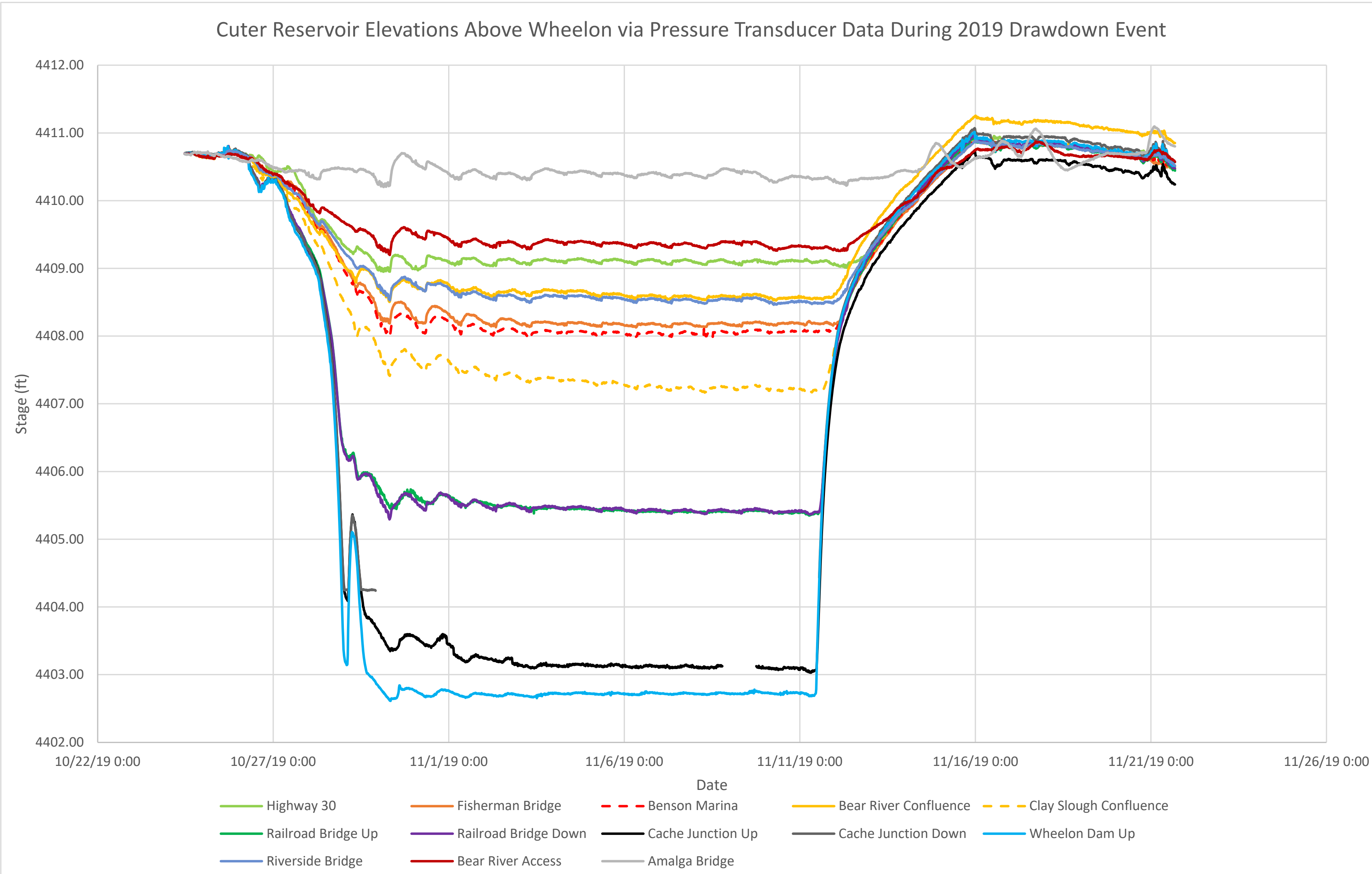
Inflow (cfs)													
6 Hour Timestep			8 Hour Timestep		12 Hour Timestep							24 Hour Timestep	
Date	North Ground Water Inflow 1	North Ground Water Inflow 2	Date	Bear River	Date	Little Bear River and Spring Creek	Logan River 1	Logan River 2	Logan River 3	Blue Spring Creek and Logan WW outflow 1	Blue Spring Creek and Logan WW Outflow 2	Date	South Ground Water Inflow
10/24/19 11:30 AM	650.0	650.0	10/24/19 11:30 AM	620.0	10/24/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	10/24/19 11:30 AM	35.5
10/24/19 5:30 PM	650.0	650.0	10/24/19 7:30 PM	620.0	10/24/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	10/25/19 11:30 AM	35.5
10/24/19 11:30 PM	650.0	650.0	10/25/19 3:30 AM	620.0	10/25/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	10/26/19 11:30 AM	35.5
10/25/19 5:30 AM	650.0	650.0	10/25/19 11:30 AM	620.0	10/25/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	10/27/19 11:30 AM	35.5
10/25/19 11:30 AM	650.0	650.0	10/25/19 7:30 PM	620.0	10/26/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	10/28/19 11:30 AM	35.5
10/25/19 5:30 PM	650.0	650.0	10/26/19 3:30 AM	620.0	10/26/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	10/29/19 11:30 AM	35.5
10/25/19 11:30 PM	650.0	650.0	10/26/19 11:30 AM	620.0	10/27/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	10/30/19 11:30 AM	35.5
10/26/19 5:30 AM	650.0	650.0	10/26/19 7:30 PM	620.0	10/27/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	10/31/19 11:30 AM	35.5
10/26/19 11:30 AM	650.0	650.0	10/27/19 3:30 AM	620.0	10/28/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	11/1/19 11:30 AM	35.5
10/26/19 5:30 PM	650.0	650.0	10/27/19 11:30 AM	620.0	10/28/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	11/2/19 11:30 AM	35.5
10/26/19 11:30 PM	650.0	650.0	10/27/19 7:30 PM	620.0	10/29/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	11/3/19 11:30 AM	35.5
10/27/19 5:30 AM	650.0	650.0	10/28/19 3:30 AM	620.0	10/29/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	11/4/19 11:30 AM	35.5
10/27/19 11:30 AM	650.0	650.0	10/28/19 11:30 AM	620.0	10/30/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	11/5/19 11:30 AM	35.5
10/27/19 5:30 PM	650.0	650.0	10/28/19 7:30 PM	620.0	10/30/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	11/6/19 11:30 AM	35.5
10/27/19 11:30 PM	650.0	650.0	10/29/19 3:30 AM	620.0	10/31/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	11/7/19 11:30 AM	35.5
10/28/19 5:30 AM	650.0	650.0	10/29/19 11:30 AM	620.0	10/31/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	11/8/19 11:30 AM	35.5
10/28/19 11:30 AM	650.0	650.0	10/29/19 7:30 PM	620.0	11/1/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	11/9/19 11:30 AM	35.5
10/28/19 5:30 PM	650.0	650.0	10/30/19 3:30 AM	605.0	11/1/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	11/10/19 11:30 AM	35.5
10/28/19 11:30 PM	650.0	650.0	10/30/19 11:30 AM	590.0	11/2/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	11/11/19 11:30 AM	35.5
10/29/19 5:30 AM	650.0	650.0	10/30/19 7:30 PM	575.0	11/2/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	11/12/19 11:30 AM	35.5
10/29/19 11:30 AM	650.0	650.0	10/31/19 3:30 AM	560.0	11/3/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	11/13/19 11:30 AM	35.5
10/29/19 5:30 PM	650.0	650.0	10/31/19 11:30 AM	545.0	11/3/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	11/14/19 11:30 AM	35.5
10/29/19 11:30 PM	650.0	650.0	10/31/19 7:30 PM	530.0	11/4/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	11/15/19 11:30 AM	35.5
10/30/19 5:30 AM	650.0	650.0	11/1/19 3:30 AM	515.0	11/4/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	11/16/19 11:30 AM	35.5
10/30/19 11:30 AM	650.0	650.0	11/1/19 11:30 AM	500.0	11/5/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	11/17/19 11:30 AM	35.5
10/30/19 5:30 PM	650.0	650.0	11/1/19 7:30 PM	500.0	11/5/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	-	-
10/30/19 11:30 PM	650.0	650.0	11/2/19 3:30 AM	500.0	11/6/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	-	-
10/31/19 5:30 AM	650.0	650.0	11/2/19 11:30 AM	500.0	11/6/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	-	-
10/31/19 11:30 AM	500.0	500.0	11/2/19 7:30 PM	500.0	11/7/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	-	-
10/31/19 5:30 PM	350.0	350.0	11/3/19 3:30 AM	500.0	11/7/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	-	-
10/31/19 11:30 PM	200.0	200.0	11/3/19 11:30 AM	500.0	11/8/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	-	-
11/1/19 5:30 AM	200.0	200.0	11/3/19 7:30 PM	500.0	11/8/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	-	-
11/1/19 11:30 AM	200.0	200.0	11/4/19 3:30 AM	500.0	11/9/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	-	-
11/1/19 5:30 PM	200.0	200.0	11/4/19 11:30 AM	500.0	11/9/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	-	-
11/1/19 11:30 PM	200.0	200.0	11/4/19 7:30 PM	500.0	11/10/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	-	-
11/2/19 5:30 AM	200.0	200.0	11/5/19 3:30 AM	500.0	11/10/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	-	-
11/2/19 11:30 AM	200.0	200.0	11/5/19 11:30 AM	500.0	11/11/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	-	-
11/2/19 5:30 PM	200.0	200.0	11/5/19 7:30 PM	500.0	11/11/19 11:30 PM	75.6	39.3	39.3	39.3	19.0	0.7	-	-
11/2/19 11:30 PM	200.0	200.0	11/6/19 3:30 AM	500.0	11/12/19 11:30 AM	75.6	39.3	39.3	39.3	19.0	0.7	-	-
11/3/19 5:30 AM	200.0	200.0	11/6/19 11:30 AM	500.0	11/12/19 11:30 PM	151.1	78.7	78.7	78.7	38.0	1.4	-	-
11/3/19 11:30 AM	200.0	200.0	11/6/19 7:30 PM	500.0	11/13/19 11:30 AM	151.1	78.7	78.7	78.7	38.0	1.4	-	-
11/3/19 5:30 PM	200.0	200.0	11/7/19 3:30 AM	500.0	11/13/19 11:30 PM	151.1	78.7	78.7	78.7	38.0	1.4	-	-
11/3/19 11:30 PM	200.0	200.0	11/7/19 11:30 AM	500.0	11/14/19 11:30 AM	151.1	78.7	78.7	78.7	38.0	1.4	-	-
11/4/19 5:30 AM	200.0	200.0	11/7/19 7:30 PM	500.0	11/14/19 11:30 PM	151.1	78.7	78.7	78.7	38.0	1.4	-	-
11/4/19 11:30 AM	200.0	200.0	11/8/19 3:30 AM	500.0	11/15/19 11:30 AM	151.1	78.7	78.7	78.7	38.0	1.4	-	-
11/4/19 5:30 PM	200.0	200.0	11/8/19 11:30 AM	500.0	11/15/19 11:30 PM	151.1	78.7	78.7	78.7	38.0	1.4	-	-
11/4/19 11:30 PM	200.0	200.0	11/8/19 7:30 PM	500.0	11/16/19 11:30 AM	151.1	78.7	78.7	78.7	38.0	1.4	-	-
11/5/19 5:30 AM	200.0	200.0	11/9/19 3:30 AM	500.0	11/16/19 11:30 PM	151.1	78.7	78.7	78.7	38.0	1.4	-	-
11/5/19 11:30 AM	200.0	200.0	11/9/19 11:30 AM	500.0	11/17/19 11:30 AM	151.1	78.7	78.7	78.7	38.0	1.4	-	-
11/5/19 5:30 PM	200.0	200.0	11/9/19 7:30 PM	500.0	-	-	-	-	-	-	-	-	-

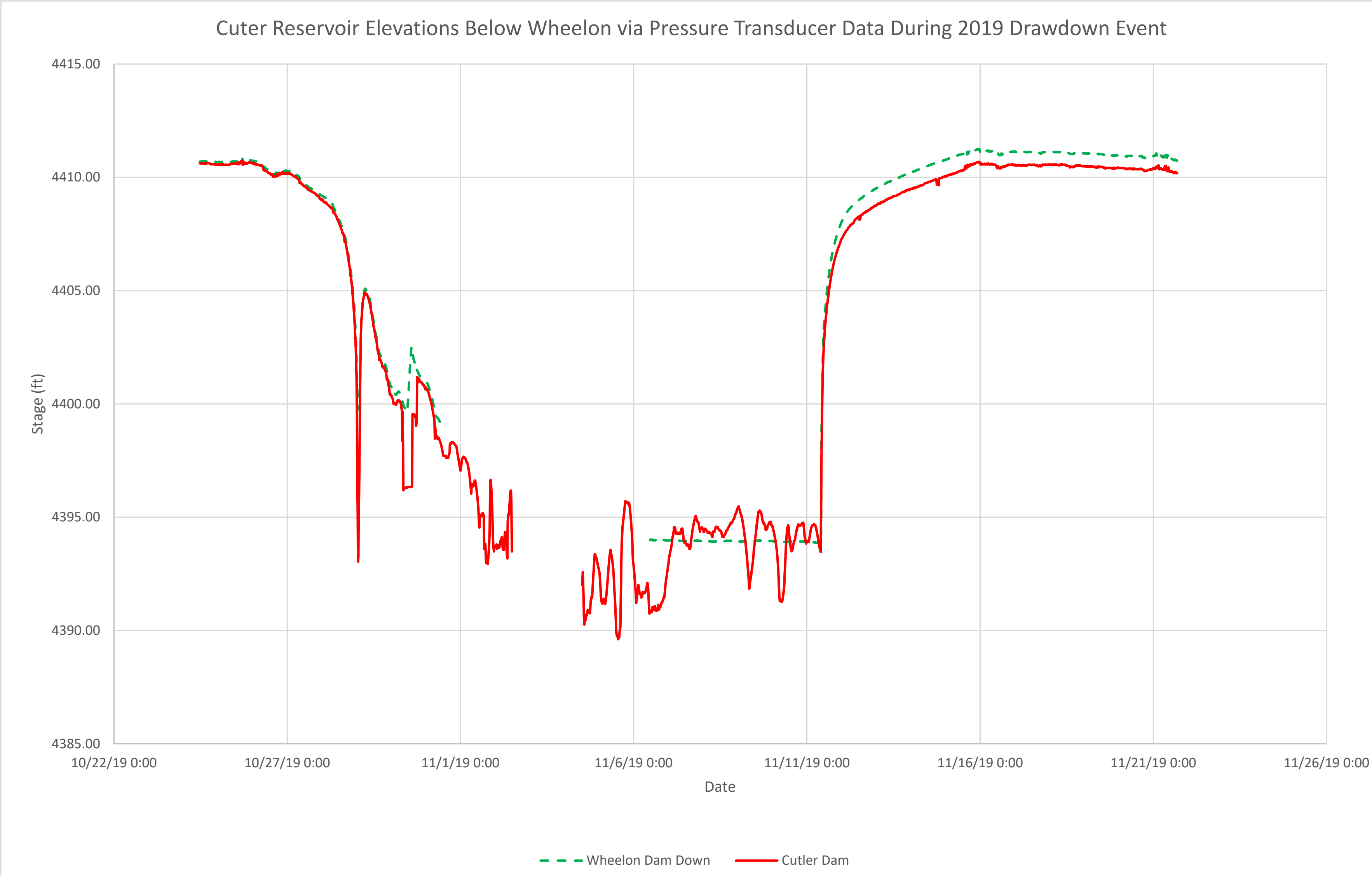
Inflow (cfs)													
6 Hour Timestep			8 Hour Timestep		12 Hour Timestep							24 Hour Timestep	
Date	North Ground Water Inflow 1	North Ground Water Inflow 2	Date	Bear River	Date	Little Bear River and Spring Creek	Logan River 1	Logan River 2	Logan River 3	Blue Spring Creek and Logan WW outflow 1	Blue Spring Creek and Logan WW Outflow 2	Date	South Ground Water Inflow
11/5/19 11:30 PM	200.0	200.0	11/10/19 3:30 AM	500.0	-	-	-	-	-	-	-	-	-
11/6/19 5:30 AM	200.0	200.0	11/10/19 11:30 AM	500.0	-	-	-	-	-	-	-	-	-
11/6/19 11:30 AM	200.0	200.0	11/10/19 7:30 PM	500.0	-	-	-	-	-	-	-	-	-
11/6/19 5:30 PM	200.0	200.0	11/11/19 3:30 AM	500.0	-	-	-	-	-	-	-	-	-
11/6/19 11:30 PM	200.0	200.0	11/11/19 11:30 AM	620.0	-	-	-	-	-	-	-	-	-
11/7/19 5:30 AM	200.0	200.0	11/11/19 7:30 PM	620.0	-	-	-	-	-	-	-	-	-
11/7/19 11:30 AM	200.0	200.0	11/12/19 3:30 AM	620.0	-	-	-	-	-	-	-	-	-
11/7/19 5:30 PM	200.0	200.0	11/12/19 11:30 AM	620.0	-	-	-	-	-	-	-	-	-
11/7/19 11:30 PM	200.0	200.0	11/12/19 7:30 PM	620.0	-	-	-	-	-	-	-	-	-
11/8/19 5:30 AM	200.0	200.0	11/13/19 3:30 AM	620.0	-	-	-	-	-	-	-	-	-
11/8/19 11:30 AM	200.0	200.0	11/13/19 11:30 AM	620.0	-	-	-	-	-	-	-	-	-
11/8/19 5:30 PM	200.0	200.0	11/13/19 7:30 PM	620.0	-	-	-	-	-	-	-	-	-
11/8/19 11:30 PM	200.0	200.0	11/14/19 3:30 AM	620.0	-	-	-	-	-	-	-	-	-
11/9/19 5:30 AM	200.0	200.0	11/14/19 11:30 AM	620.0	-	-	-	-	-	-	-	-	-
11/9/19 11:30 AM	200.0	200.0	11/14/19 7:30 PM	620.0	-	-	-	-	-	-	-	-	-
11/9/19 5:30 PM	200.0	200.0	11/15/19 3:30 AM	620.0	-	-	-	-	-	-	-	-	-
11/9/19 11:30 PM	200.0	200.0	11/15/19 11:30 AM	620.0	-	-	-	-	-	-	-	-	-
11/10/19 5:30 AM	200.0	200.0	11/15/19 7:30 PM	620.0	-	-	-	-	-	-	-	-	-
11/10/19 11:30 AM	200.0	200.0	11/16/19 3:30 AM	620.0	-	-	-	-	-	-	-	-	-
11/10/19 5:30 PM	242.9	242.9	11/16/19 11:30 AM	620.0	-	-	-	-	-	-	-	-	-
11/10/19 11:30 PM	285.7	285.7	11/16/19 7:30 PM	620.0	-	-	-	-	-	-	-	-	-
11/11/19 5:30 AM	328.6	328.6	11/17/19 3:30 AM	620.0	-	-	-	-	-	-	-	-	-
11/11/19 11:30 AM	371.4	371.4	-	-	-	-	-	-	-	-	-	-	-
11/11/19 5:30 PM	414.3	414.3	-	-	-	-	-	-	-	-	-	-	-
11/11/19 11:30 PM	457.1	457.1	-	-	-	-	-	-	-	-	-	-	-
11/12/19 5:30 AM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/12/19 11:30 AM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/12/19 5:30 PM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/12/19 11:30 PM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/13/19 5:30 AM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/13/19 11:30 AM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/13/19 5:30 PM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/13/19 11:30 PM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/14/19 5:30 AM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/14/19 11:30 AM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/14/19 5:30 PM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/14/19 11:30 PM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/15/19 5:30 AM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/15/19 11:30 AM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/15/19 5:30 PM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/15/19 11:30 PM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/16/19 5:30 AM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/16/19 11:30 AM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/16/19 5:30 PM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/16/19 11:30 PM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/17/19 5:30 AM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-
11/17/19 11:30 AM	500.0	500.0	-	-	-	-	-	-	-	-	-	-	-


Hydrualic Model Inflow Hydrographs for Drawdown Calibration Event
Inflow (cfs)
700.0
650.0
600.0
550.0
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
10/24/19 11:30 AM
10/28/19 11:30 AM
11/1/19 11:30 AM
11/5/19 11:30 AM
11/9/19 11:30 AM
11/13/19 11:30 AM
11/17/19 11:30 AM
Time
North Groundwater Inflow 1&2
Bear River
Little Bear River & Spring Creek
Logan River Locations 1-3
Blue Spring Creek and Logan WW Outflow1
Blue Spring Creek and Logan WW Outflow 2
South Groundwater Inflow

ATTACHMENT G-4

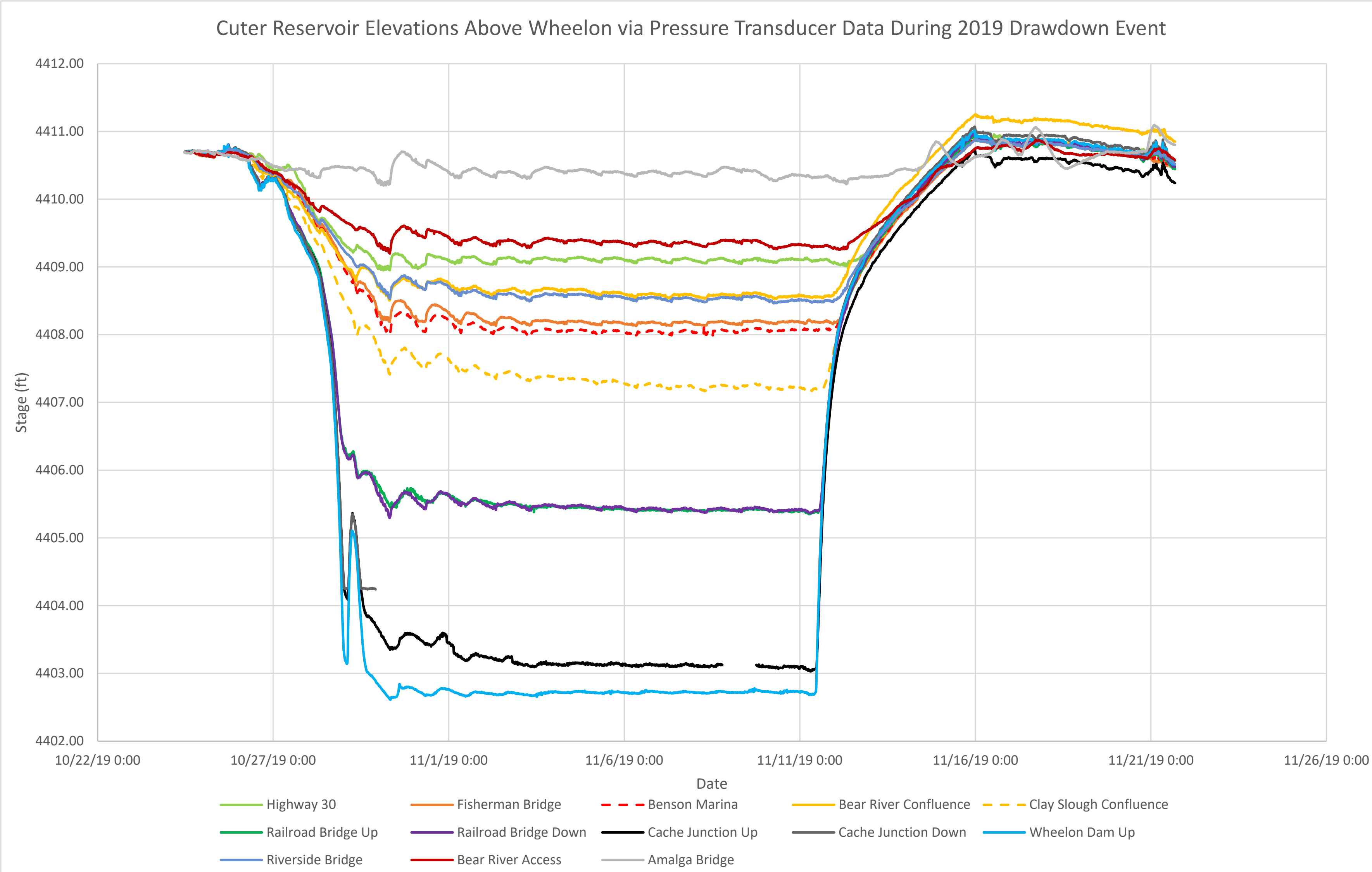
LOGAN AND BEAR RIVER TSS CONCENTRATION TIME SERIES

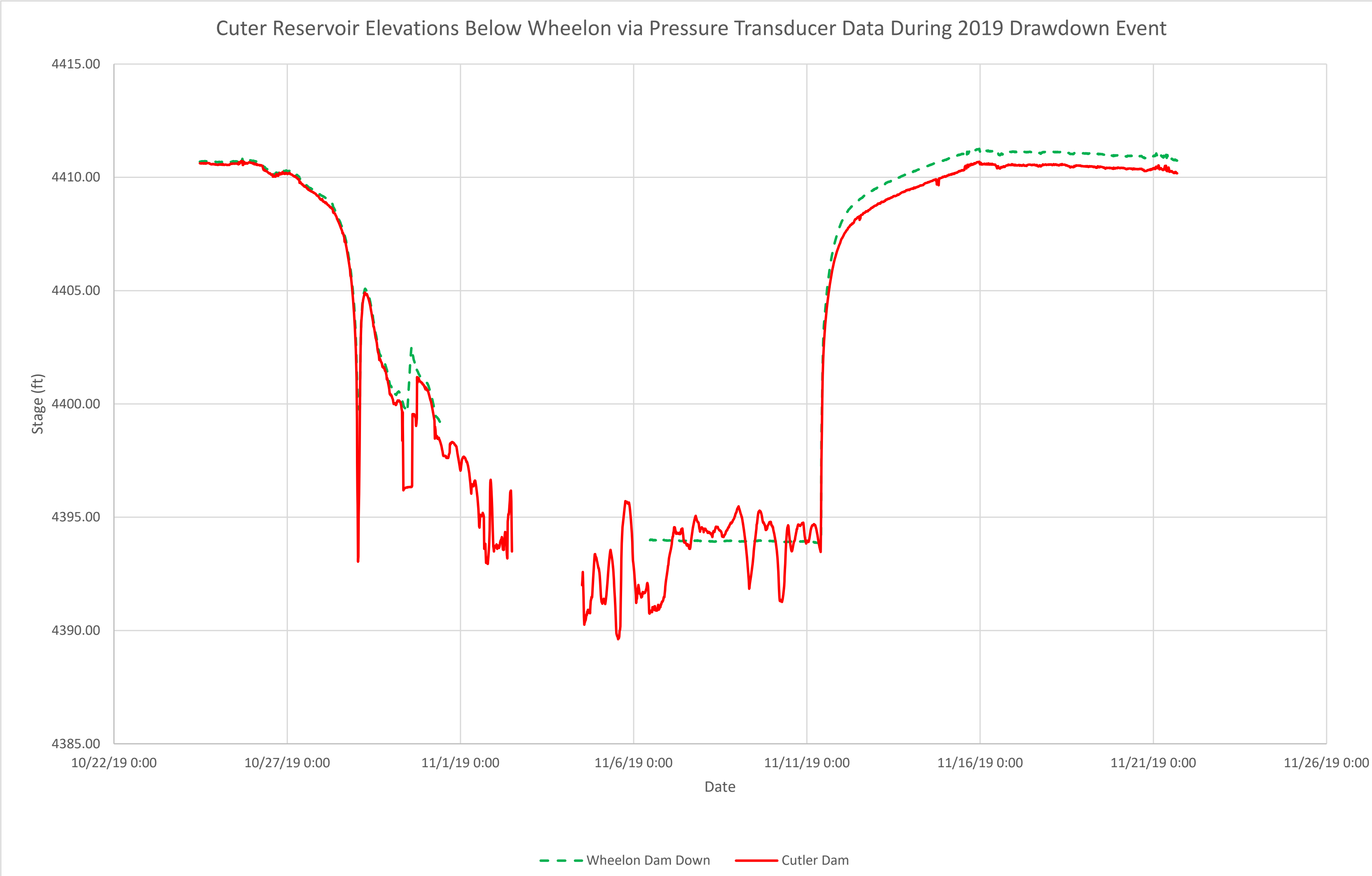

Cuter Reservoir Elevations Above Wheelon via Pressure Transducer Data During 2019 Drawdown Event
Stage (ft)
4412.00
4411.00
4410.00
4409.00
4408.00
4407.00
4406.00
4405.00
4404.00
4403.00
4402.00
10/22/19 0:00
10/27/19 0:00
11/1/19 0:00
11/6/19 0:00
11/11/19 0:00
11/16/19 0:00
11/21/19 0:00
11/26/19 0:00
Date
Highway 30
Fisherman Bridge
Benson Marina
Bear River Confluence
Clay Slough Confluence
Railroad Bridge Up
Railroad Bridge Down
Cache Junction Up
Cache Junction Down
Wheelon Dam Up
Riverside Bridge
Bear River Access
Amalga Bridge


Cuter Reservoir Elevations Below Wheelon via Pressure Transducer Data During 2019 Drawdown Event
Stage (ft)
4415.00
4410.00
4405.00
4400.00
4395.00
4390.00
4385.00
10/22/19 0:00
10/27/19 0:00
11/1/19 0:00
11/6/19 0:00
11/11/19 0:00
11/16/19 0:00
11/21/19 0:00
11/26/19 0:00
Date
Wheelon Dam Down
Cutler Dam

ATTACHMENT G-5

PRESSURE TRANSDUCER DATA DURING DRAWDOWN


Cuter Reservoir Elevations Above Wheelon via Pressure Transducer Data During 2019 Drawdown Event
Stage (ft)
4412.00
4411.00
4410.00
4409.00
4408.00
4407.00
4406.00
4405.00
4404.00
4403.00
4402.00
10/22/19 0:00
10/27/19 0:00
11/1/19 0:00
11/6/19 0:00
11/11/19 0:00
11/16/19 0:00
11/21/19 0:00
11/26/19 0:00
Date
Highway 30
Fisherman Bridge
Benson Marina
Bear River Confluence
Clay Slough Confluence
Railroad Bridge Up
Railroad Bridge Down
Cache Junction Up
Cache Junction Down
Wheelon Dam Up
Riverside Bridge
Bear River Access
Amalga Bridge


Cuter Reservoir Elevations Below Wheelon via Pressure Transducer Data During 2019 Drawdown Event
Stage (ft)
4415.00
4410.00
4405.00
4400.00
4395.00
4390.00
4385.00
10/22/19 0:00
10/27/19 0:00
11/1/19 0:00
11/6/19 0:00
11/11/19 0:00
11/16/19 0:00
11/21/19 0:00
11/26/19 0:00
Date
Wheelon Dam Down
Cutler Dam

ATTACHMENT G-6

INITIAL CONDITIONS BY CROSS SECTION IN SEDIMENT MODEL

Sediment Model Initial Conditions

Reach	River Sta	Invert (ft, NAVD88)	Max depth (ft)	Min Elev	Left Station	Right Station	Bed Gradation
Bear River	33184.00	4401.12	100.00	N/A	60.26	191.83	Site 34
Bear River	33141.00	4400.60	100.00	N/A	49.76	188.95	Site 34
Bear River	33078.00	4400.76	100.00	N/A	50.77	196.54	Site 34
Bear River	33024.00	4401.67	100.00	N/A	53.46	201.14	Site 34
Bear River	32967.00	4401.16	100.00	N/A	37.75	190.64	Site 34
Bear River	32922.00	4401.44	100.00	N/A	38.36	182.14	Site 34
Bear River	32862.00	4400.59	100.00	N/A	45.73	184.61	Site 34
Bear River	32803.00	4401.50	100.00	N/A	62.86	191.44	Site 34
Bear River	32764.00	4402.00	100.00	N/A	53.32	185.54	Site 34
Bear River	32704.00	4401.73	100.00	N/A	39.29	163.05	Site 34
Bear River	32553.00	4402.35	100.00	N/A	36.58	154.53	Site 34
Bear River	32433.00	4399.95	100.00	N/A	41.52	142.28	Site 34
Bear River	32272.00	4401.43	100.00	N/A	53.00	168.33	Site 34
Bear River	32102.00	4397.13	100.00	N/A	48.98	163.06	Site 34
Bear River	32045.00	4396.05	100.00	N/A	45.45	159.27	Site 34
Bear River	31919.00	4394.94	100.00	N/A	31.08	138.97	Site 34
Bear River	31803.00	4394.51	100.00	N/A	25.31	137.42	Site 34
Bear River	31757.00	4397.10	100.00	N/A	30.97	147.23	Site 34
Bear River	31660.00	4400.76	100.00	N/A	25.89	149.13	Site 34
Bear River	31490.00	4403.38	100.00	N/A	22.90	169.01	Site 34
Bear River	31316.00	4405.00	100.00	N/A	44.75	194.92	Site 34
Bear River	31123.00	4401.74	100.00	N/A	11.49	191.94	Site 34
Bear River	31047.00	4399.65	100.00	N/A	23.38	225.02	Site 34
Bear River	31029.00	4395.31	100.00	N/A	14.54	213.01	Site 34
Bear River	30996.00	4394.66	100.00	N/A	23.58	209.54	Site 34
Bear River	30957.00	4392.03	100.00	N/A	17.49	173.49	Site 34
Bear River	30913.00	4392.03	100.00	N/A	12.71	148.85	Site 34
Bear River	30855.00	4392.00	100.00	N/A	7.27	112.96	Site 34
Bear River	30811.00	4394.49	100.00	N/A	17.72	117.99	Site 34
Bear River	30767.00	4397.06	100.00	N/A	13.12	138.63	Site 34
Bear River	30639.00	4399.81	100.00	N/A	15.44	121.40	Site 34
Bear River	30531.00	4401.50	100.00	N/A	12.91	135.51	Site 34
Bear River	30350.00	4394.97	100.00	N/A	7.90	111.12	Site 34
Bear River	30172.00	4399.22	100.00	N/A	16.92	128.99	Site 34
Bear River	29999.00	4401.81	100.00	N/A	32.50	143.38	Site 34
Bear River	29943.00	4396.78	100.00	N/A	25.27	168.23	Site 34
Bear River	29910.00	4394.92	100.00	N/A	21.48	159.88	Site 34

Bear River	29891.00	4396.74	100.00	N/A	23.53	163.46	Site 34
Bear River	29847.00	4396.99	100.00	N/A	18.58	147.87	Site 34
Bear River	29827.00	4390.81	100.00	N/A	21.09	147.86	Site 34
Bear River	29793.00	4389.14	100.00	N/A	22.78	136.25	Site 34
Bear River	29751.00	4391.83	100.00	N/A	16.38	121.15	Site 34
Bear River	29711.00	4396.67	100.00	N/A	21.42	135.97	Site 34
Bear River	29653.00	4401.06	100.00	N/A	10.97	139.41	Site 34
Bear River	29515.00	4401.75	100.00	N/A	24.08	148.54	Site 34
Bear River	29366.00	4401.97	100.00	N/A	20.68	147.77	Site 34
Bear River	29211.00	4401.97	100.00	N/A	31.84	153.70	Site 34
Bear River	29042.00	4399.21	100.00	N/A	33.50	139.10	Site 34
Bear River	28911.00	4400.47	100.00	N/A	47.25	148.39	Site 34
Bear River	28762.00	4402.00	100.00	N/A	48.95	186.38	Site 34
Bear River	28615.00	4403.68	100.00	N/A	43.28	199.54	Site 34
Bear River	28468.00	4402.85	100.00	N/A	46.44	207.53	Site 34
Bear River	28334.00	4397.00	100.00	N/A	62.73	184.24	Site 34
Bear River	28208.00	4394.12	100.00	N/A	39.65	167.89	Site 34
Bear River	28053.00	4394.03	100.00	N/A	32.13	143.20	Site 34
Bear River	27904.00	4398.28	100.00	N/A	38.17	167.61	Site 34
Bear River	27749.00	4401.38	100.00	N/A	55.65	188.76	Site 34
Bear River	27545.00	4401.38	100.00	N/A	41.36	168.51	Site 34
Bear River	27324.00	4403.53	100.00	N/A	23.72	170.59	Site 34
Bear River	27095.00	4404.97	100.00	N/A	23.68	167.30	Site 34
Bear River	26904.00	4404.22	100.00	N/A	27.42	194.38	Site 34
Bear River	26732.00	4403.84	100.00	N/A	31.73	206.51	Site 34
Bear River	26635.00	4395.49	100.00	N/A	43.30	209.85	Site 34
Bear River	26554.00	4396.42	100.00	N/A	38.36	204.18	Site 34
Bear River	26479.00	4394.41	100.00	N/A	48.85	163.49	Site 34
Bear River	26388.00	4395.21	100.00	N/A	37.22	145.71	Site 34
Bear River	26306.00	4397.02	100.00	N/A	41.68	154.96	Site 34
Bear River	26220.00	4400.70	100.00	N/A	46.97	182.23	Site 34
Bear River	26077.00	4399.42	100.00	N/A	57.26	196.63	Site 34
Bear River	25943.00	4397.19	100.00	N/A	92.26	214.41	Site 34
Bear River	25847.00	4392.25	100.00	N/A	71.03	180.18	Site 34
Bear River	25721.00	4395.25	100.00	N/A	67.36	195.64	Site 34
Bear River	25565.00	4402.62	100.00	N/A	74.23	247.01	Site 34
Bear River	25391.00	4404.22	100.00	N/A	45.76	224.70	Site 34
Bear River	25268.00	4404.52	100.00	N/A	55.03	248.59	Site 34
Bear River	25126.00	4404.53	100.00	N/A	76.39	247.30	Site 34
Bear River	24975.00	4403.68	100.00	N/A	114.46	262.36	Site 34
Bear River	24855.00	4404.07	100.00	N/A	76.04	229.53	Site 34
Bear River	24748.00	4404.63	100.00	N/A	54.68	229.83	Site 34
Bear River	24554.00	4404.00	100.00	N/A	48.61	239.68	Site 34

Bear River	24391.00	4405.72	100.00	N/A	36.83	248.61	Site 34
Bear River	24263.00	4406.54	100.00	N/A	36.75	275.20	Site 34
Bear River	24129.00	4407.66	100.00	N/A	56.02	298.79	Site 34
Bear River	24018.00	4405.82	100.00	N/A	36.58	262.76	Site 34
Bear River	23887.00	4396.44	100.00	N/A	37.26	219.64	Site 34
Bear River	23789.00	4396.43	100.00	N/A	32.97	149.72	Site 34
Bear River	23705.00	4396.34	100.00	N/A	43.40	139.90	Site 34
Bear River	23529.00	4398.60	100.00	N/A	11.94	126.68	Site 34
Bear River	23348.00	4402.15	100.00	N/A	43.76	184.83	Site 34
Bear River	23196.00	4404.21	100.00	N/A	52.64	197.75	Site 34
Bear River	23144.00	4402.98	100.00	N/A	26.09	178.74	Site 34
Bear River	23048.00	4403.06	100.00	N/A	31.18	308.18	Site 34
Bear River	23005.00	4399.90	100.00	N/A	53.25	464.12	Site 34
Bear River	22966.00	4399.32	100.00	N/A	47.16	444.71	Site 34
Bear River	22922.00	4399.06	100.00	N/A	53.68	458.77	Site 34
Bear River	22842.00	4403.06	100.00	N/A	34.85	596.62	Site 34
Bear River	22724.00	4404.88	100.00	N/A	61.56	700.64	Site 34
Bear River	22631.00	4407.00	100.00	N/A	63.05	744.04	Site 34
Bear River	22555.00	4405.91	100.00	N/A	55.16	774.85	Site 34
Bear River	22442.00	4405.89	100.00	N/A	63.28	841.41	Site 34
Bear River	22328.00	4405.63	100.00	N/A	42.56	910.40	Site 34
Bear River	22219.00	4403.69	100.00	N/A	40.86	972.48	Site 34
Bear River	22157.00	4406.04	100.00	N/A	30.09	1004.59	Site 34
Bear River	22004.00	4402.84	100.00	N/A	64.87	1110.21	Site 34
Bear River	21878.00	4398.75	100.00	N/A	50.40	1150.13	Site 34
Bear River	21777.00	4395.39	100.00	N/A	42.70	1126.15	Site 34
Bear River	21654.00	4389.99	100.00	N/A	34.43	1077.31	Site 34
Bear River	21562.00	4387.22	100.00	N/A	31.32	1046.09	Site 34
Bear River	21380.00	4388.88	100.00	N/A	29.19	934.35	Site 34
Bear River	21175.00	4389.50	100.00	N/A	34.16	759.98	Site 34
Bear River	20943.00	4390.05	100.00	N/A	39.11	583.15	Site 34
Bear River	20692.00	4393.53	100.00	N/A	39.12	426.59	Site 34
Bear River	20461.00	4399.00	100.00	N/A	50.76	393.59	Site 34
Bear River	20287.00	4399.06	100.00	N/A	36.98	381.64	Site 34
Bear River	20119.00	4402.34	100.00	N/A	9.74	335.91	Site 34
Bear River	19981.00	4403.58	100.00	N/A	34.67	326.20	Site 34
Bear River	19867.00	4403.66	100.00	N/A	43.52	285.14	Site 34
Bear River	19818.00	4403.53	100.00	N/A	34.79	241.16	Site 34
Bear River	19675.00	4397.94	100.00	N/A	40.13	170.53	Site 34
Bear River	19536.00	4396.97	100.00	N/A	31.89	147.63	Site 34
Bear River	19404.00	4397.19	100.00	N/A	35.45	150.73	Site 34
Bear River	19289.00	4397.04	100.00	N/A	38.96	176.31	Site 34
Bear River	19134.00	4399.00	100.00	N/A	13.72	194.74	Site 34

Bear River	19079.00	4399.52	100.00	N/A	13.60	216.39	Site 34
Bear River	19051.00	4401.00	100.00	N/A	12.65	164.55	Site 34
Bear River	18937.00	4400.59	100.00	N/A	28.86	169.80	Site 34
Bear River	18815.00	4400.41	100.00	N/A	18.81	167.42	Site 34
Bear River	18698.00	4399.00	100.00	N/A	18.11	149.08	Site 34
Bear River	18610.00	4397.56	100.00	N/A	37.33	155.21	Site 34
Bear River	18490.00	4397.06	100.00	N/A	36.93	136.53	Site 34
Bear River	18341.00	4395.03	100.00	N/A	18.81	116.83	Site 34
Bear River	18217.00	4395.00	100.00	N/A	32.51	129.96	Site 34
Bear River	18102.00	4396.85	100.00	N/A	24.99	126.96	Site 34
Bear River	17991.00	4398.22	100.00	N/A	41.86	153.29	Site 34
Bear River	17862.00	4400.91	100.00	N/A	35.81	171.07	Site 34
Bear River	17740.00	4403.25	100.00	N/A	29.97	193.06	Site 34
Bear River	17561.00	4404.34	100.00	N/A	46.60	237.25	Site 34
Bear River	17452.00	4404.53	100.00	N/A	46.11	232.28	Site 34
Bear River	17354.00	4402.91	100.00	N/A	42.45	213.92	Site 34
Bear River	17255.00	4398.19	100.00	N/A	36.97	187.49	Site 34
Bear River	17144.00	4388.13	100.00	N/A	45.74	172.50	Site 34
Bear River	17026.00	4392.87	100.00	N/A	36.05	154.70	Site 34
Bear River	16878.00	4399.00	100.00	N/A	31.25	168.76	Site 34
Bear River	16711.00	4402.51	100.00	N/A	26.66	196.55	Site 34
Bear River	16497.00	4404.63	100.00	N/A	21.62	211.68	Site 34
Bear River	16285.00	4400.38	100.00	N/A	15.67	155.44	Site 34
Bear River	16147.00	4398.83	100.00	N/A	17.21	129.46	Site 34
Bear River	16008.00	4398.94	100.00	N/A	19.12	127.98	Site 34
Bear River	15882.00	4398.97	100.00	N/A	24.50	141.33	Site 34
Bear River	15777.00	4398.28	100.00	N/A	29.35	141.83	Site 34
Bear River	15702.00	4395.19	100.00	N/A	19.33	113.91	Site 34
Bear River	15653.00	4393.11	100.00	N/A	18.11	124.10	Site 34
Bear River	15590.00	4390.77	100.00	N/A	17.56	134.75	Site 34
Bear River	15487.00	4395.91	100.00	N/A	17.59	123.34	Site 34
Bear River	15362.00	4397.00	100.00	N/A	22.38	124.43	Site 34
Bear River	15287.00	4396.97	100.00	N/A	21.99	133.68	Site 34
Bear River	15202.00	4399.42	100.00	N/A	30.31	156.21	Site 34
Bear River	15159.00	4400.75	100.00	N/A	18.31	175.17	Site 34
Bear River	15112.00	4397.92	100.00	N/A	14.75	167.24	Site 34
Bear River	15082.00	4396.16	100.00	N/A	12.71	173.52	Site 34
Bear River	15028.00	4392.95	100.00	N/A	24.27	179.79	Site 34
Bear River	14958.00	4394.60	100.00	N/A	23.58	142.09	Site 34
Bear River	14909.00	4390.71	100.00	N/A	14.37	122.62	Site 34
Bear River	14749.00	4394.83	100.00	N/A	8.62	125.44	Site 34
Bear River	14508.00	4400.94	100.00	N/A	16.36	177.34	Site 34
Bear River	14257.00	4402.77	100.00	N/A	12.28	200.35	Site 34

Bear River	13931.00	4401.80	100.00	N/A	9.22	196.88	Site 34
Bear River	13739.00	4402.77	100.00	N/A	33.89	203.31	Site 34
Bear River	13597.00	4401.02	100.00	N/A	22.09	204.30	Site 34
Bear River	13454.00	4393.17	100.00	N/A	39.61	181.91	Site 34
Bear River	13352.00	4390.00	100.00	N/A	31.97	152.94	Site 34
Bear River	13225.00	4389.97	100.00	N/A	24.97	129.39	Site 34
Bear River	13112.00	4394.90	100.00	N/A	37.96	157.97	Site 34
Bear River	13009.00	4397.19	100.00	N/A	37.78	176.73	Site 34
Bear River	12832.00	4400.48	100.00	N/A	44.70	197.76	Site 34
Bear River	12684.00	4401.88	100.00	N/A	45.40	222.81	Site 34
Bear River	12576.00	4403.84	100.00	N/A	56.47	253.66	Site 34
Bear River	12482.00	4404.47	100.00	N/A	42.17	255.71	Site 34
Bear River	12331.00	4404.47	100.00	N/A	36.46	271.96	Site 34
Bear River	12112.00	4404.31	100.00	N/A	26.48	282.18	Site 34
Bear River	11944.00	4404.66	100.00	N/A	35.09	301.42	Site 34
Bear River	11908.00	4404.39	100.00	N/A	36.31	279.04	Site 34
Bear River	11763.00	4401.00	100.00	N/A	21.55	250.24	Site 34
Bear River	11623.00	4400.52	100.00	N/A	24.40	222.01	Site 34
Bear River	11512.00	4398.82	100.00	N/A	55.93	217.29	Site 34
Bear River	11409.00	4397.00	100.00	N/A	50.07	184.72	Site 34
Bear River	11305.00	4397.03	100.00	N/A	46.93	163.35	Site 34
Bear River	11207.00	4397.03	100.00	N/A	43.70	160.98	Site 34
Bear River	11108.00	4396.97	100.00	N/A	36.83	156.82	Site 34
Bear River	10990.00	4397.68	100.00	N/A	41.09	158.64	Site 34
Bear River	10924.00	4398.73	100.00	N/A	31.33	157.95	Site 34
Bear River	10680.00	4396.58	100.00	N/A	21.33	144.76	Site 34
Bear River	10425.00	4397.82	100.00	N/A	19.94	150.08	Site 34
Bear River	10203.00	4398.94	100.00	N/A	26.57	143.67	Site 34
Bear River	9960.00	4398.15	100.00	N/A	11.90	150.77	Site 34
Bear River	9804.00	4399.00	100.00	N/A	17.94	145.49	Site 34
Bear River	9705.00	4398.65	100.00	N/A	11.81	149.60	Site 34
Bear River	9585.00	4399.00	100.00	N/A	16.65	159.74	Site 34
Bear River	9498.00	4398.43	100.00	N/A	14.31	146.02	Site 34
Bear River	9398.00	4398.50	100.00	N/A	23.37	151.01	Site 34
Bear River	9245.00	4396.71	100.00	N/A	18.07	135.64	Site 34
Bear River	9118.00	4395.58	100.00	N/A	13.69	122.01	Site 34
Bear River	8979.00	4396.20	100.00	N/A	14.00	124.18	Site 34
Bear River	8870.00	4396.14	100.00	N/A	6.22	115.15	Site 34
Bear River	8732.00	4396.91	100.00	N/A	27.03	139.75	Site 34
Bear River	8476.00	4398.77	100.00	N/A	32.97	156.71	Site 34
Bear River	8280.00	4399.00	100.00	N/A	27.61	170.15	Site 34
Bear River	8112.00	4400.25	100.00	N/A	33.14	182.89	Site 34
Bear River	7936.00	4400.90	100.00	N/A	33.12	182.86	Site 34

Bear River	7769.00	4400.81	100.00	N/A	23.66	192.39	Site 34
Bear River	7609.00	4401.50	100.00	N/A	44.08	217.66	Site 34
Bear River	7491.00	4401.59	100.00	N/A	24.85	192.99	Site 34
Bear River	7341.00	4401.70	100.00	N/A	41.71	205.78	Site 34
Bear River	7187.00	4401.30	100.00	N/A	25.46	185.27	Site 34
Bear River	7014.00	4402.81	100.00	N/A	20.20	214.51	Site 34
Bear River	6838.00	4403.26	100.00	N/A	19.05	211.14	Site 34
Bear River	6726.00	4403.69	100.00	N/A	41.44	243.05	Site 34
Bear River	6584.00	4404.72	100.00	N/A	25.37	243.06	Site 34
Bear River	6477.00	4404.81	100.00	N/A	28.31	266.55	Site 34
Bear River	6234.00	4404.53	100.00	N/A	19.47	257.54	Site 34
Bear River	5965.00	4404.97	100.00	N/A	33.57	296.64	Site 34
Bear River	5737.00	4402.27	100.00	N/A	17.17	267.74	Site 34
Bear River	5534.00	4402.93	100.00	N/A	23.72	257.98	Site 34
Bear River	5338.00	4401.00	100.00	N/A	22.04	233.41	Site 34
Bear River	5150.00	4401.00	100.00	N/A	24.51	214.19	Site 34
Bear River	4904.00	4397.08	100.00	N/A	37.33	210.37	Site 34
Bear River	4690.00	4401.03	100.00	N/A	12.46	206.43	Site 34
Bear River	4502.00	4402.57	100.00	N/A	5.19	233.45	Site 34
Bear River	4319.00	4403.68	100.00	N/A	4.35	221.21	Site 34
Bear River	4127.00	4403.00	100.00	N/A	16.26	220.35	Site 34
Bear River	3937.00	4400.96	100.00	N/A	14.93	172.23	Site 34
Bear River	3754.00	4395.51	100.00	N/A	21.26	177.86	Site 34
Confluence 1	2853.00	4404.57	100.00	N/A	20.24	101.04	Site 34
Confluence 1	2649.00	4405.22	100.00	N/A	23.25	115.88	Site 34
Confluence 1	2365.00	4405.19	100.00	N/A	29.89	115.24	Site 34
Confluence 1	2030.00	4405.53	100.00	N/A	32.01	133.82	Site 34
Confluence 1	1717.00	4404.52	100.00	N/A	0.57	132.98	Site 34
Confluence 1	1409.00	4404.65	100.00	N/A	3.67	132.70	Site 34
Confluence 1	1146.00	4405.94	100.00	N/A	7.77	124.30	Site 34
Confluence 1	842.00	4403.97	100.00	N/A	9.76	95.36	Site 34
Confluence 1	682.00	4407.49	100.00	N/A	0.00	193.16	Site 34
Confluence 1	526.00	4406.00	100.00	N/A	0.00	218.13	Site 34
Confluence 2	2948.00	4402.03	100.00	N/A	40.91	199.88	Site 34
Confluence 2	2936.00	4402.01	100.00	N/A	14.60	163.77	Interpolated
Confluence 2	2738.00	4402.54	100.00	N/A	26.89	176.64	Interpolated
Confluence 2	2515.00	4400.22	100.00	N/A	35.31	158.80	Interpolated
Confluence 2	2326.00	4400.41	100.00	N/A	29.27	161.79	Site 1
Confluence 2	2183.00	4403.00	100.00	N/A	20.90	159.85	Interpolated
Confluence 2	2045.00	4403.38	100.00	N/A	11.49	163.91	Site 1
Confluence 2	1904.00	4403.69	100.00	N/A	21.18	213.58	Interpolated
Confluence 2	1803.00	4398.94	100.00	N/A	33.26	314.31	Interpolated
Confluence 2	1672.00	4403.84	100.00	N/A	28.44	402.64	Interpolated

Confluence 2	1592.00	4405.00	100.00	N/A	28.68	500.95	Interpolated
Confluence 2	1495.00	4405.00	100.00	N/A	52.99	567.84	Interpolated
Confluence 2	1365.00	4403.30	100.00	N/A	28.74	590.02	Interpolated
Confluence 2	1148.00	4401.98	100.00	N/A	33.79	745.48	Site 29
Confluence 2	857.00	4405.91	100.00	N/A	30.01	968.68	Interpolated
Confluence 2	574.00	4405.97	100.00	N/A	0.00	1148.17	Interpolated
Confluence 2	327.00	4405.63	100.00	N/A	0.00	1216.74	Site 35
Confluence 2	122.00	4405.91	100.00	N/A	0.00	1195.90	Copy Site 35
South Cutler	88366.00	4409.50	100.00	N/A	85.32	262.29	Site 2
South Cutler	87156.00	4405.81	100.00	N/A	58.14	1335.11	Site 2
South Cutler	85687.00	4405.97	100.00	N/A	35.60	1303.45	Site 2
South Cutler	84023.00	4406.53	100.00	N/A	89.33	2319.84	Site 2
South Cutler	81765.00	4407.16	100.00	N/A	26.77	3569.62	Site 1
South Cutler	80771.00	4406.03	100.00	N/A	121.98	3087.31	Interpolated
South Cutler	80563.00	4405.50	100.00	N/A	90.66	2952.41	Interpolated
South Cutler	80247.00	4405.00	100.00	N/A	53.52	4119.04	Interpolated
South Cutler	79980.00	4405.03	100.00	N/A	54.43	4164.37	Interpolated
South Cutler	79456.00	4400.40	100.00	N/A	26.59	3581.17	Interpolated
South Cutler	79167.00	4399.85	100.00	N/A	64.46	2549.57	Interpolated
South Cutler	79147.00	Hwy 30 Culvert					
South Cutler	79040.00	4400.35	100.00	N/A	149.79	4692.58	Interpolated
South Cutler	78859.00	4400.70	100.00	N/A	100.60	5773.38	Interpolated
South Cutler	78690.00	4402.94	100.00	N/A	101.41	5408.63	Interpolated
South Cutler	78496.00	4402.71	100.00	N/A	346.78	4727.37	Interpolated
South Cutler	77911.00	4406.66	100.00	N/A	162.16	3609.97	Interpolated
South Cutler	77403.00	4404.89	100.00	N/A	362.98	3223.62	Interpolated
South Cutler	77171.00	4404.44	100.00	N/A	140.19	2325.79	Interpolated
South Cutler	76672.00	4405.81	100.00	N/A	40.46	2387.74	Interpolated
South Cutler	76383.00	4405.97	100.00	N/A	299.30	3824.80	Interpolated
South Cutler	75838.00	4405.94	100.00	N/A	144.96	3694.36	Interpolated
South Cutler	74875.00	4402.00	100.00	N/A	205.64	4252.82	Interpolated
South Cutler	74501.00	4402.28	100.00	N/A	163.37	4379.05	Interpolated
South Cutler	73564.00	4407.16	100.00	N/A	152.69	5245.98	Site 1
South Cutler	72925.00	4407.50	100.00	N/A	63.39	5071.69	Interpolated
South Cutler	72764.00	4407.75	100.00	N/A	86.04	5434.14	Interpolated
South Cutler	72492.00	4407.72	100.00	N/A	30.44	5532.00	Interpolated
South Cutler	71601.00	4407.47	100.00	N/A	93.00	5890.63	Interpolated
South Cutler	71221.00	4407.84	100.00	N/A	119.70	6567.44	Interpolated
South Cutler	70835.00	4407.97	100.00	N/A	101.24	6782.45	Interpolated
South Cutler	70479.00	4407.66	100.00	N/A	131.83	5893.46	Interpolated
South Cutler	69857.00	4408.16	100.00	N/A	217.91	5775.89	Interpolated
South Cutler	69440.00	4407.72	100.00	N/A	42.49	5020.16	Interpolated

South Cutler	68868.00	4407.38	100.00	N/A	37.20	3678.67	Site 11
South Cutler	68506.00	4407.09	100.00	N/A	85.87	4282.12	Site 11
South Cutler	68017.00	4407.31	100.00	N/A	86.93	4125.55	Interpolated
South Cutler	67703.00	4407.34	100.00	N/A	157.36	3035.45	Interpolated
South Cutler	67300.00	4407.25	100.00	N/A	115.39	2560.23	Site 1
South Cutler	66882.00	4406.72	100.00	N/A	76.62	2401.31	Interpolated
South Cutler	66542.00	4405.40	100.00	N/A	12.00	1885.07	Interpolated
South Cutler	66401.00	4406.31	100.00	N/A	39.51	2070.96	Interpolated
South Cutler	66308.00	4406.38	100.00	N/A	28.65	1868.04	Interpolated
South Cutler	66234.00	4406.34	100.00	N/A	40.76	1827.36	Interpolated
South Cutler	66193.00	4406.31	100.00	N/A	36.76	1938.87	Interpolated
South Cutler	66018.00	4405.94	100.00	N/A	15.50	1975.80	Interpolated
South Cutler	65748.00	4406.14	100.00	N/A	21.73	1777.67	Interpolated
South Cutler	65468.00	4404.94	100.00	N/A	26.92	1721.90	Interpolated
South Cutler	65291.00	4405.41	100.00	N/A	64.62	1418.26	Interpolated
South Cutler	64845.00	4405.69	100.00	N/A	116.84	1850.47	Interpolated
South Cutler	64582.00	4405.53	100.00	N/A	155.00	1492.24	Interpolated
South Cutler	64435.00	4405.72	100.00	N/A	219.97	3545.89	Interpolated
South Cutler	64282.00	4405.03	100.00	N/A	177.64	2880.81	Interpolated
South Cutler	63938.00	4405.56	100.00	N/A	15.64	2086.80	Site 1
South Cutler	63476.00	4404.94	100.00	N/A	32.60	2108.21	Interpolated
South Cutler	63219.00	4405.69	100.00	N/A	21.92	2114.57	Interpolated
South Cutler	62901.00	4406.16	100.00	N/A	34.02	1468.32	Interpolated
South Cutler	62712.00	4405.62	100.00	N/A	5.21	961.27	Site 17 Depth 1
South Cutler	62553.00	4404.11	100.00	N/A	10.38	592.55	Site 17 Depth 1
South Cutler	62414.00	4398.99	100.00	N/A	12.34	309.69	Interpolated
South Cutler	62355.00	4399.91	100.00	N/A	12.84	354.95	Interpolated
South Cutler	62153.00	4403.30	100.00	N/A	8.71	830.66	Interpolated
South Cutler	61888.00	4406.19	100.00	N/A	5.01	1506.64	Interpolated
South Cutler	61572.00	4406.62	100.00	N/A	28.76	1528.32	Interpolated
South Cutler	61072.00	4406.00	100.00	N/A	38.89	1637.15	Interpolated
South Cutler	60657.00	4406.00	100.00	N/A	26.09	1776.80	Interpolated
South Cutler	60244.00	4406.03	100.00	N/A	30.16	1813.44	Interpolated
South Cutler	59764.00	4406.00	100.00	N/A	23.60	1830.32	Interpolated
South Cutler	59305.00	4406.00	100.00	N/A	17.52	1845.44	Interpolated
South Cutler	59044.00	4405.72	100.00	N/A	28.09	1860.14	Interpolated
South Cutler	58866.00	4405.66	100.00	N/A	46.31	2037.40	Interpolated
South Cutler	58676.00	4405.22	100.00	N/A	36.41	1904.52	Interpolated
South Cutler	58413.00	4405.00	100.00	N/A	57.95	1422.88	Interpolated
South Cutler	58110.00	4404.44	100.00	N/A	45.60	906.11	Interpolated
South Cutler	57862.00	4401.70	100.00	N/A	47.10	523.45	Interpolated

South Cutler	57741.00	4391.84	100.00	N/A	47.38	261.35	Interpolated
South Cutler	57633.00	4393.65	100.00	N/A	70.83	330.31	Interpolated
South Cutler	57549.00	4392.50	100.00	N/A	27.40	291.88	Interpolated
South Cutler	57513.00	4392.88	100.00	N/A	25.97	341.81	Interpolated
South Cutler	57409.00	4392.92	100.00	N/A	37.14	591.25	Interpolated
South Cutler	57227.00	4401.28	100.00	N/A	35.15	765.82	Site 21
South Cutler	57086.00	4405.75	100.00	N/A	59.73	999.95	Site 21
South Cutler	57014.00	4406.00	100.00	N/A	56.42	978.14	Copy Site 21
South Cutler	56890.00	4406.31	100.00	N/A	10.90	959.75	Copy Site 21
South Cutler	56341.00	4404.91	100.00	N/A	62.58	1167.42	Copy Site 21
South Cutler	55865.00	4405.38	100.00	N/A	100.78	1154.26	Copy Site 21
South Cutler	55402.00	4405.75	100.00	N/A	63.49	3316.40	Copy Site 21
South Cutler	55025.00	4406.19	100.00	N/A	41.74	3299.91	Copy Site 21
South Cutler	54709.00	4406.53	100.00	N/A	117.30	5058.33	Copy Site 21
South Cutler	54464.00	4406.50	100.00	N/A	173.10	4359.93	Copy Site 21
South Cutler	54241.00	4406.69	100.00	N/A	63.31	3612.68	Copy Site 21
South Cutler	53946.00	4406.84	100.00	N/A	131.52	2315.95	Copy Site 21
South Cutler	53278.00	4406.28	100.00	N/A	163.97	1699.69	Copy Site 21
South Cutler	52971.00	4405.88	100.00	N/A	90.41	1169.01	Copy Site 21
Confluence Zone	52598.00	4405.67	100.00	N/A	78.05	888.22	Copy Site 26
Confluence Zone	52437.00	4405.69	100.00	N/A	79.82	1330.19	Copy Site 26
Confluence Zone	52197.00	4405.84	100.00	N/A	87.83	1457.25	Site 26
Confluence Zone	51860.00	4405.88	100.00	N/A	134.81	2122.43	Site 26
Confluence Zone	51421.00	4405.94	100.00	N/A	21.31	2127.91	Site 1
Confluence Zone	51038.00	4406.03	100.00	N/A	116.25	2396.73	Interpolated
Confluence Zone	50507.00	4406.38	100.00	N/A	64.96	1744.18	Interpolated
Confluence Zone	50159.00	4406.03	100.00	N/A	45.05	1863.25	Interpolated
Confluence Zone	49775.00	4406.12	100.00	N/A	116.62	1948.89	Interpolated
Confluence Zone	49610.00	4405.94	100.00	N/A	0.00	1930.56	Interpolated
Confluence Zone	49441.00	4405.47	100.00	N/A	112.91	2149.05	Interpolated
Confluence Zone	49353.00	4405.19	100.00	N/A	30.21	2864.90	Interpolated

Confluence Zone	49239.00	4404.50	100.00	N/A	126.42	2886.13	Interpolated
Confluence Zone	49211.00	4404.19	100.00	N/A	40.94	2526.99	Interpolated
Confluence Zone	49076.00	4402.38	100.00	N/A	82.27	2105.69	Interpolated
Confluence Zone	48940.00	4402.84	100.00	N/A	56.29	1335.58	Site 29
Confluence Zone	48821.00	4403.56	100.00	N/A	86.58	1128.68	Copy Site 29
Confluence Zone	48631.00	4405.58	100.00	N/A	91.56	920.80	Copy Site 29
Confluence Zone	48365.00	4404.75	100.00	N/A	75.07	563.37	Copy Site 29
Confluence Zone	48157.00	4403.81	100.00	N/A	97.19	389.72	Copy Site 29
North Cutler	47825.00	4402.88	100.00	N/A	104.24	1327.94	Copy Site 36
North Cutler	47655.00	4401.94	100.00	N/A	107.36	1187.12	Copy Site 36
North Cutler	47448.00	4401.00	100.00	N/A	70.43	1014.75	Copy Site 36
North Cutler	47325.00	4398.59	100.00	N/A	36.51	911.69	Copy Site 36
North Cutler	47158.00	4398.91	100.00	N/A	21.39	759.80	Copy Site 36
North Cutler	47034.00	4399.22	100.00	N/A	44.35	717.00	Copy Site 36
North Cutler	46907.00	4399.72	100.00	N/A	70.68	640.94	Copy Site 36
North Cutler	46761.00	4399.00	100.00	N/A	79.58	519.50	Copy Site 36
North Cutler	46624.00	4392.12	100.00	N/A	78.25	441.80	Copy Site 36
North Cutler	46512.00	4392.25	100.00	N/A	85.38	405.99	Copy Site 36
North Cutler	46341.00	4395.25	100.00	N/A	56.12	333.66	Site 36
North Cutler	46112.00	4397.00	100.00	N/A	93.18	354.39	Interpolated
North Cutler	45735.00	4401.12	100.00	N/A	78.81	1436.71	Interpolated
North Cutler	45376.00	4401.38	100.00	N/A	76.78	1434.27	Interpolated
North Cutler	44936.00	4405.03	100.00	N/A	95.29	1467.96	Site 1
North Cutler	44532.00	4404.91	100.00	N/A	73.30	1116.67	Interpolated
North Cutler	44079.00	4405.82	100.00	N/A	71.91	1014.39	Interpolated
North Cutler	43782.00	4405.47	100.00	N/A	24.20	873.28	Interpolated
North Cutler	43422.00	4404.84	100.00	N/A	130.30	967.73	Site 37
North Cutler	43109.00	4402.70	100.00	N/A	152.24	862.20	Interpolated
North Cutler	42988.00	4402.00	100.00	N/A	156.88	824.85	Interpolated
North Cutler	42615.00	4403.72	100.00	N/A	235.51	835.19	Interpolated
North Cutler	42178.00	4400.94	100.00	N/A	68.99	1128.17	Interpolated
North Cutler	41771.00	4399.47	100.00	N/A	57.12	1149.70	Interpolated
North Cutler	41407.00	4393.94	100.00	N/A	60.24	1250.31	Interpolated
North Cutler	41112.00	4394.62	100.00	N/A	47.20	1218.44	Interpolated
North Cutler	40808.00	4394.91	100.00	N/A	115.68	1115.27	Interpolated

North Cutler	40521.00	4395.97	100.00	N/A	75.68	953.18	Interpolated
North Cutler	40110.00	4398.50	100.00	N/A	37.40	1253.80	Site 39
North Cutler	39437.00	4400.91	100.00	N/A	52.13	1314.79	Site 40
North Cutler	38979.00	4403.28	100.00	N/A	83.82	2083.31	Interpolated
North Cutler	38501.00	4402.94	100.00	N/A	123.91	2166.37	Interpolated
North Cutler	37952.00	4401.13	100.00	N/A	101.11	2114.46	Interpolated
North Cutler	37453.00	4398.00	100.00	N/A	47.43	1967.59	Interpolated
North Cutler	37114.00	4395.88	100.00	N/A	50.38	1770.56	Interpolated
North Cutler	36748.00	4399.18	100.00	N/A	83.73	1599.36	Interpolated
North Cutler	36513.00	4401.31	100.00	N/A	59.98	1734.74	Interpolated
North Cutler	36230.00	4402.59	100.00	N/A	44.77	1774.70	Interpolated
North Cutler	35787.00	4402.52	100.00	N/A	67.24	2146.45	Site 44
North Cutler	35132.00	4403.78	100.00	N/A	113.93	2375.24	Site 1
North Cutler	34802.00	4403.88	100.00	N/A	51.09	2638.19	Interpolated
North Cutler	34417.00	4402.31	100.00	N/A	27.29	2454.76	Interpolated
North Cutler	34275.00	4401.34	100.00	N/A	17.87	2556.46	Interpolated
North Cutler	34098.00	4401.91	100.00	N/A	108.86	2568.03	Interpolated
North Cutler	33636.00	4402.44	100.00	N/A	127.67	2553.76	Interpolated
North Cutler	33131.00	4400.66	100.00	N/A	34.81	2043.93	Interpolated
North Cutler	32809.00	4401.12	100.00	N/A	41.01	1736.33	Site 47
North Cutler	32515.00	4400.34	100.00	N/A	39.49	1443.68	Interpolated
North Cutler	32172.00	4399.44	100.00	N/A	31.17	1050.51	Interpolated
North Cutler	31788.00	4401.03	100.00	N/A	23.63	680.02	Interpolated
North Cutler	31574.00	4402.56	100.00	N/A	23.10	515.77	Interpolated
North Cutler	31409.00	4396.76	100.00	N/A	3.73	392.08	Interpolated
North Cutler	31291.00	4393.79	100.00	N/A	61.13	366.40	Interpolated
North Cutler	31186.00	4386.84	100.00	N/A	20.25	281.64	Interpolated
North Cutler	31125.00	4387.57	100.00	N/A	27.18	1087.23	Interpolated
North Cutler	31040.00	4392.89	100.00	N/A	27.93	1083.97	Interpolated
North Cutler	30883.00	4399.09	100.00	N/A	29.91	1295.66	Interpolated
North Cutler	30750.00	4399.66	100.00	N/A	59.12	1412.64	Interpolated
North Cutler	30504.00	4400.56	100.00	N/A	36.79	1763.57	Interpolated
North Cutler	30248.00	4400.56	100.00	N/A	77.07	1782.22	Interpolated
North Cutler	29752.00	4401.63	100.00	N/A	42.33	1985.23	Site 50
North Cutler	29224.00	4402.12	100.00	N/A	65.27	1703.33	Site 50
North Cutler	28914.00	4401.88	100.00	N/A	24.25	1538.75	Interpolated
North Cutler	28304.00	4401.91	100.00	N/A	48.16	1642.39	Site 1
North Cutler	27902.00	4402.53	100.00	N/A	63.82	1762.39	Interpolated
North Cutler	27536.00	4400.70	100.00	N/A	53.63	1531.42	Site 52
North Cutler	27242.00	4400.53	100.00	N/A	45.03	1378.50	Interpolated
North Cutler	26981.00	4400.03	100.00	N/A	68.10	1365.95	Interpolated
North Cutler	26699.00	4398.98	100.00	N/A	32.66	1132.55	Site 53
North Cutler	26368.00	4395.00	100.00	N/A	22.24	917.68	Site 53

North Cutler	26312.00	4394.87	100.00	N/A	54.33	836.63	Interpolated
North Cutler	26272.00	4392.09	100.00	N/A	112.96	775.43	Interpolated
North Cutler	26175.00	4390.94	100.00	N/A	95.90	373.38	Interpolated
North Cutler	26136.00	4390.61	100.00	N/A	41.77	515.66	Interpolated
North Cutler	26090.00	4389.96	100.00	N/A	23.22	645.58	Interpolated
North Cutler	25989.00	4392.32	100.00	N/A	21.15	833.00	Interpolated
North Cutler	25916.00	4395.93	100.00	N/A	33.88	806.88	Interpolated
North Cutler	25763.00	4397.98	100.00	N/A	55.36	772.32	Interpolated
North Cutler	25588.00	4399.09	100.00	N/A	64.12	737.29	Interpolated
North Cutler	25499.00	4399.31	100.00	N/A	53.11	749.02	Interpolated
North Cutler	25100.00	4399.47	100.00	N/A	41.00	783.73	Interpolated
North Cutler	24723.00	4396.41	100.00	N/A	40.00	724.68	Interpolated
North Cutler	24534.00	4395.34	100.00	N/A	23.15	657.60	Interpolated
North Cutler	24352.00	4395.98	100.00	N/A	38.22	436.72	Interpolated
North Cutler	24153.00	4396.96	100.00	N/A	29.11	470.91	Interpolated
North Cutler	23828.00	4398.06	100.00	N/A	44.54	585.94	Interpolated
North Cutler	23438.00	4393.31	100.00	N/A	41.09	663.57	Interpolated
North Cutler	23109.00	4393.06	100.00	N/A	6.90	594.64	Interpolated
North Cutler	22782.00	4396.34	100.00	N/A	51.94	592.54	Interpolated
North Cutler	22627.00	4396.44	100.00	N/A	22.16	611.18	Interpolated
North Cutler	22281.00	4394.84	100.00	N/A	16.43	607.82	Interpolated
North Cutler	22041.00	4394.34	100.00	N/A	21.05	574.58	Interpolated
North Cutler	21808.00	4394.15	100.00	N/A	20.01	432.38	Interpolated
North Cutler	21598.00	4396.44	100.00	N/A	12.51	442.96	Interpolated
North Cutler	21368.00	4397.64	100.00	N/A	19.28	464.17	Interpolated
North Cutler	21178.00	4397.75	100.00	N/A	21.00	422.93	Interpolated
North Cutler	20905.00	4397.06	100.00	N/A	24.48	338.92	Interpolated
North Cutler	20620.00	4394.20	100.00	N/A	23.08	292.87	Interpolated
North Cutler	20363.00	4395.19	100.00	N/A	16.59	345.02	Interpolated
North Cutler	20132.00	4396.17	100.00	N/A	19.70	330.69	Interpolated
North Cutler	19952.00	4396.66	100.00	N/A	15.19	365.82	Interpolated
North Cutler	19747.00	4395.62	100.00	N/A	25.71	385.23	Interpolated
North Cutler	19579.00	4394.62	100.00	N/A	28.44	385.07	Site 56 Depth 1
North Cutler	19387.00	4396.38	100.00	N/A	38.21	340.70	Site 56 Depth 1
North Cutler	19155.00	4395.50	100.00	N/A	36.67	334.65	Interpolated
North Cutler	18953.00	4395.59	100.00	N/A	38.88	321.33	Interpolated
North Cutler	18772.00	4395.76	100.00	N/A	39.20	315.70	Interpolated
North Cutler	18547.00	4393.83	100.00	N/A	40.03	308.60	Interpolated
North Cutler	18266.00	4393.00	100.00	N/A	49.70	317.08	Interpolated
North Cutler	18035.00	4393.69	100.00	N/A	21.03	340.48	Interpolated
North Cutler	17934.00	4393.34	100.00	N/A	40.57	413.17	Interpolated

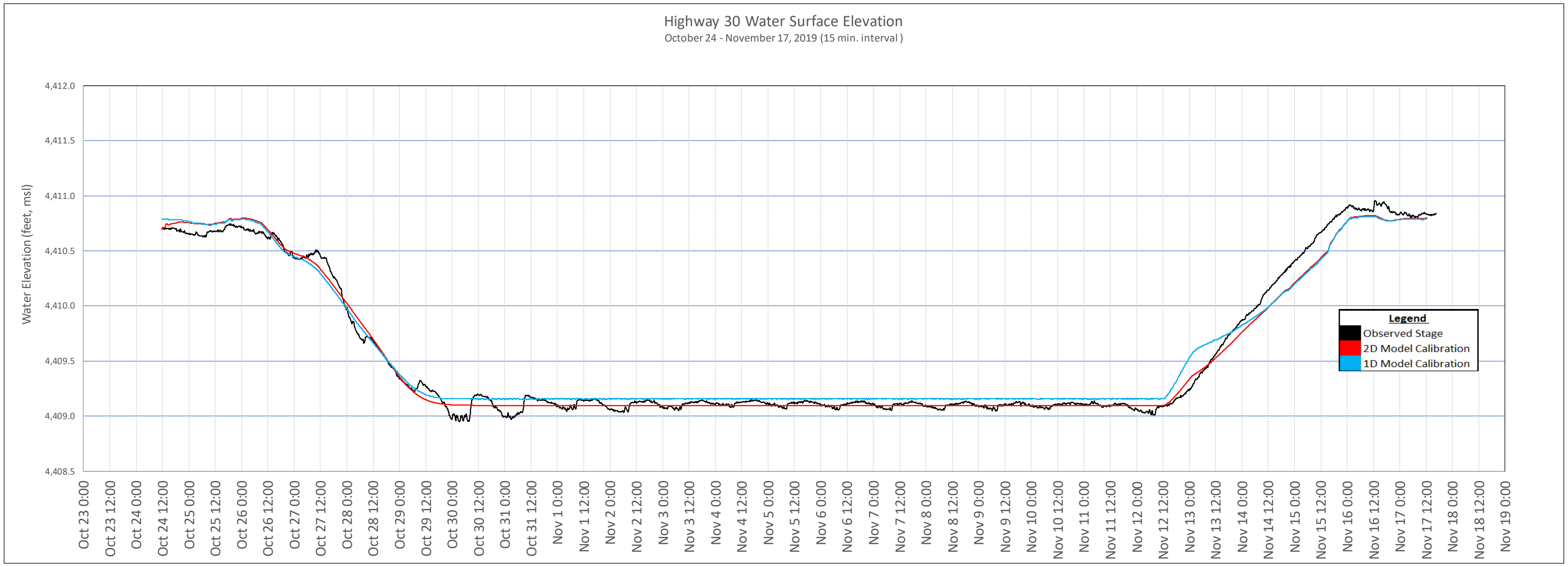
North Cutler	17654.00	4397.30	100.00	N/A	21.73	447.56	Interpolated
North Cutler	17553.00	4398.45	100.00	N/A	32.83	561.21	Interpolated
North Cutler	17321.00	4398.88	100.00	N/A	18.60	539.09	Interpolated
North Cutler	17203.00	4398.19	100.00	N/A	15.05	461.58	Interpolated
North Cutler	17069.00	4399.03	100.00	N/A	15.87	541.37	Interpolated
North Cutler	16730.00	4400.59	100.00	N/A	21.62	592.82	Interpolated
North Cutler	16497.00	4400.09	100.00	N/A	21.69	522.67	Interpolated
North Cutler	16210.00	4396.62	100.00	N/A	21.11	450.87	Interpolated
North Cutler	15904.00	4393.76	100.00	N/A	29.71	402.43	Interpolated
North Cutler	15697.00	4392.06	100.00	N/A	56.68	380.34	Interpolated
North Cutler	15570.00	4392.19	100.00	N/A	25.04	388.26	Interpolated
North Cutler	15325.00	4391.94	100.00	N/A	28.92	410.20	Interpolated
North Cutler	14972.00	4392.56	100.00	N/A	51.57	407.54	Site 62 Depth 1
North Cutler	14812.00	4393.97	100.00	N/A	46.15	397.80	Site 62 Depth 1
North Cutler	14647.00	4393.97	100.00	N/A	32.42	373.12	Site 62 Depth 1
North Cutler	14249.00	4393.78	100.00	N/A	67.50	457.77	Site 62 Depth 1
North Cutler	14081.00	4395.10	100.00	N/A	66.75	487.00	Site 62 Depth 1
North Cutler	13980.00	4396.16	100.00	N/A	32.99	476.87	Site 62 Depth 1
North Cutler	13872.00	4397.22	100.00	N/A	13.26	469.87	Site 62 Depth 1
North Cutler	13652.00	4398.44	100.00	N/A	16.20	481.56	Site 62 Depth 1
North Cutler	13358.00	4399.38	100.00	N/A	12.19	477.61	Site 62 Depth 1
North Cutler	13269.00	4400.62	100.00	N/A	13.16	503.33	Site 62 Depth 1
North Cutler	13232.00	4400.08	100.00	N/A	19.62	507.84	Site 62 Depth 1
North Cutler	13230.00	Wheelon Dam - Inline Structure					
North Cutler	13206.00	4393.11	100.00	N/A	17.37	489.67	Site 58 Depth 1
North Cutler	13182.00	4392.50	100.00	N/A	21.07	468.63	Site 58 Depth 1
North Cutler	13132.00	4392.42	100.00	N/A	28.12	460.09	Site 58 Depth 1

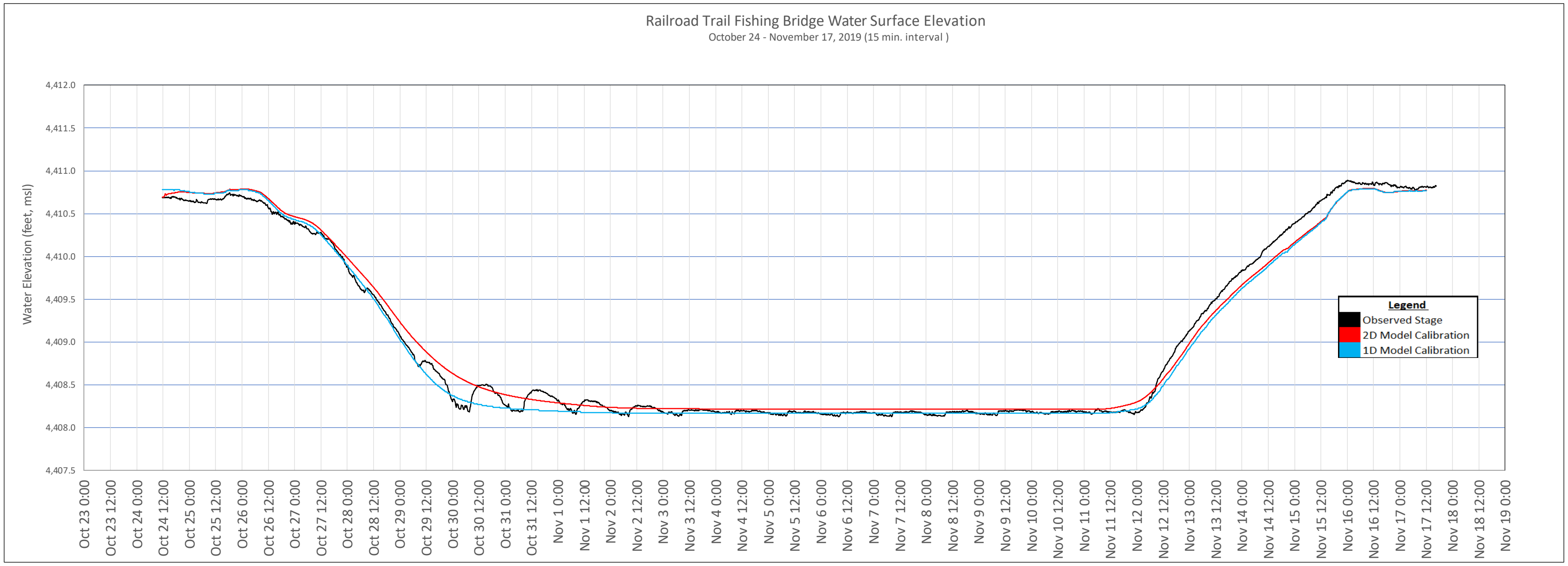
North Cutler	13101.00	4391.62	100.00	N/A	33.83	478.52	Site 58 Depth 1
North Cutler	12985.00	4392.78	100.00	N/A	58.78	474.93	Site 58 Depth 1
North Cutler	12900.00	4391.31	100.00	N/A	43.96	416.74	Site 58 Depth 1
North Cutler	12784.00	4387.40	100.00	N/A	46.72	367.86	Site 58 Depth 1
North Cutler	12694.00	4386.00	100.00	N/A	40.49	387.56	Site 58 Depth 1
North Cutler	12664.00	4385.95	100.00	N/A	47.77	385.63	Site 58 Depth 1
North Cutler	12623.00	4385.00	100.00	N/A	40.10	365.61	Site 58 Depth 1
North Cutler	12573.00	4384.04	100.00	N/A	42.32	373.81	Site 58 Depth 1
North Cutler	12446.00	4384.81	100.00	N/A	48.43	312.21	Site 58 Depth 1
North Cutler	12273.00	4385.84	100.00	N/A	32.45	377.17	Site 58 Depth 1
North Cutler	12158.00	4388.72	100.00	N/A	45.15	389.14	Site 58 Depth 1
North Cutler	11976.00	4392.81	100.00	N/A	60.38	369.24	Site 58 Depth 1
North Cutler	11807.00	4393.99	100.00	N/A	82.90	351.65	Site 58 Depth 1
North Cutler	11691.00	4395.07	100.00	N/A	62.65	410.27	Site 58 Depth 1
North Cutler	11589.00	4394.59	100.00	N/A	59.28	448.88	Site 58 Depth 1
North Cutler	11434.00	4395.12	100.00	N/A	40.74	394.06	Site 58 Depth 1
North Cutler	11295.00	4393.88	100.00	N/A	24.59	409.58	Site 58 Depth 1
North Cutler	11067.00	4392.71	100.00	N/A	42.08	299.32	Site 58 Depth 1
North Cutler	10920.00	4392.25	100.00	N/A	45.24	358.86	Site 58 Depth 1
North Cutler	10710.00	4390.34	100.00	N/A	32.91	324.27	Site 58 Depth 1
North Cutler	10425.00	4388.56	100.00	N/A	20.03	338.40	Interpolated
North Cutler	10117.00	4390.60	100.00	N/A	43.58	422.16	Site 59
North Cutler	9841.00	4390.11	100.00	N/A	44.08	462.49	Site 59
North Cutler	9493.00	4388.06	100.00	N/A	31.60	486.43	Site 59

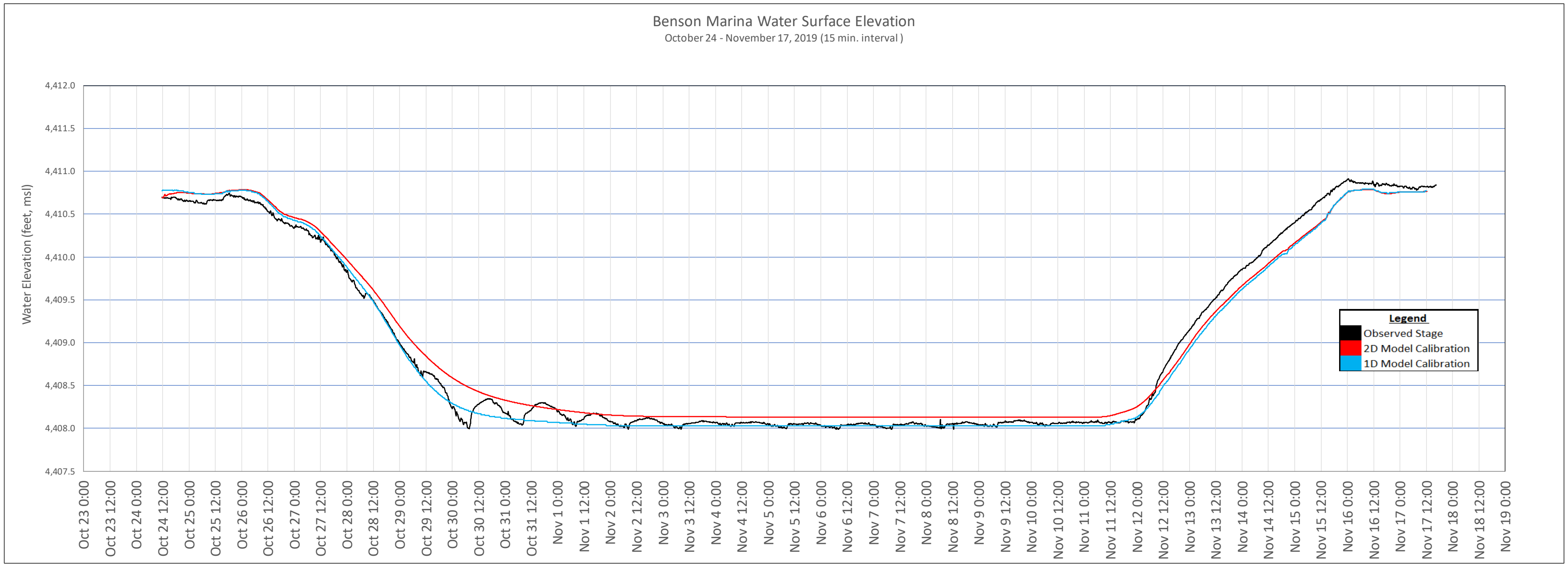
North Cutler	9157.00	4386.02	100.00	N/A	32.18	516.72	Site 59
North Cutler	8925.00	4386.00	100.00	N/A	59.94	553.94	Site 59
North Cutler	8690.00	4385.84	100.00	N/A	20.94	501.62	Site 59
North Cutler	8608.00	4385.03	100.00	N/A	21.94	512.89	Site 59
North Cutler	8546.00	4374.39	100.00	N/A	21.66	518.78	Site 59
North Cutler	8496.00	4367.13	100.00	N/A	33.56	535.94	Site 59
North Cutler	8454.00	4377.27	100.00	N/A	8.33	556.33	Site 59

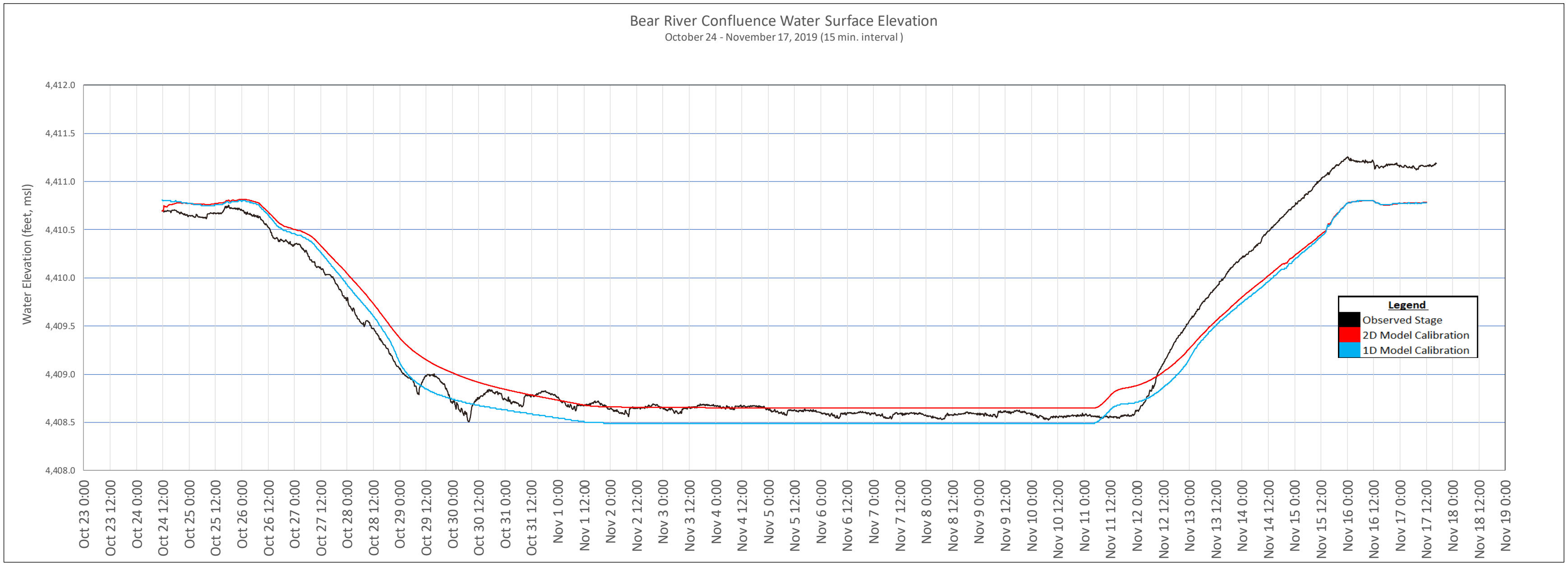
ATTACHMENT G-7

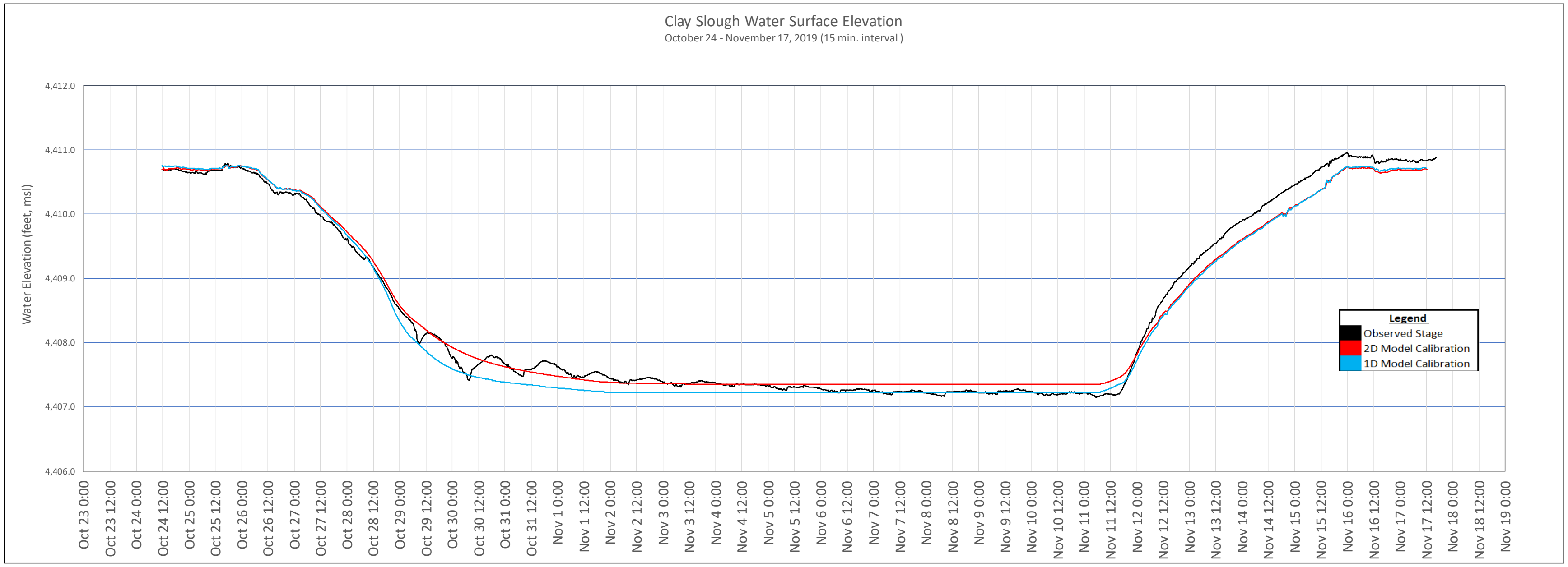
CALIBRATED WSE HYDROGRAPHS FOR PRESSURE TRANSDUCER LOCATIONS

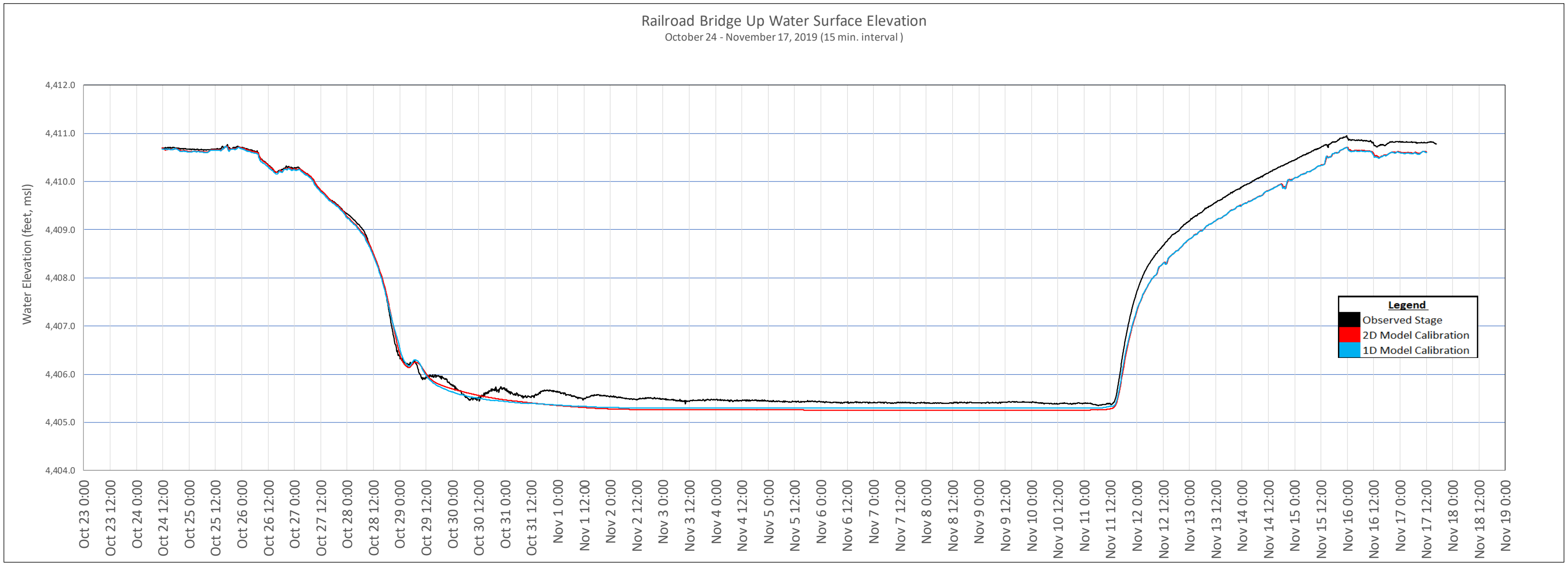

Highway 30 Water Surface Elevation
October 24 - November 17, 2019 (15 min. interval)
Water Elevation (feet, msl)
Legend
Observed Stage
2D Model Calibration
1D Model Calibration

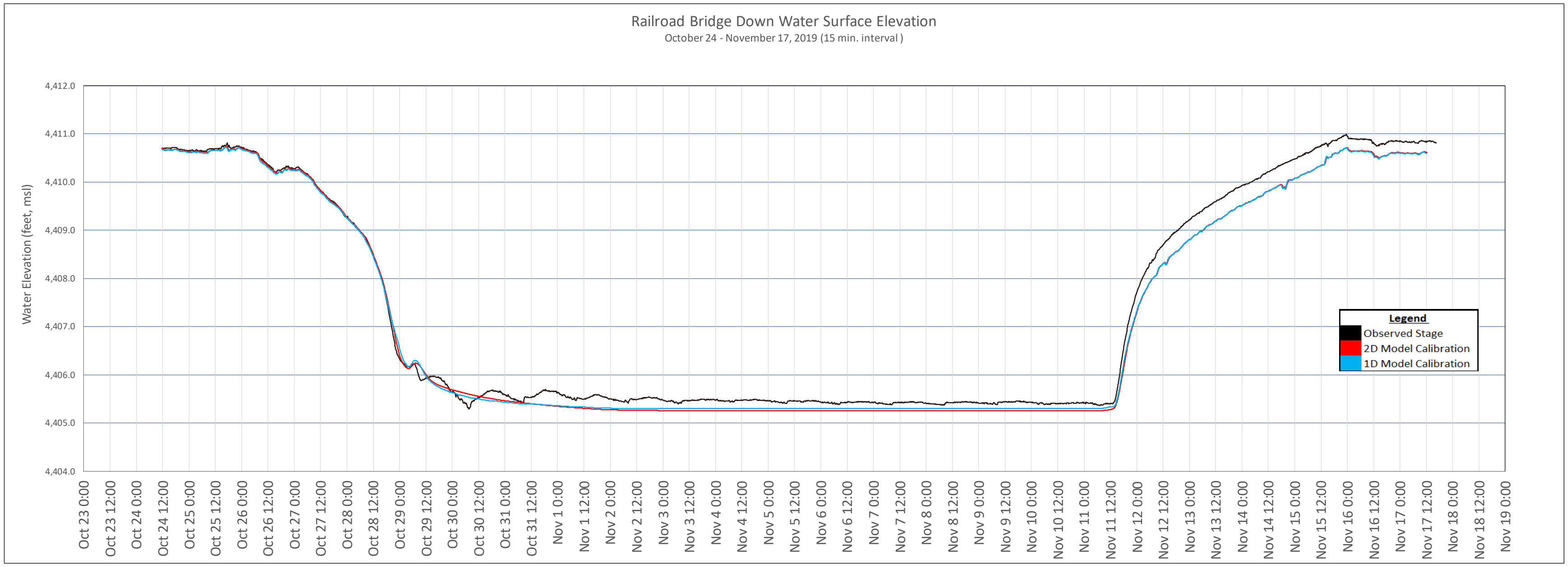

Railroad Trail Fishing Bridge Water Surface Elevation
October 24 - November 17, 2019 (15 min. interval)
Water Elevation (feet, msl)
Legend
Observed Stage
2D Model Calibration
1D Model Calibration

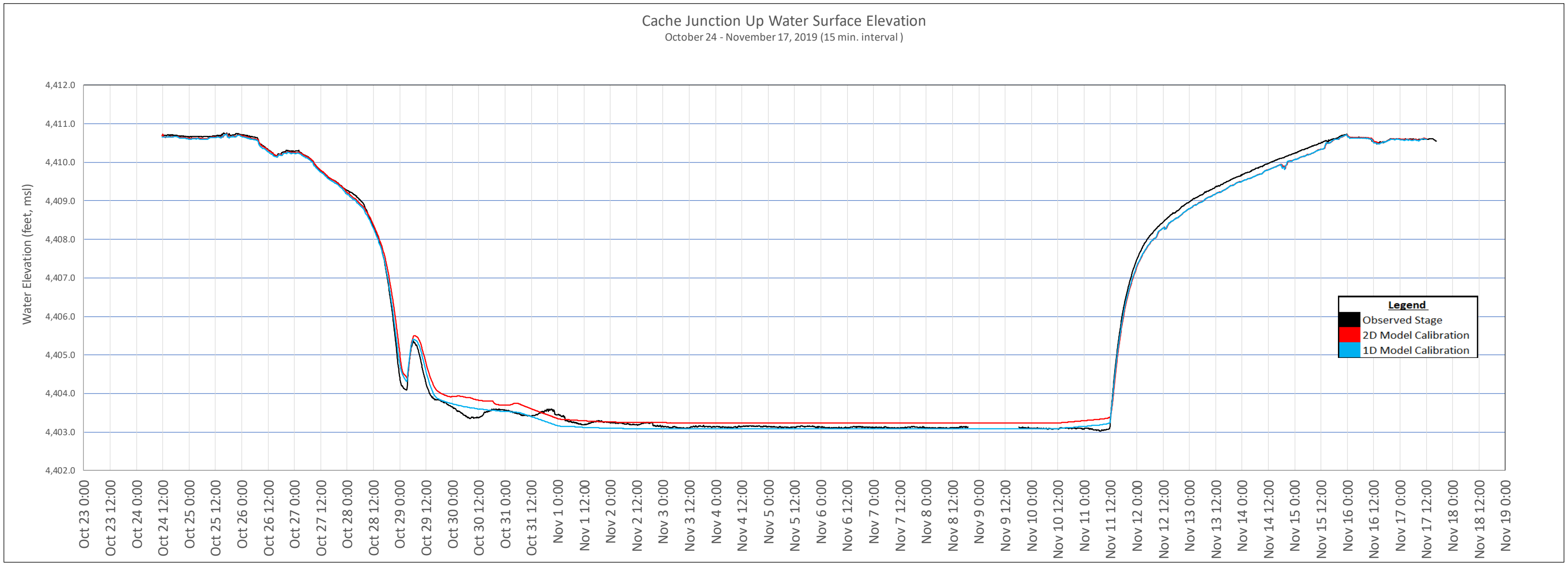

Benson Marina Water Surface Elevation
October 24 - November 17, 2019 (15 min. interval)
Water Elevation (feet, msl)
Legend
Observed Stage
2D Model Calibration
1D Model Calibration

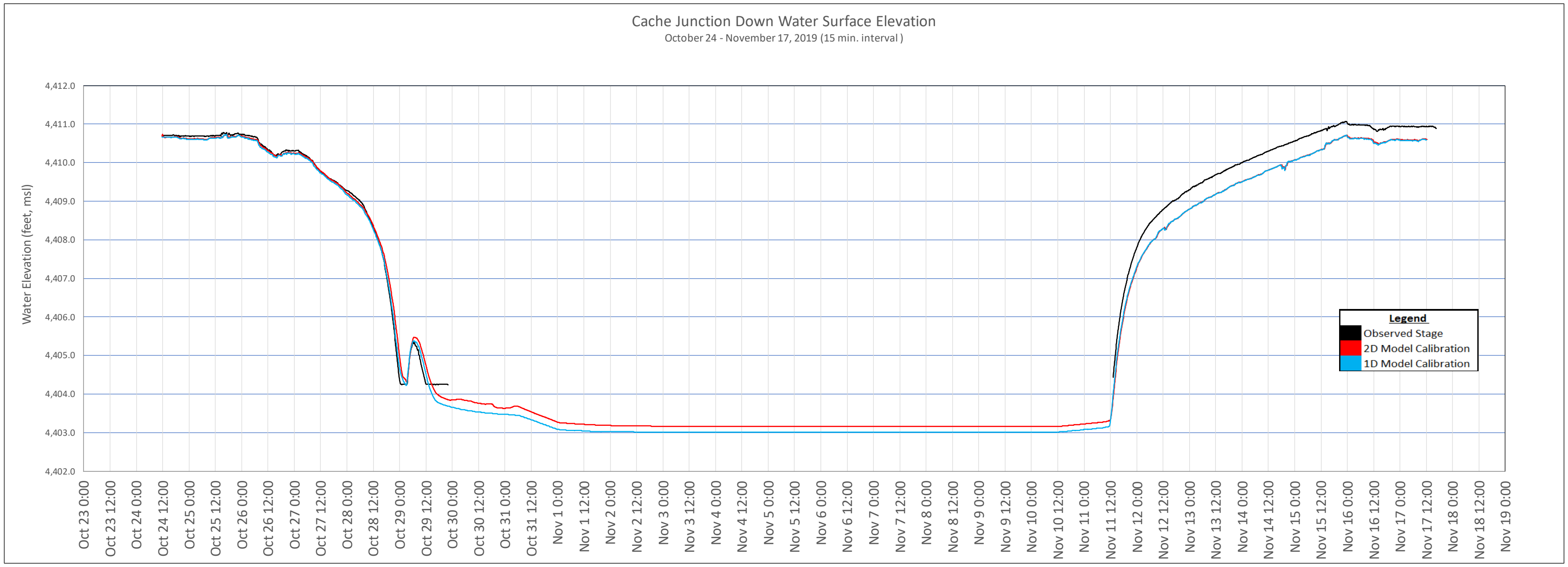

Bear River Confluence Water Surface Elevation
October 24 - November 17, 2019 (15 min. interval)
Water Elevation (feet, msl)
Legend
Observed Stage
2D Model Calibration
1D Model Calibration

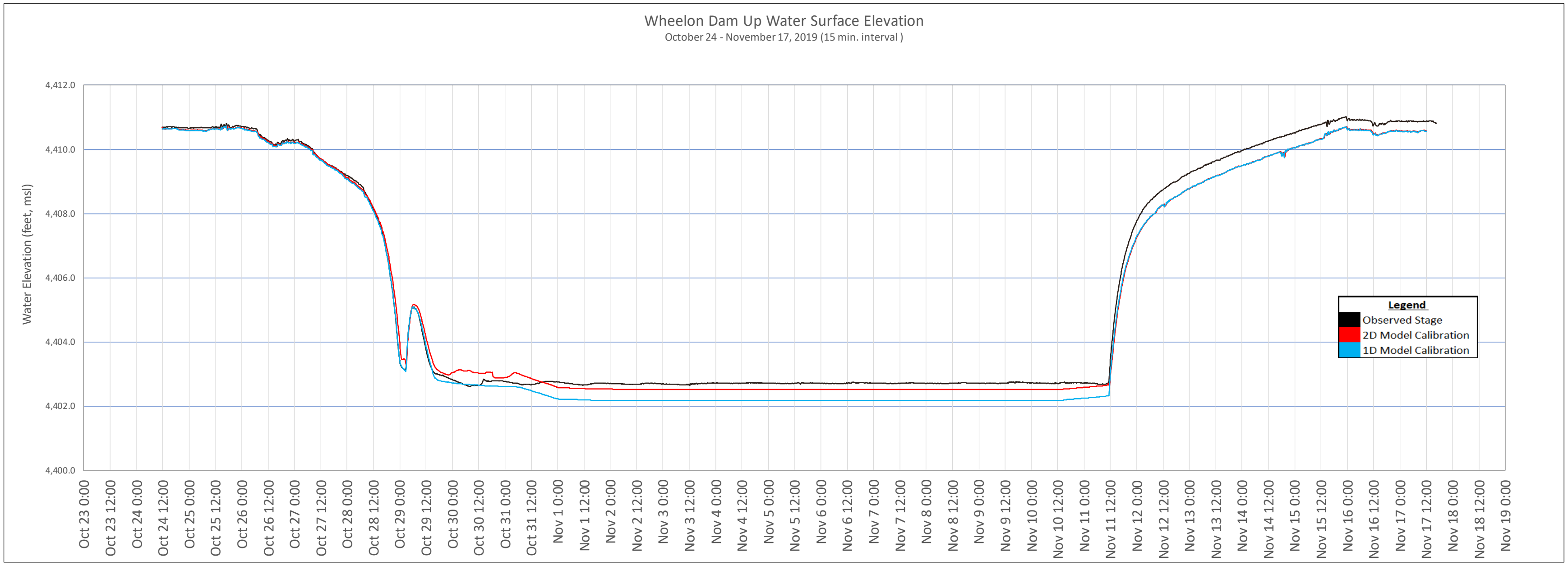

Clay Slough Water Surface Elevation
October 24 - November 17, 2019 (15 min. interval)
Water Elevation (feet, msl)
Legend
Observed Stage
2D Model Calibration
1D Model Calibration

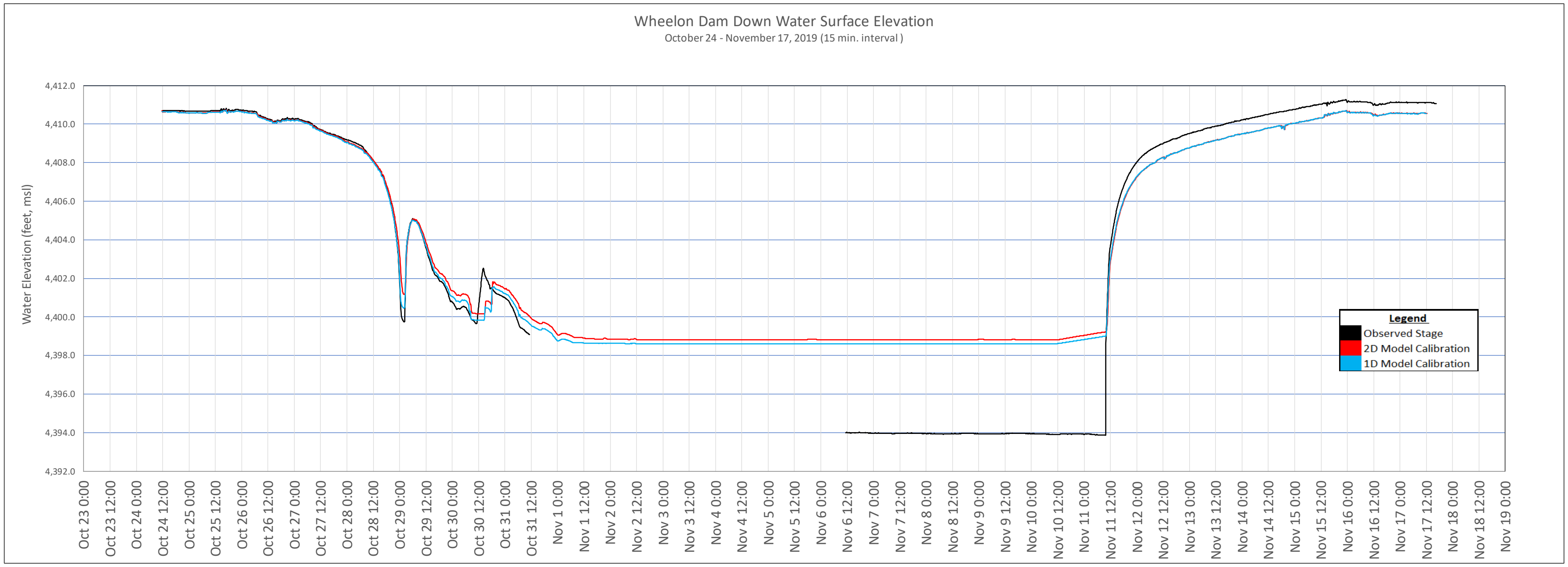

Railroad Bridge Up Water Surface Elevation
October 24 - November 17, 2019 (15 min. interval)
Water Elevation (feet, msl)
Legend
Observed Stage
2D Model Calibration
1D Model Calibration

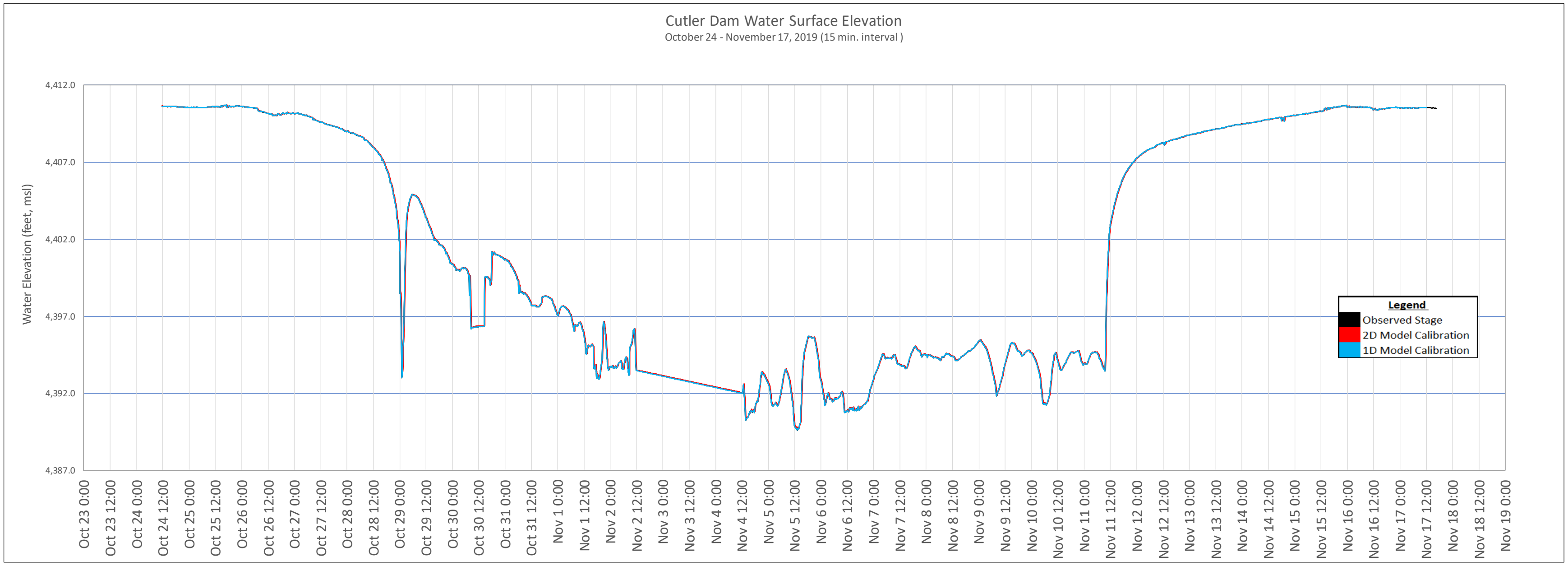

Railroad Bridge Down Water Surface Elevation
October 24 - November 17, 2019 (15 min. interval)
Water Elevation (feet, msl)
Legend
Observed Stage
2D Model Calibration
1D Model Calibration

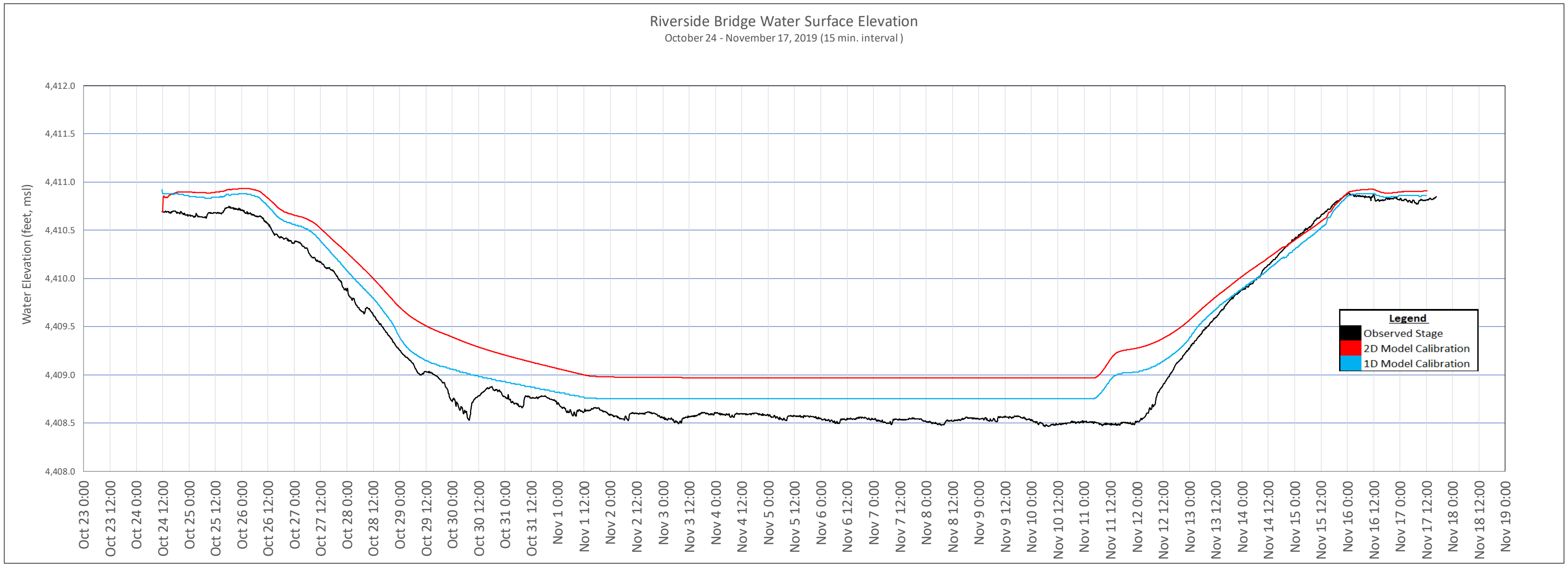

Cache Junction Up Water Surface Elevation
October 24 - November 17, 2019 (15 min. interval)
Water Elevation (feet, msl)
Legend
Observed Stage
2D Model Calibration
1D Model Calibration

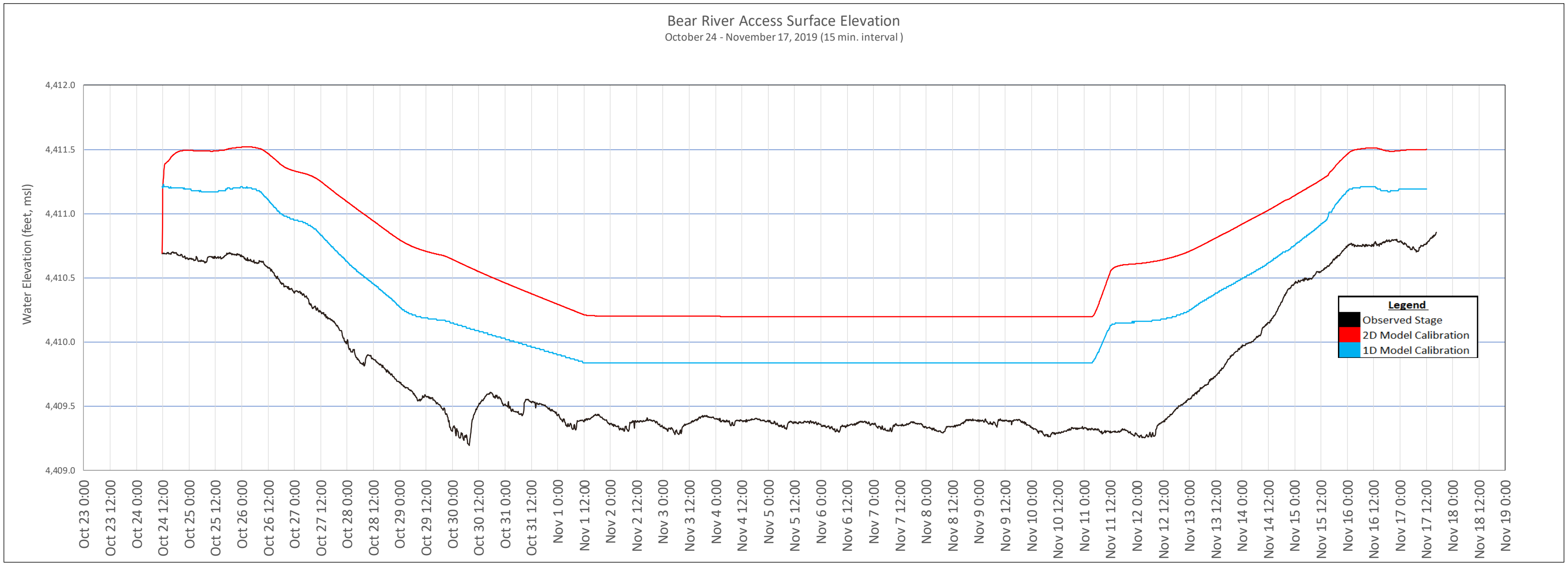

Cache Junction Down Water Surface Elevation
October 24 - November 17, 2019 (15 min. interval)
Water Elevation (feet, msl)
Legend
Observed Stage
2D Model Calibration
1D Model Calibration


Wheelon Dam Up Water Surface Elevation
October 24 - November 17, 2019 (15 min. interval)
Water Elevation (feet, msl)
Legend
Observed Stage
2D Model Calibration
1D Model Calibration


Wheelon Dam Down Water Surface Elevation
October 24 - November 17, 2019 (15 min. interval)
Water Elevation (feet, msl)
4,412.0
4,410.0
4,408.0
4,406.0
4,404.0
4,402.0
4,400.0
4,398.0
4,396.0
4,394.0
4,392.0
Oct 23 0:00
Nov 19 0:00
Legend
Observed Stage
2D Model Calibration
1D Model Calibration

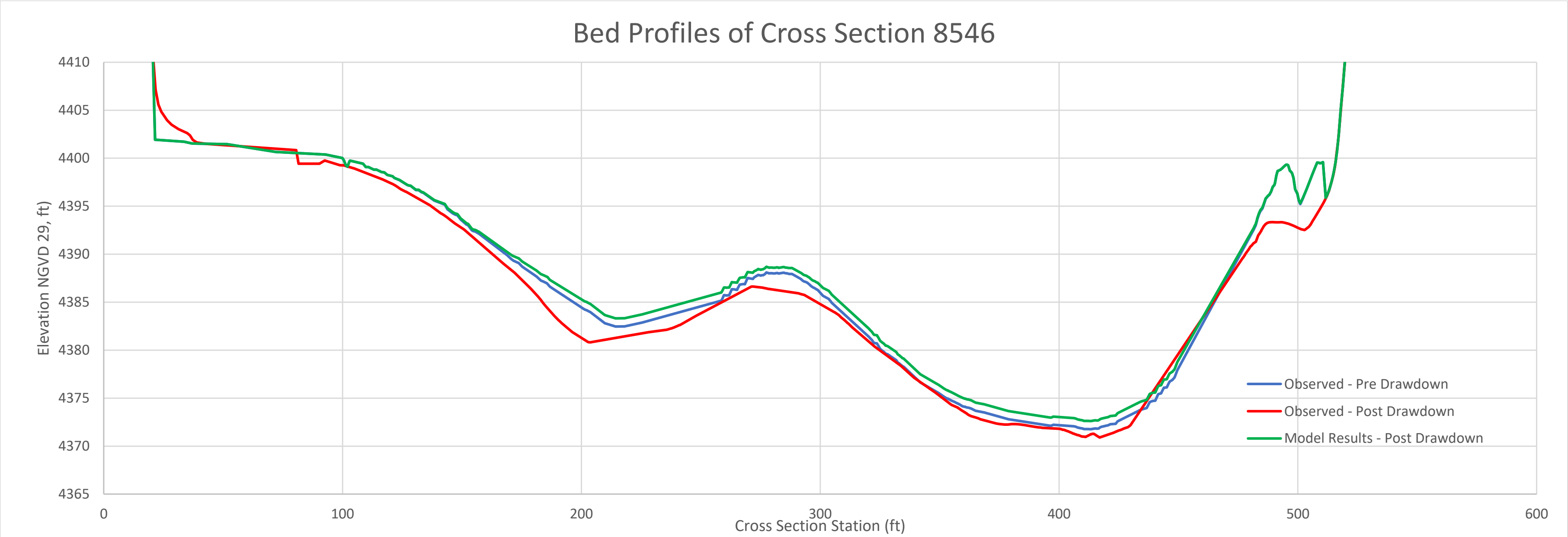

Cutler Dam Water Surface Elevation
October 24 - November 17, 2019 (15 min. interval)
Water Elevation (feet, msl)
4,412.0
4,407.0
4,402.0
4,397.0
4,392.0
4,387.0
Oct 23 0:00
Nov 19 0:00
Legend
Observed Stage
2D Model Calibration
1D Model Calibration

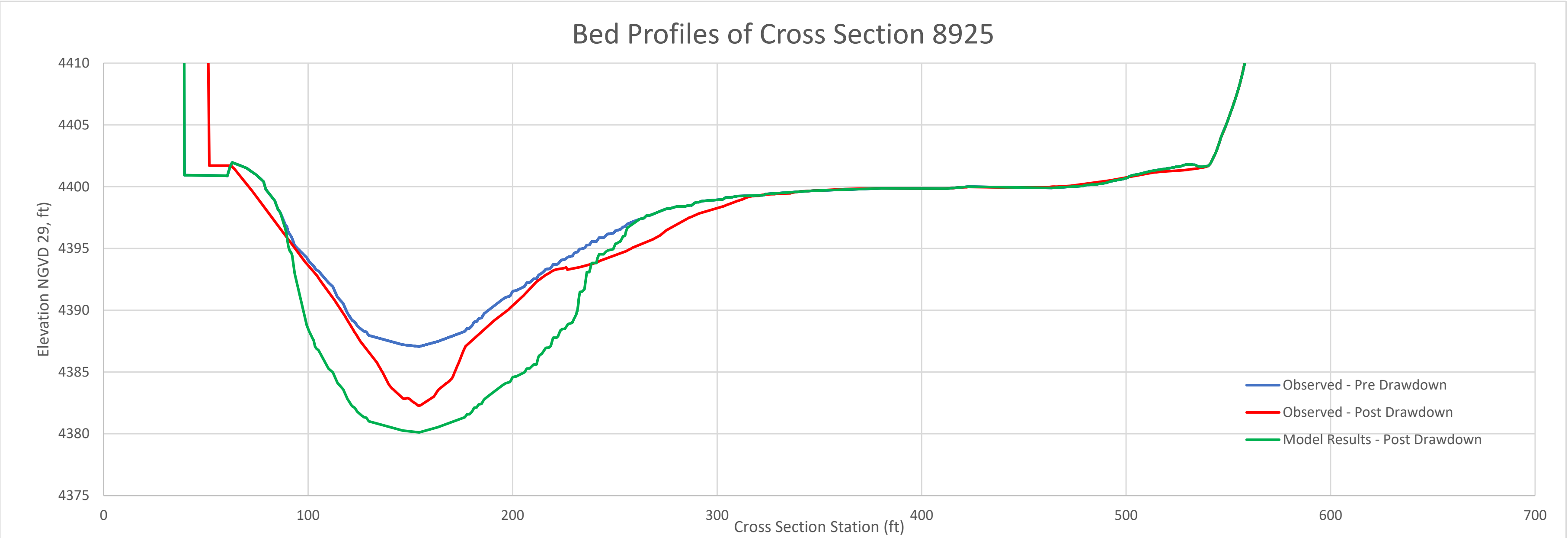

Riverside Bridge Water Surface Elevation
October 24 - November 17, 2019 (15 min. interval)
Water Elevation (feet, msl)
4,412.0
4,411.5
4,411.0
4,410.5
4,410.0
4,409.5
4,409.0
4,408.5
4,408.0
Legend
Observed Stage
2D Model Calibration
1D Model Calibration

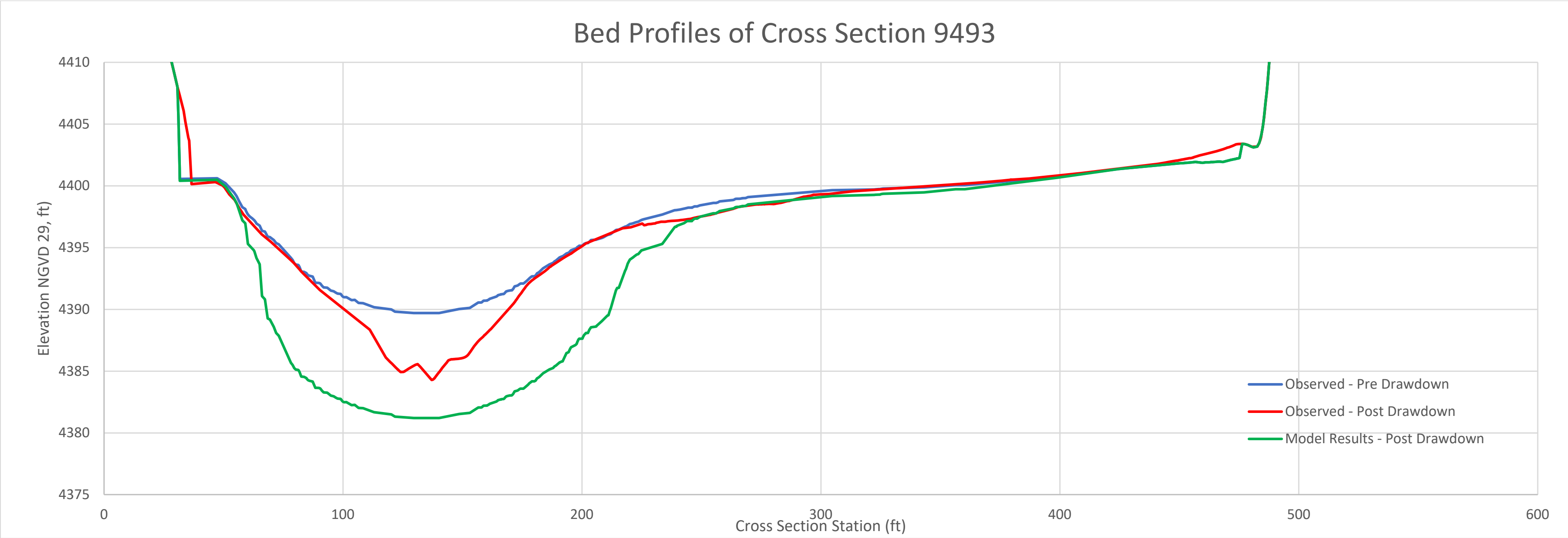

Bear River Access Surface Elevation
October 24 - November 17, 2019 (15 min. interval)
Water Elevation (feet, msl)
4,412.0
4,411.5
4,411.0
4,410.5
4,410.0
4,409.5
4,409.0
Legend
Observed Stage
2D Model Calibration
1D Model Calibration

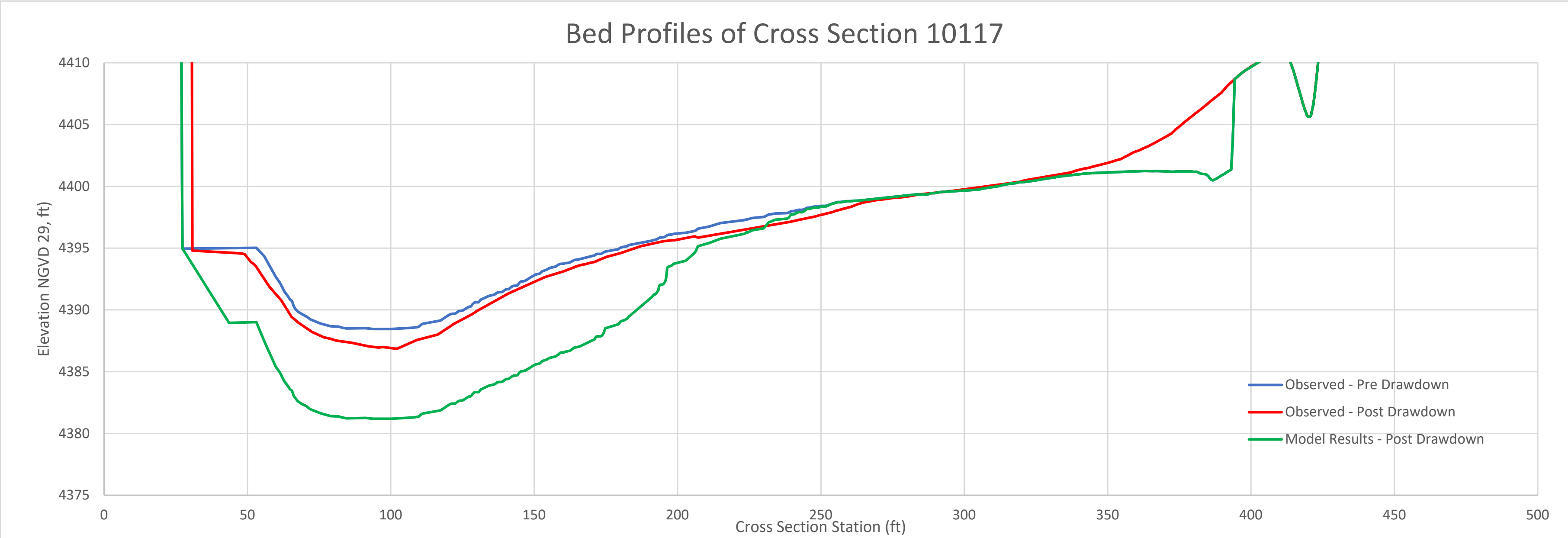
ATTACHMENT G-8

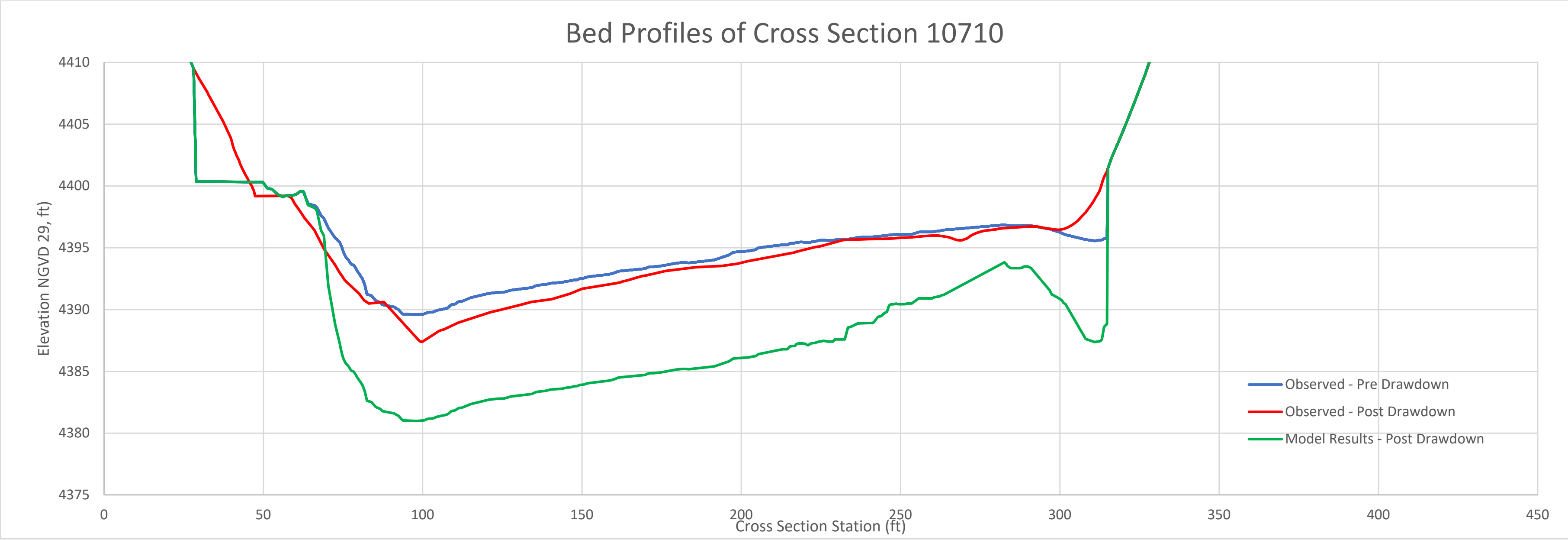
CALIBRATED BED PROFILES AT THE CALIBRATION CROSS SECTIONS

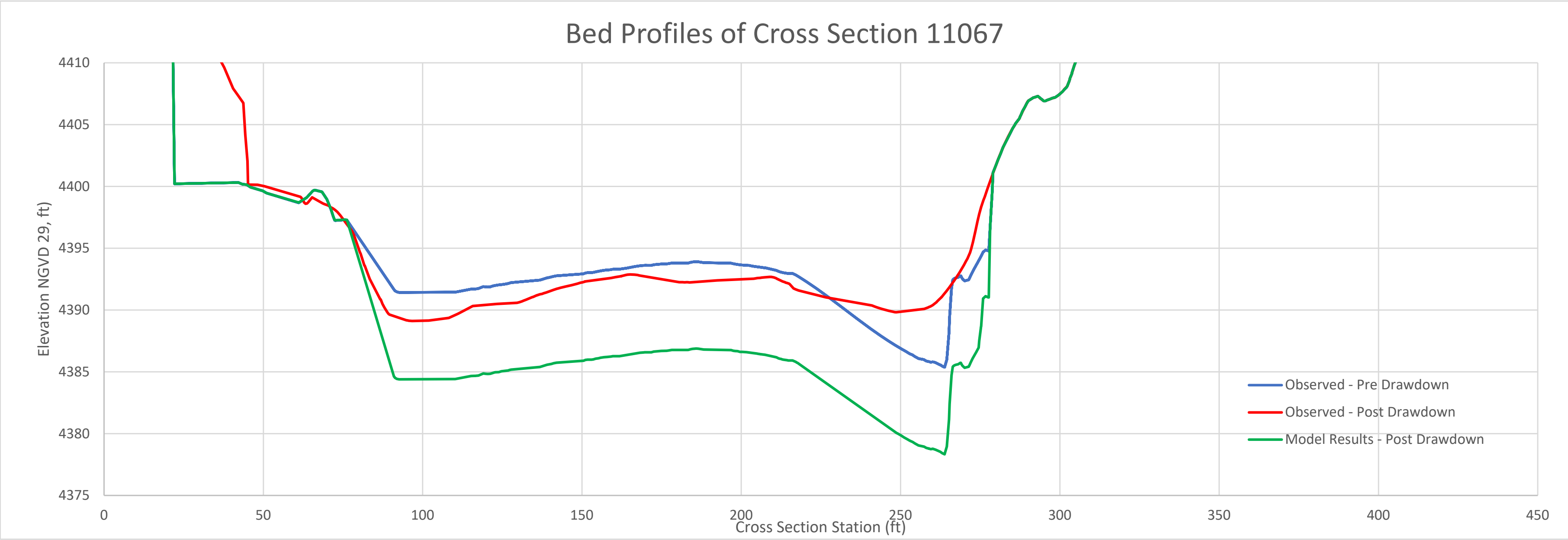

Bed Profiles of Cross Section 8546
Elevation NGVD 29, ft)
4410
4405
4400
4395
4390
4385
4380
4375
4370
4365
0
100
200
300
400
500
600
Cross Section Station (ft)
Observed - Pre Drawdown
Observed - Post Drawdown
Model Results - Post Drawdown

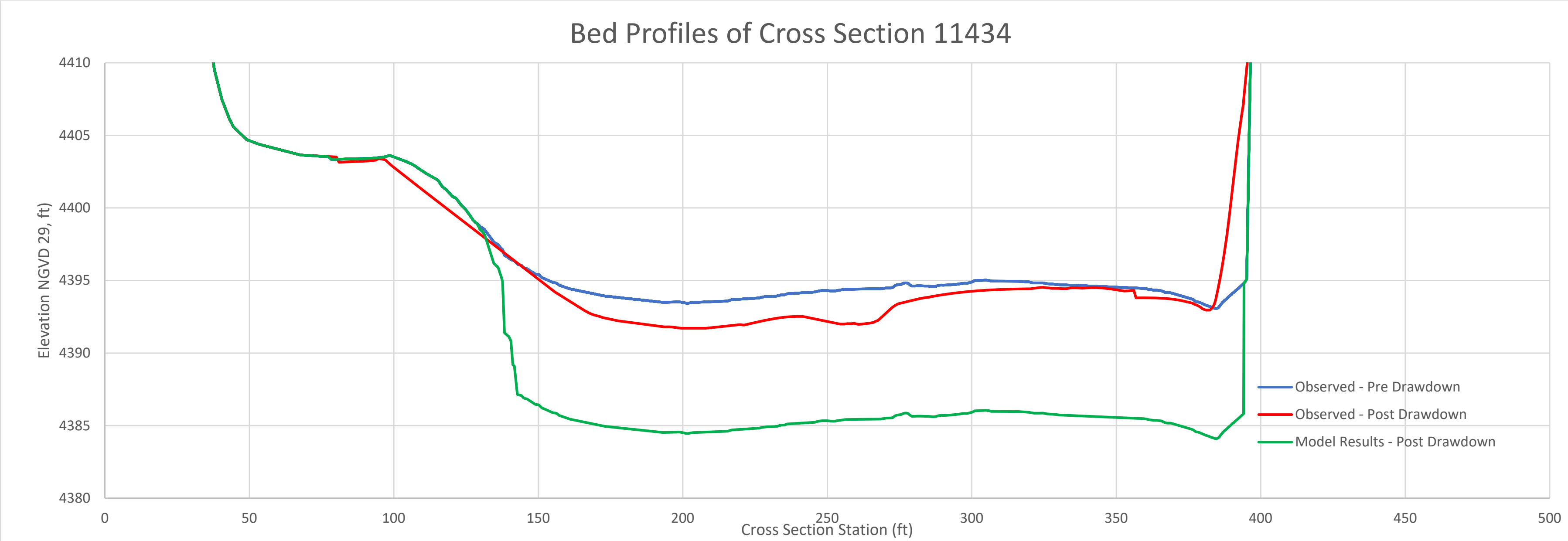

Bed Profiles of Cross Section 8925
Elevation NGVD 29, ft)
4410
4405
4400
4395
4390
4385
4380
4375
0
100
200
300
400
500
600
700
Cross Section Station (ft)
Observed - Pre Drawdown
Observed - Post Drawdown
Model Results - Post Drawdown

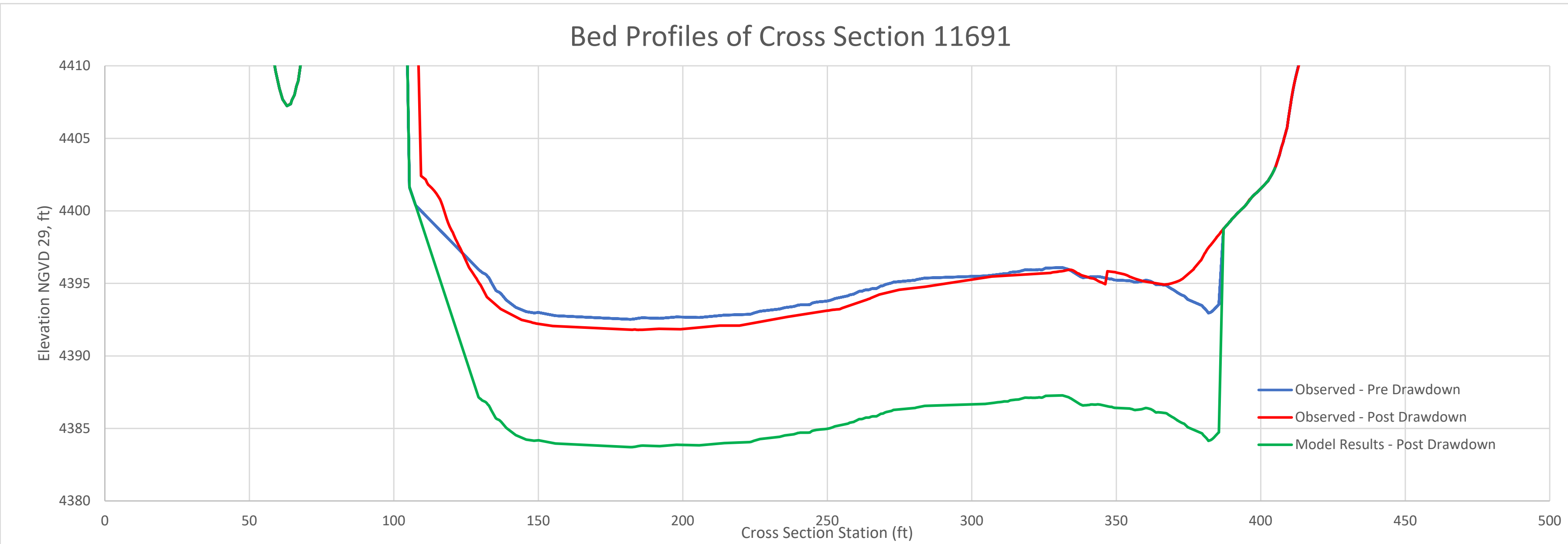

Bed Profiles of Cross Section 9493
Elevation NGVD 29, ft)
4410
4405
4400
4395
4390
4385
4380
4375
0
100
200
300
400
500
600
Cross Section Station (ft)
Observed - Pre Drawdown
Observed - Post Drawdown
Model Results - Post Drawdown

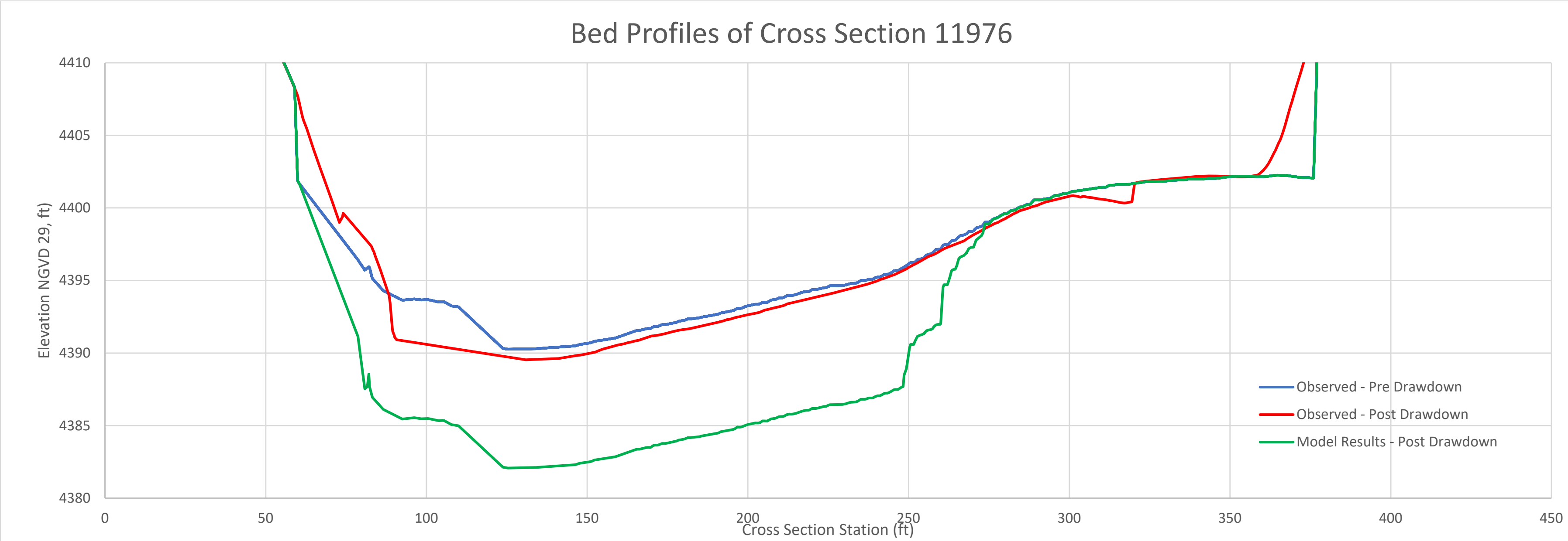

Bed Profiles of Cross Section 10117
Elevation NGVD 29, ft)
4410
4405
4400
4395
4390
4385
4380
4375
0
50
100
150
200
250
300
350
400
450
500
Cross Section Station (ft)
Observed - Pre Drawdown
Observed - Post Drawdown
Model Results - Post Drawdown

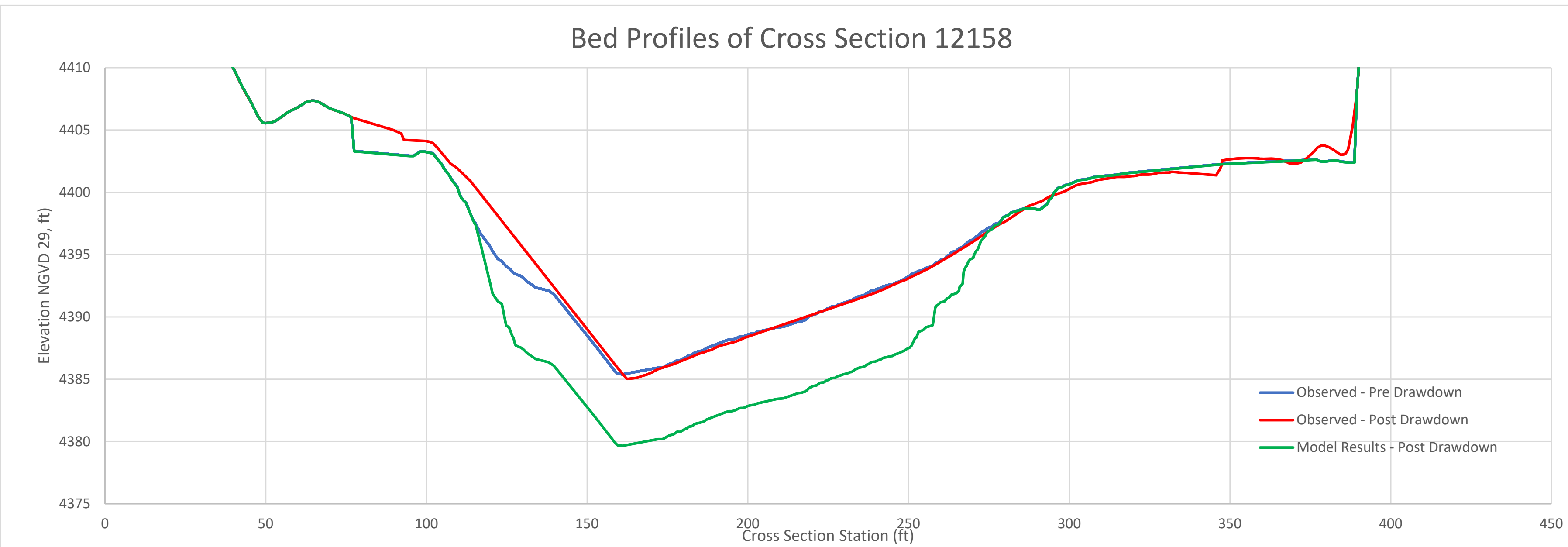

Bed Profiles of Cross Section 10710
Elevation NGVD 29, ft)
4410
4405
4400
4395
4390
4385
4380
4375
0
50
100
150
200
250
300
350
400
450
Cross Section Station (ft)
Observed - Pre Drawdown
Observed - Post Drawdown
Model Results - Post Drawdown

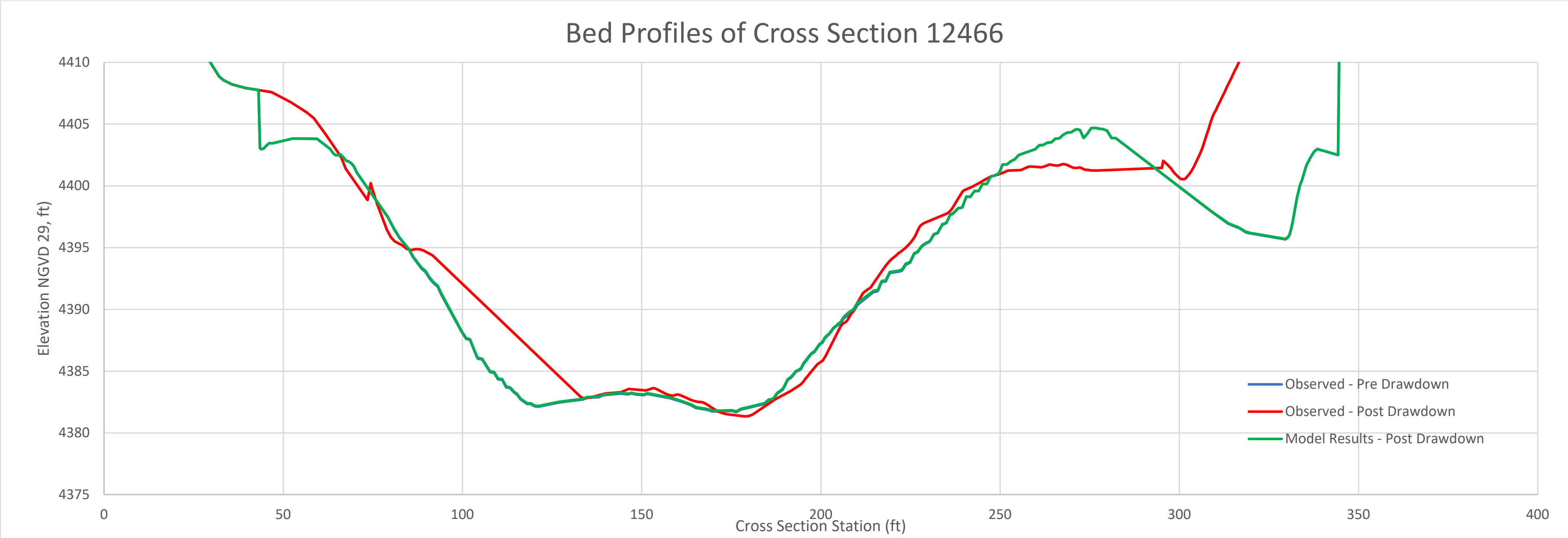

Bed Profiles of Cross Section 11067
Elevation NGVD 29, ft)
4410
4405
4400
4395
4390
4385
4380
4375
0
50
100
150
200
250
300
350
400
450
Cross Section Station (ft)
Observed - Pre Drawdown
Observed - Post Drawdown
Model Results - Post Drawdown

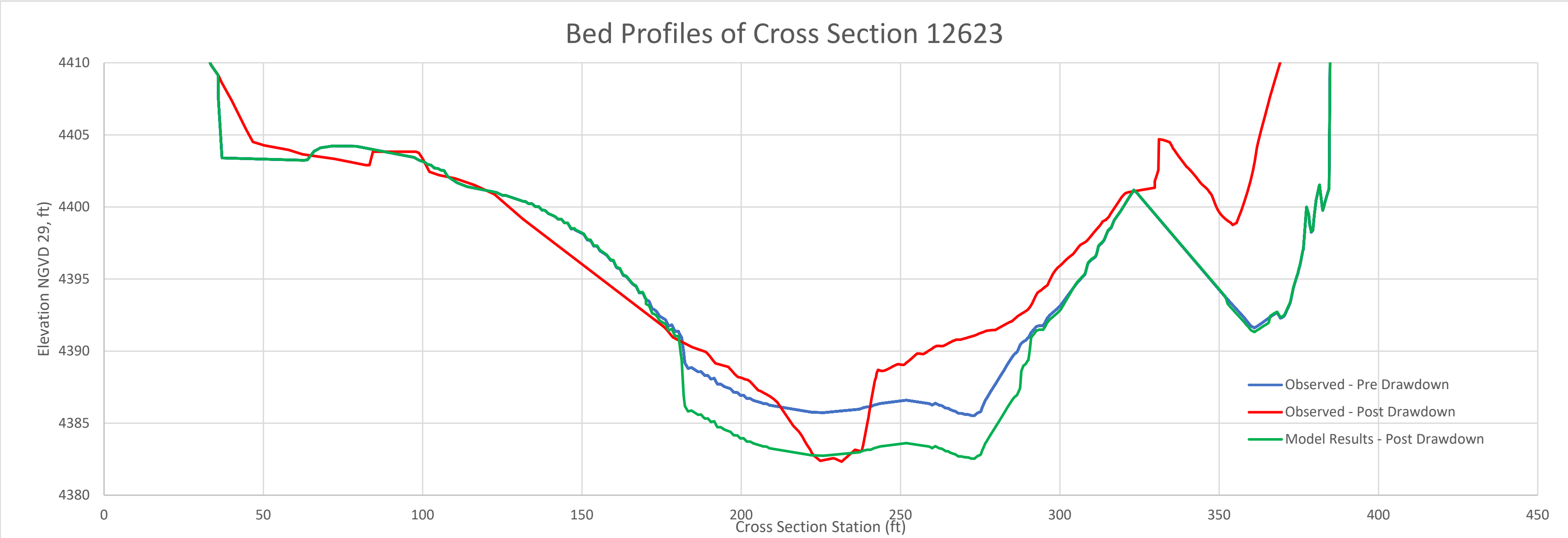

Bed Profiles of Cross Section 11434
Elevation NGVD 29, ft)
4410
4405
4400
4395
4390
4385
4380
0
50
100
150
200
250
300
350
400
450
500
Cross Section Station (ft)
Observed - Pre Drawdown
Observed - Post Drawdown
Model Results - Post Drawdown

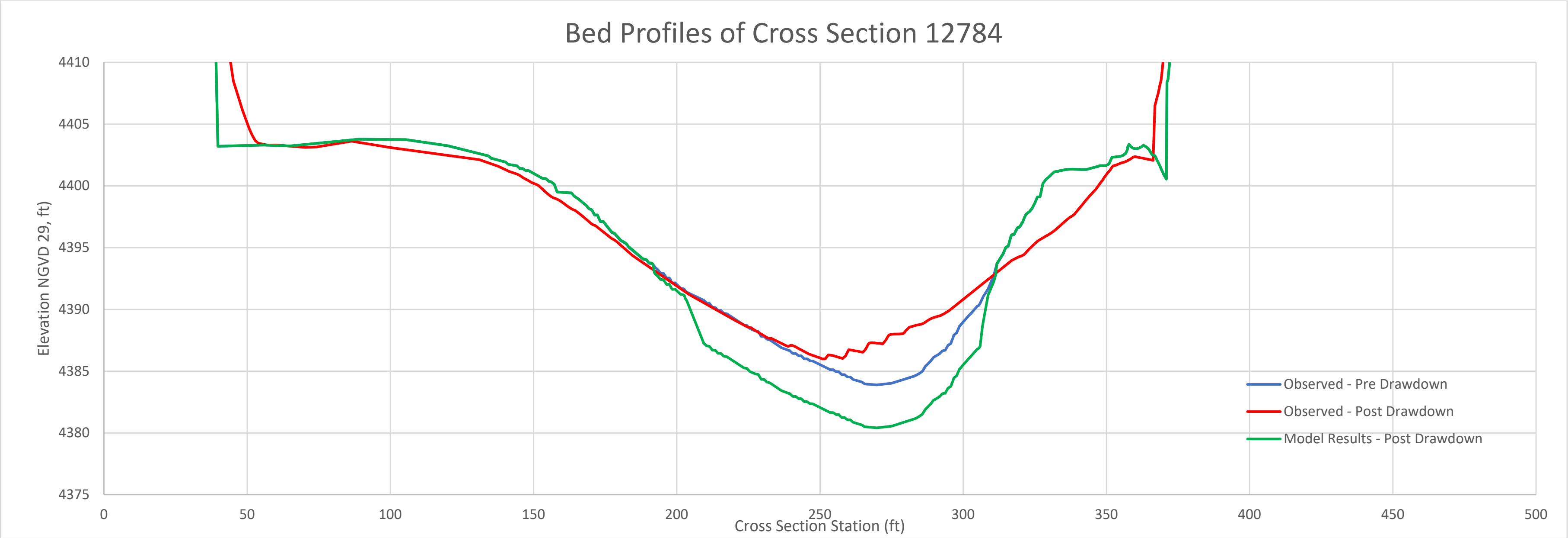

Bed Profiles of Cross Section 11691
Elevation NGVD 29, ft)
4410
4405
4400
4395
4390
4385
4380
0
50
100
150
200
250
300
350
400
450
500
Cross Section Station (ft)
Observed - Pre Drawdown
Observed - Post Drawdown
Model Results - Post Drawdown

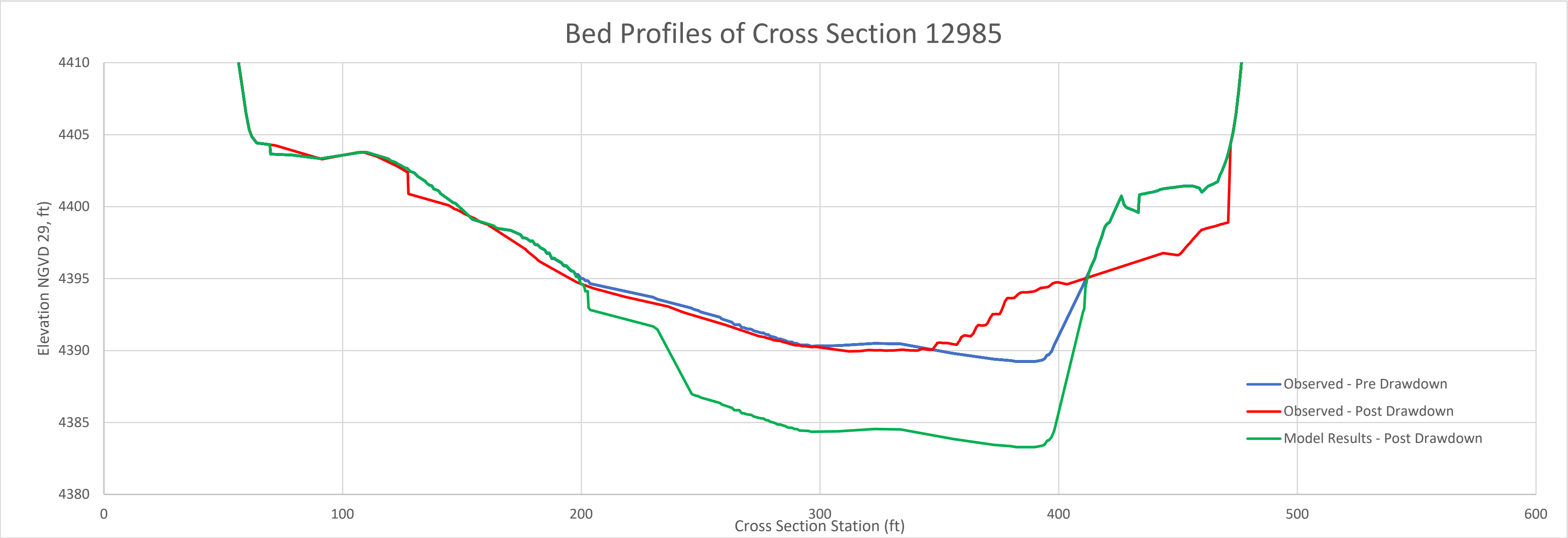

Bed Profiles of Cross Section 11976
Elevation NGVD 29, ft)
4410
4405
4400
4395
4390
4385
4380
0
50
100
150
200
250
300
350
400
450
Cross Section Station (ft)
Observed - Pre Drawdown
Observed - Post Drawdown
Model Results - Post Drawdown

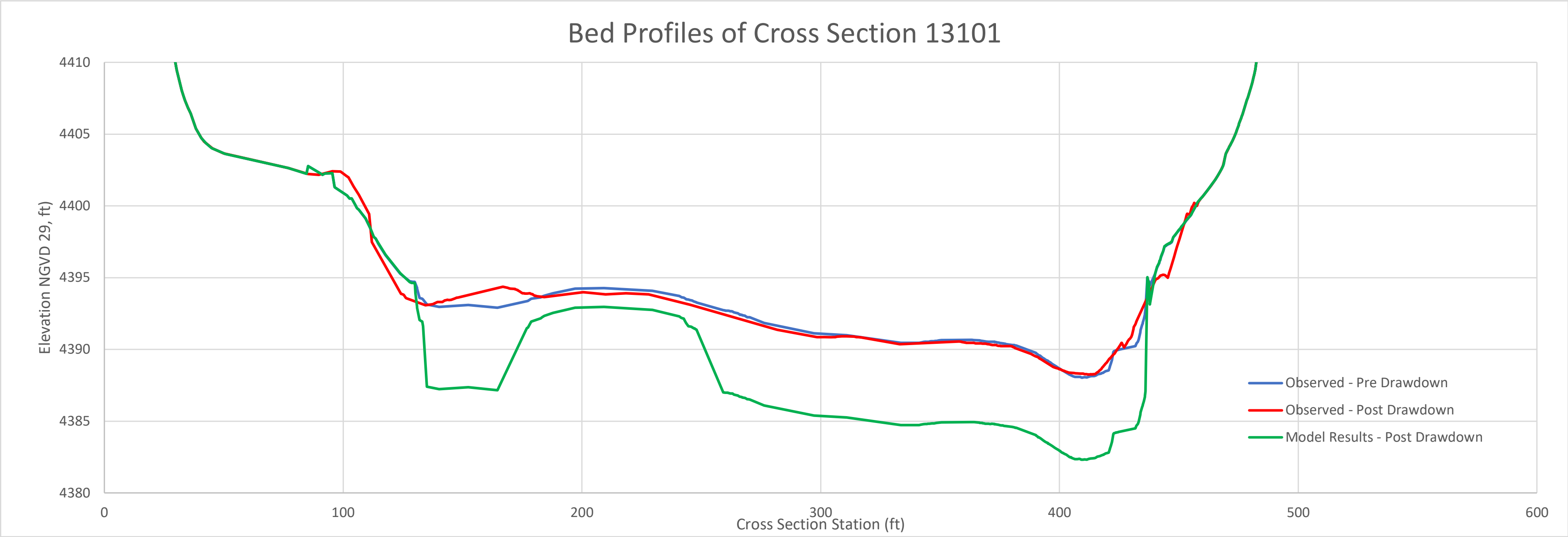

Bed Profiles of Cross Section 12158
Elevation NGVD 29, ft)
4410
4405
4400
4395
4390
4385
4380
4375
0
50
100
150
200
250
300
350
400
450
Cross Section Station (ft)
Observed - Pre Drawdown
Observed - Post Drawdown
Model Results - Post Drawdown


Bed Profiles of Cross Section 12466
Elevation NGVD 29, ft)
Cross Section Station (ft)
Observed - Pre Drawdown
Observed - Post Drawdown
Model Results - Post Drawdown


Bed Profiles of Cross Section 12623
Elevation NGVD 29, ft)
Cross Section Station (ft)
Observed - Pre Drawdown
Observed - Post Drawdown
Model Results - Post Drawdown

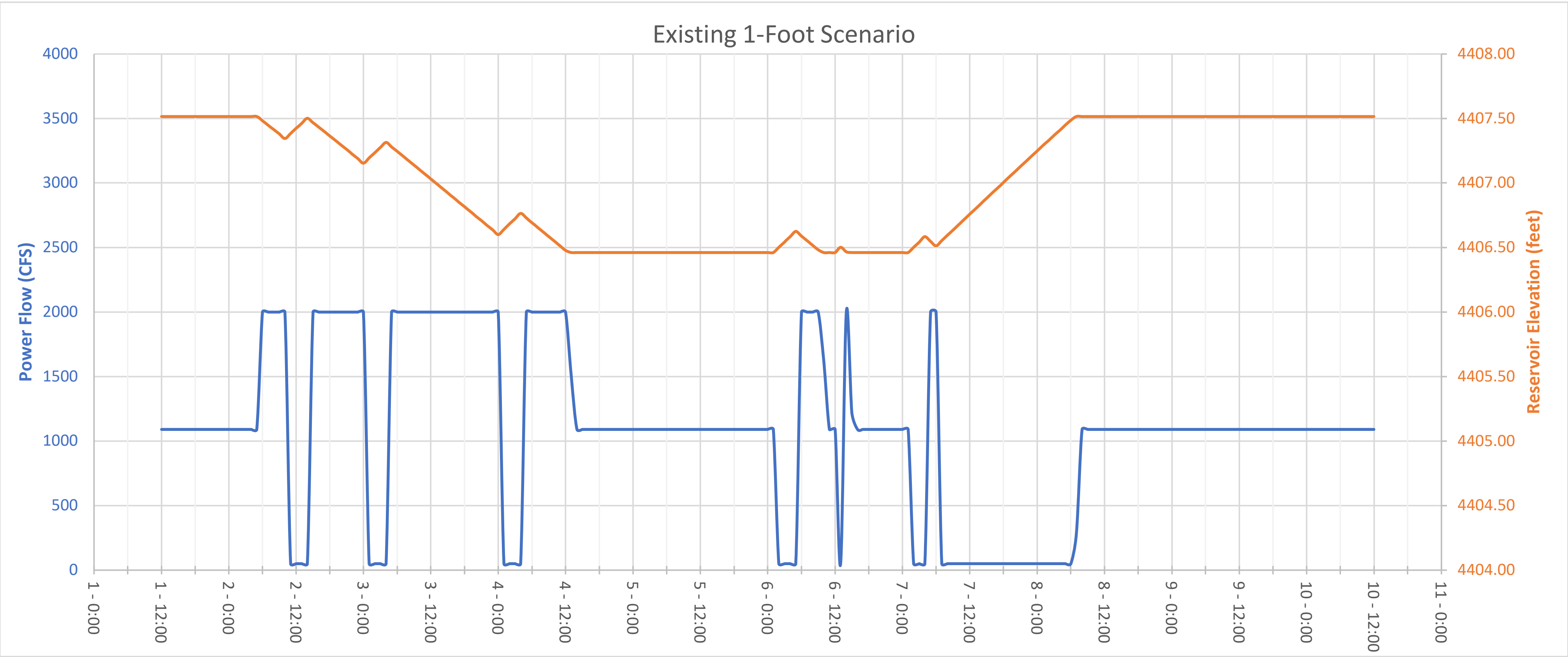

Bed Profiles of Cross Section 12784
Elevation NGVD 29, ft)
4410
4405
4400
4395
4390
4385
4380
4375
0
50
100
150
200
250
300
350
400
450
500
Cross Section Station (ft)
Observed - Pre Drawdown
Observed - Post Drawdown
Model Results - Post Drawdown

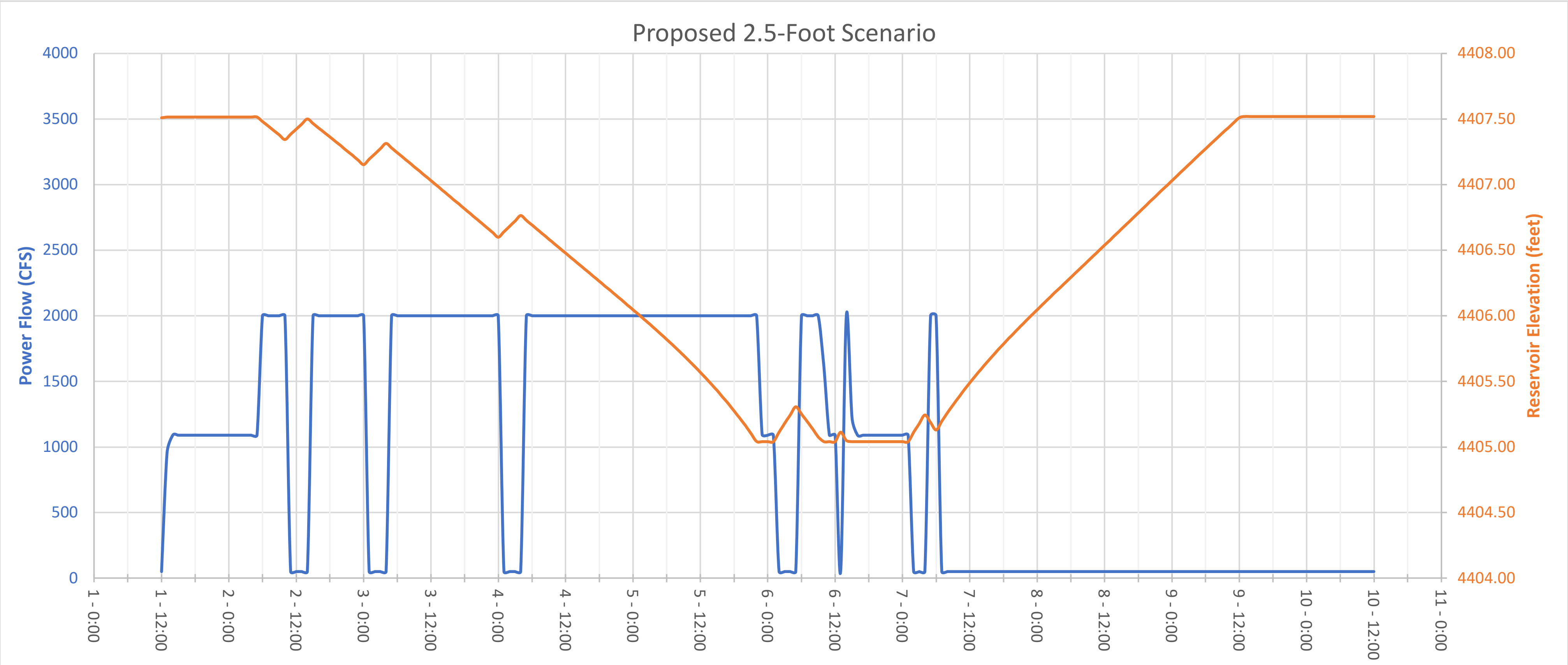

Bed Profiles of Cross Section 12985
Elevation NGVD 29, ft)
4410
4405
4400
4395
4390
4385
4380
0
100
200
300
400
500
600
Cross Section Station (ft)
Observed - Pre Drawdown
Observed - Post Drawdown
Model Results - Post Drawdown


Bed Profiles of Cross Section 13101
4410
4405
4400
4395
4390
4385
4380
Elevation NGVD 29, ft)
0
100
200
300
400
500
600
Cross Section Station (ft)
Observed - Pre Drawdown
Observed - Post Drawdown
Model Results - Post Drawdown

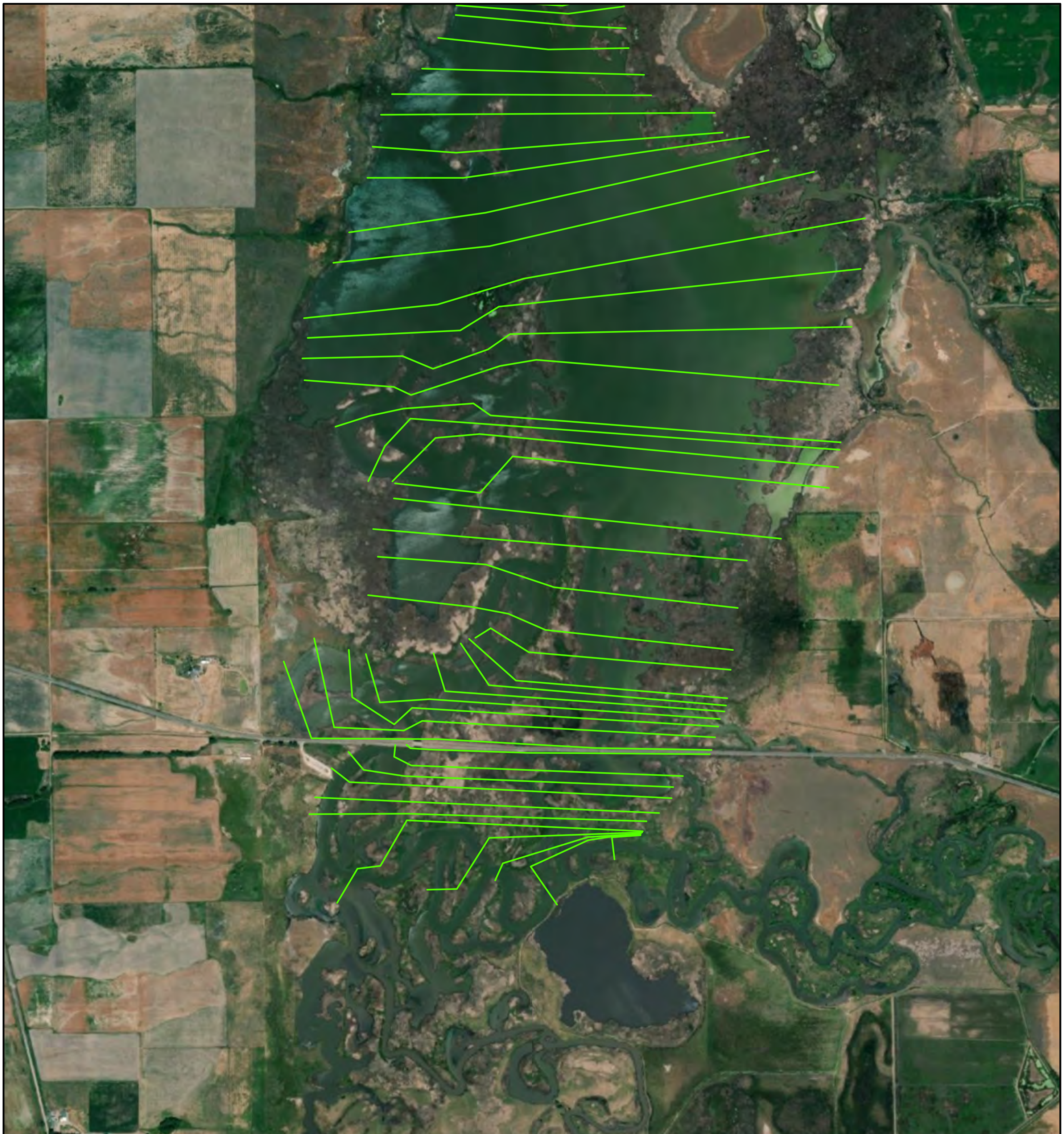
ATTACHMENT G-9

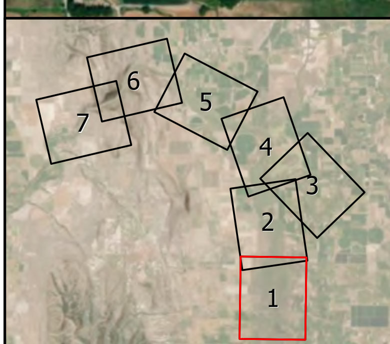
STAGE AND OUTFLOW HYDROGRAPHS AT CUTLER DAM AND DOWNSTREAM REACH BY OPERATIONAL SCENARIO


Existing 1-Foot Scenario
Power Flow (CFS)
Reservoir Elevation (feet)
0
500
1000
1500
2000
2500
3000
3500
4000
4404.00
4404.50
4405.00
4405.50
4406.00
4406.50
4407.00
4407.50
4408.00
1 - 0:00
1 - 12:00
2 - 0:00
2 - 12:00
3 - 0:00
3 - 12:00
4 - 0:00
4 - 12:00
5 - 0:00
5 - 12:00
6 - 0:00
6 - 12:00
7 - 0:00
7 - 12:00
8 - 0:00
8 - 12:00
9 - 0:00
9 - 12:00
10 - 0:00
10 - 12:00
11 - 0:00


Proposed 2.5-Foot Scenario
Power Flow (CFS)
Reservoir Elevation (feet)
4000
3500
3000
2500
2000
1500
1000
500
0
4408.00
4407.50
4407.00
4406.50
4406.00
4405.50
4405.00
4404.50
4404.00
1 - 0:00
1 - 12:00
2 - 0:00
2 - 12:00
3 - 0:00
3 - 12:00
4 - 0:00
4 - 12:00
5 - 0:00
5 - 12:00
6 - 0:00
6 - 12:00
7 - 0:00
7 - 12:00
8 - 0:00
8 - 12:00
9 - 0:00
9 - 12:00
10 - 0:00
10 - 12:00
11 - 0:00

ATTACHMENT G-10
1D MODEL MESH GEOMETRY





1D Cross Sections

N

Coordinate System:

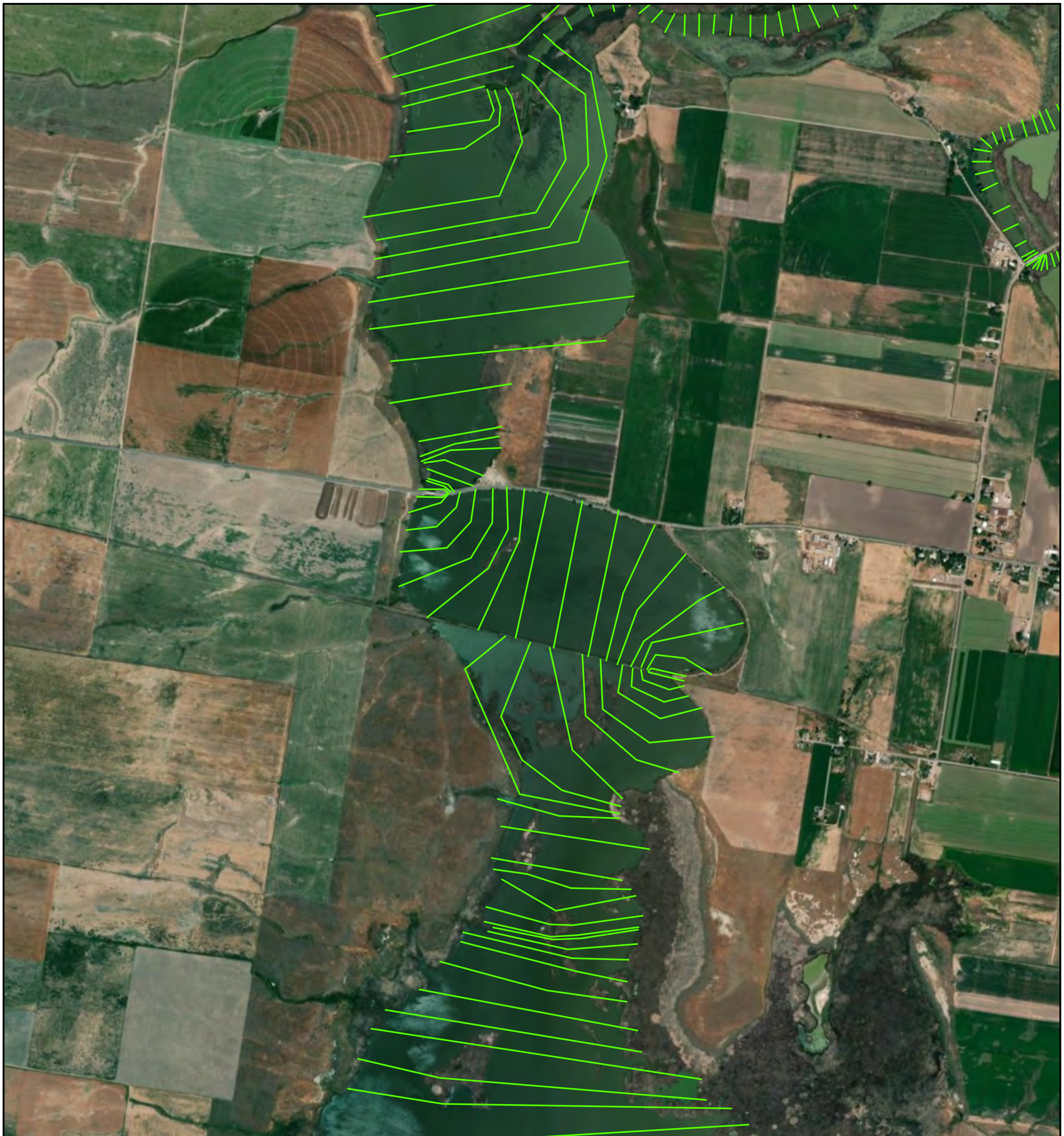
0 500 1,000
Feet

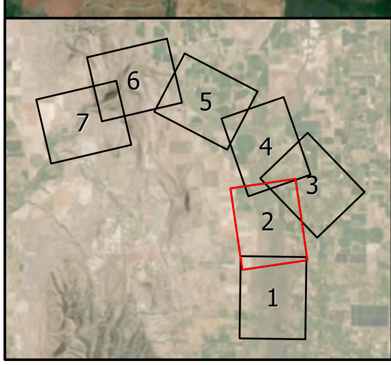
1D Model Geometry

Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP





1D Cross Sections

N

Coordinate System:

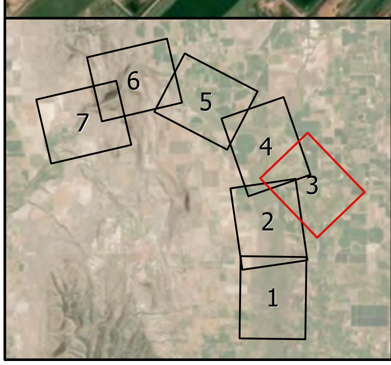
0 500 1,000
Feet

1D Model Geometry

Notes
- *Assumed duration of the event: 9 days or 216 hours.*
- *Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.*

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP



1D Cross Sections

Notes
- *Assumed duration of the event: 9 days or 216 hours.*
- *Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.*

N

Coordinate System:

0 500 1,000 Feet

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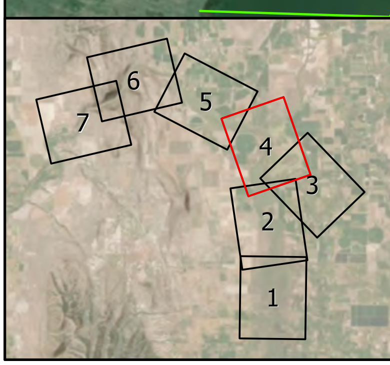
1D Model Geometry

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP



1D Cross Sections

N

Coordinate System:

0 500 1,000
Feet

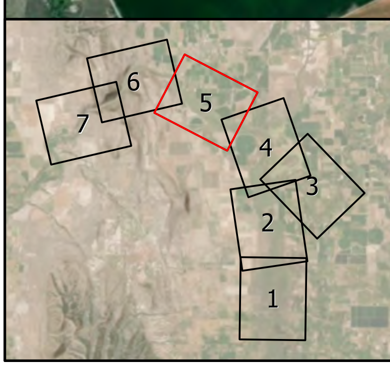
1D Model Geometry

Notes
- *Assumed duration of the event: 9 days or 216 hours.*
- *Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.*

PacifiCorp collects data from a variety of government and private sources. This map is not to be released nor put into any location that is accessible electronically or otherwise available to market affiliates. PacifiCorp makes no warranty as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data. For complete validation, the source organization should be contacted or source documents consulted to verify the findings of this product.

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP



1D Cross Sections

Notes

- *Assumed duration of the event: 9 days or 216 hours.*
- *Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.*

N

Coordinate System:

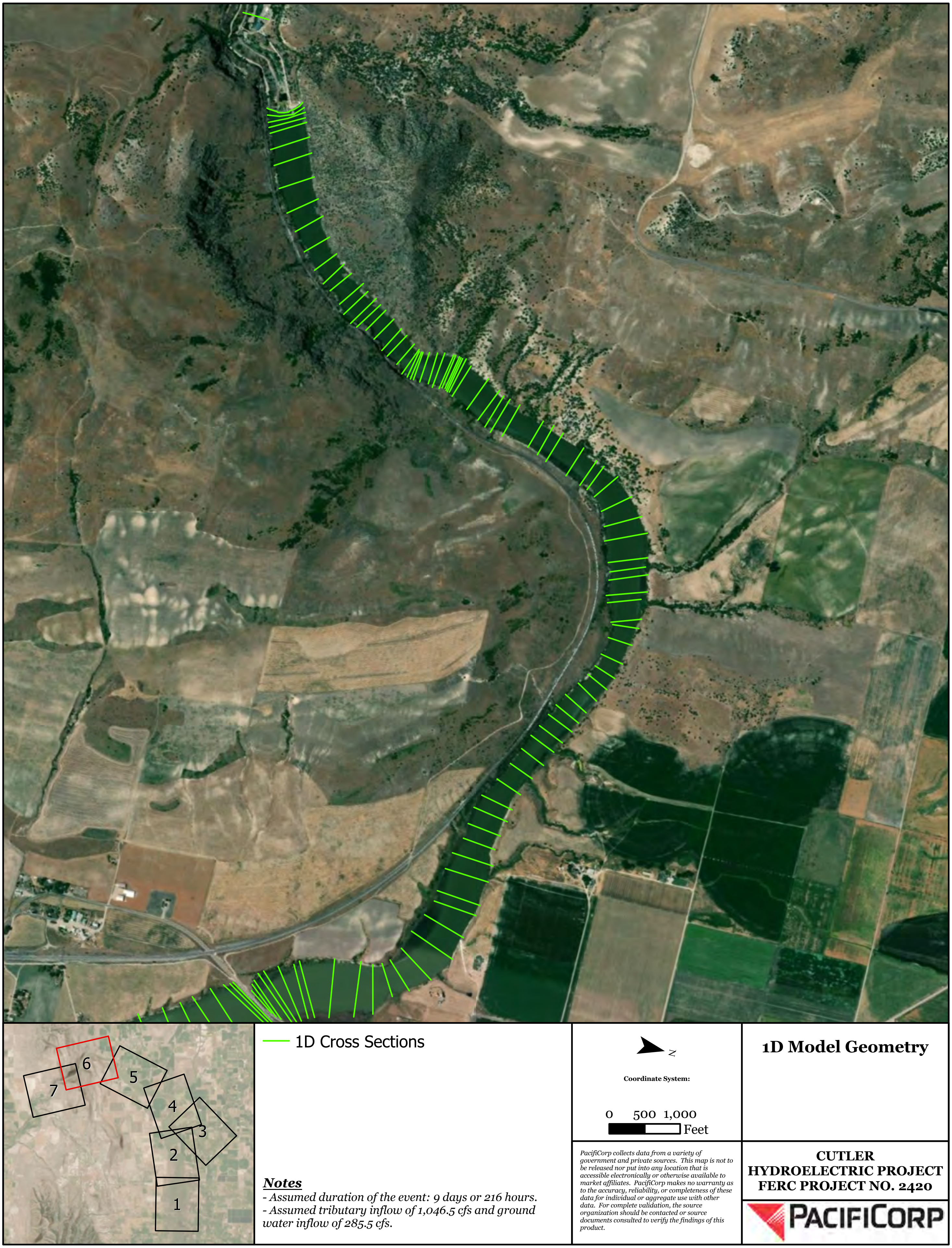
0 500 1,000 Feet

PacifiCorp collects data from a variety of government and private sources. This map is not to be released nor put into any location that is accessible electronically or otherwise available to market affiliates. PacifiCorp makes no warranty as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data. For complete validation, the source organization should be contacted or source documents consulted to verify the findings of this product.

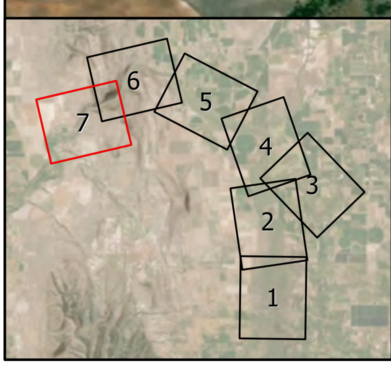
1D Model Geometry

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP



Notes
- *Assumed duration of the event: 9 days or 216 hours.*
- *Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.*



1D Cross Sections

Notes

- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.

N

Coordinate System:

0 500 1,000 Feet

1D Model Geometry

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP

ATTACHMENT G-11

HYDROGRAPH GROUNDWATER INPUTS FOR PROPOSED PROJECT OPERATIONAL SCENARIOS

Groundwater Inflows for Proposed and Existing Operations	
Site	**Inflow (cfs)**
South Groundwater	35.5
North Groundwater #1	100.0
North Groundwater #2	150.0

ATTACHMENT G-12

SITE PHOTO AND INUNDATION BOUNDARY COMPARISON

During the drawdown event photos were taken at 1-minute intervals at 13 sites throughout the reservoir. These photos were used as a qualitative data points and were visually compared to the resulting inundation boundaries from the Hydraulic model overlaid on aerial imagery in order to verify if inundation boundaries matched what was shown in the photo log at the time the photo was taken. Particular attention was paid to five photo site locations near Cutler marsh given that Cutler marsh contains a significant amount of wildlife habitat that is sensitive to the quantity and timing of exposed shoreline. Figure 1, and Photos 1 through Photo 5 compare the inundation boundary model results and photos taken during the drawdown on October 26th, 2019. Figure 2 and Photos 6 through Photo 10, compare the inundation boundary model results and photos taken during the drawdown on November 4th, 2019.

Figure 1 October 26th, 2019 12:00pm Inundation Boundary

PHOTO 1 Site 1

PHOTO 2 Site 2

PHOTO 3 Site 4

PHOTO 4 Site 4

PHOTO 5 Site 5

Figure 2 November 4th, 2019 12:00pm Inundation Boundary

PHOTO 6 Site 1

PHOTO 7 Site 2

PHOTO 8 Site 3

PHOTO 9 Site 4

PHOTO 10 Site 5

ATTACHMENT G-13

1 FT AND 2.5 FT OPERATION SCENARIOS – RESERVOIR LEVELS

Proposed 2.5 foot Drawdown Scenerio

		Reservoir Surface Elevations (NGVD 29, ft)								
Stage at Cutler (ft, NGVD29)	Time after start of event (hrs)	Highway 30	Fisherman Bridge	Benson Marina	Bear River Confluence	Clay Slough Confluence	Railroad Bridge up	Cache Junction Up	Wheelon Dam Up	Cutler Dam
4407.50	17.25	4407.50	4407.50	4407.50	4407.50	4407.50	4407.50	4407.50	4407.50	4407.50
4407.00	48.75	4407.48	4407.45	4407.43	4407.44	4407.29	4407.11	4407.09	4407.04	4407.01
4406.50	71.25	4407.13	4407.08	4407.06	4407.08	4406.89	4406.63	4406.61	4406.54	4406.51
4406.00	85.25	4406.90	4406.83	4406.80	4406.84	4406.56	4406.17	4406.13	4406.05	4406.00
4405.50	97.50	4406.67	4406.57	4406.55	4406.61	4406.25	4405.72	4405.65	4405.56	4405.50
4405.00	133.00	4406.23	4406.05	4406.02	4406.17	4405.71	4405.19	4405.13	4405.07	4405.04
Minimum during entire event	-	4406.20	4406.02	4405.99	4406.16	4405.71	4405.19	4405.13	4405.07	4405.04

*Assumed duration of the event: 9 days or 216 hours.

**Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.

***The reservoir was assumed to operate at a level pool, with the energy gradient from the Bear River Access to Cutler Dam assumed to be negligible.

Existing 1 foot Drawdown Scenerio

		Reservoir Surface Elevations (NGVD 29, ft)								
Stage at Cutler (ft, NGVD29)	Time after start of event (hrs)	Highway 30	Fisherman Bridge	Benson Marina	Bear River Confluence	Clay Slough Confluence	Railroad Bridge up	Cache Junction Up	Wheelon Dam Up	Cutler Dam
4407.50	17.25	4407.50	4407.50	4407.50	4407.50	4407.50	4407.50	4407.50	4407.50	4407.50
4407.00	48.75	4407.48	4407.45	4407.43	4407.44	4407.29	4407.11	4407.09	4407.04	4407.01
4406.50	132.00	4406.88	4406.82	4406.81	4406.87	4406.69	4406.52	4406.52	4406.51	4406.50
Minimum during entire event	-	4406.87	4406.82	4406.81	4406.87	4406.69	4406.52	4406.52	4406.51	4406.50

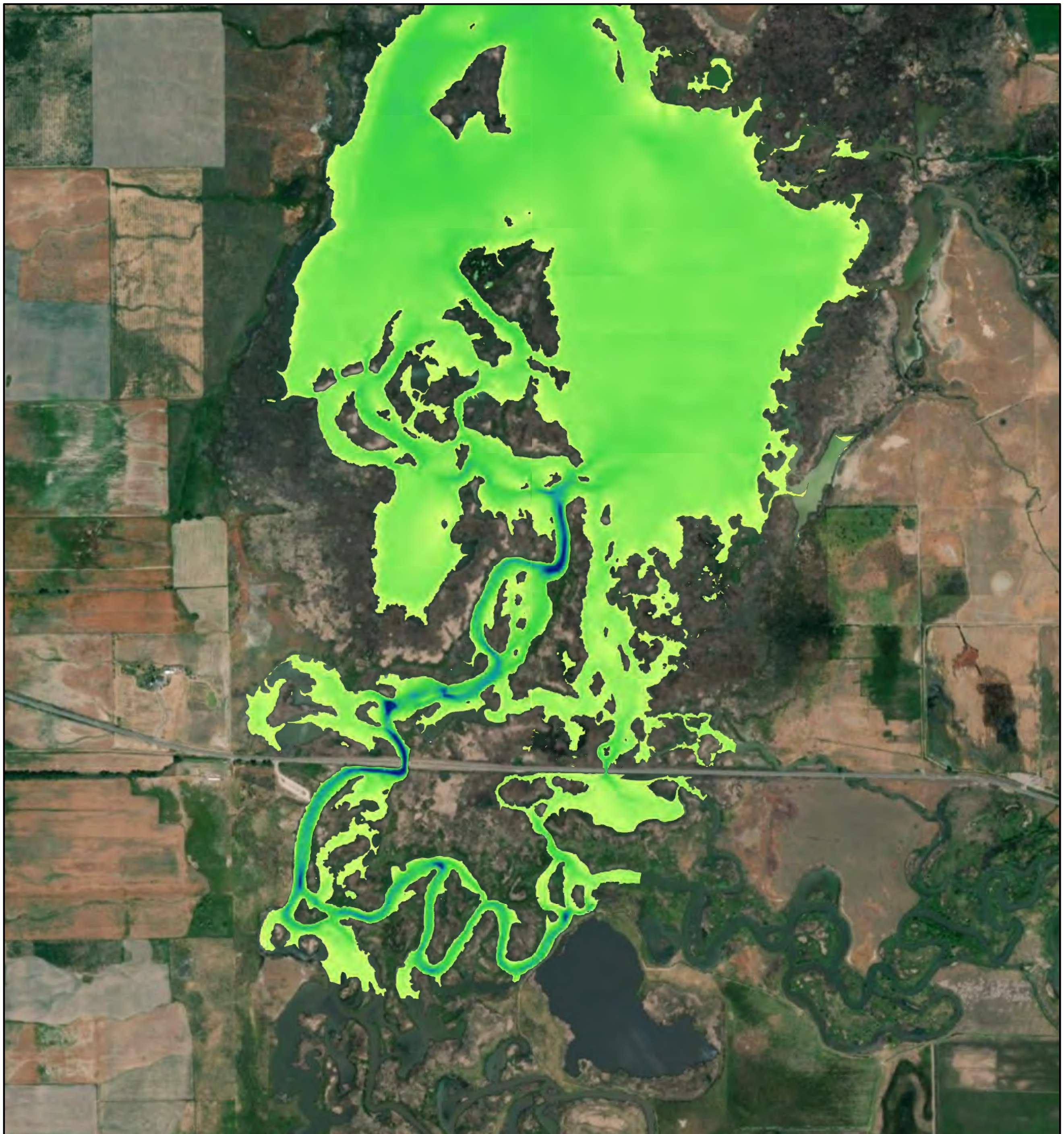
*Assumed duration of the event: 9 days or 216 hours.

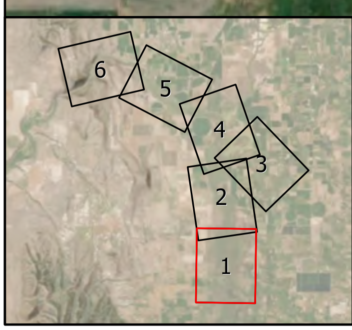
**Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.

***The reservoir was assumed to operate at a level pool, with the energy gradient from the Bear River Access to Cutler Dam assumed to be negligible.

ATTACHMENT G-14

1 FT AND 2.5 FT OPERATION SCENARIOS – MINIMUM DEPTHS





Minimum Depth (ft)
45
0

Notes
- *Assumed duration of the event: 9 days or 216 hours.*
- *Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.*

N

Coordinate System:
NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983

0 500 1,000
Feet

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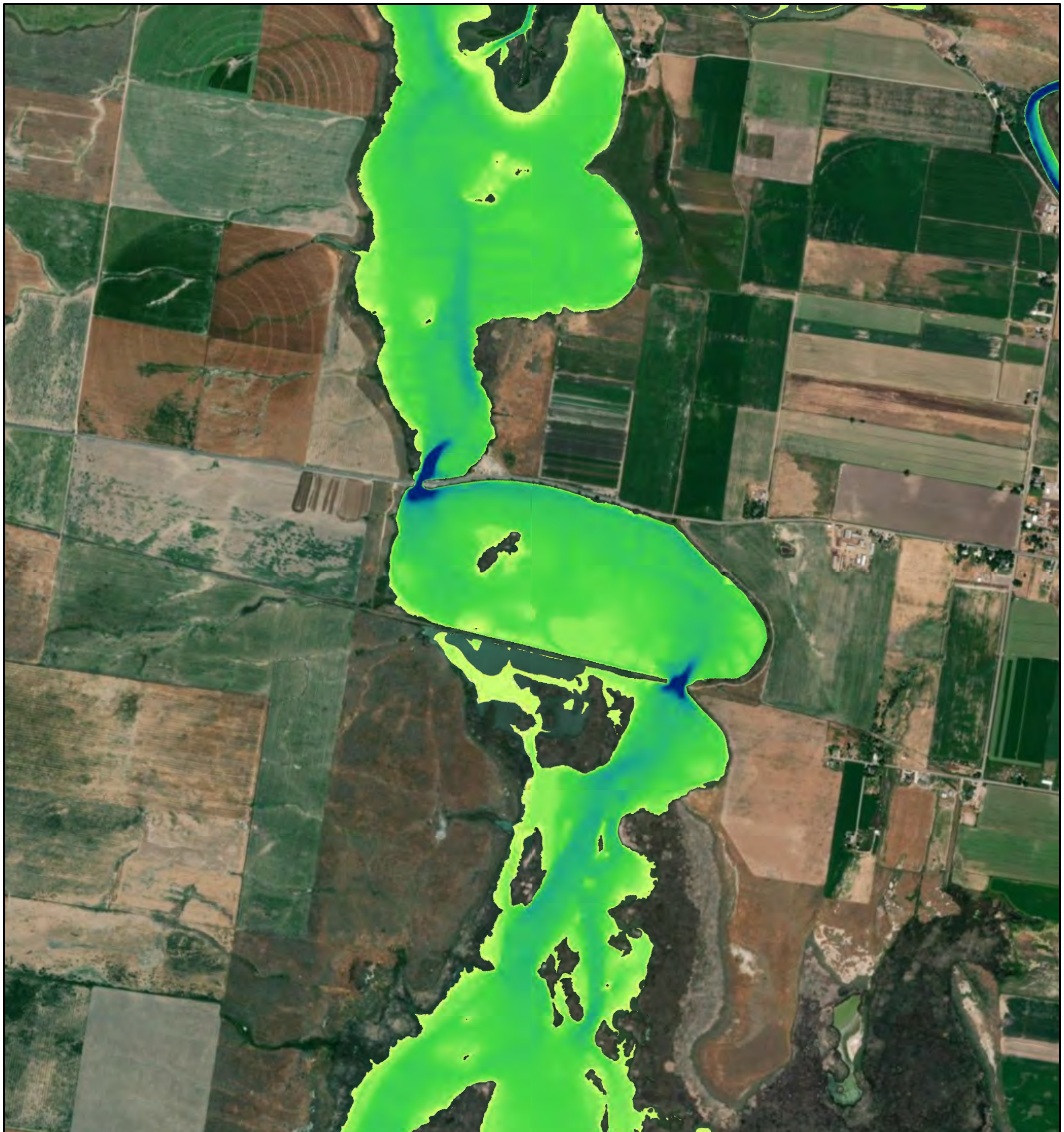
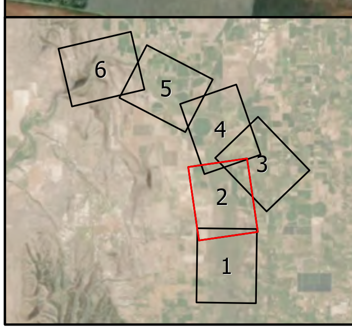
1.0 Ft Proposed Normal Operating Range Depths

Sheet 1 of 6

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP





Minimum Depth (ft)
45
0

Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.

N

Coordinate System:
NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983

0 500 1,000
Feet

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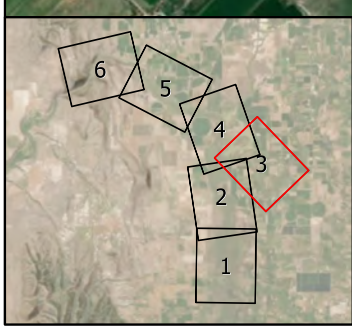
1.0 Ft Proposed Normal Operating Range Depths

Sheet 2 of 6

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP



Minimum Depth (ft)
45
0

Notes
- *Assumed duration of the event: 9 days or 216 hours.*
- *Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.*

N

Coordinate System:
NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983

0 500 1,000
Feet

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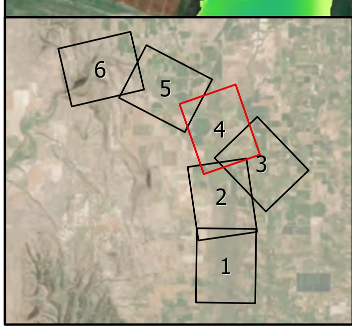
1.0 Ft Proposed Normal Operating Range Depths

Sheet 3 of 6

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP



Minimum Depth (ft)
45
0

Notes

- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.

N

Coordinate System:
NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983

0 500 1,000
Feet

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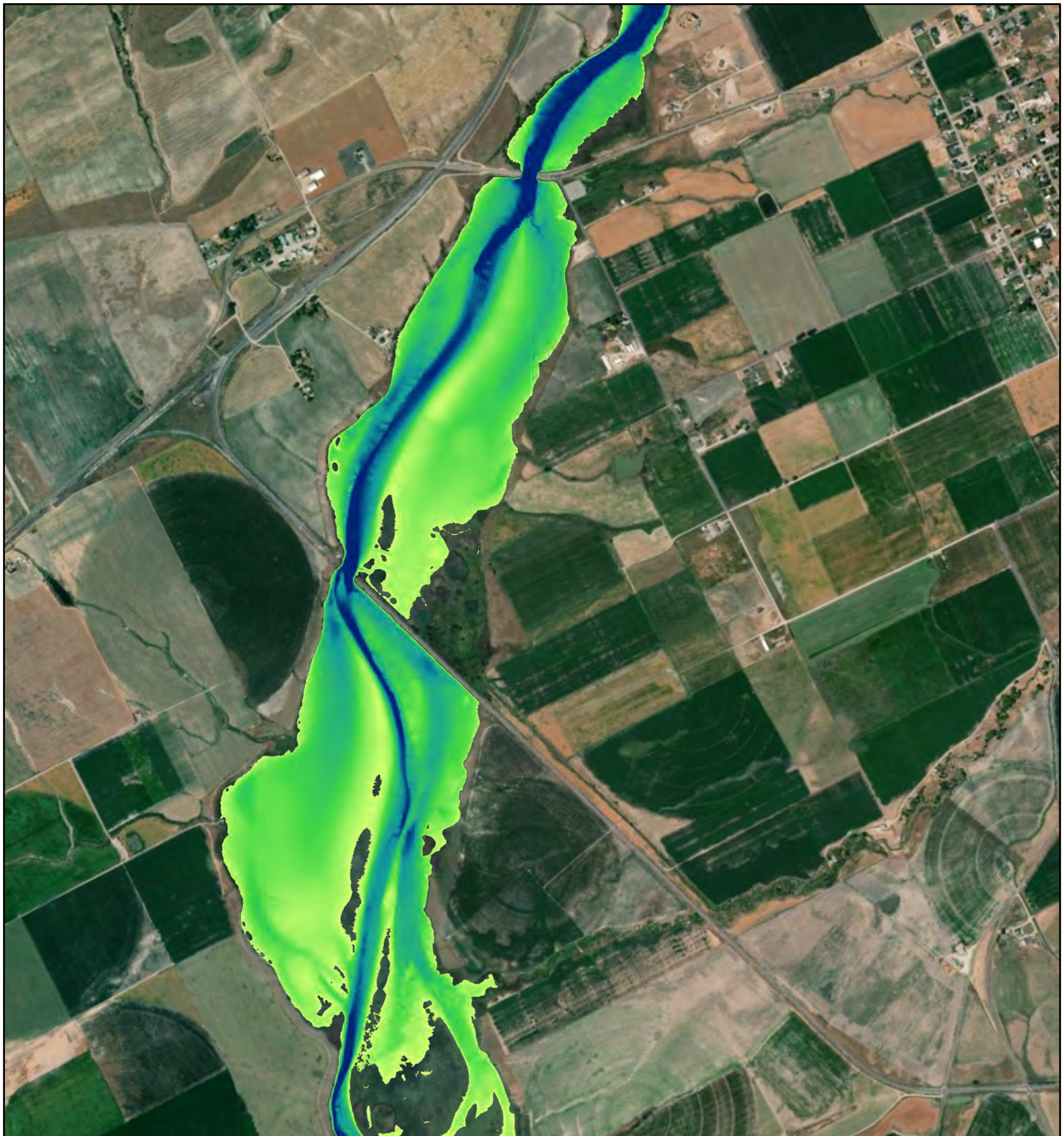
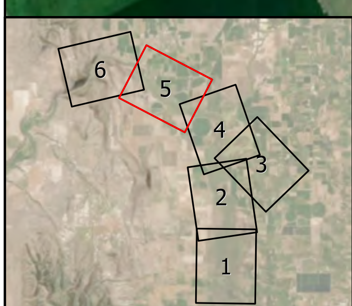
1.0 Ft Proposed Normal Operating Range Depths

Sheet 4 of 6

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP





Minimum Depth (ft)

45

0

Notes

- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.

N

Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983

0 500 1,000 Feet

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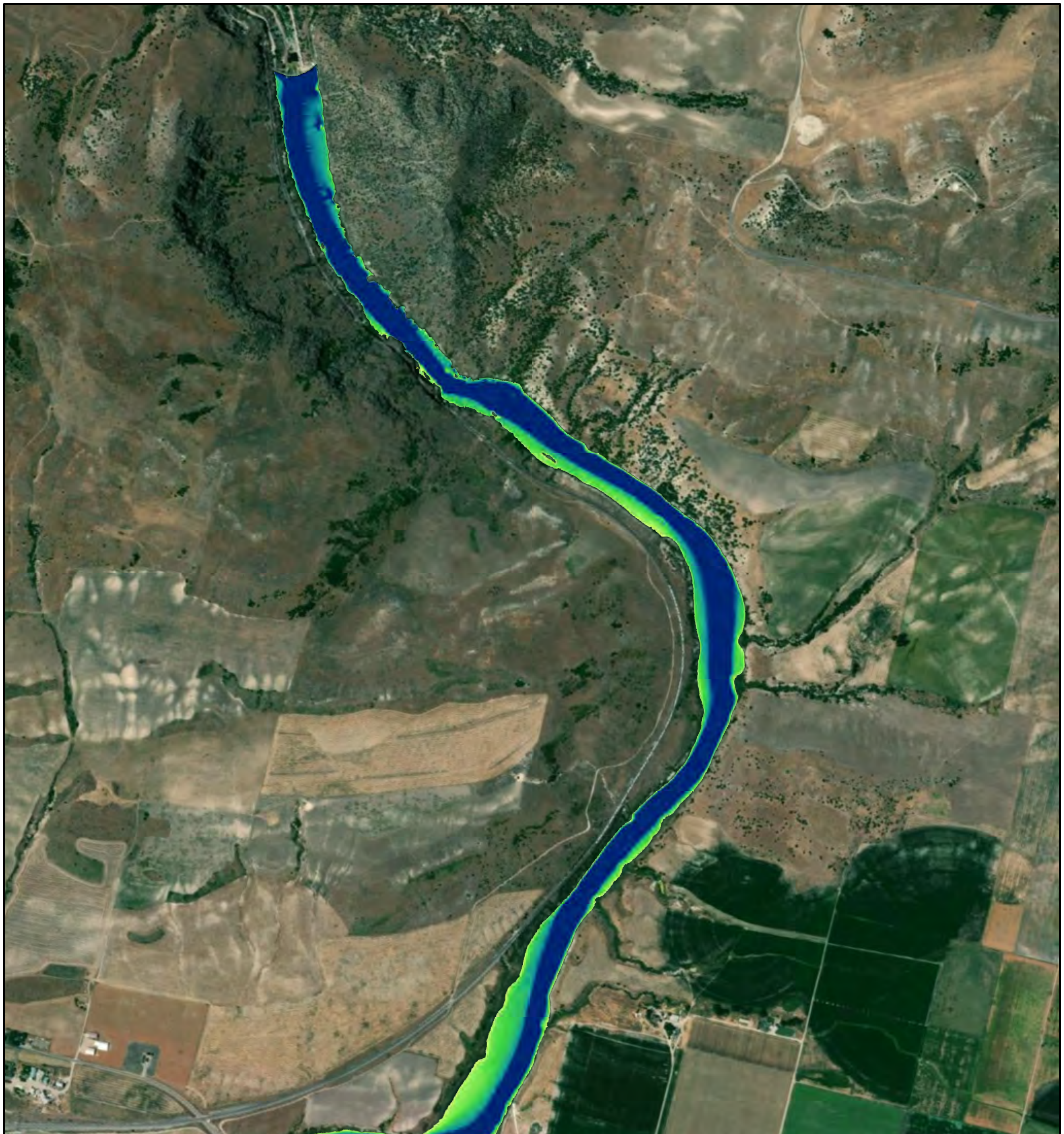
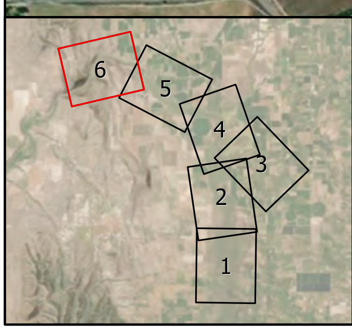
1.0 Ft Proposed Normal Operating Range Depths

Sheet 5 of 6

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP





Minimum Depth (ft)

45

0

Notes

- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.

N

Coordinate System:
NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983

0 500 1,000
Feet

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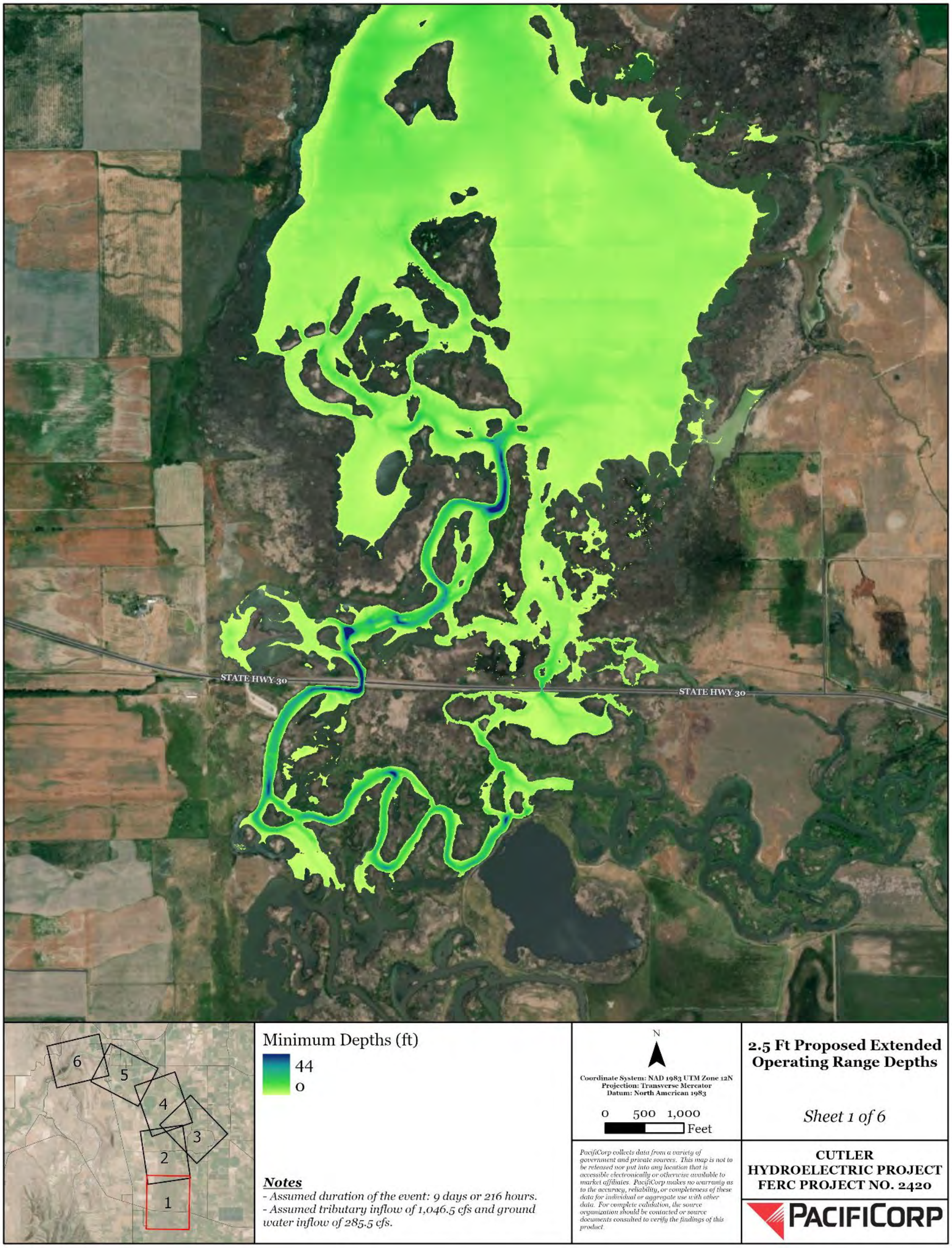
1.0 Ft Proposed Normal Operating Range Depths

Sheet 6 of 6

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP


STATE HWY 30
STATE HWY 30
6
5
4
3
2
1
Minimum Depths (ft)
44
0
Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.
N
Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983
0 500 1,000
Feet
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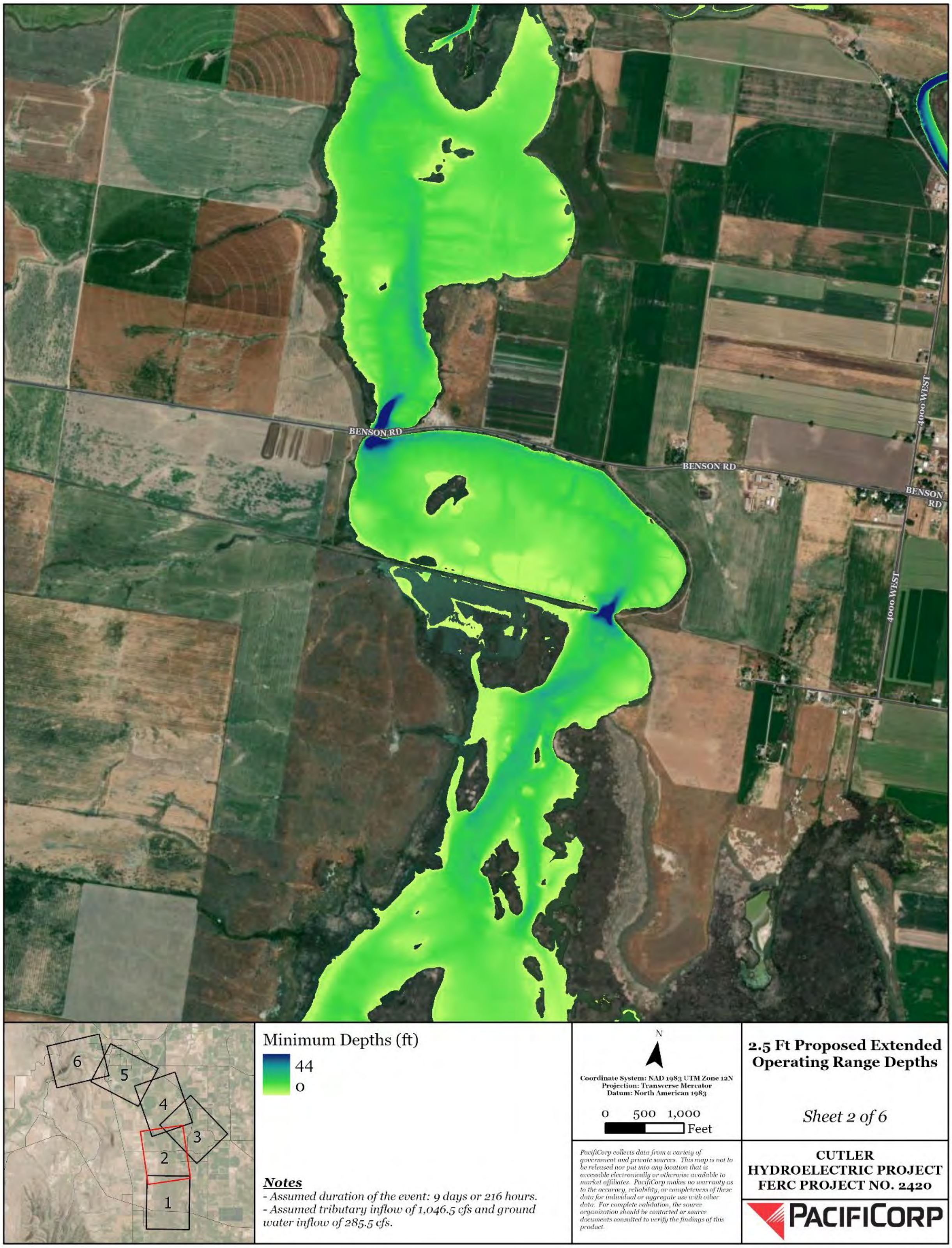
2.5 Ft Proposed Extended Operating Range Depths
Sheet 1 of 6
CUTLER
HYDROELECTRIC PROJECT
FERC PROJECT NO. 2420
PACIFICORP


BENSON RD
BENSON RD
BENSON RD
4000 WEST
4000 WEST
6
5
4
3
2
1
Minimum Depths (ft)
44
0
Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.
N
Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983
0 500 1,000
Feet
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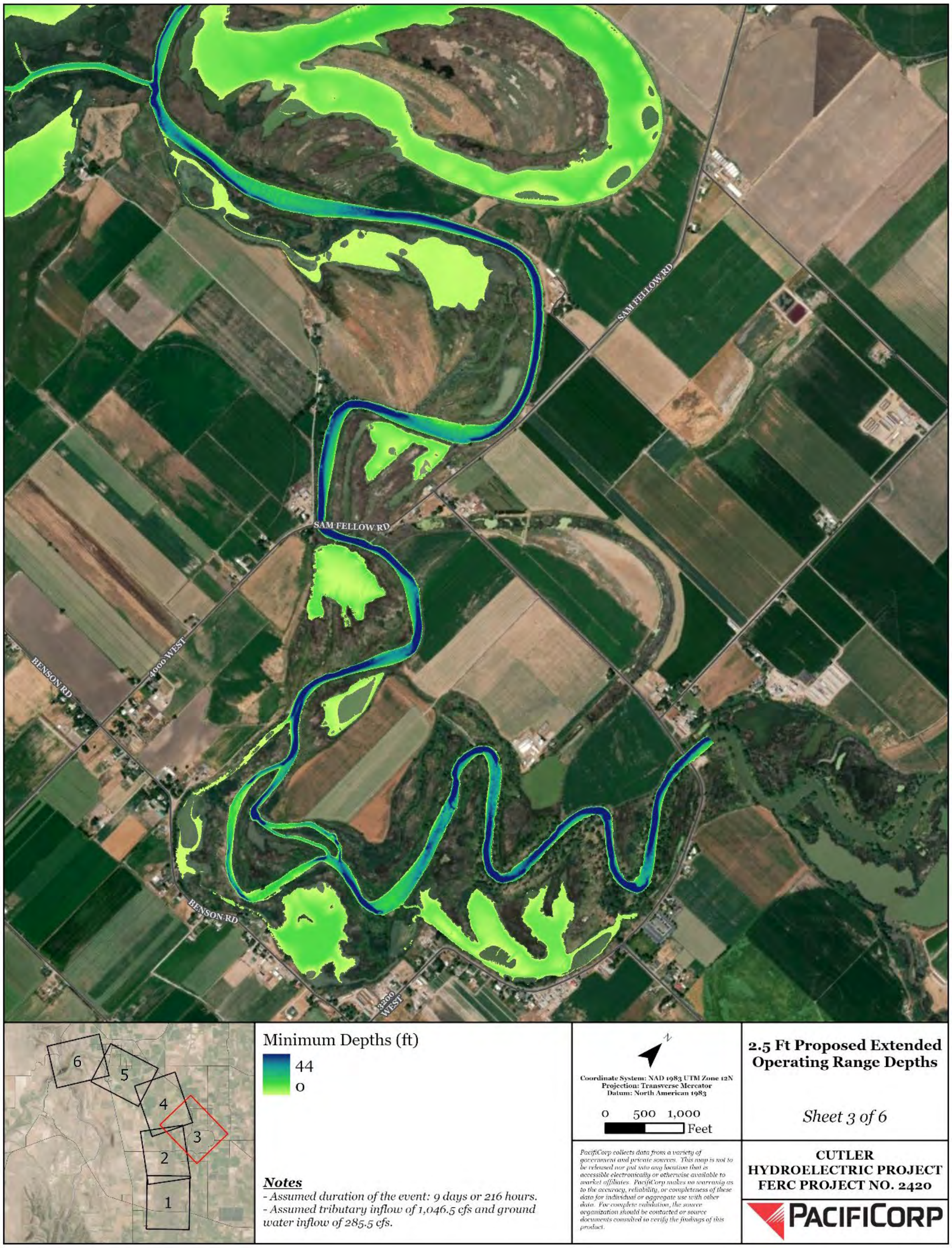
2.5 Ft Proposed Extended Operating Range Depths
Sheet 2 of 6
CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420
PACIFICORP


SAM FELLOW RD
SAM FELLOW RD
4000 WEST
BENSON RD
BENSON RD
3200 WEST
6
5
4
3
2
1
Minimum Depths (ft)
44
0
Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.
N
Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983
0 500 1,000
Feet
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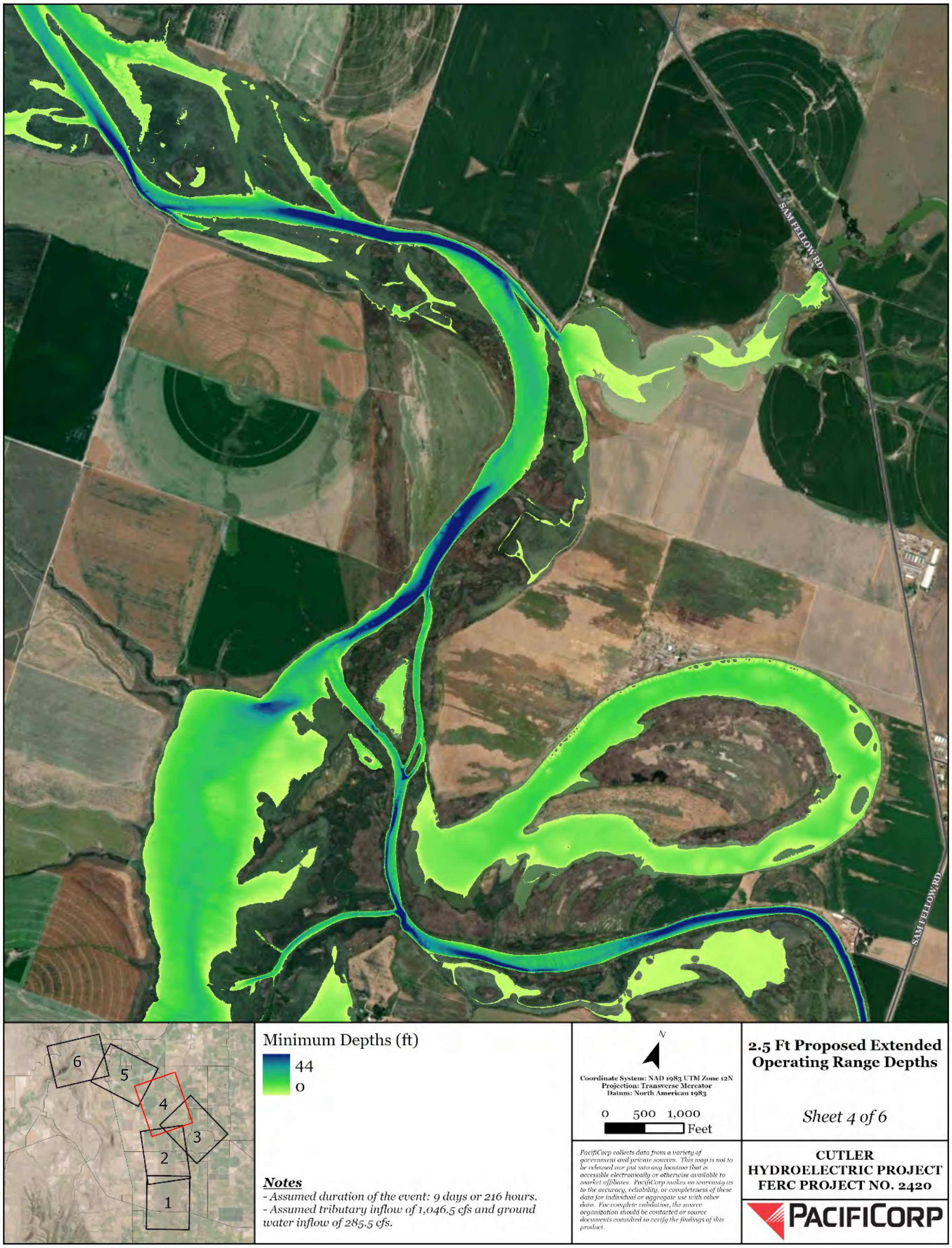
2.5 Ft Proposed Extended Operating Range Depths
Sheet 3 of 6
CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420
PACIFICORP


SAM FELLOW RD
SAM FELLOW RD
6
5
4
3
2
1
Minimum Depths (ft)
44
0
Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.
N
Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983
0 500 1,000
Feet
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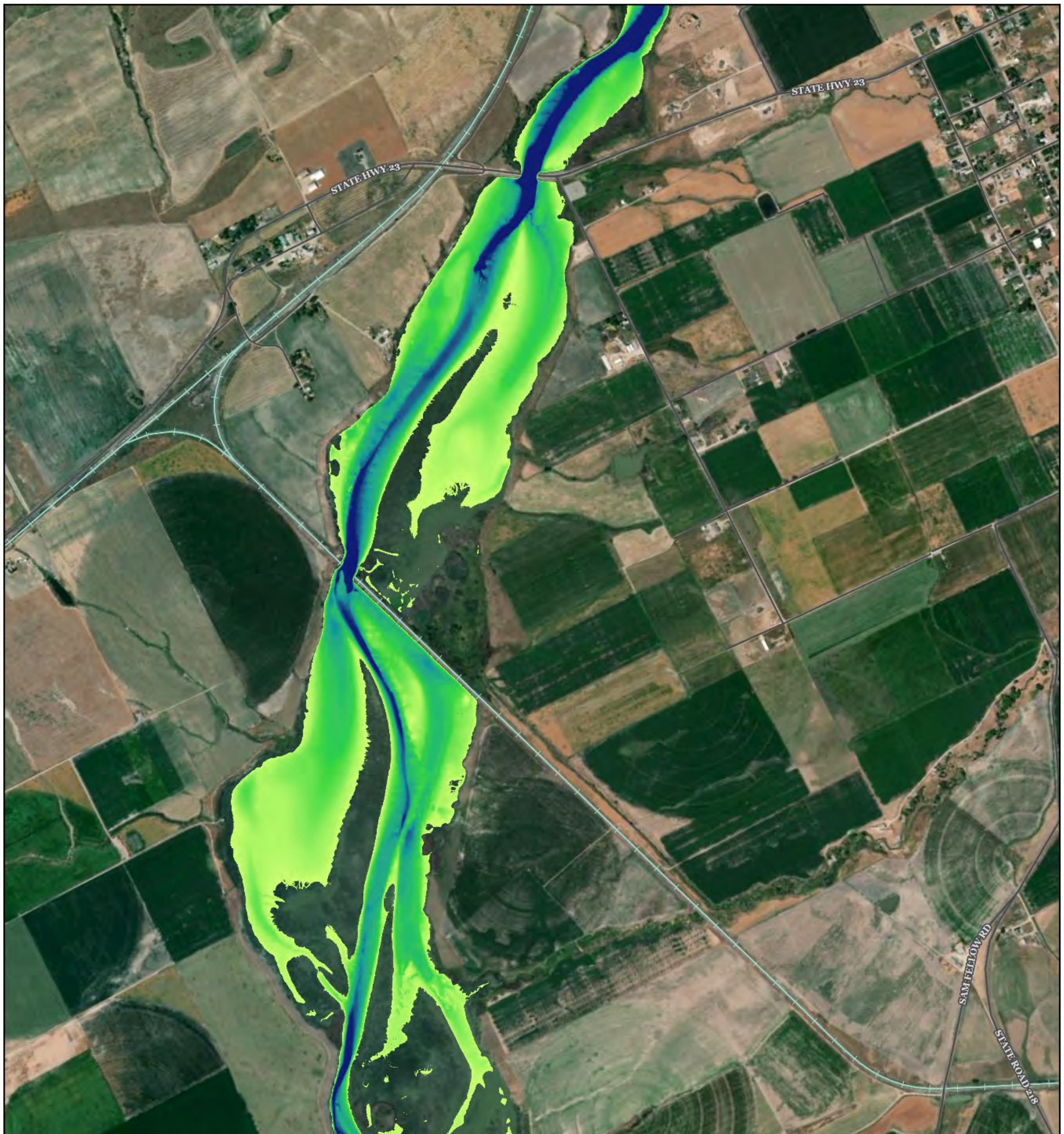
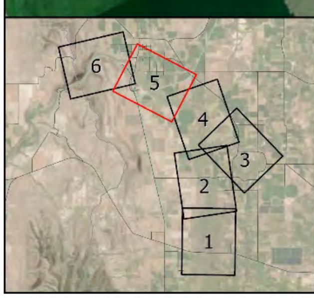
2.5 Ft Proposed Extended Operating Range Depths
Sheet 4 of 6
CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420
PACIFICORP





Minimum Depths (ft)
44
0

Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.

N

Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983

0 500 1,000
Feet

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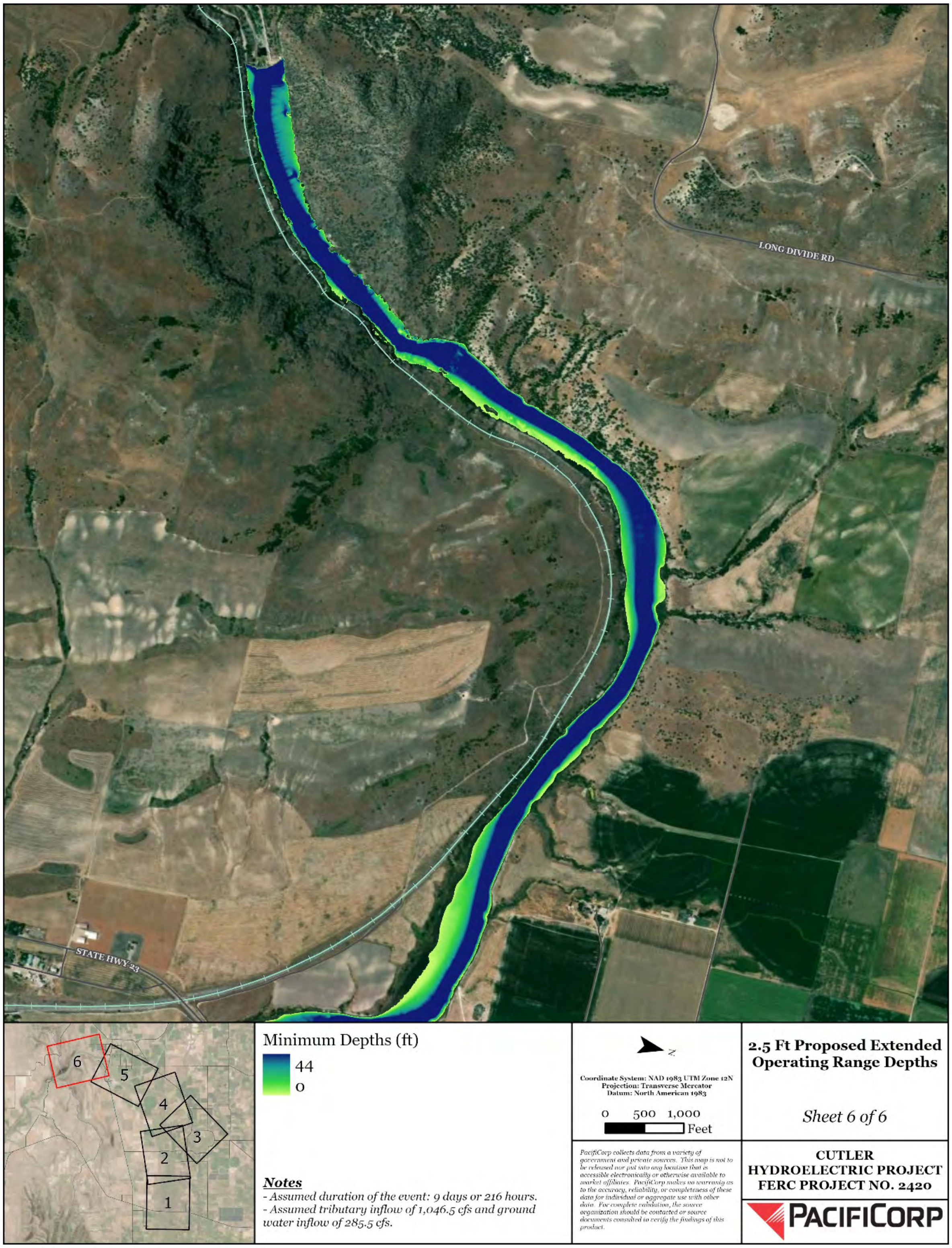
2.5 Ft Proposed Extended Operating Range Depths

Sheet 5 of 6

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP



Notes
- *Assumed duration of the event: 9 days or 216 hours.*
- *Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.*

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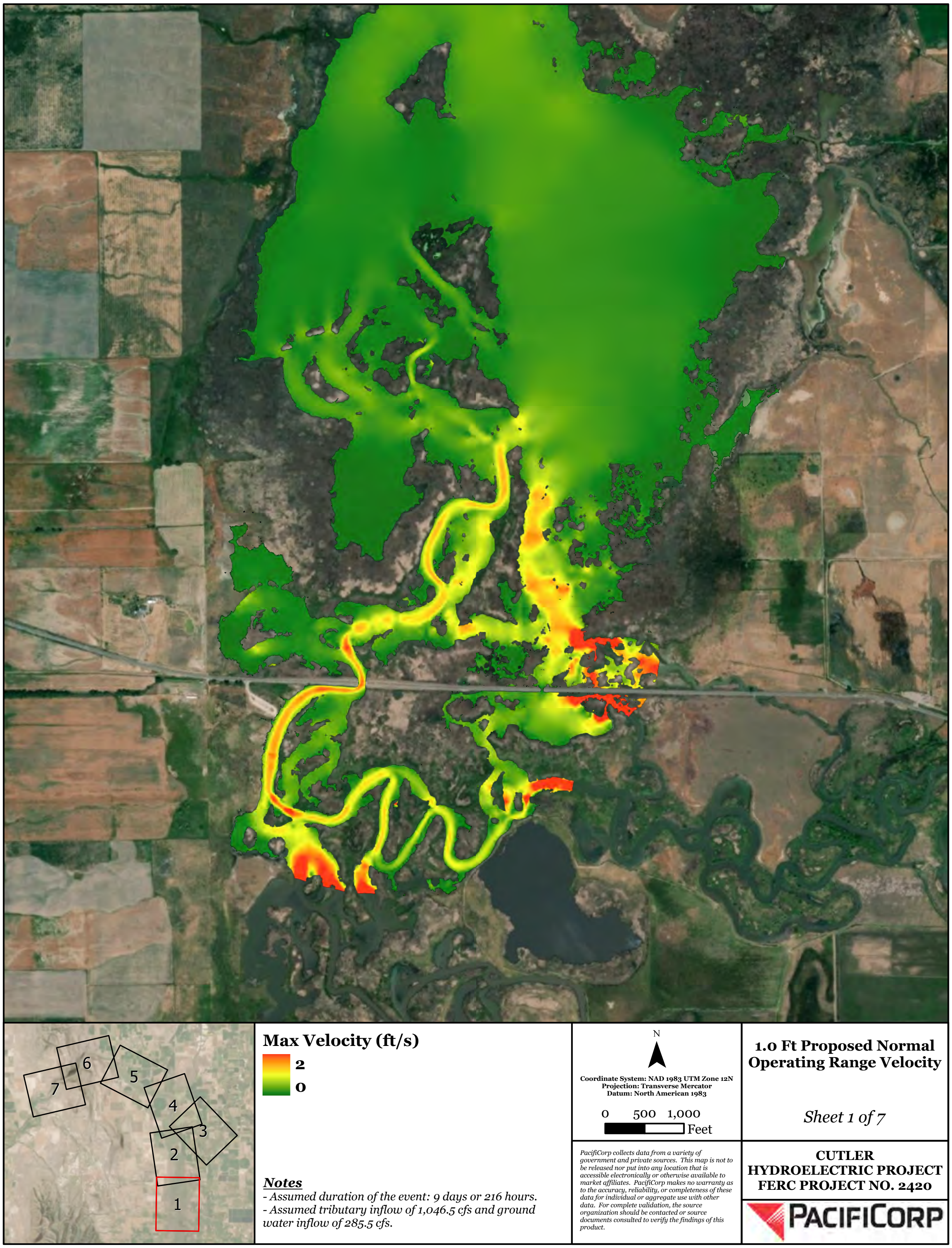
ATTACHMENT G-15

1 FT AND 2.5 FT OPERATION SCENARIOS – VELOCITY AT MAX DRAWDOWN



Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.

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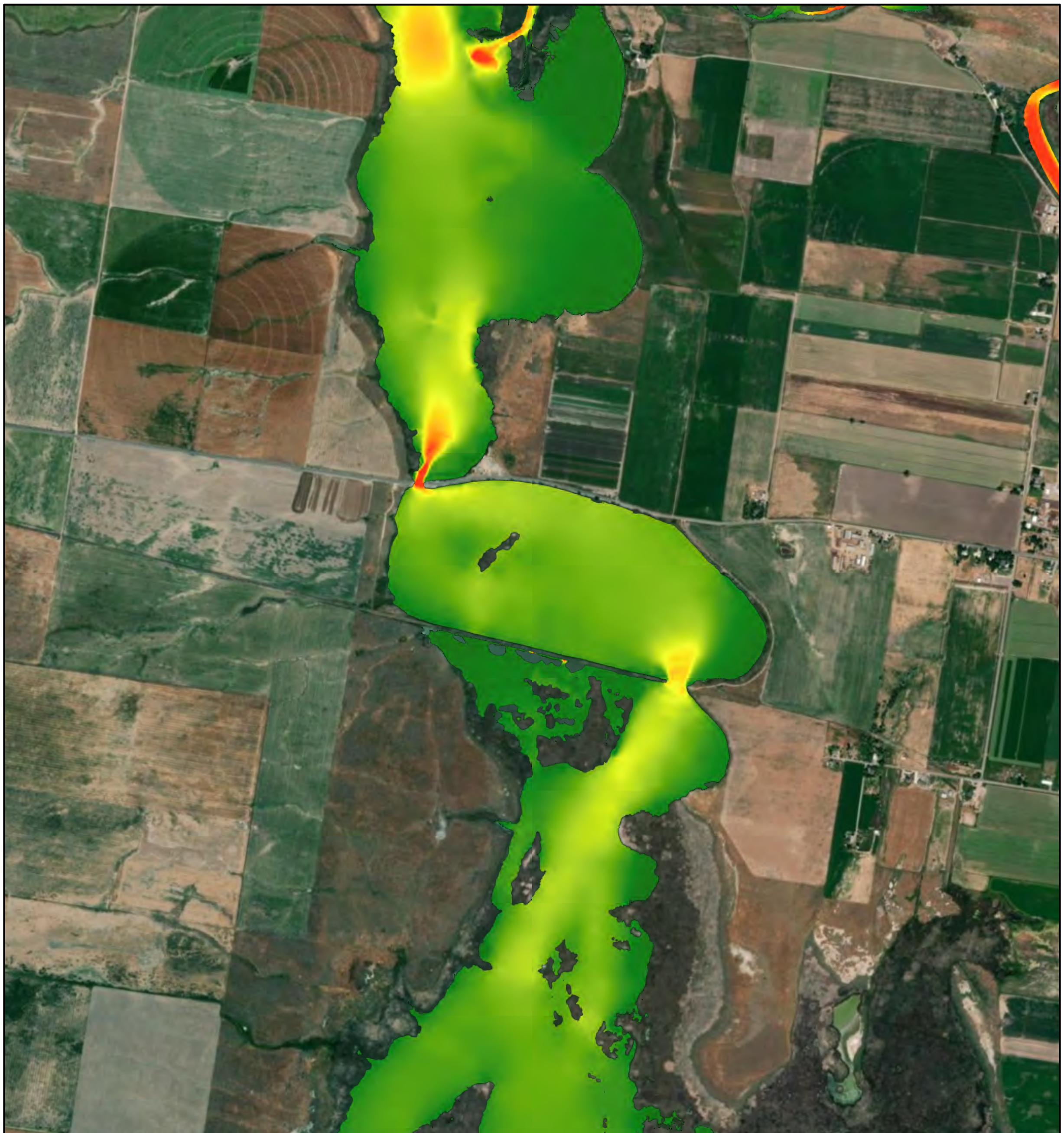

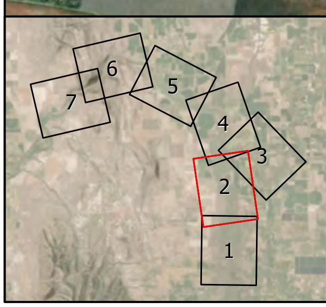

Max Velocity (ft/s)

2

0

Notes

- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.

N

Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983

0 500 1,000
Feet

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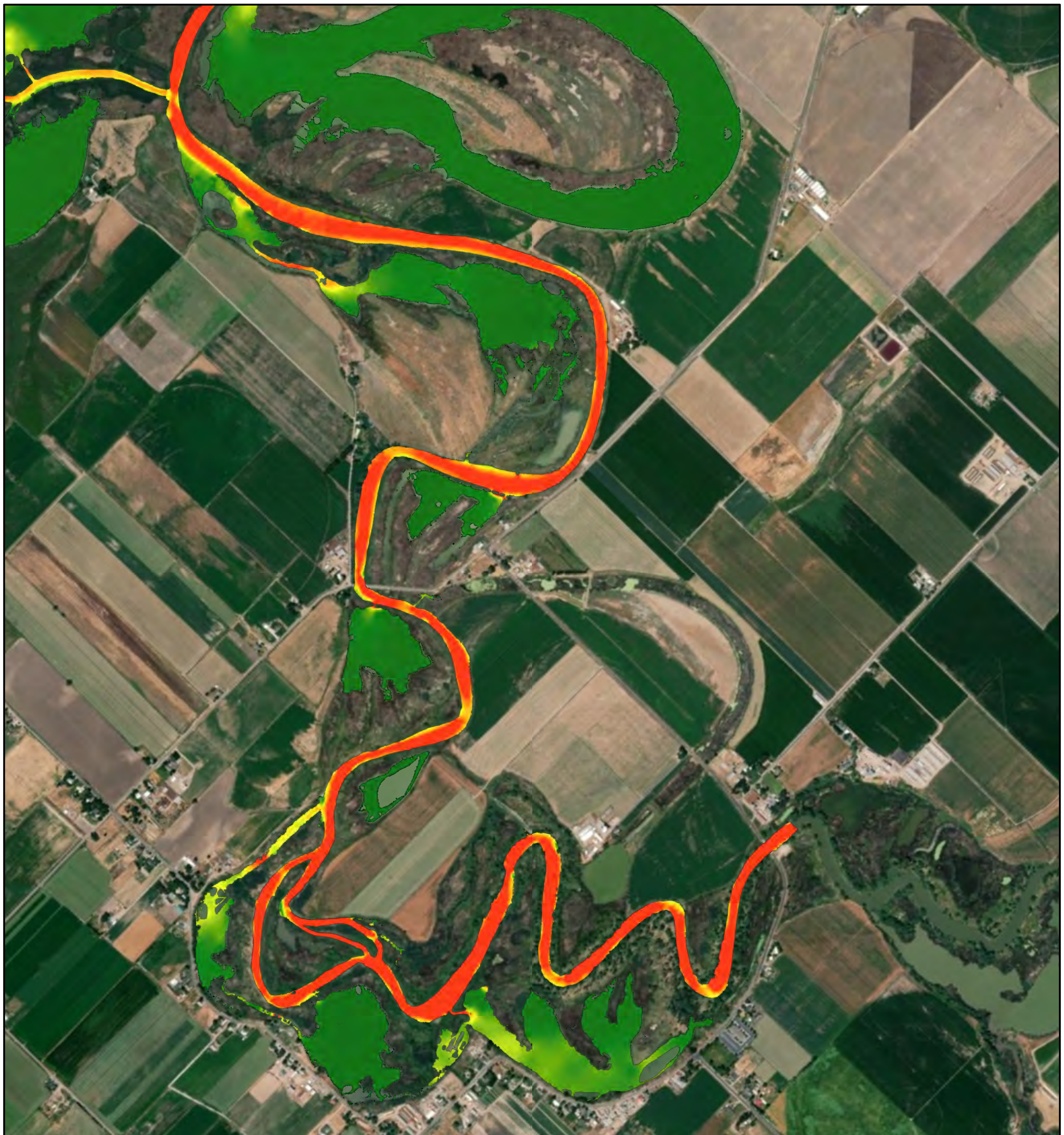
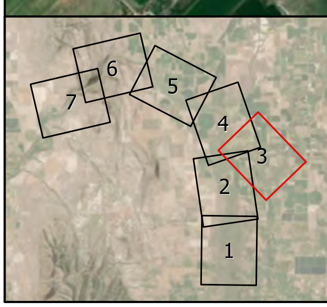
1.0 Ft Proposed Normal Operating Range Velocity

Sheet 2 of 7

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP





Max Velocity (ft/s)

2

0

Notes

- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.

N

Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983

0 500 1,000
Feet

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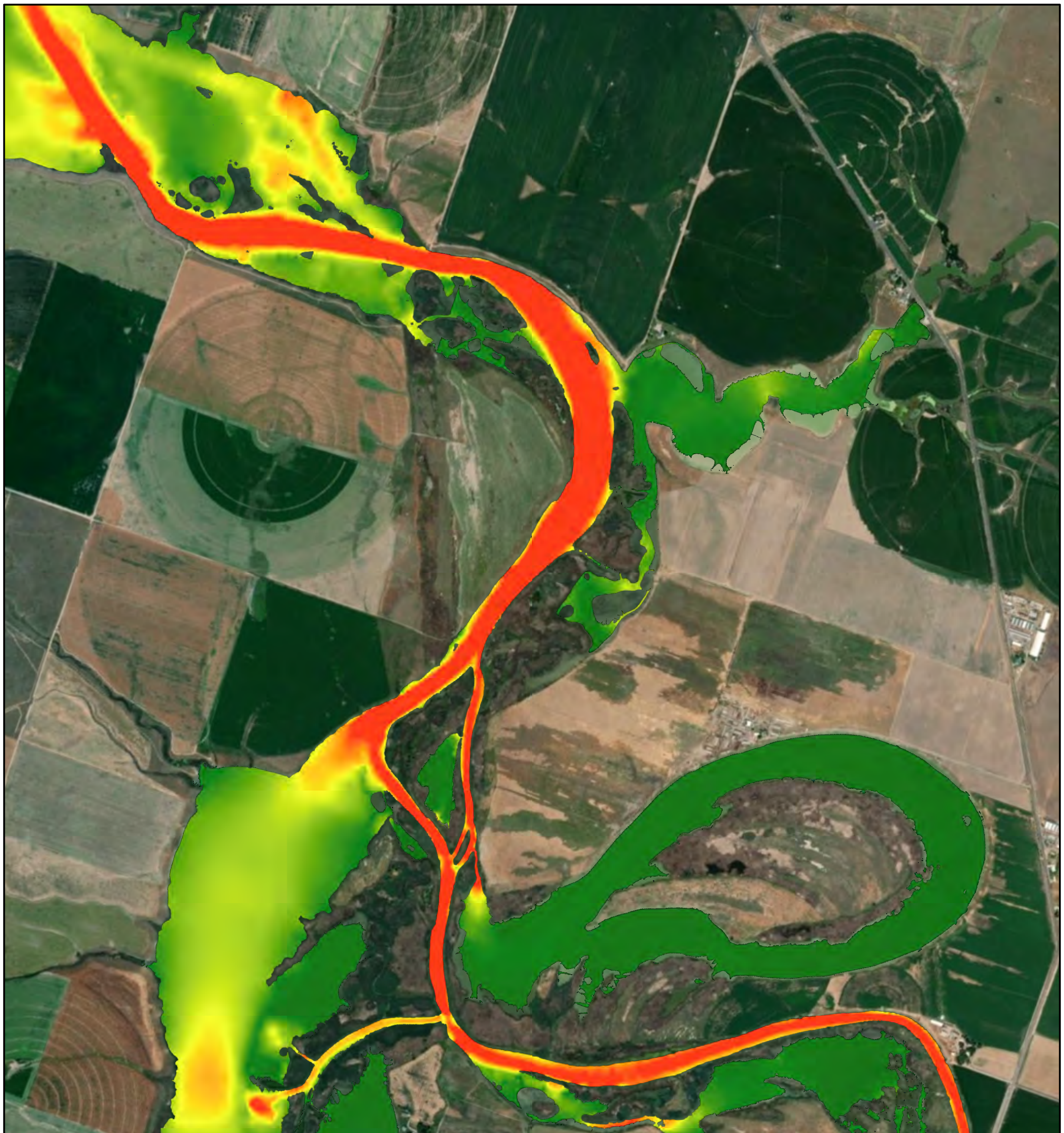
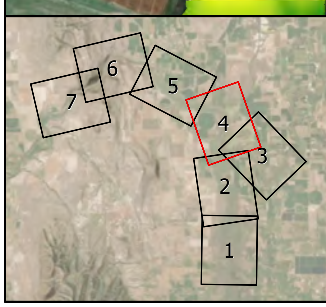
1.0 Ft Proposed Normal Operating Range Velocity

Sheet 3 of 7

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP





Max Velocity (ft/s)

2

0

Notes

- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.

N

Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983

0 500 1,000
Feet

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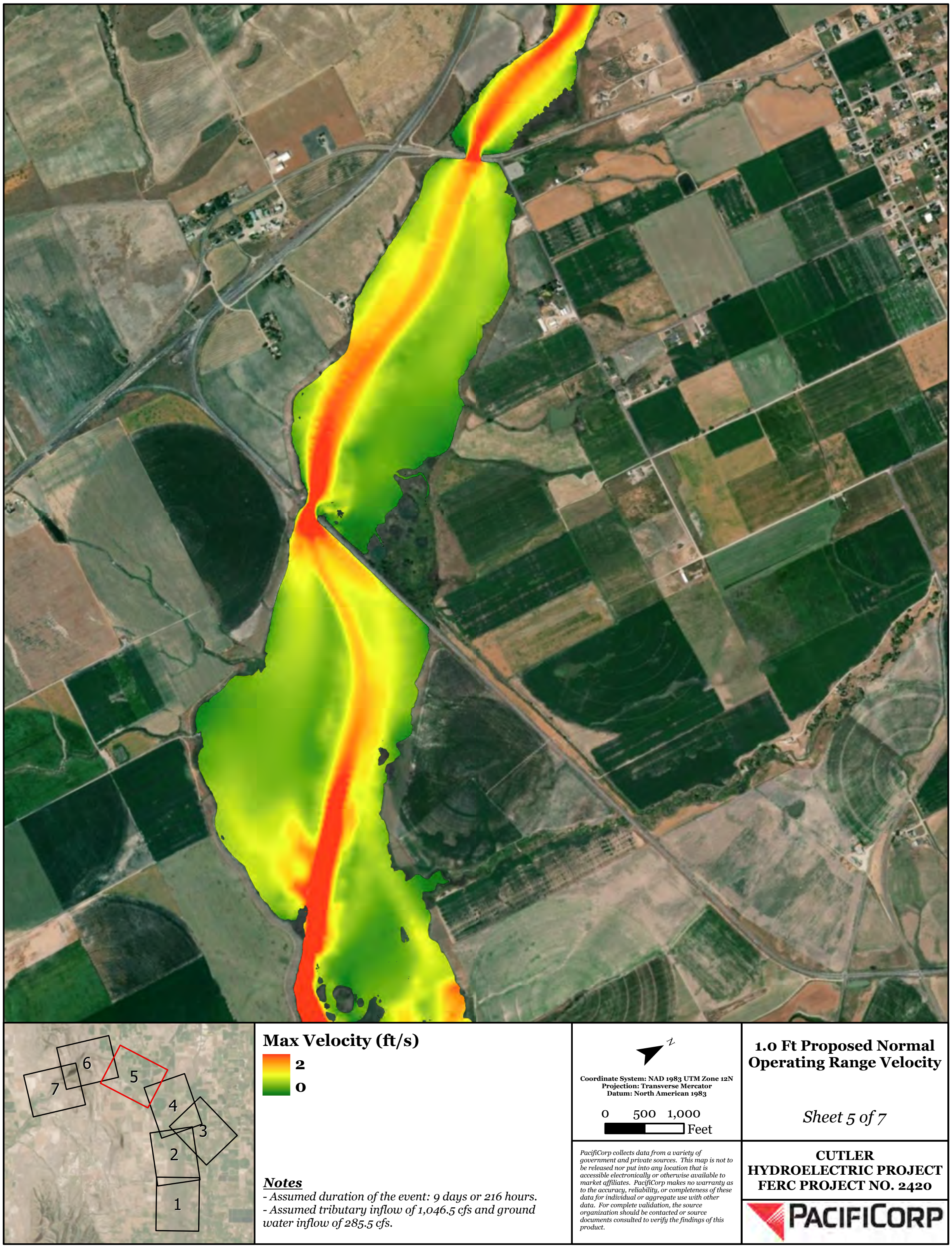
1.0 Ft Proposed Normal Operating Range Velocity

Sheet 4 of 7

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP



Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.

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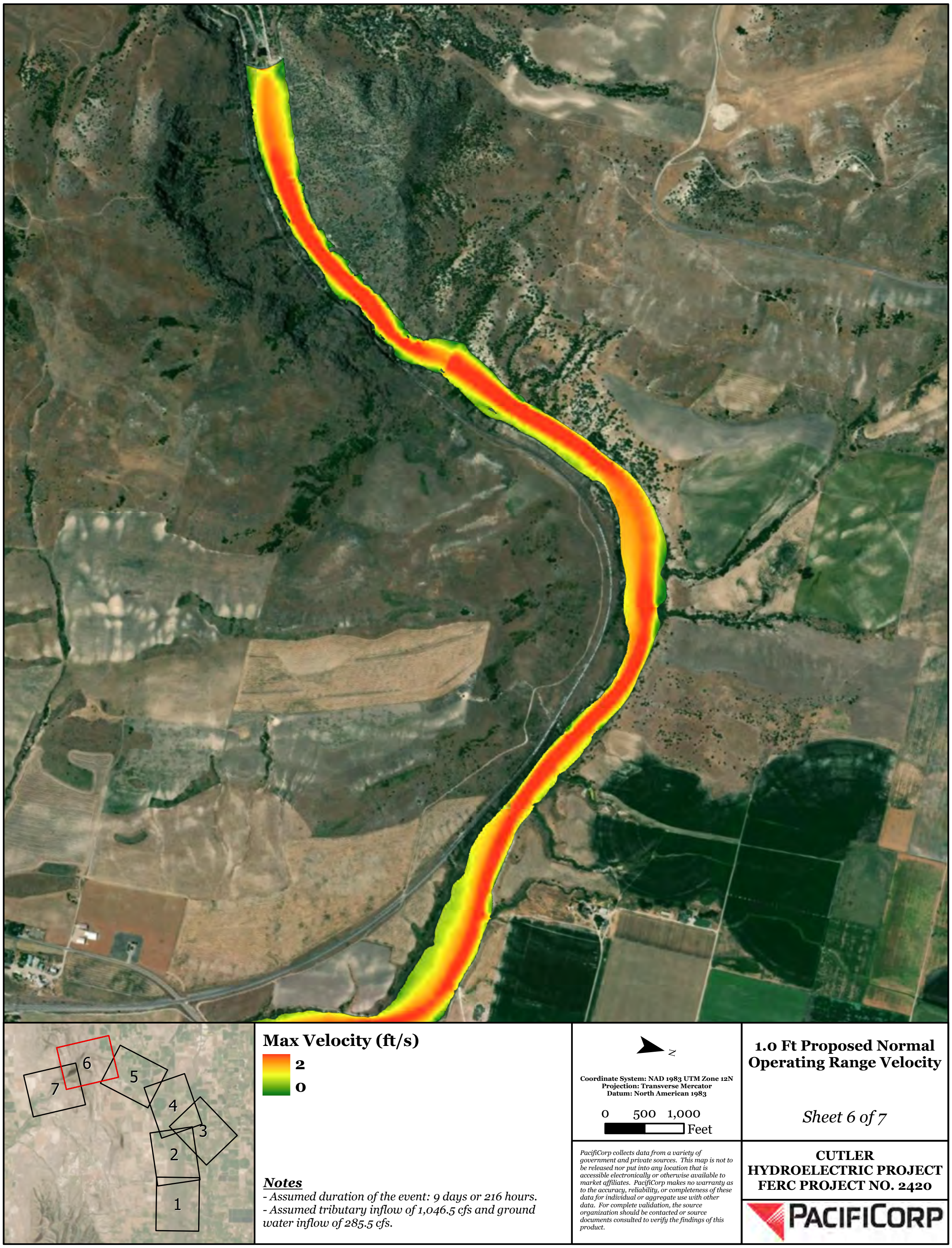
7
6
5
4
3
2
1
Max Velocity (ft/s)
2
0
Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.
N
Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983
0 500 1,000
Feet
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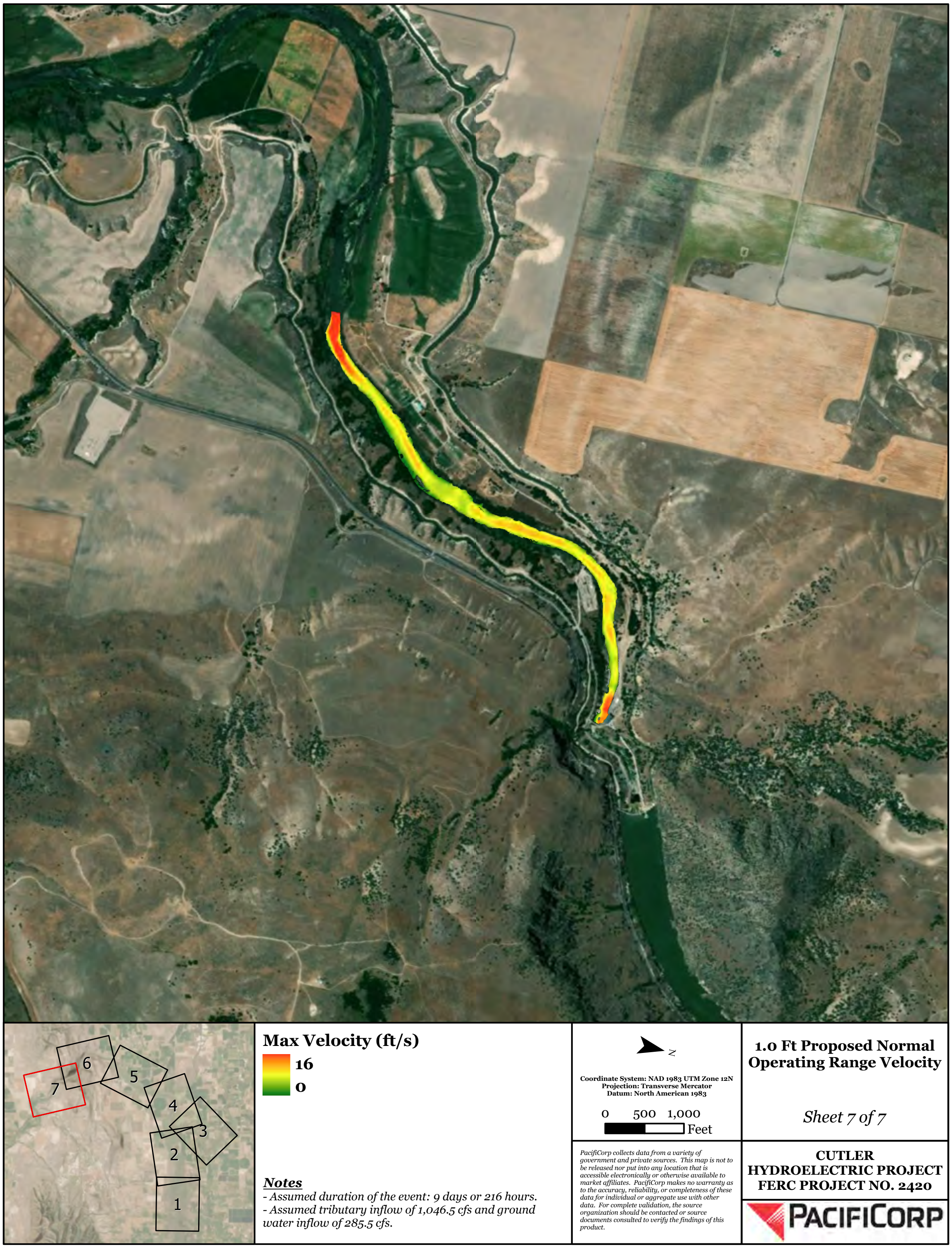
1.0 Ft Proposed Normal Operating Range Velocity
Sheet 6 of 7
CUTLER HYDROELECTRIC PROJECT
FERC PROJECT NO. 2420
PACIFICORP


6
5
7
4
3
2
1
Max Velocity (ft/s)
16
0
Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.
N
Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983
0 500 1,000
Feet
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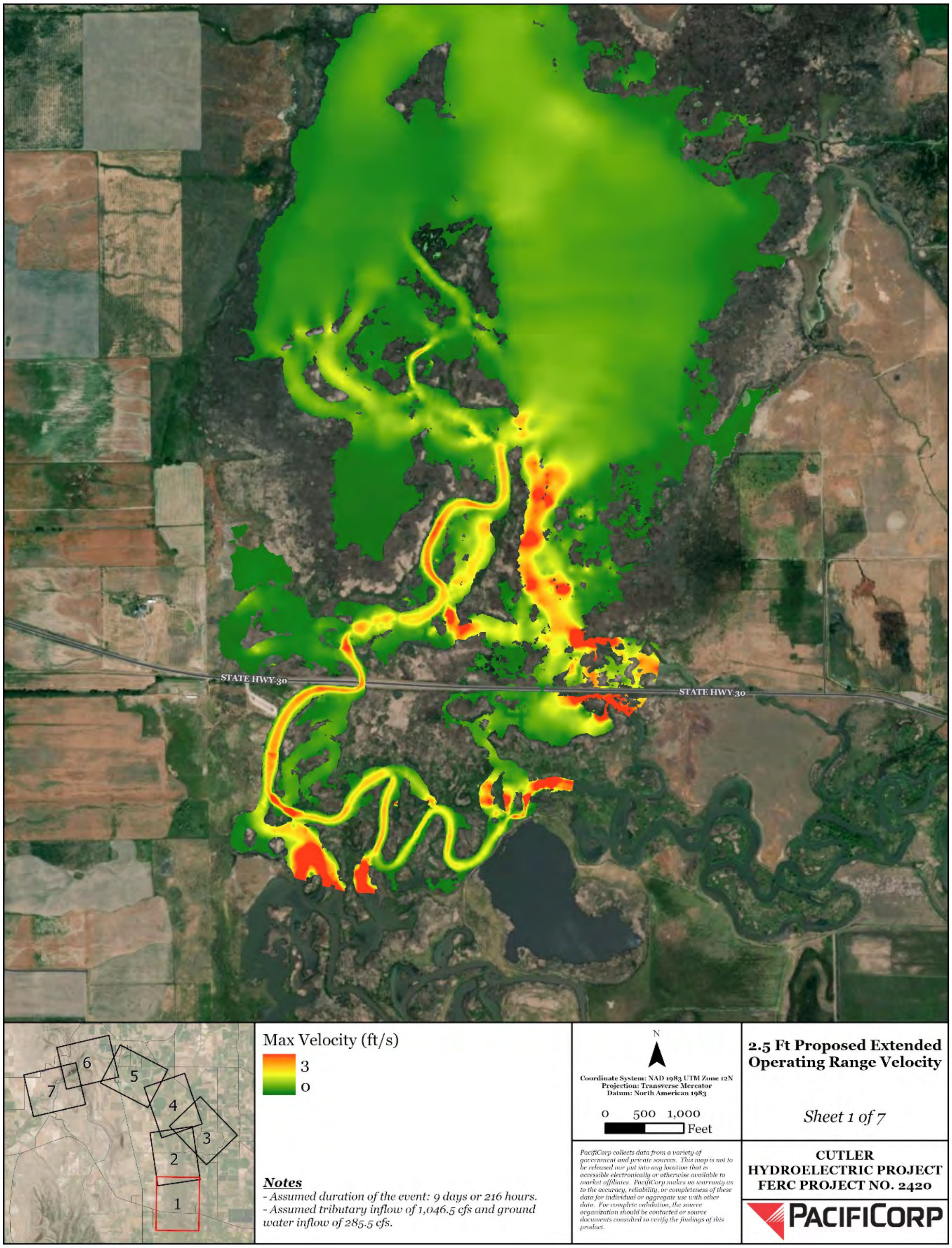
1.0 Ft Proposed Normal Operating Range Velocity
Sheet 7 of 7
CUTLER HYDROELECTRIC PROJECT
FERC PROJECT NO. 2420
PACIFICORP


STATE HWY 30
STATE HWY 30
7
6
5
4
3
2
1
Max Velocity (ft/s)
3
0
Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.
N
Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983
0 500 1,000
Feet
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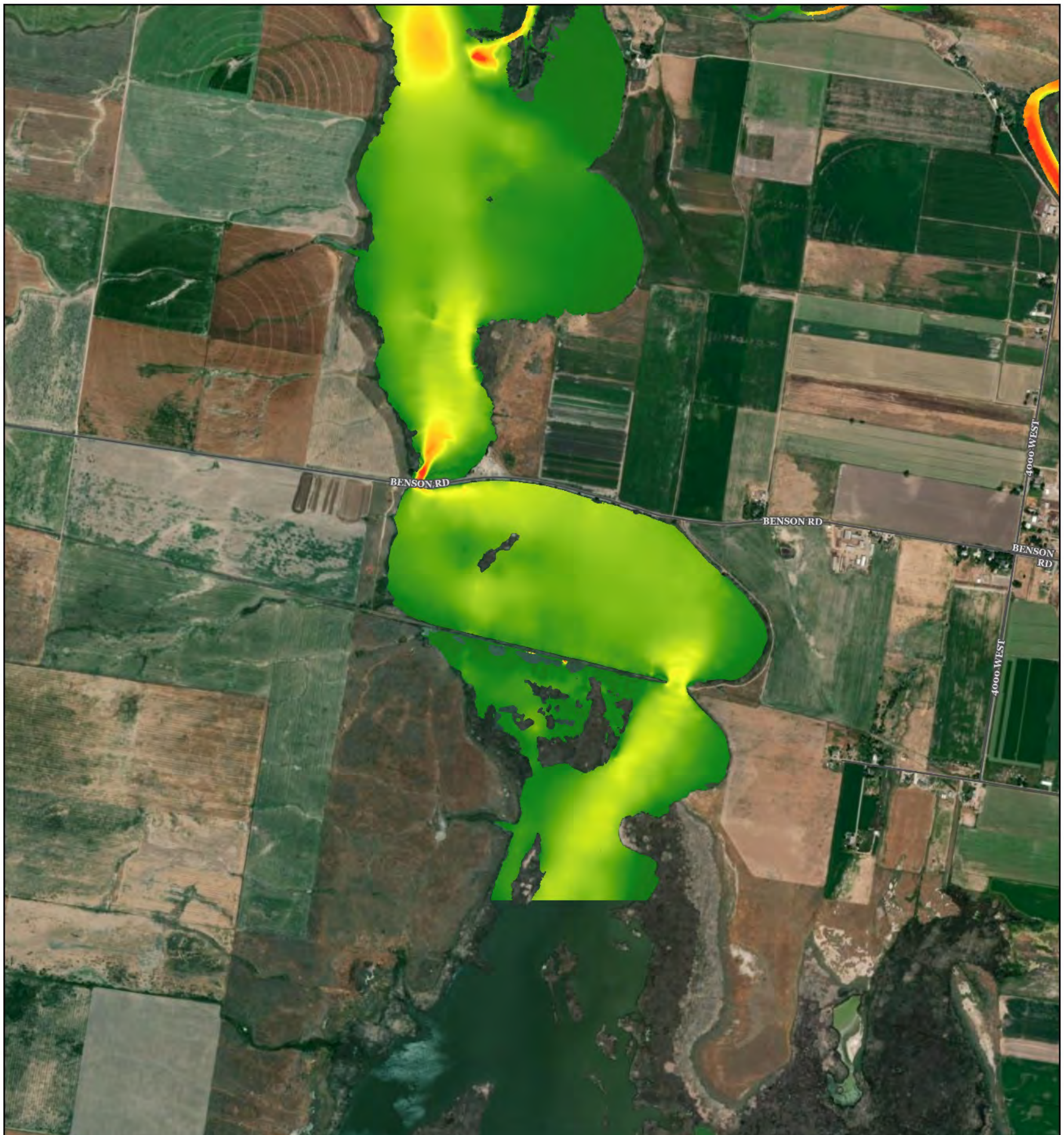
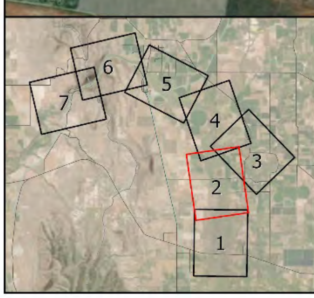
2.5 Ft Proposed Extended Operating Range Velocity
Sheet 1 of 7
CUTLER
HYDROELECTRIC PROJECT
FERC PROJECT NO. 2420
PACIFICORP





Max Velocity (ft/s)

3

0

Notes

- Assumed duration of the event: 9 days or 216 hours.

- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.

N

Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983

0 500 1,000 Feet

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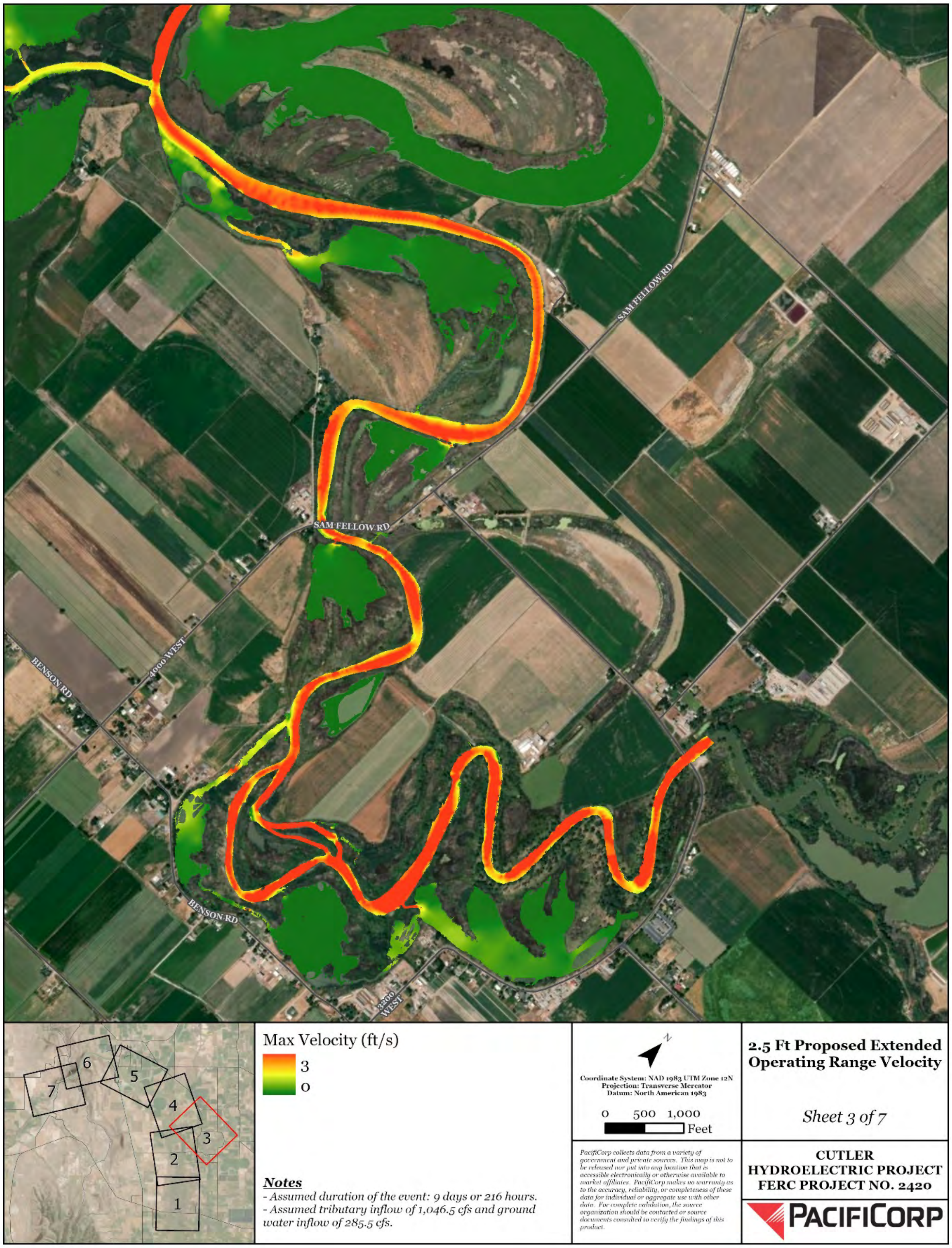
2.5 Ft Proposed Extended Operating Range Velocity

Sheet 2 of 7

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP


SAM FELLOW RD
SAM FELLOW RD
BENSON RD
4000 WEST
BENSON RD
3200 WEST
7
6
5
4
3
2
1
Max Velocity (ft/s)
3
0
Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.
N
Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983
0 500 1,000
Feet
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2.5 Ft Proposed Extended Operating Range Velocity
Sheet 3 of 7
CUTLER
HYDROELECTRIC PROJECT
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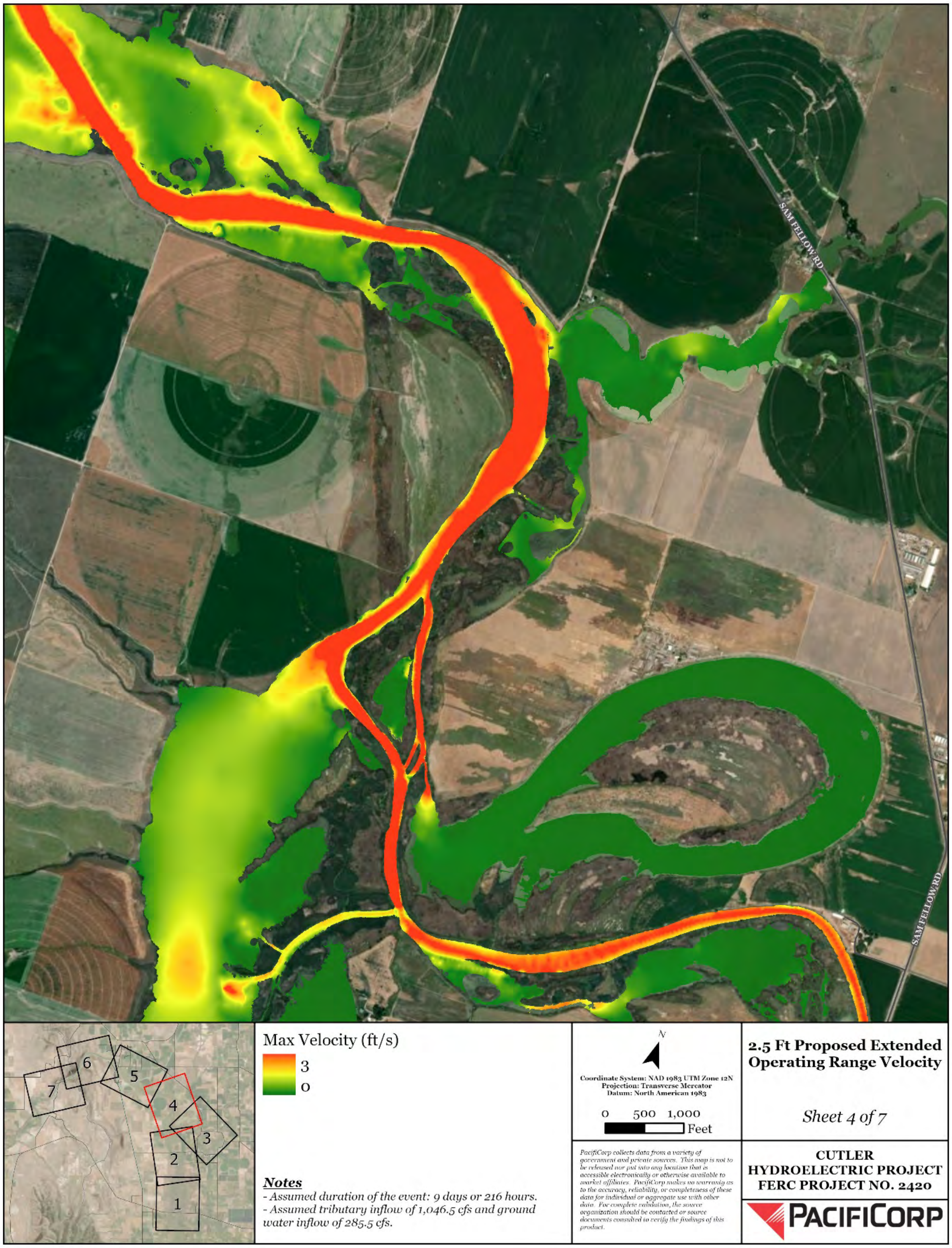

Notes
- *Assumed duration of the event: 9 days or 216 hours.*
- *Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.*

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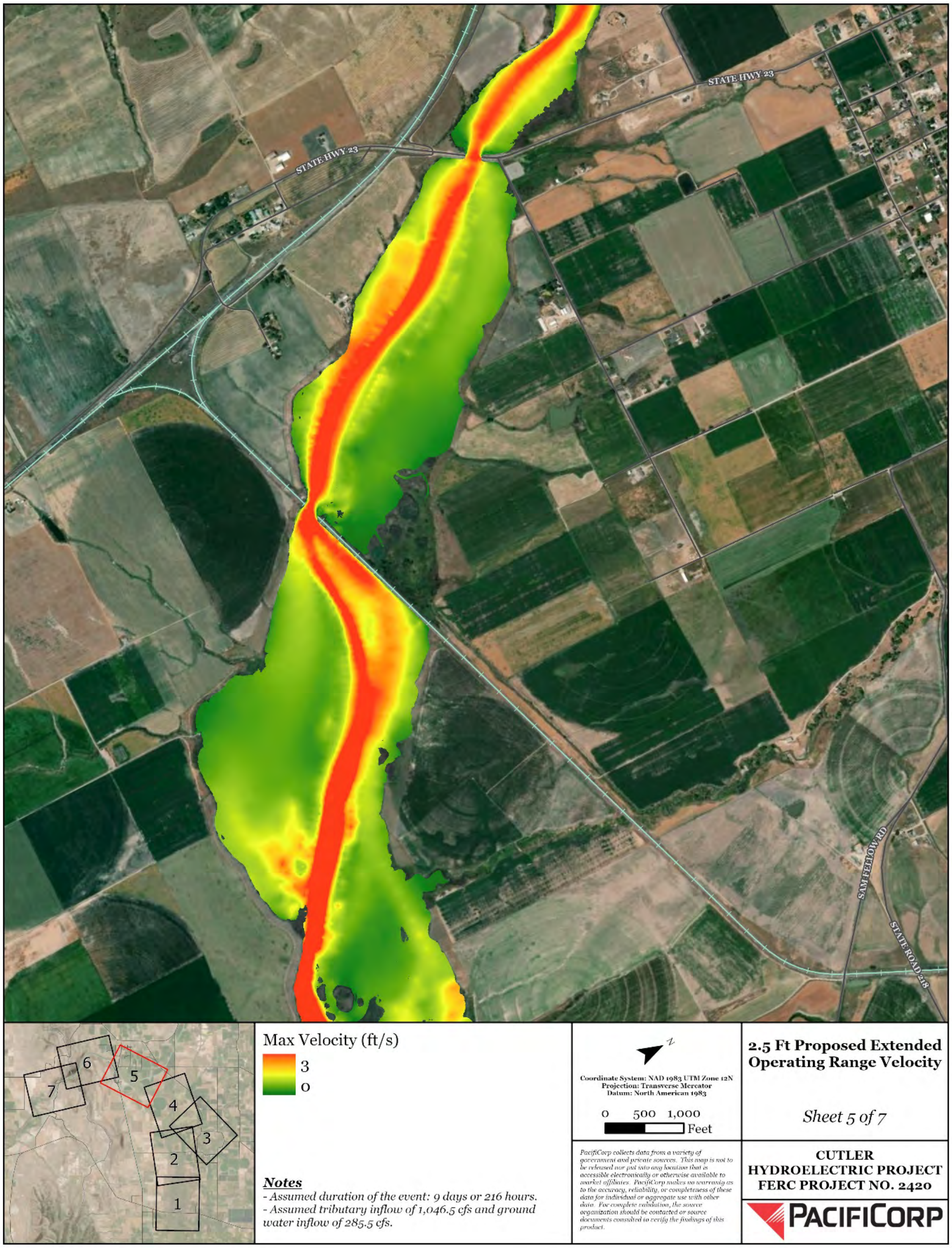
STATE HWY 23
STATE HWY 23
SAM FELLOW RD
STATE ROAD 218
6
5
7
4
3
2
1
Max Velocity (ft/s)
3
0
Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.
N
Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983
0 500 1,000
Feet
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2.5 Ft Proposed Extended Operating Range Velocity
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CUTLER HYDROELECTRIC PROJECT
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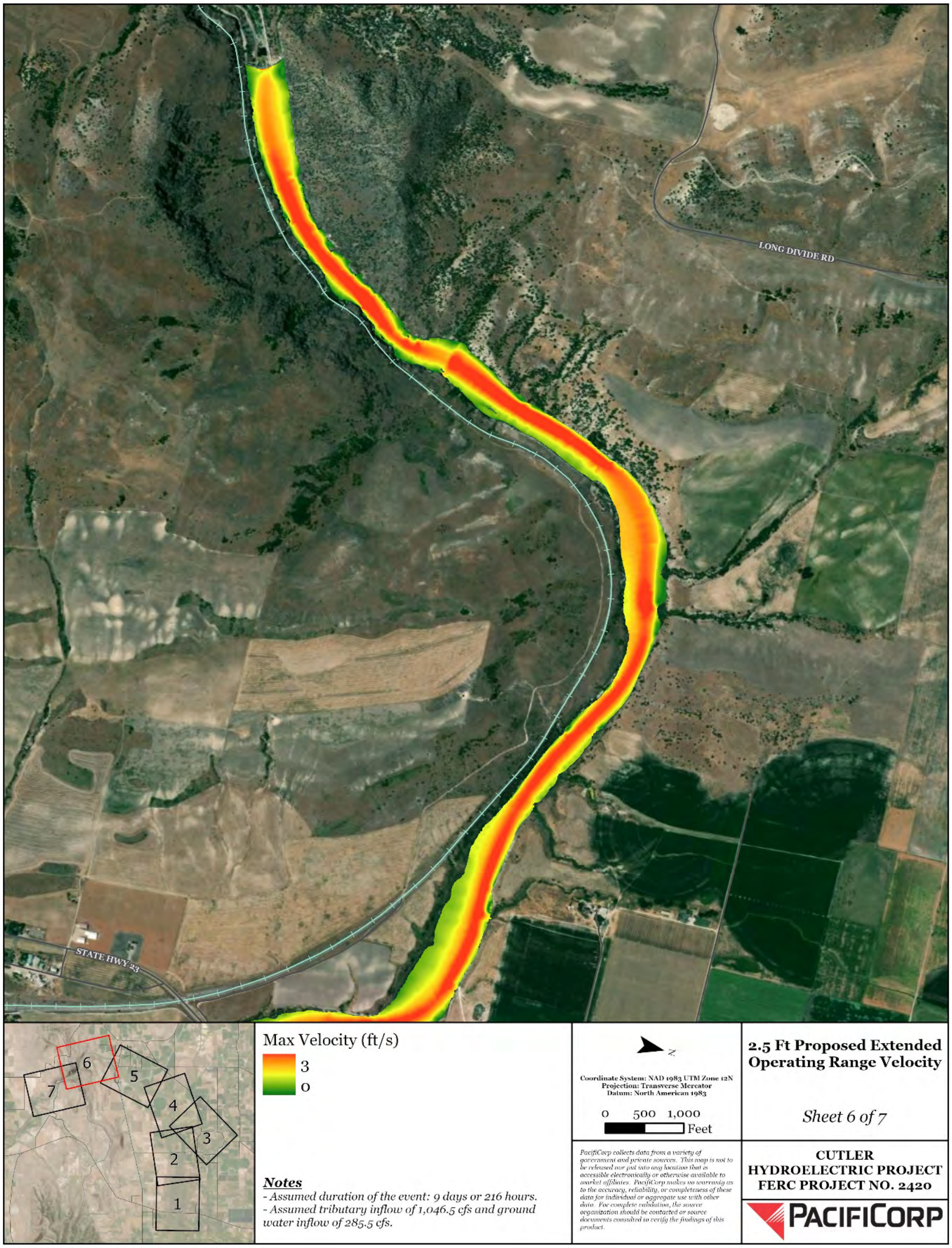
LONG DIVIDE RD
STATE HWY 23
6
5
7
4
3
2
1
Max Velocity (ft/s)
3
0
Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.
N
Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983
0 500 1,000
Feet
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2.5 Ft Proposed Extended Operating Range Velocity
Sheet 6 of 7
CUTLER
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PACIFICORP


W 18000 N
LONG DIVIDE RD
LONG DIVIDE RD
6
5
7
4
3
2
1
Max Velocity (ft/s)
12
0
Notes
- Assumed duration of the event: 9 days or 216 hours.
- Assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.
N
Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983
0 500 1,000
Feet
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2.5 Ft Proposed Extended Operating Range Velocity
Sheet 7 of 7
CUTLER
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ATTACHMENT G-16

1D SEDIMENT TRANSPORT PARAMETER SENSITIVITY ANALYSIS

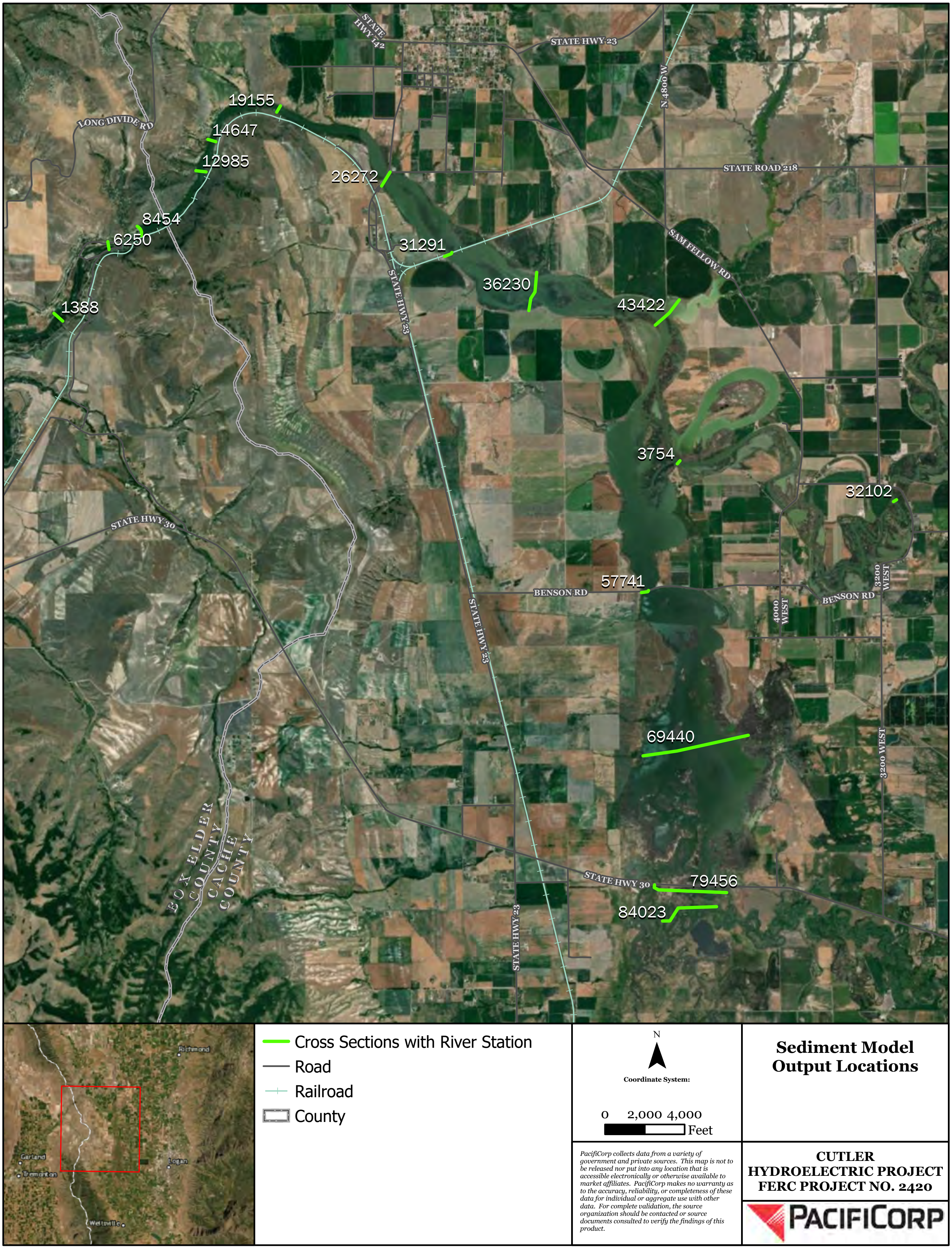
Transport Parameter Sensativity Group	Transport Function	Sorting Method	Fall Velocity Method
1	Ackers-White	Thomas (Ex5)	Ruby
2	Toffaleti	Copeland (Ex7)	Dietrich

Sediment Transport Paramteter Sensativity Group 1								
XS ID	Location	Existing Operational Range (4407.5 – 4406.5 ft NGVD29)		Proposed Operational Range (4407.5 – 4405.0 ft NGVD29)		Difference		
		Final Bed Elevation (ft)	Avg TSS (Tons/Day)	Final Bed Elevation (ft)	Avg TSS (Tons/Day)	Final Bed Elevation (ft)	Avg TSS (Tons/Day)	Peak TSS Concentration
1388	Bear River DS Cutler	4266.1	19.9	4266.1	19.0	-0.02	-0.9	-5%
6250	Bear River DS Cutler	4271.8	6.7	4271.7	9.8	-0.04	3.1	46%
8454	Cutler Dam	4370.0	495.0	4370.1	3086.7	0.06	2591.8	524%
12985	Cutler Caynon	4389.9	542.7	4390.0	3328.4	0.06	2785.7	513%
14647	Cutler Caynon	4390.8	546.8	4389.2	3255.7	-1.67	2708.9	495%
19155	Cutler Caynon	4392.5	536.0	4392.6	3142.1	0.06	2606.1	486%
26272	US Cache Junction	4388.8	556.8	4388.8	2755.1	0.04	2198.3	395%
31291	US Rail Road Bridge	4390.6	535.1	4390.6	2058.4	0.00	1523.3	285%
36230	Cutler Reservoir	4399.5	594.6	4399.5	1859.7	0.00	1265.1	213%
43422	Clay Slough	4401.5	518.7	4401.4	1240.7	-0.02	722.0	139%
3754	Bear River Confluence	4390.3	191.8	4390.3	936.9	0.00	745.1	388%
32102	Bear River Access	4392.9	5.5	4392.9	5.6	0.00	0.1	2%
57741	Benson Marina	4389.9	0.6	4389.9	0.7	0.00	0.1	20%
69440	Cutler Reservoir	4404.4	1.2	4404.4	1.4	0.00	0.2	20%
79456	US Highway 30	4396.7	8.4	4396.7	8.8	0.00	0.3	4%
84023	South Marsh	4403.1	28.5	4403.1	28.6	0.00	0.1	0%

Sediment Transport Paramteter Sensativity Group 2								
XS ID	Location	Existing Operational Range (4407.5 – 4406.5 ft NGVD29)		Proposed Operational Range (4407.5 – 4405.0 ft NGVD29)		Difference		
		Final Bed Elevation (ft)	Avg TSS (Tons/Day)	Final Bed Elevation (ft)	Avg TSS (Tons/Day)	Final Bed Elevation (ft)	Avg TSS (Tons/Day)	% Increase TSS
1388	Bear River DS Cutler	4269.5	14.3	4269.5	13.0	0.00	-1.3	-9%
6250	Bear River DS Cutler	4275.0	7.2	4275.0	6.0	0.00	-1.2	-17%
8454	Cutler Dam	4369.9	64.1	4369.9	136.8	0.00	72.7	113%
12985	Cutler Caynon	4389.2	72.8	4389.2	155.4	0.00	82.7	114%
14647	Cutler Caynon	4390.5	73.0	4390.5	155.9	0.00	82.9	113%
19155	Cutler Caynon	4391.5	81.9	4391.5	179.3	0.00	97.4	119%
26272	US Cache Junction	4388.0	84.1	4388.0	182.0	0.00	97.9	117%
31291	US Rail Road Bridge	4388.3	87.7	4388.3	194.7	0.00	106.9	122%
36230	Cutler Reservoir	4401.3	95.5	4401.3	216.5	0.00	121.0	127%
43422	Clay Slough	4401.6	122.0	4401.6	241.9	0.00	119.9	98%
3754	Bear River Confluence	4391.5	169.3	4391.5	275.5	0.00	106.2	63%
32102	Bear River Access	4394.6	53.2	4394.5	70.2	-0.08	17.1	32%
57741	Benson Marina	4388.0	3.3	4388.0	3.9	0.00	0.6	19%
69440	Cutler Reservoir	4404.3	5.2	4404.3	6.4	0.00	1.2	23%
79456	US Highway 30	4396.4	24.0	4396.4	31.2	0.00	7.2	30%
84023	South Marsh	4403.1	76.8	4403.1	98.7	0.00	21.9	29%

ATTACHMENT G-17

SEDIMENT MODEL OUTPUT LOCATIONS


STATE HWY 142
STATE HWY 23
N 4800 W
LONG DIVIDE RD
STATE ROAD 218
SAM FELLOW RD
STATE HWY 30
BENSON RD
4000 WEST
3200 WEST
BOX ELDER COUNTY
CACHE COUNTY
19155
14647
12985
26272
8454
6250
31291
36230
43422
1388
3754
32102
57741
69440
79456
84023
Cross Sections with River Station
Road
Railroad
County
N
Coordinate System:
0 2,000 4,000
Feet
Sediment Model Output Locations
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CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420
PACIFICORP

APPENDIX H
SEDIMENT INITIAL STUDY REPORT

SEDIMENT
INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT

(FERC NO. 2420)

Prepared for:

PacifiCorp
Salt Lake City, UT

Prepared by:

Cirrus
Ecological Solutions, LC

FEBRUARY 2021

SEDIMENT
INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT

(FERC NO. 2420)

Prepared for:

PacifiCorp
Salt Lake City, UT

Prepared by:

Cirrus Ecological Solutions, LC

February 2021

SEDIMENT
INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

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SEDIMENT
INITIAL STUDY REPORT

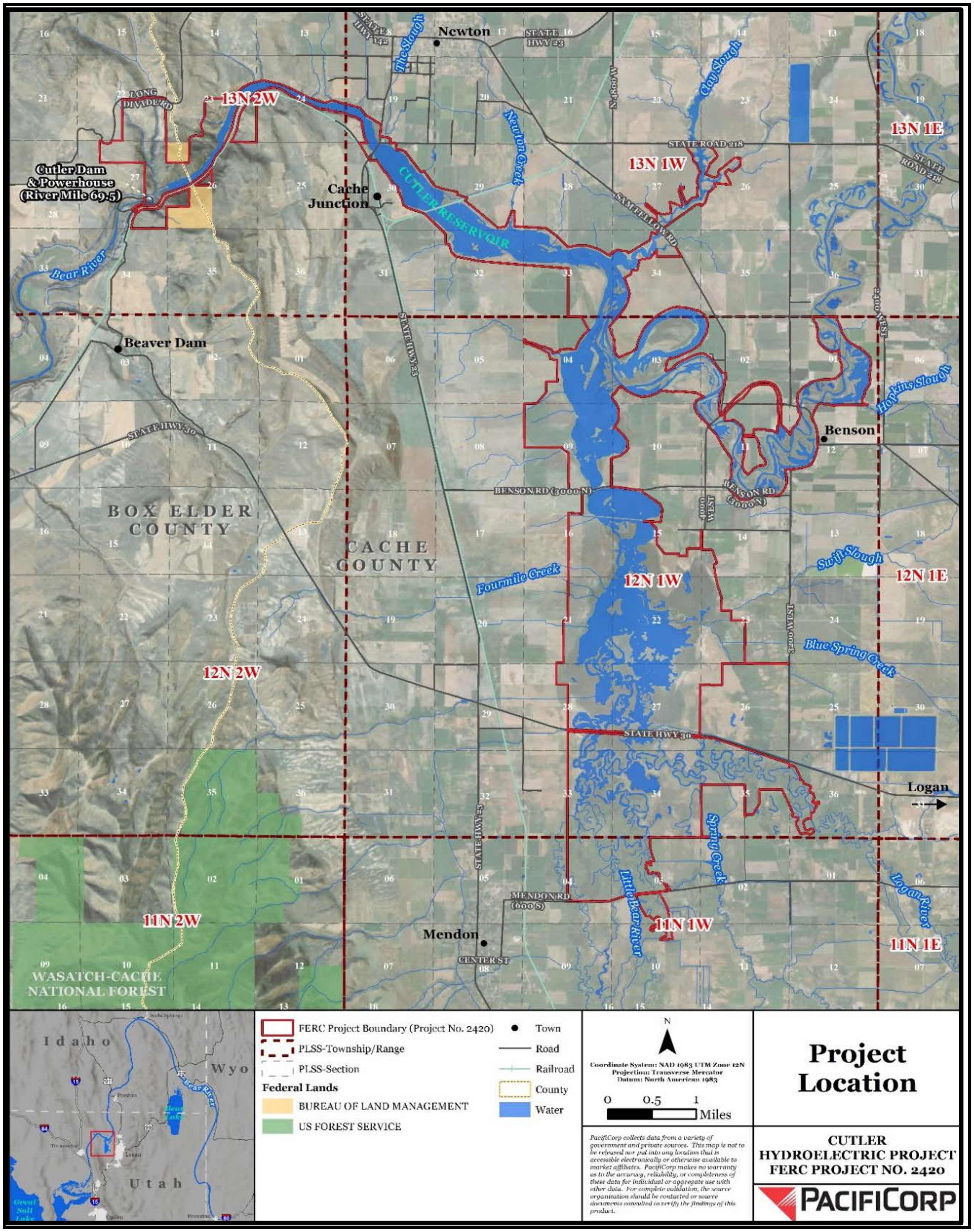
CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

1.0 INTRODUCTION

PacifiCorp is the owner, operator, and licensee for the Federal Energy Regulatory Commission (FERC) Cutler Hydroelectric Project (Project) (FERC Project No. 2420). The Project is located on the Bear River in western Cache Valley, Utah, between the Wasatch and Wellsville Mountains. Cutler Dam is located in Box Elder County; however, most of the Project reservoir lies within Cache County. The Project reservoir is formed at the confluence of Spring Creek and the Bear, Logan, and Little Bear Rivers (Figure 1-1). PacifiCorp operates the Project under a 30-year license issued by the FERC on April 29, 1994; the current license will expire on March 31, 2024. PacifiCorp initiated the formal relicensing process utilizing the Integrated Licensing Process by filing the Notice of Intent and Pre-Application Document (PAD) with FERC on March 29, 2019.

The relicensing process involves cooperation and collaboration between PacifiCorp, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. PacifiCorp coordinated with stakeholders throughout the study scoping process. They invited federal and state agencies, NGO's, and Native American tribes and tribal organizations to participate in a public meeting, workshops, scoping meetings, and a site visit. These meetings facilitated the identification of study needs to be addressed. Study scoping occurred in March 2019 through February 2020 when FERC issued the Study Plan Determination. PacifiCorp, FERC, and stakeholders identified the potential need for a sediment study during the study scoping process. Components of the Sediment study began in October of 2019 (along with several other preliminary studies), and final data collection concluded in early November 2020.



Source: PacifiCorp 2018

FIGURE 1-1 CUTLER PROJECT LOCATION MAP

2.0 PROJECT NEXUS AND RATIONALE FOR STUDY

There have been few studies on sediment movement and the resultant potential effects on existing resources within the Project Boundary. In the PAD, Water Resource Section 6.3.10 outlined some of the concerns with sediment given the shallow nature of the southern and northern reservoir areas, with average depths of 1.8 feet and 3.6 feet, respectively. Movement of bed sediments resulting from in-reservoir hydraulics or from mechanical actions such as dredging (a frequently discussed potential Protection, Mitigation and Enhancement action) may increase total suspended solids (TSS) and phosphorus (P) in the water column affecting a number of resources.

The nexus for this study is to determine if potential future changes in Project operations have the potential to re-suspend and mobilize bed sediments in key areas and throughout Cutler Reservoir. Changing reservoir surface elevations may accelerate water velocity in areas that are prone to bed scour or increase lateral scour and bank erosion. During periods of lower reservoir elevation, shifts in deposited material may occur, leading to deposition in deeper zones. The internal movement of sediment could lead to the mobilization of P and other pollutants currently bound in bed sediment and affect water quality.

This study was intended to improve the understanding of existing conditions as well as identifying the spatial and temporal extent of potential re-suspension and mobilization of bed sediments, with associated water quality effects, in Cutler Reservoir associated with potential future operational changes. The study results would address the practicability of dredging and removal of Wheelon Dam as a sediment management measure and assess its potential environmental effects (note that although the Sediment Study Plan identified both of these as possible future Project operation changes in the project nexus), subsequent hydraulic modeling has since indicated that neither would be feasible for future Project operations. This information will be included in the Draft License Application (DLA), rather than this Initial Study Report (ISR).

2.1 BACKGROUND INFORMATION AND DATA

Cutler Reservoir can be characterized as a shallow reservoir with two distinct areas, the southern reach, which comprises most of the inundated lands, and the northern reach, which is mostly Cutler Canyon. The southern reach of the reservoir is a flooded shallow river valley bounded by low-angle valley slopes. The Logan and Bear rivers, the two main tributaries to this portion of the reservoir, meander through the valley in a sinuous manner forming long bends and cutoff oxbows. This southern area comprises the majority of inundated areas forming Cutler Reservoir. These long historic (i.e., pre-construction) tributary meanders and river bends terminate near the Newton (Highway 23) Bridge as the Bear River enters Cutler Canyon. Some of the earliest known aerial photographs of Cutler Reservoir were taken by the Utah Geological Survey in 1937 (UGS 1937) (Photo 2-1 and Photo 2-2) and highlight the meanders and oxbows throughout the main body of the reservoir.

Cutler Canyon of the Bear River is a long, narrow feature that cuts through the northern end of the Wellsville Mountain foothills, extending from near the town of Newton, Utah, west to the Cutler Dam and powerhouse at the western end of the canyon. The Bear River is bound by steep to vertical walls, narrowing to 250-feet-wide in some areas of the canyon. The canyon can be divided in to two sections (upstream and downstream) with the boundary being the historic and now inundated Wheelon Dam. The upper section of the canyon from Newton Bridge to Wheelon maintains a similar gradient with very little vertical drop. Early studies noted that the base elevation at Wheelon Dam was approximately 2-feet-higher than the Newton Bridge bed elevation (Clyde 1953) (Figure 2-1). From Wheelon Dam downstream to Cutler Dam the canyon drops approximately 80 to 90 feet in less than 1 mile. Historical photographs illustrate the canyon prior to construction of Cutler Dam (Photo 2-3 and Photo 2-4); several accounts and historic photos show a cascade in the river near/at the location of Wheelon Dam.

The area shown in Photo 2-1 is Cutler Reservoir near Newton Bridge (center), the railroad (center right), and Cutler Canyon (upper left). Note the Bear River main channel meandering through the reservoir.

PHOTO 2-1 AERIAL PHOTOGRAPH TAKEN BY UTAH GEOLOGICAL SURVEY (NOV. 1937)

The area shown in Photo 2-2 is the North Marsh unit south of Benson Marina. The Logan River (left side of photograph), and Swift Slough (middle draining to Cutler from the right) converge near what is now the Railroad Trail Fishing Bridge (upper left side of photograph).

PHOTO 2-2 AERIAL PHOTOGRAPH TAKEN BY UTAH GEOLOGICAL SURVEY (OCT. 1937)

In Photo 2-3, note the flow through left of dam (right side of photograph). No headworks are in place for the Hammond (East) Canal.

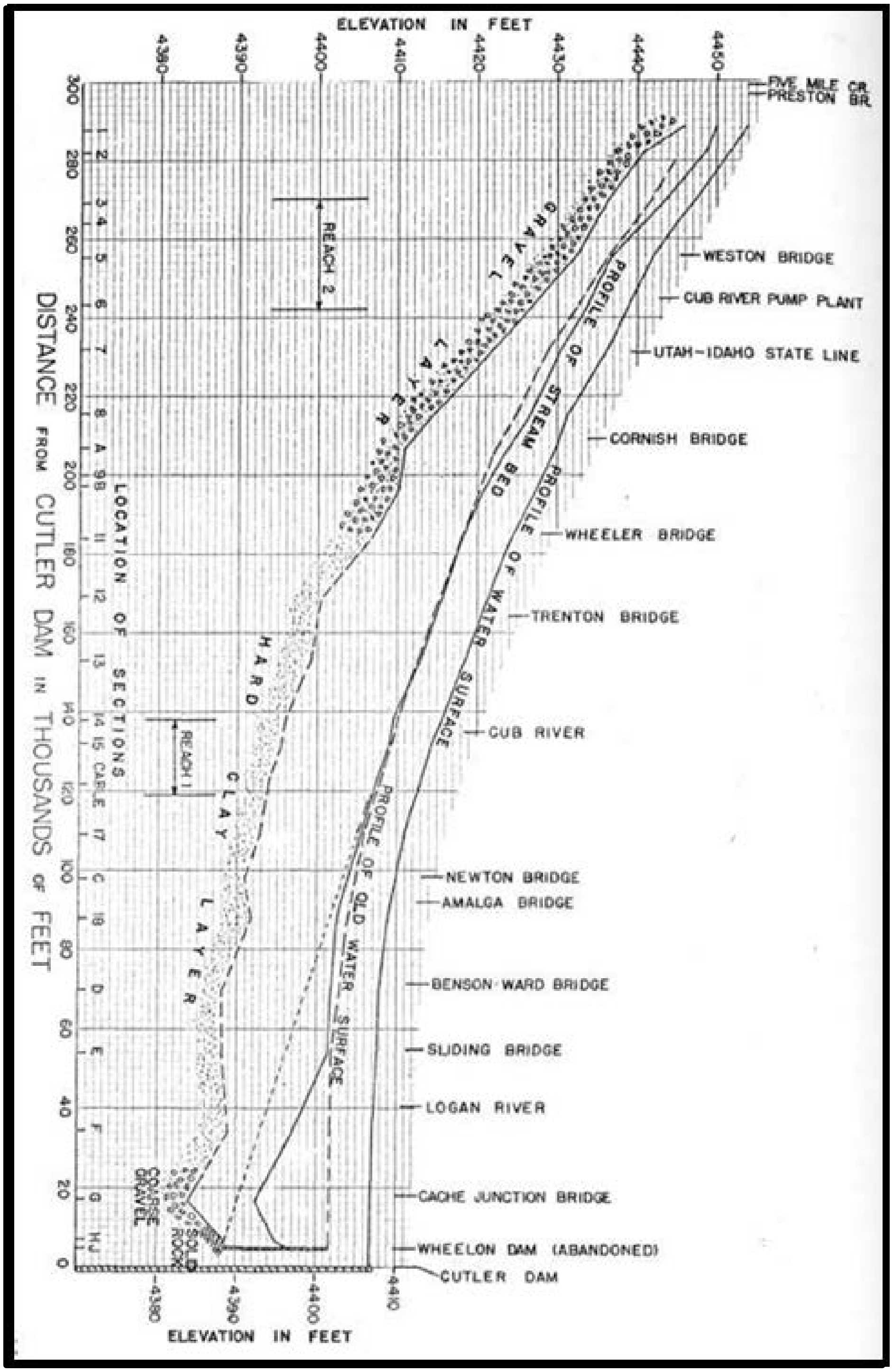
Source: Ray Somers Collection 1894

PHOTO 2-3 LOOKING UPSTREAM AT WHEELON DAM (1894)

Source: Lee Perry Special Collections; Brigham Young University

PHOTO 2-4 BEAR RIVER LOOKING DOWNSTREAM (WEST) OF WHEELON DAM DURING CONSTRUCTION OF CANALS (MID-1890S)

The shallow depth and highly silted environment of the reservoir result from import of fine sediment continuously from the Bear River and seasonally during spring runoff from other smaller tributaries. Over time, millions of tons of fine sediment have been deposited in the Bear River, largely as a result of accelerated erosion due to irrigation practices over a century ago (Clyde 1953). Clyde (1953) estimated that as a result of bench erosion and gully formation, the Bear River bed elevation was raised in excess of 12 feet in places upstream of the Project, and some 6 million tons of sediment were deposited into Cutler Reservoir prior to 1950, raising the river bed as much as 6 feet in areas (Figure 2-1). Today the Bear River continues to transport these fine material deposits, along with bank material, into the reservoir.



Source: Clyde 1953

Note: Cutler Reservoir historic elevations include: Benson Ward Bridge (Bear River Access), Sliding Bridge (Riverside), Logan River (Benson Marina Bridge), Cache Junction Bridge (Newton), and Wheelon Dam.

FIGURE 2-1 GRADIENT GRAPH OF BEAR RIVER FROM PRESTON, IDAHO TO CUTLER DAM

3.0 STUDY OBJECTIVES

The Sediment Study Plan outlined a three-tiered study approach to address sediment composition, sediment deposition, and P in sediment in Cutler Reservoir. The objective of defining sediment composition in the reservoir was to assess the role of potential sediment mobility under a range of operating conditions. The data collected provided a foundation for the sediment transport model discussed in the Hydraulics Study Plan. The combination of data collection and modeling provided a management tool for PacifiCorp to model a range of potential operational conditions and examine the effects on sediment.

Defining the volume and location of accumulated sediments in the reservoir provides a detailed understanding of sediment deposition throughout the main open water habitats in the FERC Project Boundary (Figure 1-1). The base map included in this report (Figure 3-1) illustrates where sediment deposition occurs. This information can be used to aid in decision-making processes and developing options to control sediment movement.

A final component of the sediment study is examining P composition and distribution in the FERC Project Boundary. P movement in the reservoir could affect water quality and is one of the identified pollutants in the Middle Bear River and Cutler Reservoir Total Maximum Daily Load Study (UDWQ 2010). Results of this sediment study help define the interaction of P bound in bed sediments and the water column. Understanding the movement and release of internal P from recycling of bed sediments may provide valuable insight into management of Cutler Reservoir.

3.1 STUDY AREA

3.1.1 SEDIMENT COMPOSITION CORE SAMPLING

The sediment distribution analysis encompassed much of the wetted surface area of Cutler Reservoir to address critical areas located inside the Project Boundary. Critical areas assessed for sediment composition were divided into strategic zones, based on factors such as inflow, cutting potential, constrictions that increase velocities, and potential for erosion at different elevations. The sediment cores collected as part of this study were used to develop the sediment transport component of the hydraulics model. Sediment structure inputs provided the model with data necessary to predict scour, deposition, re-suspension, and transport load from the reservoir system under a defined model condition. The number of core samples necessary to characterize the sediment structure was dependent upon the sediment variability throughout the reservoir.

Strategic study reaches within the Project Boundary were defined as follows (Figure 3-1):

- **Wheelon Reach** from Cutler Dam to Wheelon Dam, to account for sedimentation at the upstream base of Cutler Dam.
- **Canyon Reach** from Wheelon Dam to the Newton Bridge, to assess the effects of Wheelon Dam as a factor in sediment accumulation.
- **Reservoir Reach** from Newton Bridge upstream to the Bear River/reservoir confluence, accounting for the formation of large bars with areas of lateral flow, continued deposition, and susceptibility to erosion under lowered elevations.
- **Bear River Inflow Reach** upstream to the Project Boundary. The Bear River is highly channelized in this area and continues to lose volume due to forming natural levees that isolate areas of the reservoir except during high spring flows. Lowered elevations could erode this highly channelized area.
- **North and South Marsh Reach** from Benson Marina and open water habitats south to the Logan River and other southern tributaries (Little Bear River and Spring Creek).

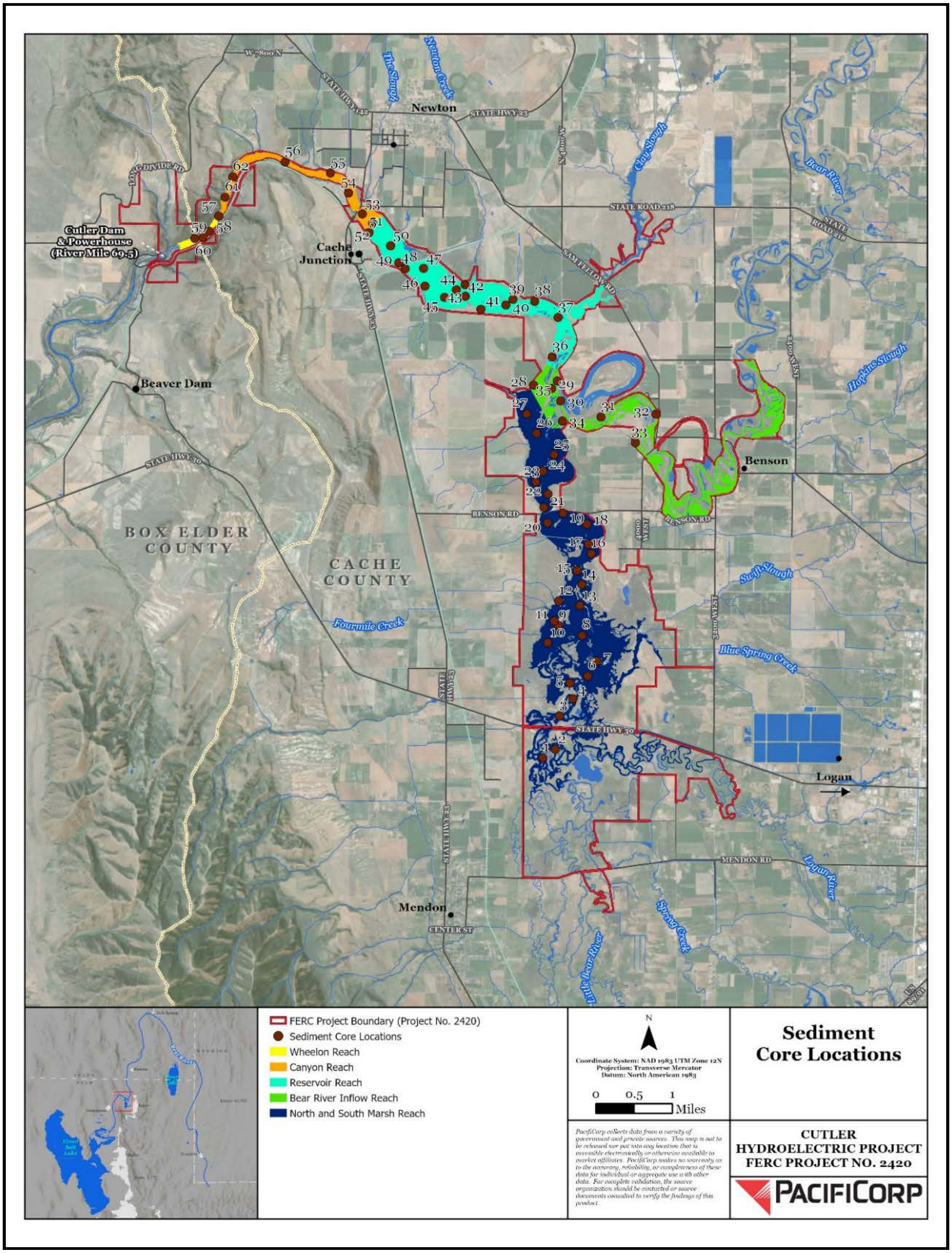


FIGURE 3-1 STUDY REACHES USED IN SEDIMENT COMPOSITION AND SAMPLING LOCATIONS IN CUTLER RESERVOIR

3.1.2 DISTRIBUTION OF SEDIMENT IN CUTLER RESERVOIR

Sediment distribution covered open water habitats in areas where sub-bottom data collected revealed original bed elevations. Areas of focus included historically open water habitats and low water velocity or notable deposition zones. Water depth and vegetation limited the collection of sub-bottom data in marshy areas such as the South Marsh and the North Marsh near State Highway 30.

3.1.3 PHOSPHOROUS DISTRIBUTION IN SEDIMENT

The three areas described below encompassed the focus of the sediment P sampling effort (Figure 3-2):

- **North and South Marsh Units** - The southern portions of the reservoir, which include the Highway 30 to Benson Marina area and the Logan and Little Bear inflow areas (defined in the Cutler Resource Management Plan as the North and South Marsh Resource Management Areas, respectively). This area has a number of National Pollutant Discharge Elimination System (NPDES) permit dischargers (including Logan City's effluent discharge) and has the highest concentration of P in the system (additional detail is provided in Appendix F, Water Quality). A number of sample sites were developed in this area to identify sediment movement and potential sources of P (both external and internal) that could be contributing to the high concentrations found in the reservoir. Sites include the Logan River inflow, the Spring Creek/Little Bear River inflow, the large area south of the Benson Railroad Trail and Fishing Bridge (the North Marsh) where inflow from the Logan Wastewater Treatment Plant enters the reservoir, and Benson Marina between the Fishing Bridge and the confluence with the Bear River (Main Reservoir Resource Management Area).
- **Bear River Unit** - The Bear River Resource Management Area, upstream of potential influences from the southern tributary areas of the North and South Marshes. This area has the greatest inflow, a high number of cattle feeding operations, and extensive surface runoff from agricultural operations. Sample sites included areas upstream and downstream of pollutant sources to understand the changes that are occurring throughout the marsh and reservoir.
- **Canyon and Reservoir Unit** - Cutler Canyon and Main Reservoir Resource Management Areas combine inflows from tributaries in the North and South Marshes, as well as the Bear River, with the addition of Clay Slough inflows. This area combines the vast majority of all inflow and potential dischargers into the system. Samples collected here helped to develop an understanding of P distribution in the system. Sample sites included Clay Slough and sites downstream of Newton Creek inflow, and Cutler Reservoir at the Newton Bridge and near the Wheelon Dam.

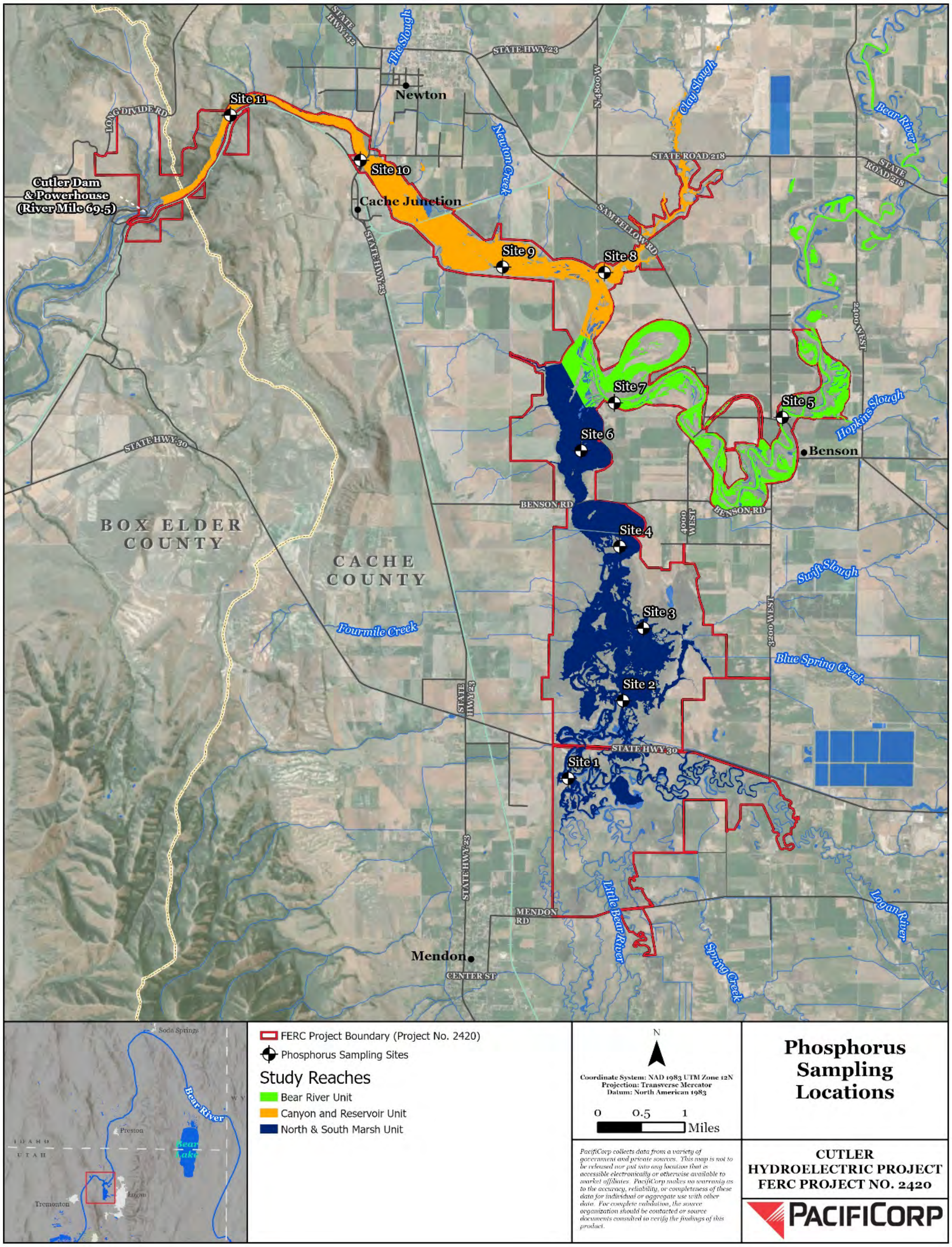


FIGURE 3-2 LOCATIONS OF SEDIMENT PHOSPHORUS STUDY LOCATIONS ON CUTLER RESERVOIR

4.0 METHODS

The sediment study used several methods to address study objectives, as outlined below.

4.1 SEDIMENT COMPOSITION CORE SAMPLING

The reservoir was divided into five key areas for collecting sediment cores. Originally a stratified random design was proposed. However, during pre-site selection it became apparent that a more strategic sampling program was needed than originally proposed. Given the nature of the subsurface and historic (i.e., prior to construction of Cutler Dam) meandering of the river channel throughout the reservoir, a targeted sampling scheme was developed to ensure that both the river channel and inundated former riverbank areas were sampled. Using aerial photographs where possible, the historic channel was located, and a larger percentage of samples was strategically selected for the channel. The channel provided the greatest variability in sediment depth and structure. Areas outside of the main channel were randomly selected and sampled as a proportion of the main channel samples in each study reach.

Because Cutler Reservoir is very shallow, a vibrating corer was the best option for sample collection due to its mobility. The vibrating corer generates acoustic vibrations that mobilize sediment in contact with the core rod, allowing it to penetrate to the point of rejection. Depending on sediment type and sediment layering, this is typically 20 to 25 feet in clay and silt.

Reservoir core sampling was completed for all sites in July 2020. During sampling, daily field notes were collected that included:

1. Date, time, location, weather conditions, sample identification (ID) number, and global positioning system (GPS) location.
2. Depth of water in inches, core barrel length in inches, and depth at rejection or bottom depth of sediments in inches, which were converted to elevations. Bottom depth was assumed when native material was encountered, such as hard clays found throughout much of Cutler Reservoir.

Core samples were examined according to the inspection protocol and physical measurements listed below including:

1. Once the core tube was recovered and sediment core removed, a preliminary inspection for sediment type using the Wentworth scale was used to classify core sections. Any stratification or changes in sediment type were noted from top of the reservoir bed down to the closest inch. Core logs were created at each site (Attachment H-1).
2. Twenty-nine samples were collected for particle size analysis and classified using the Unified Soil Classification System (USCS; Table 4-2). Depth of each sample was recorded or noted as a composite sample within the core. All core depth measurements were recorded in inches from the bed surface down. To determine the percentage of grain size sands, all samples were tested using a set of USCS metric sieves from 1.00 millimeter (mm) down to 0.050 mm. All samples were reprocessed with a 0.05-mm sieve before running a hydrometer test on the samples. No samples were tested for percent organic as per laboratory recommendations after inspection.
3. To test for elasticity or shear strength, sediment cores were measured in the field using a Gilson shear vane. Sand samples were not tested for shear strength (Table 4-1).
4. Six cores were tested at various depths in ten samples (Table 4-3). A full elemental scan was completed for each site. The focus was on calcium carbonate ($CaCO_3$), iron (Fe), aluminum (Al), and total phosphorus (TP). Because $CaCO_3$ exerts a great influence on phosphate fixation through surface absorption, $CaCO_3$ can also limit the solubility of phosphate. Fe and Al are two ions that can fix P through cation exchange, greatly reducing the solubility of P in toxic conditions.
5. Three composite samples were tested for a range of pesticides including dichlorodiphenyldichloroethylene (DDE) and dichlorodiphenyltrichloroethane (DDT), polychlorinated biphenyl (PCBs), and Resource Conservation and Recovery Act (RCRA) metals in bed sediments (Table 4-4). The composite sample locations included Benson Marina, Newton Bridge, and Wheelon Dam. Samples were composited throughout the sediment core.

Table 4-1 Sediment Log Data Of The Core Samples Throughout Cutler

Site	Date	Time	Latitude	Longitude	Study Reach	Water D. (in)	Core D. (in)	Total D. (in)	Bed Elev. (ft)*	Condition Note
1	7/20	11:35	41.7405	-111.9547	South and North Marsh Area	16	79	95	4399.6	Hot, Sunny
2	7/20	14:12	41.7421	-111.9516	South and North Marsh Area	54	88	142	4395.7	Hot, Sunny
3	7/20	14:40	41.7485	-111.9506	South and North Marsh Area	52	0	52	4403.2	Hot, Sunny
4	7/21	9:00	41.7517	-111.9473	South and North Marsh Area	35	46	81	4400.8	Hot, Sunny
5	7/21	9:45	41.7547	-111.9481	South and North Marsh Area	32	113	145	4395.5	Hot, Sunny
6	7/21	10:45	41.7561	-111.9436	South and North Marsh Area	28	34	62	4402.4	Hot, Sunny
7	7/21	11:20	41.7589	-111.9414	South and North Marsh Area	30	32	62	4402.4	Hot, Sunny
8	7/21	12:45	41.7637	-111.9452	South and North Marsh Area	30	18	48	4403.6	Hot, Sunny
9	7/21	13:30	41.7656	-111.9512	South and North Marsh Area	42	102	144	4394.7	Hot, Sunny
10	7/21	14:00	41.7623	-111.9539	South and North Marsh Area	33	23	56	4402.9	Hot, Sunny
11	7/21	14:45	41.7664	-111.9523	South and North Marsh Area	42	105	147	4395.3	Hot, Sunny
12	7/21	15:30	41.7702	-111.9512	South and North Marsh Area	31	20	51	4403.3	Hot, Sunny
13	7/21	16:11	41.7694	-111.9458	South and North Marsh Area	39	18	57	4402.8	Hot, Sunny
14	7/22	8:30	41.7733	-111.9454	South and North Marsh Area	55	65	120	4397.6	Warm, Light Rain, Storm halted coring

SITE	**DATE**	**TIME**	**LATITUDE**	**LONGITUDE**	**STUDY REACH**	**WATER D. (IN)**	**CORE D. (IN)**	**TOTAL D. (IN)**	**BED ELEV. (FT)***	**CONDITION NOTE**
15	7/23	8:37	41.7760	-111.9466	South and North Marsh Area	68	89	157	4394.5	Hot, Sunny
16	7/23	9:19	41.7792	-111.9431	South and North Marsh Area	42	25	67	4402.0	Hot, Sunny
17	7/23	9:58	41.7810	-111.9438	South and North Marsh Area	60	92	152	4394.9	Hot, Sunny
18	7/23	10:51	41.7848	-111.9443	South and North Marsh Area	48	117	165	4393.8	Hot, Sunny
19	7/23	12:15	41.7868	-111.9503	South and North Marsh Area	52	71	123	4397.3	Hot, Sunny
20	7/23	12:47	41.7850	-111.9543	South and North Marsh Area	50	24	74	4401.4	Hot, Sunny
21	7/23	13:58	41.7879	-111.9552	South and North Marsh Area	52	30	82	4400.7	Hot, Sunny
22	7/23	14:40	41.7904	-111.9542	South and North Marsh Area	77	94	171	4393.3	Hot, Sunny
23	7/23	15:30	41.7927	-111.9573	South and North Marsh Area	38	12	50	4403.4	Hot, Sunny
24	7/23	16:00	41.7948	-111.9556	South and North Marsh Area	53	93	146	4395.4	Hot, Sunny
25	7/24	8:00	41.7979	-111.9528	South and North Marsh Area	44	108	152	4394.9	Hot, Sunny
26	7/24	8:45	41.8019	-111.9573	South and North Marsh Area	42	27	69	4401.8	Hot, Sunny
27	7/24	9:11	41.8056	-111.9598	South and North Marsh Area	57	71	128	4396.9	Hot, Sunny
28	7/24	9:50	41.8110	-111.9582	Bear River Inflow	69	14	83	4400.6	Hot, Sunny
29	7/24	10:35	41.8104	-111.9536	Bear River Inflow	147	32	179	4392.6	Hot, Sunny
30	7/24	11:10	41.8081	-111.9513	Bear River Inflow	107	41	148	4395.2	Hot, Sunny
31	7/24	11:40	41.8051	-111.9410	Bear River Inflow	59	94	153	4394.8	Hot, Sunny
32	7/24	12:20	41.8058	-111.9271	Bear River Inflow	110	81	191	4391.6	Hot, Sunny
33	7/24	12:52	41.8003	-111.9322	Bear River Inflow	84	88	172	4393.2	Hot, Sunny
34	7/24	13:30	41.8043	-111.9508	Bear River Inflow	68	7	75	4401.3	Hot, Sunny

Site	Date	Time	Latitude	Longitude	Study Reach	Water D. (in)	Core D. (in)	Total D. (in)	Bed Elev. (ft)*	Condition Note
35	7/27	9:20	41.8119	-111.9522	Bear River Inflow	66	73	139	4396.0	Hot, Sunny
36	7/27	10:11	41.8164	-111.9535	Reservoir Reach	196	80	276	4384.6	Hot, Sunny
37	7/27	11:23	41.8239	-111.9521	Reservoir Reach	78	10	88	4400.2	Hot, Sunny
38	7/27	12:12	41.8269	-111.9581	Reservoir Reach	60	116	176	4392.9	Hot, Sunny
39	7/27	12:41	41.8272	-111.9636	Reservoir Reach	58	6	64	4402.2	Hot, Sunny
40	7/27	13:06	41.8261	-111.9654	Reservoir Reach	89	95	184	4392.2	Hot, Sunny
41	7/27	13:41	41.8253	-111.9718	Reservoir Reach	80	65	145	4395.5	Hot, Sunny
42	7/28	9:40	41.8277	-111.9757	Reservoir Reach	80	126	206	4390.4	Warm, Overcast
43	7/28	10:05	41.8299	-111.9758	Reservoir Reach	52	10	62	4402.4	Warm, Overcast
44	7/28	10:30	41.8289	-111.9780	Reservoir Reach	79	122	201	4390.8	Warm, Overcast
45	7/28	11:30	41.8274	-111.9810	Reservoir Reach	28	74	102	4399.1	Warm, Overcast
46	7/28	12:05	41.8295	-111.9860	Reservoir Reach	44	35	79	4401.0	Warm, Overcast
47	7/28	13:20	41.8329	-111.9864	Reservoir Reach	44	27	71	4401.6	Warm, Overcast
48	7/28	13:44	41.8328	-111.9910	Reservoir Reach	95	100	195	4391.3	Warm, Overcast
49	7/29	8:47	41.8339	-111.9926	Reservoir Reach	108	112	220	4389.2	Hot, Sunny
50	7/29	9:45	41.8371	-111.9948	Reservoir Reach	28	100	128	4396.9	Hot, Sunny
51	7/29	10:22	41.8395	-112.0003	Reservoir Reach	53	48	101	4399.1	Hot, Sunny
52	7/29	10:55	41.8412	-111.9994	Reservoir Reach	64	62	126	4397.1	Hot, Sunny
53	7/29	11:30	41.8431	-112.0020	Canyon Reach	123	90	213	4389.8	Hot, Sunny
54	7/29	12:15	41.8470	-112.0056	Canyon Reach	144	78	222	4389.1	Hot, Sunny
55	7/29	13:10	41.8507	-112.0102	Canyon Reach	174	41	215	4389.6	Hot, Sunny
56	7/29	13:35	41.8527	-112.0218	Canyon Reach	186	71	257	4386.1	Hot, Sunny
57	7/30	9:07	41.8423	-112.0384	Dam Reach	106	144	250	4386.7	Hot, Sunny
58	7/30	9:45	41.8395	-112.0408	Dam Reach	192	174	366	4377.1	Hot, Sunny
59	7/30	11:05	41.8382	-112.0423	Dam Reach	240	102	342	4379.1	Hot, Sunny

SITE	DATE	TIME	LATITUDE	LONGITUDE	STUDY REACH	WATER D. (IN)	CORE D. (IN)	TOTAL D. (IN)	BED ELEV. (FT)*	CONDITION NOTE
60	7/30	11:48	41.8381	-112.0444	Dam Reach	96	96	192	4391.6	Hot, Sunny
61	7/30	12:30	41.8459	-112.0369	Canyon Reach	144	120	264	4385.6	Hot, Sunny
62	7/30	13:09	41.8498	-112.0349	Canyon Reach	227	46	273	4384.8	Hot, Sunny

*Bed elevation refers to National Geodetic Vertical Datum of 1929 (NGVD 29).

TABLE 4-2 SEDIMENT CORE SAMPLE RESULTS FROM TWO TESTS INCLUDING SAND SIEVE AND HYDROMETER TESTS FROM THE SAME CORE SAMPLE

SITE	SHEAR VALUE	SAMPLE DEPTH	HYDROMETER (%)			SAND SIEVES (%)				
	kg/cm	in.	Sand (>0.050)	Silt (0.05-0.002)	Clay (<0.002)	1 mm	0.5 mm	0.250 mm	0.105 mm	0.050 mm
1	0.06	10-15, 42-47	35	46	19	0.40	1.88	0.99	6.09	23.1
2	0.02	30-40	53	31	16	2.55	6.04	8.66	16.1	22.6
11	sand	36-44	47	38	15	0.58	0.82	0.85	13.8	30.5
17 Depth 1	0.07	12-20	27	53	20	0.06	0.41	0.40	4.08	20.8
17 Depth 2	sand	80-90	86	7	7	0.07	1.30	10.4	68.3	7.04
21	0.15	12-20	20	51	29	0.49	1.79	1.37	2.44	11.2
26	sand	20-27	41	45	14	0.10	0.96	0.71	5.15	35.4
29	sand	10-20	97	1	2	2.40	12.3	12.8	65.8	3.05
34	sand	1-7	41	31	28	0.14	0.23	0.37	12.2	27.6
35	sand	12-22	66	19	15	0.07	0.17	0.17	15.9	49.9
36	sand	44-52	36	41	23	0.37	0.84	1.37	17.9	13.2
37	0.18	1-8	20	40	40	0.11	0.60	1.46	5.31	9.99
39	0.19	0-6	26	39	35	0.51	3.12	2.74	9.29	10.7
40	sand	22-32	97	1	2	4.04	17.0	28.7	46.6	1.07
44	sand	122-118	96	1	3	8.60	27.2	32.9	27.2	1.31
45 Depth 1	sand	64-72	55	36	9	0.16	1.96	1.23	11.6	44.2
45 Depth 2	sand	24-32	69	21	10	9.13	8.33	4.64	32.1	22.3
45 Depth 3	sand	8-18	35	41	24	2.47	2.92	1.81	4.69	23.3
47	sand	18-27	68	24	8	0.12	1.36	1.58	27.6	41.6
50	0.06	5-15	47	43	10	0.10	1.36	0.91	7.19	38.4
52	sand	2-10	70	21	9	0.23	0.74	1.67	40.7	28.6
53	sand	13-20	69	21	10	0.41	1.20	5.02	40.8	20.0
56 Depth 1	0.06	10-20	17	51	32	0.55	0.93	2.54	3.68	7.00
56 Depth 2	sand	60-70	97	1	2	0.55	16.1	39.7	37.5	2.97
58 Depth 1	0.03	22-30	18	51	31	0.10	0.94	1.17	8.62	5.16
58 Depth 2	0.05	168-174	22	50	28	0.71	1.42	1.61	7.04	8.00
59	0.04	32-38	8	57	35	0.38	0.27	0.21	0.44	2.94
62 Depth 1	0.03	31-37	6	49	45	0.35	0.21	0.20	0.79	1.14
62 Depth 2	sand	38-45	89	6	5	31.83	36.2	12.5	4.06	3.83
Clay Slough	na	4-12	18	57	25	0.08	0.60	0.35	1.35	10.7

Note: Sand sieve results indicate percent mass retained on each sieve

TABLE 4-3 TOTAL ELEMENTAL SCAN AT SIX SITES FROM CORE SAMPLES

USU ID	SITE	CALCIUM CARBONATE	ALUMINUM	ARSENIC	BORON	BARIUM	CALCIUM	CADMIUM	COBALT	CHROMIUM	COPPER	IRON	POTASSIUM
		%	%	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	%	%
2170	11	29.7	0.69	1.87	6.01	67.9	9.75	0.49	2.91	10.1	6.19	0.63	0.14
2171	17 Depth 1	29.7	0.87	2.95	6.62	83.7	10.4	0.58	3.80	11.9	7.35	0.81	0.15
2172	17 Depth 2	27.2	0.22	1.36	3.47	24.2	10.5	0.16	1.79	4.68	1.56	0.24	0.06
2173	21	44.6	0.82	2.17	8.48	113	14.5	0.53	3.25	11.1	4.63	0.74	0.17
2179	37	35.3	1.06	6.71	32.6	222	9.40	0.57	4.56	12.1	8.14	0.91	0.34
2183	45 Depth 1	16.7	0.51	3.23	5.43	93.7	7.04	0.42	4.83	7.80	5.66	0.59	0.14
2184	45 Depth 2	29.1	0.55	1.43	12.9	197	9.21	0.30	2.80	7.39	5.10	0.50	0.20
2185	45 Depth 3	31.0	0.70	1.58	6.8	180	10.6	0.45	4.30	9.49	4.32	0.75	0.20
2192	58 Depth 1	19.8	1.33	5.02	10.5	167	7.39	0.93	6.03	15.4	13.6	1.32	0.36
2193	58 Depth 2	24.8	1.17	4.04	9.05	163	9.09	0.78	5.27	14.3	12.4	1.15	0.31
Detection Limits:			0.00005	0.1	0.1	0.2	0.00001	0.1	0.1	0.1	0.1	0.00001	0.0001

continued

USU ID	SITE	MAGNESIUM	MANGANESE	MOLYBDENUM	SODIUM	NICKEL	PHOSPHORUS	LEAD	SULFUR	SELENIUM	STRONTIUM	ZINC
		%	mg/kg	mg/kg	%	mg/kg	%	mg/kg	%	mg/kg	mg/kg	mg/kg
2170	11	2.94	179	0.13	0.02	6.75	0.06	3.57	0.04	<	67.1	31.3
2171	17 Depth 1	2.61	242	0.10	0.03	8.52	0.07	4.78	0.03	<	80.9	35.1
2172	17 Depth 2	3.66	153	<	0.02	2.46	0.07	1.50	0.04	<	58.3	10.3
2173	21	2.58	212	<	0.04	6.94	0.06	4.17	0.03	<	172	32.4
2179	37	4.28	561	<	0.09	36.4	0.10	4.22	0.03	<	369	36.2
2183	45 Depth 1	1.01	217	0.19	0.03	6.92	0.07	4.06	0.09	<	148	24.9
2184	45 Depth 2	2.58	194	0.11	0.04	4.74	0.07	1.89	0.03	<	509	22.0
2185	45 Depth 3	1.47	427	<	0.03	8.15	0.06	3.88	0.02	<	354	25.7
2192	58 Depth 1	1.13	495	0.10	0.04	13.0	0.09	10.6	0.06	<	151	55.1
2193	58 Depth 2	1.14	413	0.14	0.04	11.3	0.10	7.81	0.09	<	182	50.5
Detection Limits:		0.00001	0.1	0.1	0.00001	0.1	0.0001	0.1	0.0001	0.1	0.1	0.1

Note: Some of the ions are expressed as a percentage of the total samples and not measured as milligram per kilogram (mg/kg). To convert from percentage, multiply by 10,000.

TABLE 4-4 RESULTS OF CORE SAMPLES FOR RCRA METALS, PCBS AND PESTICIDES

LOCATION (SITE)	26	52	62	SCREENING LEVEL[1] (SOIL RESIDENTIAL)	SCREENING LEVEL[1] (SOIL COMMERCIAL)
Metals mg/kg					
Arsenic, Total	4.18	9.49	6.53	0.68 / 35	3 / 480
Barium, Total	97.8	115	182	1.50E+04	220000
Cadmium, Total	ND	ND	ND	NA	NA
Chromium, Total	9.34	9.48	14.7	1.20E+05	1800000
Lead, Total	4.87	4.19	9.67	5.50E+04	820000
Mercury, Total	0.02	0.02	0.06	11	46
Selenium, Total	ND	ND	ND	NA	NA
Silver, Total	ND	ND	ND	NA	NA
PCBs mg/kg					
PCB-1260	ND	ND	ND	NA	NA
PCB-1254	ND	ND	ND	NA	NA
PCB-1248	ND	ND	ND	NA	NA
PCB-1242	ND	ND	ND	NA	NA
PCB-1232	ND	ND	ND	NA	NA
PCB-1221	ND	ND	ND	NA	NA
PCB-1016	ND	ND	ND	NA	NA
Pesticides mg/kg					
Aldrin	ND	ND	ND	NA	NA
alpha-BHC	ND	ND	ND	NA	NA
alpha-Chlordane	ND	ND	ND	NA	NA
beta-BHC	ND	ND	ND	NA	NA
DDD	ND	ND	ND	NA	NA
DDE	ND	ND	ND	NA	NA
DDT	ND	ND	ND	NA	NA
delta-BHC	ND	ND	ND	NA	NA
Dieldrin	ND	ND	ND	NA	NA
Endosulfan I	ND	ND	ND	NA	NA
Endosulfan II	ND	ND	ND	NA	NA
Endosulfan sulfate	ND	ND	ND	NA	NA
Endrin	ND	ND	ND	NA	NA
Endrin aldehyde	ND	ND	ND	NA	NA
Endrin ketone	ND	ND	ND	NA	NA
gamma-Chlordane	ND	ND	ND	NA	NA
Heptachlor	ND	ND	ND	NA	NA
Heptachlor_epoxide	ND	ND	ND	NA	NA
Lindane	ND	ND	ND	NA	NA
Methoxychlor	ND	ND	ND	NA	NA
Toxaphene	ND	ND	ND	NA	NA

[1] Carcinogenic / Non-carcinogenic, ND = Non-detect, NA = Not applicable.

4.2 DISTRIBUTION OF SEDIMENT IN CUTLER RESERVOIR

To address the distribution and depth of sediments within the reservoir, a low frequency echosounder was used to collect sub-bottom recordings, while simultaneously collecting reservoir bed elevation data, from October 5 to October 18, 2019. Acoustic sub-bottom profiling draws upon low-frequency sounders in a range of 50 kilohertz (kHz) or lower to penetrate into bed sediments. Coupling the soundings with sediment core analysis greatly expanded the resolution of sediment core data for a more accurate picture of sediment types and distribution throughout the reservoir.

Specialty Devices three-frequency (28/50/200 kHz), survey-grade echo-sounding equipment was used to map the reservoir sub-bottom. The 200-kHz frequency was used to map the bottom, and the 28- and 50-kHz frequencies were used to penetrate deeper into the lacustrine deposits to define historical (i.e., prior to construction of Cutler Dam) bed elevations and river channels.

The sounder was interfaced with Trimble R-10 survey grade GPS and connected via cellular network to the Utah Reference Network (URN) to receive real-time GPS correction updates. Connecting to the URN eliminated the need to establish benchmarks for a GPS base station to receive real-time updates. Cutler water surface elevations at the Benson gage were used as a check to smooth vertical variability from the GPS unit, and ultimately used as reference elevations for a bed-elevation and sub-bottom elevation map.

Before survey work began, the echosounder was referenced and calibrated using a bar check by physically measuring the depth of water below the sounder and adjusting depth if needed. Water temperature was checked to adjust the speed of sound, as necessary.

Soundings were typically collected perpendicular to the flow line, with an average spacing of approximately 100 feet in areas deemed critical to modeling effort (Figure 4-1). In areas deemed less critical a wider cross-section transect was implemented. Areas deemed lower priority by the hydraulics analysis team had a lower potential for scour under normal conditions.

Data processing was completed using two programs from Specialty Devices including Smart Survey and Depthpic. Smart Survey was used as a playback to view the data for errors and to reprocess soundings as needed to digitally map bed elevations (Figure 4-2). Data were then opened in Depthpic, which created an X, Y, and Z point for each sounding return. Adjustment of individual points could be fixed as visual inspection occurred. For example, a reading from debris, vegetation, or a suspended object in the water column could inadvertently measure the bottom depth above the actual reservoir bed. This error could then be adjusted to the actual bed elevation. Depthpic can define isopachs (i.e., contours that define thickness of sediment deposits) using secondary elevations from the sounding files, based on the lower frequency readings (Figure 4-3). This allowed the bottom of the isopach to be generated as an X, Y, and Z set of coordinates to map lacustrine deposits across the transect. Once manual inspection was completed for all soundings, output point files were created and imported to ArcGIS.

Bathymetry output files were used in combination with Light Detection and Ranging (LiDAR) data collected in November 2019 to create a raster map for the reservoir bed. Using geostatistical models to interpolate between cross-sections collected and point-cloud LAS files, a 1-foot raster was created for the open water habitats in the FERC Project Boundary (Figure 4-4). Isopach output data used the same geostatistical modelling process to create the interpolated bed below the lacustrine deposits and define historic (i.e., prior to construction of Cutler Dam) bed elevations (Figure 4-5). Because the intent of the sub-bottom analysis was to generate a deposition map, a larger pixel density of 5 meters was used for the raster to reduce the amount of processing time. The depth of deposition in the reservoir was determined as the difference between the active bed elevation and the isopach elevation.

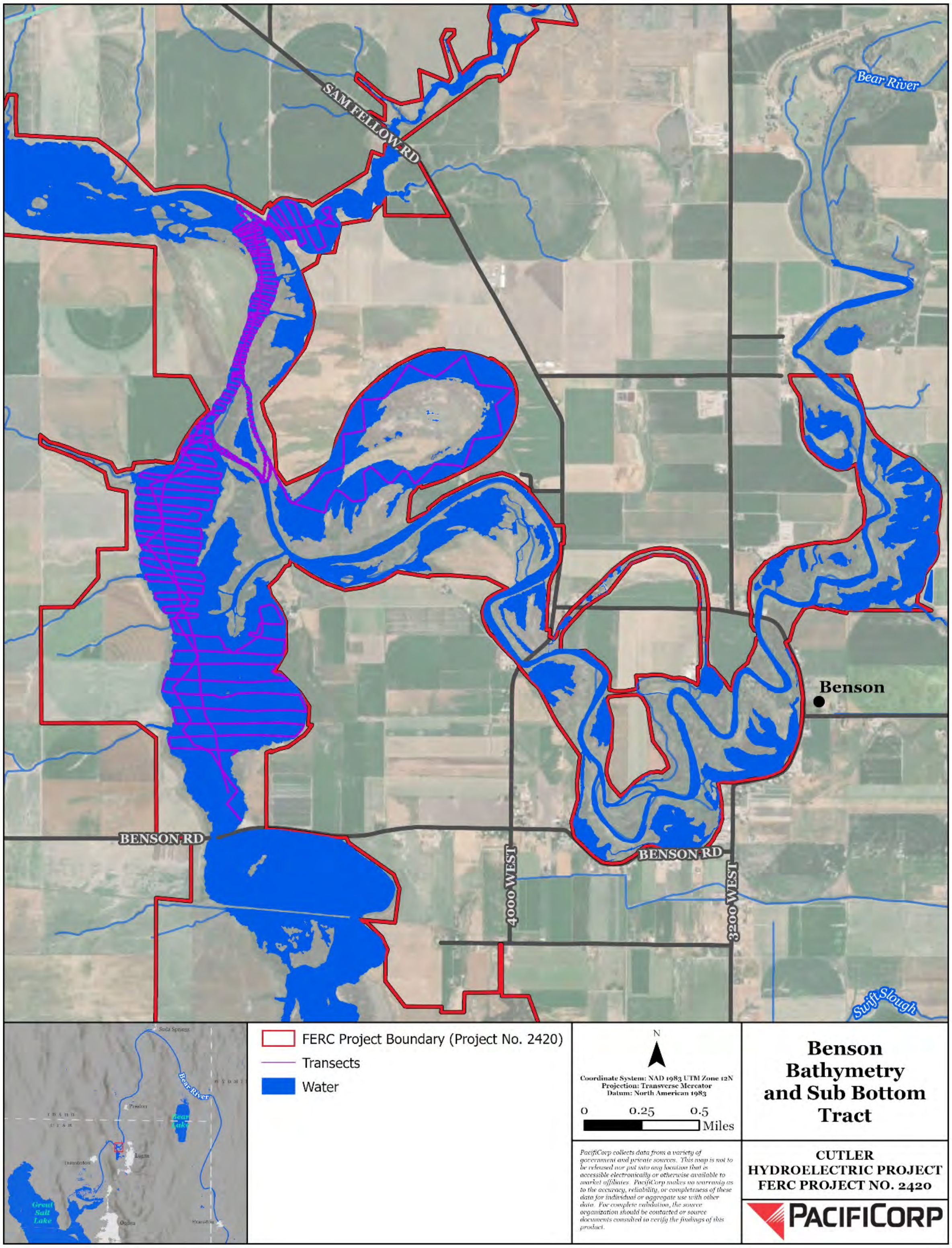
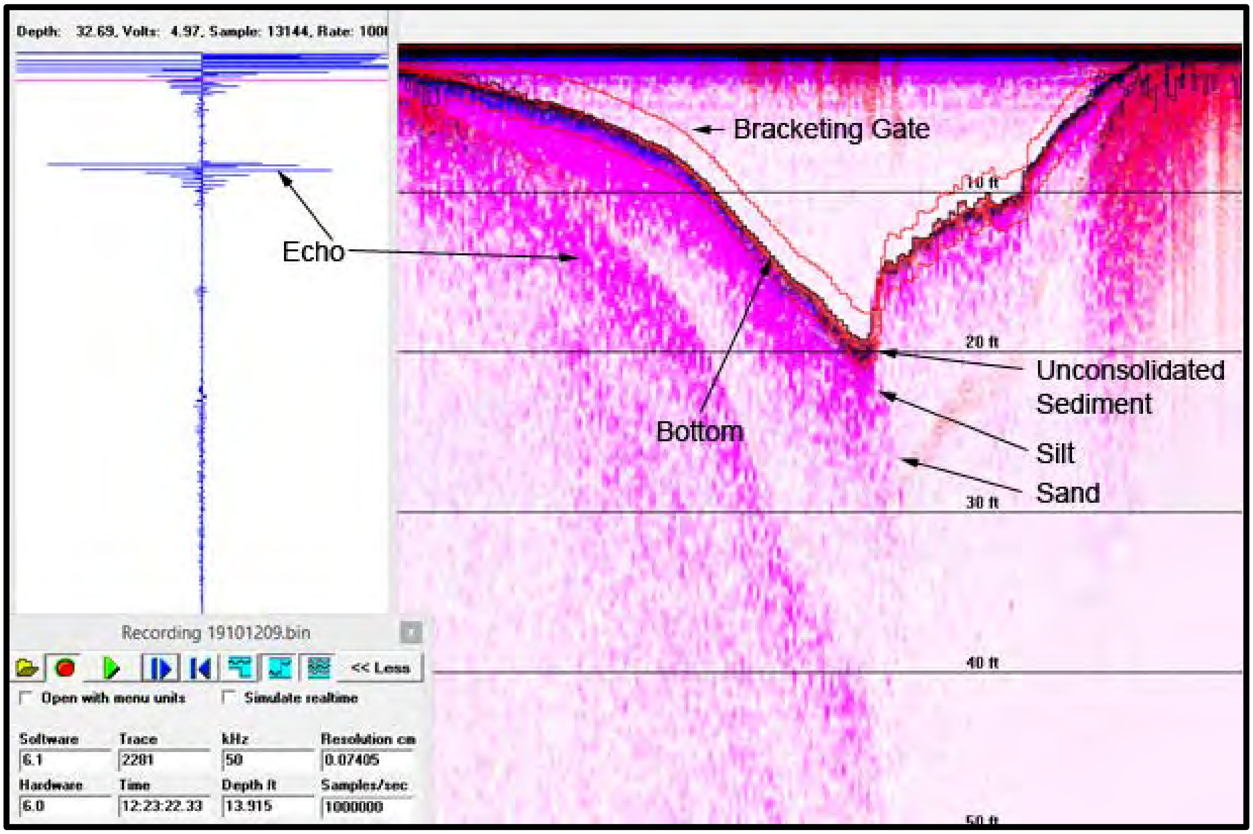
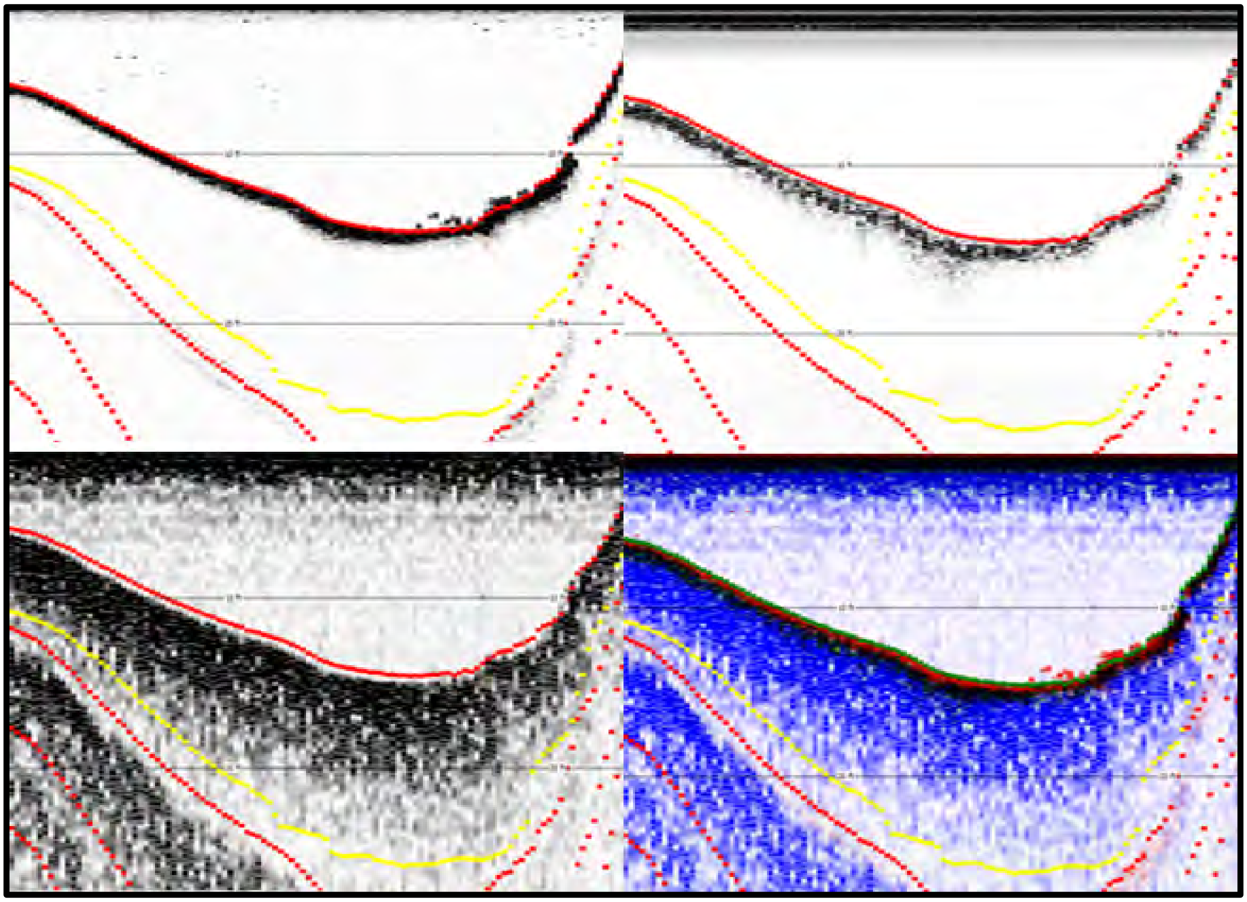


FIGURE 4-1 BENSON BATHYMETRY AND SUB-BOTTOM TRACT



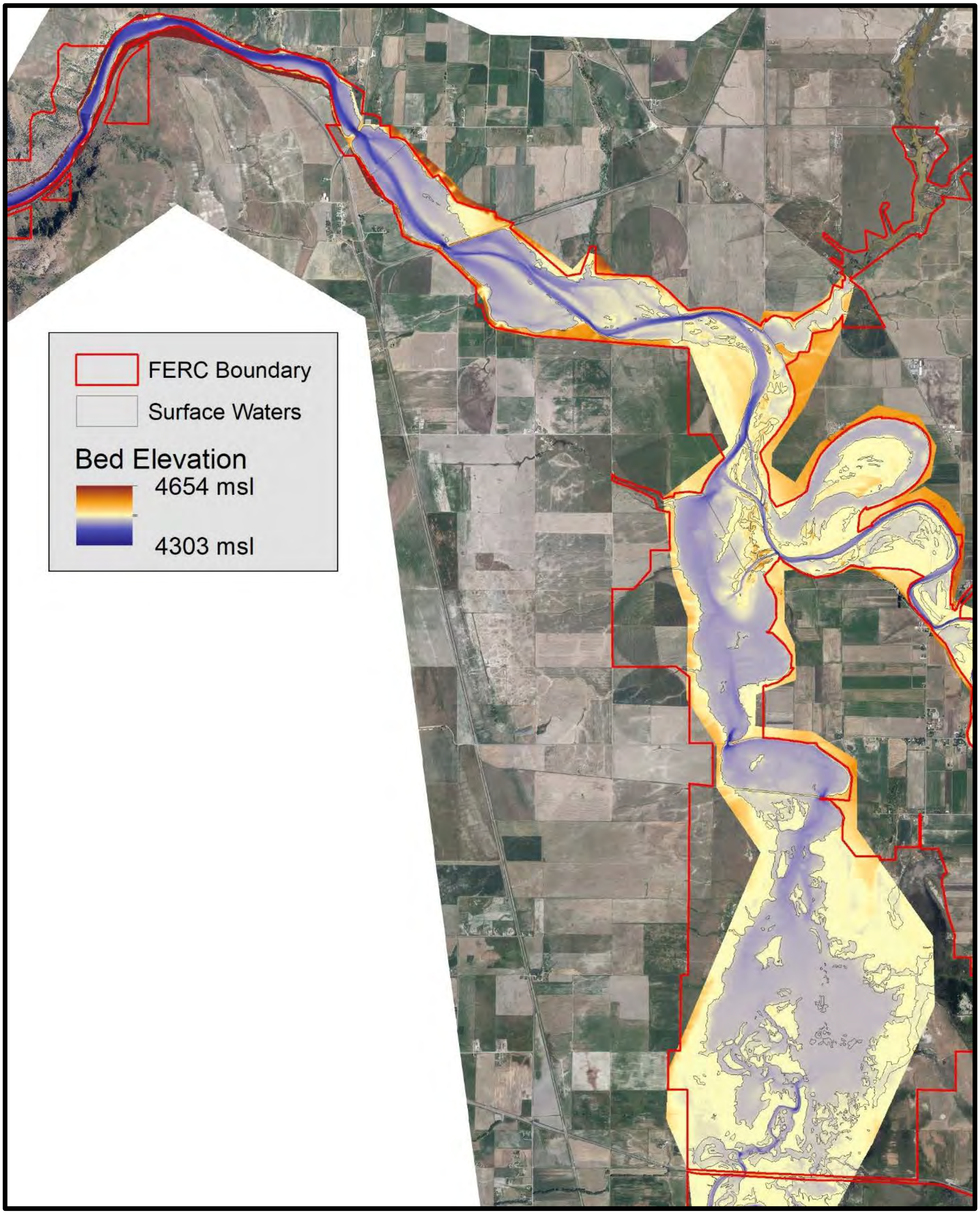
Note: Red is the 200 khz sounding, blue is the 50 khz, and pink is the 28 khz. Multiple bottoms or wounding echoes can be seen moving deeper. The multiple bottoms can also be seen on the scope (left side of image). Bottom sediments in this cross-section are shown from core logs and provided for context within the image.

FIGURE 4-2 CROSS SECTION OF CUTLER RESERVOIR IN CUTLER CANYON ABOVE WHEELON DAM



Note: Top left is 200 kHz showing active bed elevation. Top right is 50 kHz showing softer more recent deposition. Lower left is 28kHz showing deeper deposition in the reservoir. Bottom right is the combination of the three frequencies. Lower dotted red lines are multiple bottoms (echoes), yellow line is mapped bed below deposition.

FIGURE 4-3 CROSS-SECTION OF CUTLER SHOWING THE PENETRATIVE DEPTHS OF DIFFERENT FREQUENCIES INTO LACUSTRINE SEDIMENTS



Note: Area includes a section of the North Marsh (bottom), Benson (middle), Bear River (right), Clay Slough to the railroad bridge, and Cutler Canyon to just downstream of the inundated Wheelon Dam (upper).

Figure 4-4 Current Bed Elevation Raster of a Portion of Cutler Reservoir

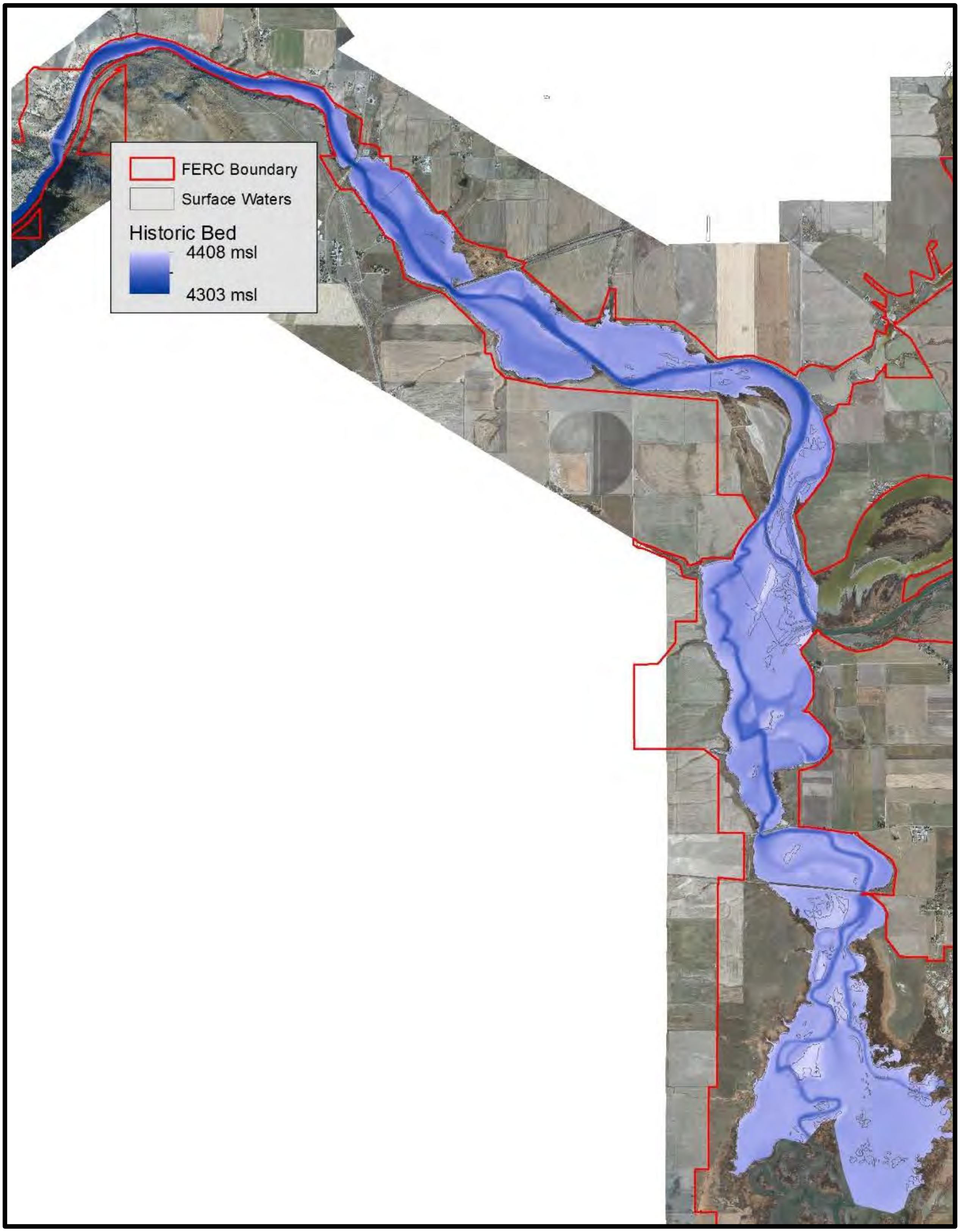


Figure 4-5 Image of the Original Channel, Mapped to Historic Bed Elevations

4.3 PHOSPHORUS DISTRIBUTION IN SEDIMENT

P is a key water-quality issue in the Project Area. Cutler Reservoir has become a sink for excess external loading of P that is not consumed biologically, and now exhibits a significant internal recycling of P. P is passed through the Bear River system as a result of surrounding land-use practices combined with surface runoff and NPDES discharges. This accumulation of P over the decades has pooled in the bed sediments of the reservoir.

Data from the 2018 Water Quality Analysis and Summary Report for Cutler Reservoir (PacifiCorp 2020) and the Middle Bear River and the Cutler Reservoir Total Maximum Daily Load (TMDL) (UDWQ 2010) confirm that TP concentrations within the reservoir are consistently higher from year to year and on average two times higher at sites south of Benson Marina . Similarly, TP samples collected by Utah State University (USU) over the past decade suggest the North and South Marsh units of Cutler contain the highest concentrations of TP (Wurtsbaugh and Lockwood 2007, Wurtsbaugh et al. 2008, and Mears and Wurtsbaugh 2009). While concentrations are variable from site to site and year to year, TP concentrations in these units are consistently up to five times higher than other locations as a result of continued internal recycling and external loading. Variability in TP concentration may be driven by Logan City wastewater discharge timing (additional information is available in Appendix F of this ISR), load (flow multiplied by concentration), and a range of natural variables.

Potential changes in Project operations could affect velocity and re-suspend sediments, which could exacerbate the existing high concentrations found in the water column and, in turn, affect the P load of water leaving the reservoir. Analysis of this issue will be incorporated in the DLA, specifically including the refined operations proposal, and results from the sediment transport model.

P in the upper 4 inches of sediment is most often associated with whole-lake metabolism. P mobilization can occur down to 10 inches, but the actual depth is dependent on sediment characteristics (Søndergaard et al. 2003). Loosely bound sediment, or floc, typically has an interstitial void with a large portion of sediment volume composed of water between the particles. This upper region of sediment is highly mobile and poses the greatest potential for resuspension, either from wind-driven mixing in shallow areas or from operational changes in water surface elevation (WSE) and water velocity.

Per the Revised Study Plan (RSP) methods, the general sample locations presented in the RSP were refined as described below.

Modified sample locations were located as close as possible to the initially proposed sample sites and were loosely associated with past sampling locations from USU research of TP in Cutler Reservoir. Precise sampling locations were selected based upon sediment structure when the first sampling event occurred (Figure 3-2).

P samples were collected seasonally (four sampling events) to better understand the dynamics and changes that may occur in the system. Temperature, flow, storm events, and discharge load affect the P concentrations and metabolism of the reservoir seasonally.

Sampling occurred from a boat to minimize disturbance of the water column or reservoir bed. When the boat would not remain stationary due to drift from current or wind, sampling occurred while standing in the water. A radial sampling pattern (i.e., extending in the same direction from the boat and into the current) was used to move away from any disturbed sediments or material that was resuspended during sampling. Each proposed site included four vertical integrated samples, separated into multiple layers for analysis. The 3-inch acrylic tube was gently lowered through the water column and into the bed sediment. The top was then capped to create a vacuum for extraction. Upon removal, the bottom was capped to eliminate sediment loss and carefully mounted vertically to not disrupt the sediment-water interface (Photo 4-1). Vertical holes in the tube drained column water down to the sediment-water interface. Reservoir water was composited with equal amounts from each column, mixed, and preserved for P analysis, including TP and orthophosphate (reactive), and was field filtered using a 0.45-micrometer (µm) filter for total dissolved P (soluble).

Beginning at the sediment-water interface down to 4 inches, sediment samples were placed in large containers. Each of the four sediment samples was roughly equal in volume. Samples were then sealed and placed in a cool dark area until pore water was extracted.

PHOTO 4-1 EXAMPLE OF INTEGRATED COLUMN SAMPLE FOR THE SEDIMENT STUDY TAKEN FROM CUTLER IN MARCH 2020

Within 8 hours after sampling, the water in the pore spacing was extracted, filtered using a 0.45-µm filter, and preserved for TDP. Vacuum pressure was applied to each container to aid in separating water from the sediment. If insufficient water was available, the sample was shaken, and vacuum pressure reapplied. Approximately 60 milliliters were removed from the sediment samples at each site. Water samples were allowed to settle before filtering occurred to reduce the need to change filter papers. The filtered samples were refrigerated until they were delivered to USU Analytical Lab. All samples were delivered within 24 hours of sampling.

Additional field notes at each site included: date, time of sampling, location ID, and weather conditions. Additional measurements included air temperature, water temperature, and dissolved oxygen (DO) to document conditions while sampling (Table 4-5).

TABLE 4-5 DISSOLVED OXYGEN AND TEMPERATURE MEASUREMENTS AT EACH SAMPLING SITE

DISSOLVED OXYGEN (MG/L)				
Site	**March**	**June**	**September**	**November**
1	8.49	8.19	8.41	10.15
2	9.77	7.03	7.65	9.97
3	7.77	7.01	7.6	10.17
4	11.2	10.67	6.91	15.75
5	8.64	6.5	7.34	9.62
6	10.11	8.19	7.36	12.89
7	9.09	8.32	8.1	11.48
8	7.25	6.67	7.66	14.22
9	9.51	8.22	7.17	11.68
10	9.71	10.85	8.42	12.46
11	10.13	8.13	8.04	11.84
WATER TEMPERATURE (°C)				
1	3.48	22.64	15.44	7.44
2	5.64	24.7	18.2	7.44
3	6.88	24.96	18.6	7.84
4	8.04	19.52	17.7	7.92
5	8.24	21.68	20.6	9.6
6	7.96	20.28	21.34	8.82
7	7.5	22.56	23.46	8.92
8	8.52	23.4	20.08	9.28
9	7.38	20.34	20.74	8.52
10	8.48	20.98	18.02	10.42
11	7.46	22.52	18.32	9.02

4.4 MODIFICATIONS TO METHODOLOGIES

The methodology used for the Sediment Study includes two changes from the RSP, namely:

1. Modifications were made regarding selection of core sample site locations. A stratified random sampling technique was originally proposed to collect core samples. The sampling approach was subsequently modified to increase the number of core samples in the channel. The rationale for this change was to ensure the historic (i.e., prior to construction of Cutler Dam) river channel was sufficiently sampled. The river channel has much deeper and older sediment deposits and may be prone to movement under high spring flows. Finally, three times the number of core samples than originally proposed in the study plan were collected due to the high variability in the sediment deposits and bed structure.

2. Modifications regarding the distribution of P in the sediment study included a decreased tube diameter from 4 to 3 inches (resulting from limitations in the sampling materials supply chain) and composited sample collection. Instead of one sample, four samples at each site were collected and composited. This change was driven by the discovery during initial sampling of the limited ability to extract enough water from a single core sample to analyze for DTP in the interstitial voids of reservoir sediment. The use of a composite sample helped to smooth anomalies in the data that could occur if a single sample were measured with extreme concentrations of a parameter.

5.0 RESULTS

5.1 REVIEW OF EXISTING INFORMATION

No historical studies have been conducted on Cutler Reservoir that focus directly on sediment deposition or composition, or the effects that deposition may have. One study looked at the mass wasting events from early agricultural practices through about 1950 (Clyde 1953). The study focus area was upstream of Cutler Reservoir in the Bear River watershed and only estimated loads into the reservoir. Clyde (1953) pointed out that Cutler Dam is not the cause of the sediment deposition but has modified it in the vicinity of the reservoir.

Other reports and databases were reviewed for historical data that may be pertinent to this sediment study. These reports and databases were water quality focused and not directly relevant to this study. Some reports offered anecdotal information on sediment and high concentrations of P to balance changes in loads from site to site. However, no actual data were provided to support the assumptions and conclusion made in these reports. A detailed review of Cutler Reservoir water quality is found in the Water Quality ISR.

The reports and databases that were reviewed for sediment data include:

- *Middle Bear River and Cutler Reservoir Total Maximum Daily Load Study* (TMDL). Utah Division of Water Quality (2010).
- Ambient Water Quality Data Monitoring System (AWQMS) database. Utah Division of Water Quality (2019).
- National Water Information System (NWIS) database. United States Geological Survey (2019).

5.2 SEDIMENT COMPOSITION CORE SAMPLING

Core samples were collected from July 20, 2020, through July 30, 2020. In total, 62 cores (Attachment H-1) were drilled throughout Cutler Reservoir using a Specialty Devices Vibecore-D with 3-inch aluminum core tubes. Native material (pre-dam) was dense clay to loamy clay soil with a low water content, which reduced the penetrative ability of the vibrating corer. Depositional sediments were much easier to penetrate, consisting of sands, silts, and clays at varying percentages throughout the reservoir. Depositional sediments had a higher water content, and some areas consisted of very unconsolidated deposits. Depth to rejection (no penetration) occurred when the core tube encountered debris suspended in a depositional layer, native material was encountered, or friction stopped progress of the drill. Friction occurred most often with coarser sands found in deeper deposits. Sampling results are described below for each study reach. All elevations are reported in feet above mean sea level (msl). Any references to historic channel features in the remainder of this report indicate conditions that existed prior to construction of Cutler Dam and Wheelon Dam.

5.2.1 NORTH AND SOUTH MARSH AND BENSON REACHES

Throughout the South Marsh, North Marsh, and Benson areas, 27 sample cores were collected (Figure 3-1 and Table 4-1). Coring began at the southern end of Cutler Reservoir, south of Highway 30.

Site 1 was located in the Little Bear River channel near the confluence of the Logan River. The total core length of the sample measured 79 inches. The bottom elevation of the core tube was 4,399.6 feet. The location and elevation suggest the core tube may have encountered the former bank of the Little Bear River. Core samples in this area were expected to extend to a greater depth based on elevations from Clyde (1953). The sediment core consisted entirely of silt.

Site 2 was located in the Logan River channel upstream of the confluence with the Little Bear. A total core length of 88 inches extending down to 4,395.7 feet elevation was measured. The upper section of core consisted of silt and transitioned to a silt-sand mixture with depth. The bottom of the core consisted of poorly graded sand with little silt. This suggests the bottom of the core reached to a depth near pre-dam elevations.

Site 3 was located next to the historic Logan River channel, where the active channel remains. The bed consisted of hard native clay, and the Vibecore was unable to penetrate beyond a few inches. This suggests that any deposition was swept downstream under a range of flow condition. Deposition was visible in areas away from the active channel in lower water-velocity areas.

Sites 6, 7, 8, 10, 12, 13, and 16, located in the North Marsh south of the Benson Railroad Trail and Fishing Bridge, represent areas sampled away from the historic channel. Sediment deposition at these locations measured a range from 18 to 34 inches. This depth includes some material from the restrictive layer as shown in the core logs (Attachment H-1). Across all the sites, the historic bed elevation prior to impoundment from the Cutler Dam appears fairly flat at an elevation range of 4,402 to 4,403.6 feet (Table 4-1). Deposits on the native layer are classified as silt. Deposits near the surface are unconsolidated, highly saturated, and have a high potential for mobility. As deposition depth increases, the silt layer tends to consolidate.

Sites 20, 21, 23, and 26 were located away from the historic channel and north of the Benson Railroad Trail and Fishing Bridge, through Benson Marina. These sites had cores with a similar deposition depth range of 12 to 30 inches. Deposition structure was similar to previous sites with unconsolidated material on the surface becoming more structural with depth or consolidated material consisting of silt. Native material was similar in structure, consisting primarily of hard loamy clay. Elevation of the historic river benches tended to slightly decrease, ranging from 4,403.4 to 4,400.7 feet (Table 4-1), suggesting a gradual slope from south to north as the Logan River flowed downstream.

The Logan River channel meanders through the historic river floodplain under what is now Cutler Reservoir. The meander can be seen from 1937 aerial photographs in areas of the study reach (Photo 2-2). A number of oxbow channels can be seen in this area as well. A total of 14 cores were drilled to characterize the Logan River from the South Marsh to the confluence with the Bear River, north of Benson Marina.

Sites 5, 9, 11, 15, 17, 18, 19, 22, and 27 were all located in the historic channel of the Logan River north of Highway 30 and extending to the confluence of the Bear River. Historic riverbed elevations range from 4,397.3 feet at Site 19, to 4,393.3 feet at Site 22 (Table 4-1). The source of variability in bottom elevations measured for these samples is not known. Possible reasons include buried debris in early deposits, variability in the channel, or friction due to larger material at greater depths. Core depths for these sites ranged from 89 to 117 inches. A core from Swift Slough was taken at Site 14; a core from an oxbow bend at Benson Marina was taken at Site 25 (Figure 3-1).

Core samples throughout this study reach consistently had upper deposits of silt with an unconsolidated and highly mobile top layer. Sediment deposits tended to become firmer, bear structure, and gain plasticity with depth (Photo 5-1). Within the river channels and oxbows, sand gradually became dominant, with the deepest cores being well graded fine to medium-fine sand (Note: classified as SM silty sands Photo 5-2). Attachment H-1 illustrates the gradient of each core drilled.

PHOTO 5-1 SECTION OF CORE SAMPLE REMOVED AT SITE 11 IN NORTH MARSH

Note: classified as SM silty sands

PHOTO 5-2 DEEPER DEPOSITS OF FINE SAND WITH SILT INTERMIXED

5.2.2 BEAR RIVER INFLOW REACH

Eight sediment cores were collected in the Bear River Inflow Reach (Sites 28–35). During inspection of the core samples, it was determined that no further upstream cores were necessary due to the homogeneity in soil classification and sediment structure throughout the cores. This reach is highly dynamic, has continuous flow resulting in bed movement, and has more riverine than pool habitat.

Site 28 was located near the confluence of the Logan and Bear Rivers in an area where higher spring flows move any deposited sediment. The bottom elevation of the core was 4,400.6 feet, indicating the core was located on the bank of the old river channel. The core structure was hard clay, similar in nature to other native material and bottom core samples collected outside the channel.

Sites 29, 30, 31, 32, and 33 were all located in the main channel of the Bear River. Core depths ranged from 32 to 94 inches. The cores in the Bear River consisted of fine sand with a small percentage of medium sand, and some silt. The bottom elevation achieved in the cores ranged from 4,395.2 to 4,391.6 feet. It is not known whether the historic riverbed elevation is below these elevations. Areas surveyed with bathymetry on some of the river bends between core sample sites show bed elevations as deep as 4,389.9 feet. These deeper areas observed in the bathymetry may be a result of natural scour, similar to what was observed at bridge crossings.

Site 34 was near the large delta formed by deposition separating the Bear River and Benson Marina. The core sample consisted of all native clay material with little silt on top. This is an active channel during spring runoff, and little deposition exists. However, the banks on either side are a result of deposition from the Bear River. The historic and now inundated river bench elevation was 4,401.3 feet.

Site 35 was located in an active channel that was either the main channel or a side channel prior to the impoundment of Cutler Reservoir. The total core depth was 73 inches to a bed elevation of 4,396.0 feet. Sediment retrieved from the core was quite different from other river samples, consisting of more silt and some very fine sand, with the top 12 inches consisting of mostly fine sand (SM).

5.2.3 RESERVOIR REACH

Seventeen sediment cores were collected in the reservoir reach from the Bear River confluence to Newton Bridge (Sites 36–52). Cores were more complex in depositional areas compared to others reaches. This condition could be the result of more open water, greater depth, and a wider range of flows seasonally. The historic river channel was located and cored, eight times. The lateral edges and areas outside the historic and inundated river channel were cored nine times.

Core samples 37, 39, 43, 45, 46, 47, 50, 51, and 52 were located on the historic river benches and/or old oxbows of the river. Elevations ranged from 4,396.9 to 4,402.4 feet. Sites 45, 50, 51, and 52 are the four lowest sampled elevations for areas outside the historic channel. These four sites are assumed to be old main channel banks or oxbows.

The core depth to native material for the nine sites ranged from 6 inches at Site 39 to a depth of 100 inches at Site 50. Throughout this reach, core samples located nearer to but outside of the historic channel tended to have fine sands, while samples closer to the reservoir edge had more silt. In this reach, less unconsolidated material was noticed in many of the core samples and tended to be more of a sand-silt mix. This is most likely the result of a greater load of Bear River sediment than Logan River sediment.

Sites 37, 39, and 43 all had shallow core depths of 6 to 10 inches. Bed elevations for these three samples ranged from 4,400.2 feet to 4402.4 feet and contained medium clay with little organic composition. Bed material suggested that these areas are original elevations of the river benches. Site 37 was located in the existing main channel. The bed elevation at Site 37 (similar to inundated river bench elevations elsewhere) and clay texture indicate the current river location is out of its original channel. Sites 39 and 43 were in an area that suggests seasonally active flow that scoured deposition to its original elevation. As the reservoir broadens west of Clay Slough, Site 39, located off the main channel, diverts some flow north towards the northern edge of the reservoir near Newton Creek where it scours sediment deposits near Site 42 downstream.

Site 45 had a core depth of 74 inches with the top 2 feet being silt with very fine sand. Below the top layer, down to 41 inches, the core consisted of fine sand with silt. From 41 inches down to the restrictive layer, the core consisted of very fine sand and silt.

Sites 46 and 47 had core depths of 37 and 25 inches, respectively. The Site 46 surface layer was silt, while Site 47 was silt sand. The restrictive layer was hard clay.

Sites 50, 51, and 52 were all located between the Union Pacific Railroad Bridge and the Newton Bridge. Sample depths varied greatly, ranging from 48 to 100 inches. Surface layers were mostly fine sand with Sites 50 and 51 having more silt than Site 52. Beyond the surface layers, all sites were mostly fine sand with little fine material. No restrictive layer was encountered at Site 50.

Sites 38, 40, 41, 42, 44, 48, and 49 were all located in the historic channel. Bed elevation ranged from 4,395.5 to 4389.2 feet. Site 41 had the shallowest depth, which was potentially due to encountering an obstruction buried in the channel. Core lengths ranged from 65 inches at Site 41 to 122 inches at Site 44. All cores consisted of mostly sand with more silt near the surface and grading to cleaner sand with fewer fines at depth. Large sand grains and fine gravel were recovered at 118 inches at Site 44.

5.2.4 CUTLER CANYON REACH

Six sediment cores were collected in the Cutler Canyon reach (Sites 53–56, 61, 62). The historic channel in this reach is well defined downstream to Wheelon Dam. The side slope above the banks of the reservoir is steep in most places. Sediment cores were collected in the thalweg of the reservoir channel. Similar to the other river channel sites, sampling efforts attempted to penetrate through all depositional layers and as deep as possible in order to reach the original bed structure of the river.

Sites 53, 54, 55, 56, 61, and 62 were all located in the thalweg of the channel. Site 53 was located immediately upstream of Newton Bridge, and Site 61 was located at the upstream foot of Wheelon Dam. Bed elevations ranged from 4,389.8 to 4,384.8 feet. Sediment core lengths ranged from 41 to 120 inches. Fine sand was the dominant texture in the upper layer of the core at Site 53. At Site 61 near Wheelon Dam, finer silts and some fine sand was prominent in the upper layer of the core. Measurements at these two sites indicate that larger sediment tends to be deposited upstream, while finer silts are carried further downstream in the canyon.

Site 53 and Site 54 consisted of fine sand throughout the core. Fine sand with some silt was found in the upper section of the cores, with well-sorted clean sand near the bottom of the cores. Site 55 and Site 56 had more silt with some fine sand in the upper core layer that transitioned to fine to medium sand at the bottom. At Site 62, the upper layer of the core consisted of silt with fine sand and transitioning to clean medium sand with some small gravel at the bottom. Clean, well-graded sand is a good indication that bottom elevation sediments are most likely pre-dam deposits. Site 61 consisted of silt throughout the much of the core and transitioned to fine sand near the bottom.

5.2.5 WHEELON TO CUTLER DAM REACH

Four sediment cores were collected in the Wheelon to Cutler Dam reach (Sites 57 to 60). From Wheelon Dam downstream to Cutler Dam, vertical canyon walls are found in most places.

Sediment deposits in this reach frequently exceeded the penetrable depth of a vibrating core sampler when friction along the core tube exceeded the ability of the sampler to excite sediment particles. Site 59 was located in the channel thalweg in more than 20 feet of water. Core sampling was limited in this narrow part of the reservoir due to substantively greater water depth and subsurface currents that produced vertical instability and prevented tube sections from being added to increase sample depth.

Sites 57, 58, 59, and 60 were all located downstream of Wheelon Dam. Core sample depths ranged from 96 to 177 inches. All core samples were silt with some clay material and little very fine sand. Sediment cores became compact with depth as overlying material pushed water from the voids. Marble sized gravels were identified interspersed throughout the core. This material was likely due to rock falls that deposited material over time.

In general, deeper core samples included sediments that trend toward fine sand (indicating early deposition) when compared with other core samples. Samples collected from the old riverbed in the deepest areas of the reservoir include clean sands and gravels that would likely have been deposited soon after Cutler Dam was finished.

5.2.6 SEDIMENT CORE ANALYSIS

Sediment cores were the primary input for the HEC-RAS Sediment Transport Model for the reservoir. Details of the model analysis are included in the Hydraulics Study Report (Attachment H-1). The Sediment Transport Model uses sediment particle size combined with shear strength to model the mobility of bed sediments and determine the velocity at which scour would begin to move bed or bank material. A shallow core was taken in Clay Slough specifically to analyze particles size for the Sediment Transport Model because it was identified early as an area that may be susceptible to erosion at lower water surface elevations.

In total, 30 sediment cores from 24 sites were further analyzed for size class. The material in the samples was sorted through a series of sand sieves (e.g., starting with 1.0 mm, 0.50 mm, 0.250 mm, 0.125 mm, and 0.050 mm), at the USU Analytical Lab (USUAL; Table 4-2). The weight retained in each sieve was expressed as a percentage of the total sample. Material finer than 0.050 mm was removed and used in the calculation of the total sample percentage.

A second analysis was conducted using a hydrometer to calculate the percentage of finer silt and clay-sized particles measuring greater than 0.050 mm. Prior to the hydrometer test, all samples were dried and processed through a 0.050-mm sieve to remove sand-sized particles. This percentage of the sample was expressed in the hydrometer column of Table 4-2. Hydrometer test results represent the fraction of finer material for silt and clay particles. Silt class-size ranges from 0.050 to 0.002 mm and clay particles are defined as material smaller than 0.002 mm. It should be noted that the sand sieve and hydrometer tests are two different analyses. Therefore, sample results by percentage may vary slightly between the two tests for any given site.

Sand was the dominant particle in 16 of the 30 sediment samples throughout the reservoir. Silt particles were dominant in the remaining 14 samples. No sediment sample was dominated by clay-sized particles. Thirteen samples consisted of more than 50 percent sand (mostly very fine sand and fine sand). Ten of the 13 samples in the Bear River and reservoir reaches were dominated by sand. Ten of the 16 samples in Cutler Canyon, Wheelon to Cutler Dam, and North and South Marsh and Benson reaches were dominated by silt.

5.2.7 SEDIMENT CORE CALCIUM CARBONATE ANALYSIS

Ten samples in six cores were analyzed for $CaCO_3$, Al, Fe, and TP. Samples were processed at USUAL to an elemental level. $CaCO_3$ was tested using standard methods from the Soil Science Society of America by dissolving the carbonate.

$CaCO_3$ is a substance consisting of calcium, carbon, and oxygen. The main sources of $CaCO_3$ in the Bear River are carbonate-dominated bedrock such as limestone and dolomite. Because $CaCO_3$ has been shown to bind phosphate in the water column through absorption and then settle through precipitation, core samples were tested for percent $CaCO_3$. TP concentrations in core samples ranged from 0.06 to 0.1 percent, and $CaCO_3$ ranged from 16.7 to 44.6 percent. It is unknown how much P measured in the sediment samples is bound to $CaCO_3$. Al and Fe are two additional ions that can bind to P during cation exchange (discussed later in this study). Al and Fe percent ranged from 0.22 to 1.33 percent and 0.50 to 1.32 percent, respectively. These parameter measurements provide an indication of the concentration of ions in the sediment that can immobilize P; therefore, reducing the potential for increased dissolved P concentrations in the water column.

5.2.8 SEDIMENT CORE METALS ANALYSIS

Three sediment cores were tested for the presence of eight Resource Conservation and Recovery Act (RCRA) metals (Table 4-4). The three sample sites included Site 26 (Benson Marina), Site 52 (Newton Bridge), and Site 62 (Wheelon Dam). Five of the eight metal tests detected arsenic, barium, chromium, lead, and mercury. Arsenic was the only metal with measured concentrations exceeding thresholds for exposure under residential and commercial level limits. Soils in the Bear River Basin have relatively higher background levels of arsenic that are naturally occurring from the erosion of native rock. Deposition from 20th century air pollution sources (regional mining and smelting activities) may add to that level, resulting in higher levels as reservoir sediments accumulate, unrelated to Project operations (Waddell et al. 2003). The screening levels in Table 4-4, have thresholds for residential and commercial exposure. Arsenic has two exposure limits under each threshold, including limits that protect against carcinogenic risk or noncarcinogenic hazardous effects (USEPA 2017). Arsenic exceeded both carcinogenic risk limits (i.e., residential and commercial) at all three sites. Arsenic did not approach noncarcinogenic hazardous limits. All other metals were well below both limits.

5.2.9 SEDIMENT CORE PESTICIDE ANALYSIS

The same three samples were also tested for the pesticides DDT and DDE and PCBs. All sample results were below detectable limits for any pesticide or PCB (Table 4-4).

5.3 DISTRIBUTION OF SEDIMENT IN CUTLER RESERVOIR

Sediment deposits throughout Cutler Reservoir were highly variable in depth and composition. The depth of sediments was subject to location, flow velocity potential, bed topography, and substrate size. As discussed above, core sample depths and composition showed high variability across the reservoir due to old, inundated river channels and oxbows having deeper deposits than inundated river channel benches. There was an overall and expected trend for deeper sediment deposits closer to Cutler Dam.

To estimate the overall impact sedimentation has had on Cutler Reservoir, a bed-elevation raster was created using the sub-bottom soundings to map the bed elevations below sediment deposits. These sub-bottom elevations would be the ground surface or riverbed prior to the construction of Cutler Reservoir (pre-inundation) and in some areas prior to Wheelon Dam. Measured core-depth elevations were compared with the raster generated from the sub-bottom soundings to check the accuracy of mapped bed elevations. A comparison of mapped elevations from the raster with the core-elevation data produced an R^2 of 0.83 (Figure 5-1). Note that core measurements downstream of Wheelon Dam were not included in the regression analysis because sediment depth exceeded the corer capabilities, and the accuracy of the interpolation in this reach is therefore unknown.

Cutler Reservoir depths were relatively shallow in most areas upstream of Wheelon Dam, generally less than 25 feet in the channel. Downstream of Wheelon Dam, water depth was much greater, and when initially constructed, the water depth behind Cutler Dam would have been approximately 100 feet. Current estimates of sediment depth behind Cutler Dam are potentially as much as 90 feet. The deeper sediment deposits downstream of Wheelon Dam exceeded the capability of the lower frequencies emitted by the sounder, which did not penetrate to the historic riverbed and would have allowed more precise measurements of the sediment deposition in these areas.

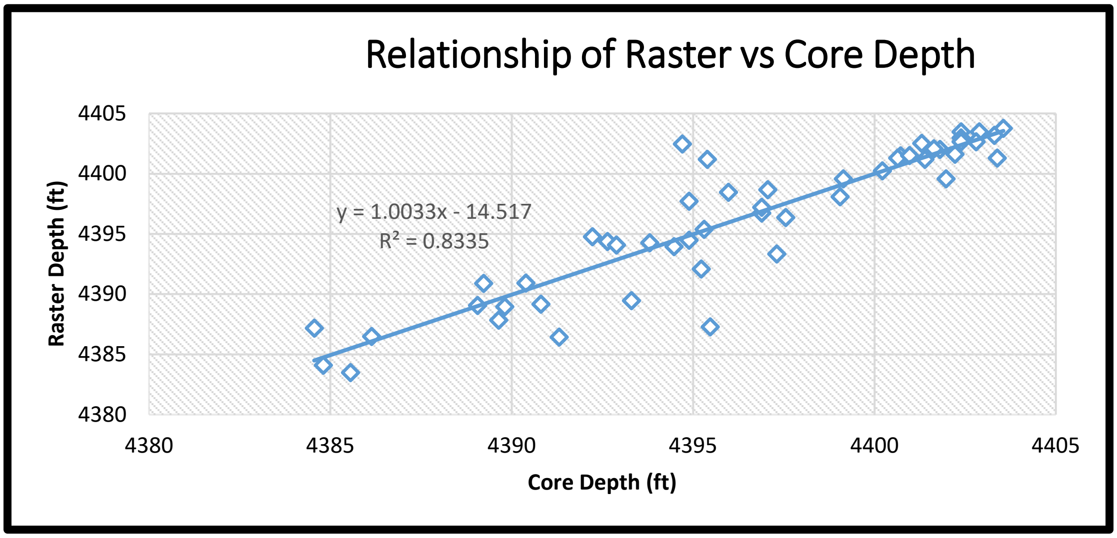


FIGURE 5-1 RELATIONSHIP BETWEEN INTERPOLATED RASTER DEPTH AND PHYSICAL CORE DEPTH DATA

Additional data sources were used to develop a bed-elevation model between Wheelon Dam and Cutler Dam where direct measurements were not possible. Data included previous survey measurements from the base of Cutler Dam, LiDAR measurements collected immediately downstream of the dam face and surface slopes adjacent to the reach, and pre-dam photographs of Cutler Canyon to determine the slope of inundated areas (Photo 2-3 and Photo 2-4). These additional data sources were used to make reasonable estimates of historic bed elevations, build elevation contours, and calculate sediment deposition downstream of Wheelon Dam.

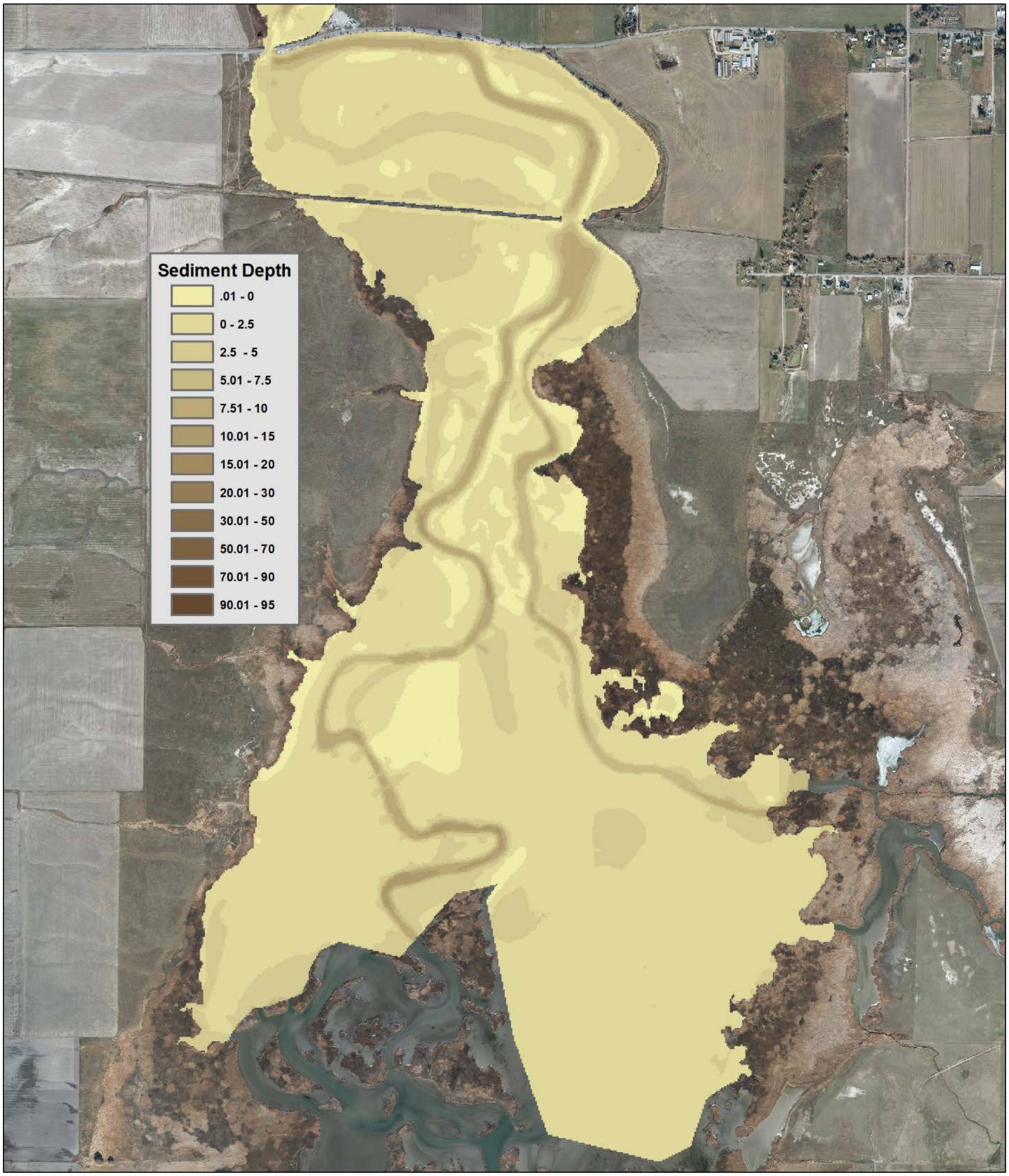
The area located between the current Union Pacific Railroad Bridge and Benson Marina at the confluence with the Bear River presented challenges in mapping the extent of sediment deposition. The pre-dam elevation profile was difficult to re-create in this area, where the river channel has substantial sediment deposition creating bars, vegetated islands, and other non-wetted or shallow areas. These areas were inaccessible for collecting sub-bottom soundings, primarily due to limitations in water depth. In areas where the channel could not be mapped, aerial photographs from 1937 were used, where available, to identify the location of the channel. Bottom elevations from core data were then used to interpolate the elevation of the river channel in these locations.

5.3.1 NORTH AND SOUTH MARSH AND BENSON REACH

The Logan River has generally maintained its original channel in the South Marsh and in most places in the North Marsh (shallow water depths in the Little Bear and Spring Creek channels prevented assessment of original channel locations in these two smaller tributaries). Once the river channel exits vegetated areas and enters open-water habitats to the north, the river channel is filled with sediment. Constriction points such as the Benson Trail Railroad Bridge and Benson Bridge are locations where sediment accumulates and subsequently forces water back into the channel. As a result, these areas tend to scour continually down to historic bed elevations. For example, the maximum depth surveyed at Benson Bridge is at approximately elevation 4,389 feet (Figure 5-2). The historic channel elevation is maintained for a short distance downstream of Benson Bridge until energy in the water is lost to dispersed flows and the channel is filled by deposition.

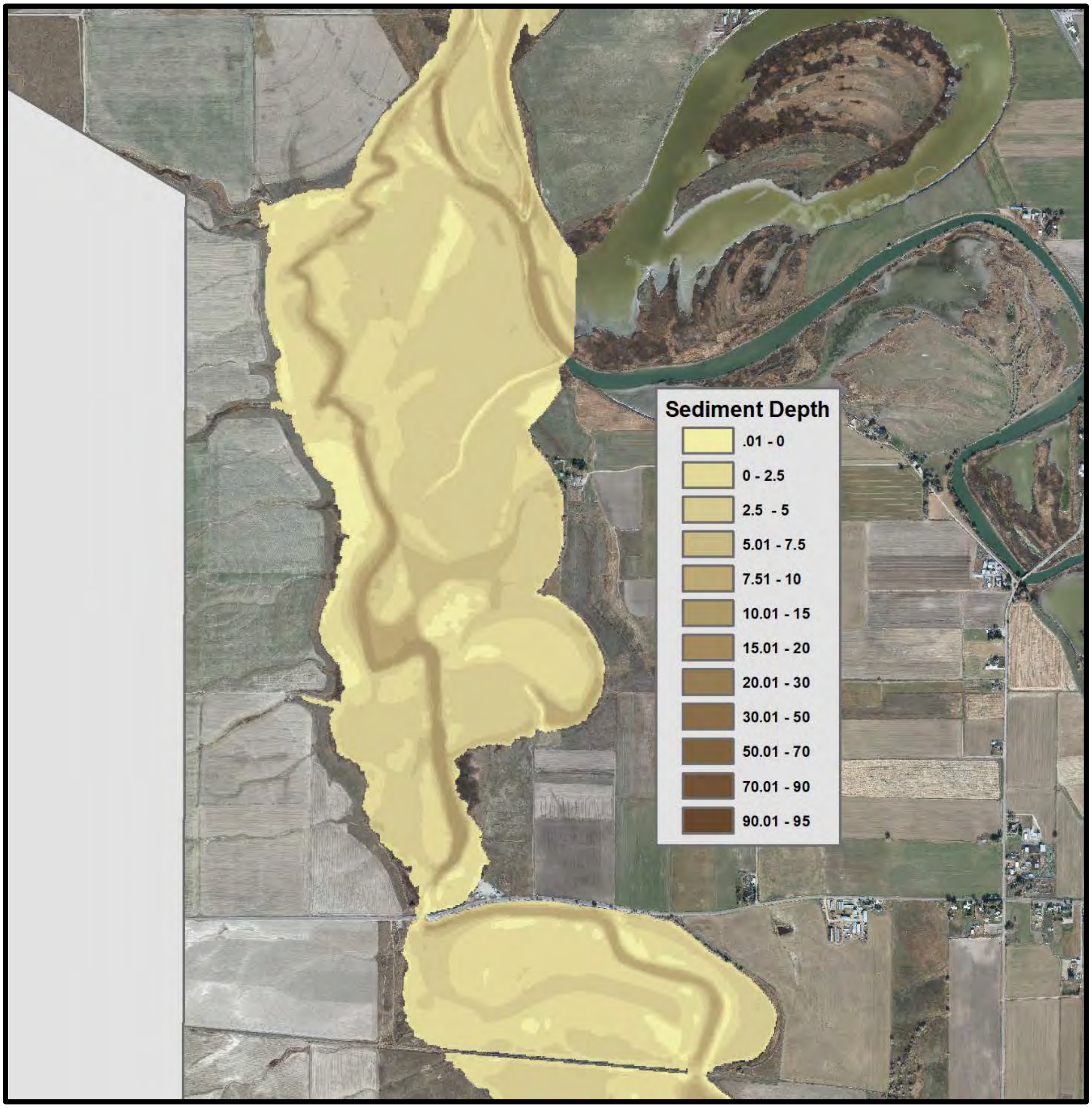
Deposition in the North Marsh was approximately 1 to 3 feet on average across historic bench areas. The Logan River channel was filled with sediment in this area, and deposits were measured in excess of 10 feet (Figure 5-2).

The Benson Marina area has a number of inundated oxbows and meanders. The historic river channel extending from this area north and downstream towards the confluence with the Bear River was difficult to map, and no aerial photographs of the historic river channel were available. Given the meander of the channel and spacing, the exact location of the channel is uncertain (Figure 5-3). Inundated river benches throughout the Benson Marina area and north to the confluence with the Bear River showed sediment depths of approximately 1 to 3 feet. At some locations in the historic river channel, sediment deposits were estimated in excess of 12 feet.



Note: Sediment depth is measured in feet.

FIGURE 5-2 MAPPED SEDIMENT DEPOSITION IN THE MARSH AREAS SOUTH OF BENSON MARINA



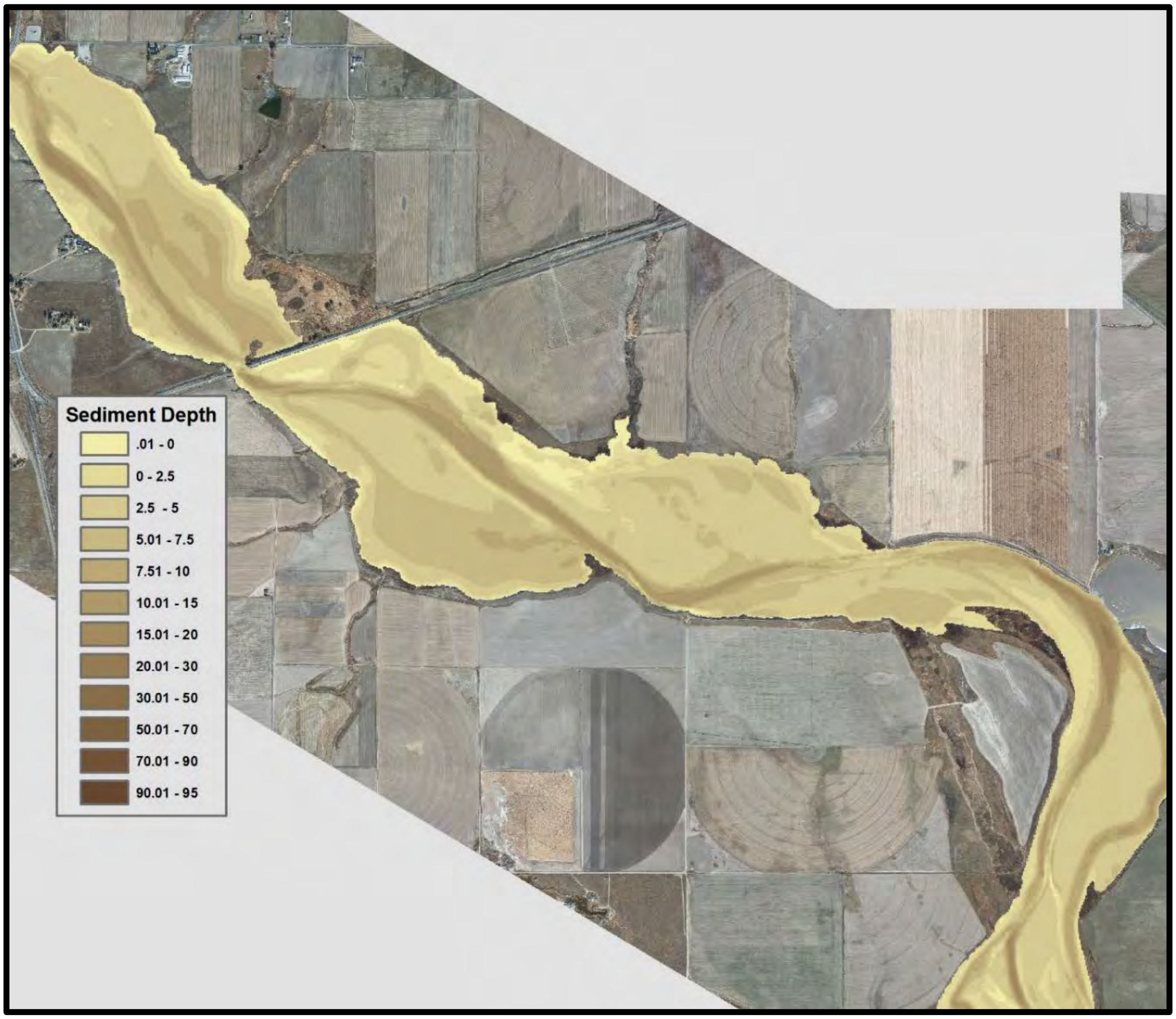
Note: Sediment depth is measured in feet.

FIGURE 5-3 BENSON MARINA AND AREAS DOWNSTREAM TO THE BEAR RIVER CONFLUENCE SEDIMENT DEPOSITION MAP

5.3.2 BEAR RIVER INFLOW REACH

A large delta has formed between Benson Marina and the Bear River Reach that has become vegetated over time. Previously (prior to the 1980s), this area was generally open water in the reservoir. The bed elevation model suggests there is now approximately 4 to 5 feet of deposition across the delta (Figure 5-3). The delta formed due to sediment deposition in the river channel between Benson Marina and Clay Slough, and specifically in the vicinity of the confluence with the Bear River.

The inflow of the Bear River as it converges with the reservoir, just north of the delta at Benson Marina, has partially scoured through the inundated riverbank and flows in the historic Logan/Little Bear River channel. Much of the existing open water area from the Bear River confluence to Clay Slough is now positioned outside the historic Bear River channel and above the old, inundated river bench. As much as 22 feet of sediment may have been deposited in the old river channel from just upstream of Clay Slough to the confluence with the Bear River. Much of the currently existing open water habitat has very little deposition (Figure 5-4).



Note: Sediment depth is measured in feet.

FIGURE 5-4 SEDIMENT DEPOSITION IN CUTLER RESERVOIR FROM NEWTON BRIDGE IN THE UPPER LEFT CORNER, UPSTREAM TO AREA NEAR CONFLUENCE WITH BEAR RIVER IN BOTTOM RIGHT

5.3.3 RESERVOIR REACH

Immediately downstream of Clay Slough the historic channel is generally reestablished. Much of this area was difficult to survey because of shallow water resulting from deposition outside of the channel.

The area upstream of the Union Pacific Railroad Bridge has a unique deposition/ channel migration history compared to other areas of the reservoir. The current channel in the reservoir is in the same location as identified in 1937 maps and is assumed to be the historic river channel. At some point within the past 30 years, the channel shifted toward the north side of the current reservoir. This is evident from areas of minimal deposition along the north side of the reservoir. In some places the area has scoured what appears to be old, inundated river bench area (Figure 5-4). Historically, it is likely the channel had a large meander through this area, but as a result of the Union Pacific Railroad dike and bridge, the river shifted and straightened prior to Cutler Dam construction, as seen in 1937, to what is evident today.

Downstream of Newton Bridge, deposition is greater compared to upstream locations. The reservoir is relatively deeper and narrower downstream of the Newton Bridge, which accumulates sediment deposition into a smaller area, resulting in deeper deposition areas. Sediment accumulations in some areas north of the current channel are as deep as 8 feet along the current reservoir's edge. This may have been an oxbow or channel prior to dam (Wheelon or Cutler) construction, or prior to construction of the Union Pacific Railroad Bridge.

The current channel in the area upstream of Newton Bridge remains generally similar to that present in 1937 but has straightened somewhat. This is evident from measurements showing deposition less than 1-foot-deep in the current channel. Low amounts of sediment deposition suggests the location is on an inundated river bench, given that the current bed elevation is higher than the historic channel elevation through this area. This shift in the channel could be observed during the 2019 fall drawdown. A riffle formed in the current channel where the water flowed across the historic riverbank and scoured the bank back into the historic channel (Photo 5-3). Adjacent to this riffle, along the southern side of the reservoir, the historic Bear River channel is buried by sediment deposits over 16 feet deep (Figure 5-4). Areas around the boat launch have less sediment deposition, ranging from of 3 to 4 feet in depth.

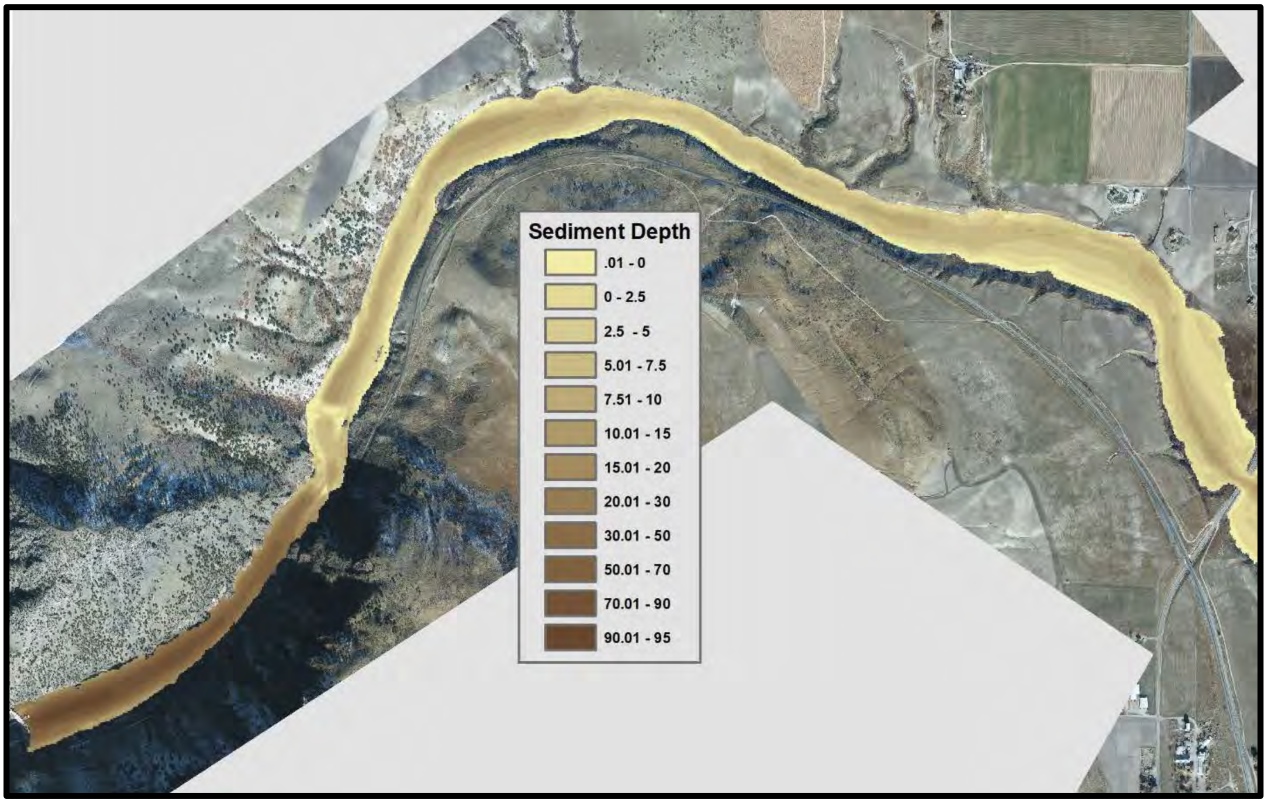
PHOTO 5-3 IMAGE OF CUTLER JUST UPSTREAM OF NEWTON BRIDGE ILLUSTRATING THE OLD HISTORIC RIVER CHANNEL RUNNING PERPENDICULAR TO THE CURRENT FLOW LINE

5.3.4 CUTLER CANYON REACH

Cutler Canyon reach, from Newton Bridge to Wheelon Dam, generally maintains the historic river channel. This is mainly due to the narrowing of the reservoir with steep banks constraining any potential river channel movement. Sediment deposition is estimated from 6 feet to as much as 12 feet in the channel (Figure 5-5). Near Wheelon Dam, sediment stacks up against the old dam face and shows substantial accumulation along the eastern side of the reservoir.

5.3.5 WHEELON TO CUTLER DAM REACH

As noted earlier and as expected, the greatest deposition occurs downstream of Wheelon Dam and is estimated to be as much as 90 feet in the small area just upstream of the dam. Currently the thalweg is on the southeast side of the reservoir and is possibly 40 feet above the historic channel in some areas near the dam. Along the dam face, as water turns towards the intake tower, sediment depth is estimated at approximately 50 feet (Figure 5-5).



Note: Area downstream of Wheelon Dam (center left, extending downstream to Cutler Dam at left edge of figure) is interpolated from known elevations.
Sediment depth is measured in feet.

FIGURE 5-5 CUTLER CANYON SEDIMENT DEPOSITION MAP SEDIMENT VOLUME ESTIMATES

Cut-and-fill estimates were created to provide a general idea of depositional volume in Cutler Reservoir. These approximations provide some insight regarding the amount of deposition that has occurred over the last century. Using the sediment-depth raster to calculate the volume, an estimated 10,131 acre-feet of sediment have been deposited. This includes deposits occurring prior to the existence of Cutler Reservoir (completed in the 1920s), due to the previous (since the late 1880s) operation of Wheelon Dam, as well as sediment bars in the original river channel. These sediment bars were identified when the sounder penetrated to a restrictive layer.

Total sediment deposition estimates include Wheelon Dam to Cutler Dam (1,468 acre-feet), Wheelon Dam to the Newton Bridge (580 acre-feet), Newton Bridge to the Bear River confluence near Benson (4,543 acre-feet), and from Benson Bridge upstream (3,539 acre-feet).

5.4 PHOSPHORUS DISTRIBUTION IN SEDIMENT

P enters Cutler Reservoir in either particulate or dissolved form. Particulate forms tend to settle into bed sediments while dissolved forms are often absorbed by organic matter including primary producers such as macrophytes or algae. These primary producers can eventually settle to the bottom as organic P in labile or refractory states.

Once P reaches the sediment, numerous chemical and biological processes occur that can permanently immobilize it in the sediment or release it through pores in the sediment surface (Sondergaard et al. 2001). These processes and chemical transformations include precipitation and adsorption to $CaCO_3$, iron hydroxides, and aluminum hydroxides, as well as contact with clay particles that can bind phosphate by adsorption and prevent biological uptake.

The release of P from bed sediments can occur through two processes. First, resuspension can occur through some mechanical mechanism such as wind or direct disturbance of the bed. Second, release can occur during a chemical process involving dissolved P. Release of dissolved P most often relies on a biomechanical reaction (e.g., microbial processes) that transforms organic P to inorganic P (USEPA 1983).

5.4.1 WATER COLUMN PHOSPHORUS

The water column in the reservoir plays a critical role in forming an oxygen rich (oxic) layer at the water column/sediment interface. This layer creates a barrier to more anoxic (oxygen poor) sediment below. The oxic layer allows iron to bind with phosphates and prevents P release from anoxic layers in the sediment. $CaCO_3$ and Al are good binders with P and are not reliant on an oxygen rich interface between the water column and sediment.

During sediment-study field work, DO and temperature were measured at each sample site. DO was saturated during each sampling event. The lowest DO measurement recorded during the any sampling period occurred at Site 5 (6.5 mg/l; Table 4-5 and Figure 5-6).

Four replicate samples were collected at each sample site, including samples from the water column and sediment. Each sample was thoroughly mixed, and composite samples at each site were collected for TP, DTP, and orthophosphate (OP) in the water column. Sediment samples were analyzed for TP in sediment and DTP in the interstitial (i.e., pore space) water of the sediment.

In general, seasonal variations in water-column P concentration tend to follow a pattern with higher concentrations observed in the summer months. This is typically attributed to lower natural flows and increased concentrations of wastewater effluent (UDWQ 2010). In some cases, the result can only be attributed to an increase in sediment load, when summer P concentrations are largely controlled by internal processes that release P from the sediment (Sondergaard et al. 2001). P retention in bed sediments exhibits a seasonal pattern that closely follows seasonal water quality variations in a lake or reservoir. In most cases, positive P retention occurs in the winter and a negative retention (or release) occurs in the summer. Retention mechanisms have largely been attributed to temperature and biological activity.

Seasonal variation for this study was measured across all Cutler sites for TP, DTP, and OP in the water column. Concentrations of TP, DTP, and OP were significantly higher in early March compared to any other sampling period. Results from March samples were not consistent with measurements reported in other systems by Sondergaard et al. (2001). External sources likely have a strong influence on P concentrations in Cutler Reservoir when biological activity is reduced. For example, during the summer season when biological activity is high, some local wastewater facilities apply their discharge to the land to reduce loading to streams, which could account for the 2020 observed reduction of P in the water column across all sample sites measured during the late spring, summer, and fall sampling events.

Substantial differences in the forms of P measured were observed across seasons (Figure 5-7, Figure 5-8, Figure 5-9). The highest concentrations of P were recorded at Site 3, including maximum concentrations of TP (0.70 mg/l), DTP (0.66 mg/L), and OP (0.58 mg/L); (Table 5-1). Site 3 maintained substantially higher TP concentrations across all sampling periods, except for June when Site 6 had higher concentrations (Table 5-1 and Figure 5-10). As temperatures warmed and biological activity increased, a reduction was observed in the concentration of all forms of P measured in the water column.

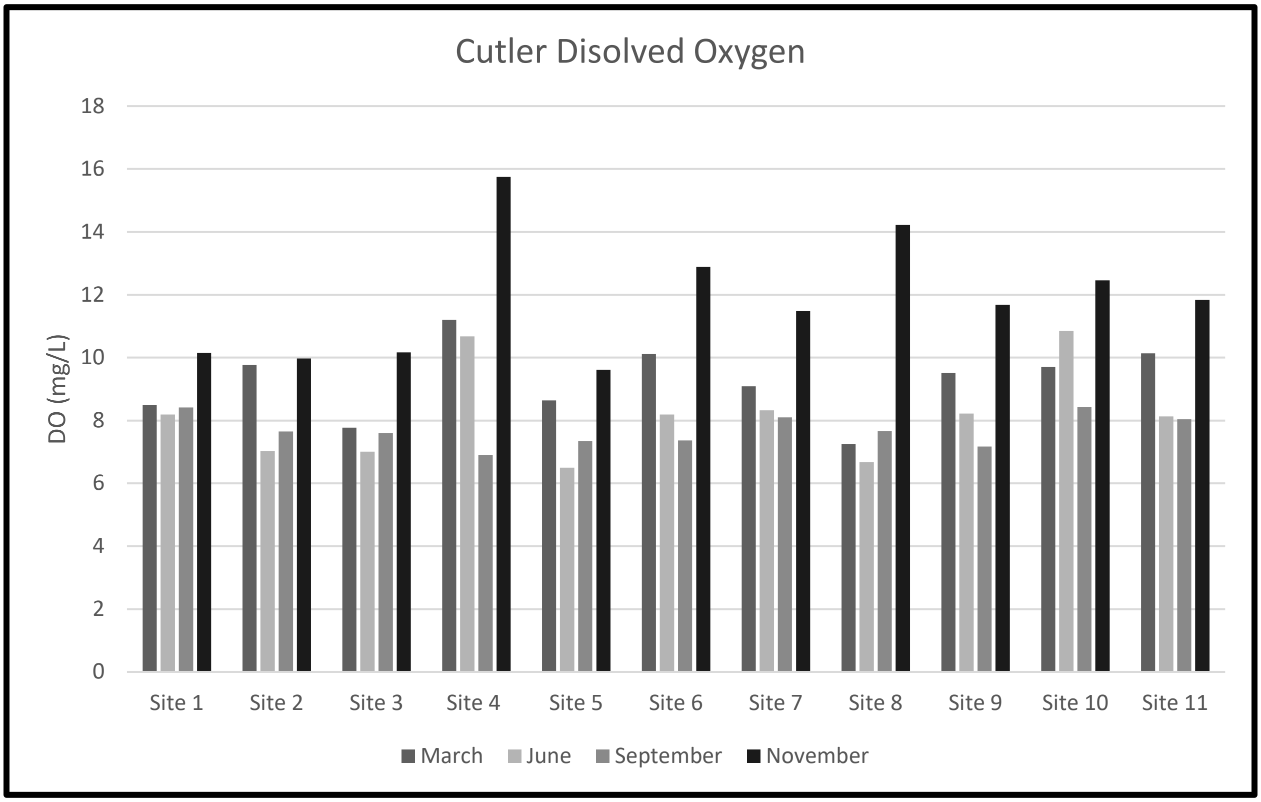


FIGURE 5-6 DISSOLVED OXYGEN MEASUREMENTS ON CUTLER DURING EACH SAMPLING PERIOD

TABLE 5-1 PHOSPHORUS MEASURED THROUGHOUT CUTLER

	Total Phosphorus (mg/L)				Total Dissolved Phosphorus (mg/L)				Orthophosphate (mg/L)			
Site	March	June	September	November	March	June	September	November	March	June	September	November
1	0.146	0.081	0.048	0.042	0.126	0.055	0.030	0.165	0.110	0.070	0.030	0.036
2	0.161	0.030	0.084	0.030	0.108	0.030	0.030	0.030	0.080	0.010	0.020	0.010
3	0.703	0.030	0.364	0.473	0.663	0.062	0.327	0.650	0.580	0.010	0.290	0.418
4	0.204	0.045	0.080	0.030	0.183	0.030	0.073	0.052	0.160	0.030	0.060	0.028
5	0.164	0.030	0.030	0.030	0.139	0.030	0.030	0.030	0.120	0.020	0.010	0.010
6	0.337	0.193	0.118	0.161	0.298	0.160	0.082	0.035	0.280	0.170	0.100	0.146
7	0.109	0.030	0.030	0.030	0.088	0.030	0.030	0.030	0.070	0.020	0.010	0.010
8	0.449	0.074	0.030	0.030	0.416	0.030	0.030	0.030	0.390	0.060	0.020	0.025
9	0.152	0.068	0.030	0.049	0.115	0.056	0.030	0.030	0.080	0.050	0.020	0.038
10	0.188	0.051	0.030	0.056	0.151	0.034	0.030	0.030	0.150	0.030	0.020	0.048
11	0.196	0.046	0.030	0.053	0.194	0.049	0.030	0.030	0.180	0.030	0.020	0.050
Min	0.109	0.030	0.030	0.030	0.088	0.030	0.030	0.030	0.070	0.010	0.010	0.010
First Quartile	0.157	0.030	0.030	0.030	0.121	0.030	0.030	0.030	0.095	0.020	0.020	0.018
Median	0.188	0.046	0.030	0.042	0.151	0.034	0.030	0.030	0.150	0.030	0.020	0.036
Third Quartile	0.270	0.071	0.082	0.055	0.246	0.055	0.051	0.043	0.230	0.055	0.045	0.049
Max	0.703	0.193	0.364	0.473	0.663	0.160	0.327	0.650	0.580	0.170	0.290	0.418
Median	0.255	0.062	0.079	0.089	0.226	0.051	0.066	0.101	0.200	0.045	0.055	0.074
Range	0.594	0.163	0.334	0.443	0.575	0.130	0.297	0.620	0.510	0.160	0.280	0.408

Note: Bold numbers are the highest observed value reported from each site during each sampling period. Note red highlighted numbers are J-flagged indicating the presence of an analyte, but at levels below the reporting limit. Reporting limit is used as the concentration in the analysis.

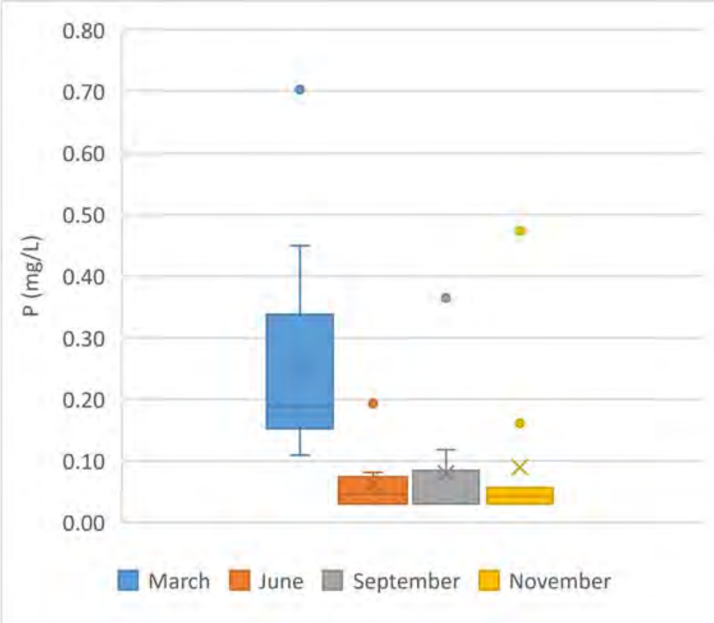


FIGURE 5-7 SEASONAL VARIANCE OF TOTAL PHOSPHORUS CONCENTRATION IN CUTLER RESERVOIR

FIGURE 5-8 SEASONAL VARIANCE OF DISSOLVED TOTAL PHOSPHORUS CONCENTRATIONS IN CUTLER RESERVOIR

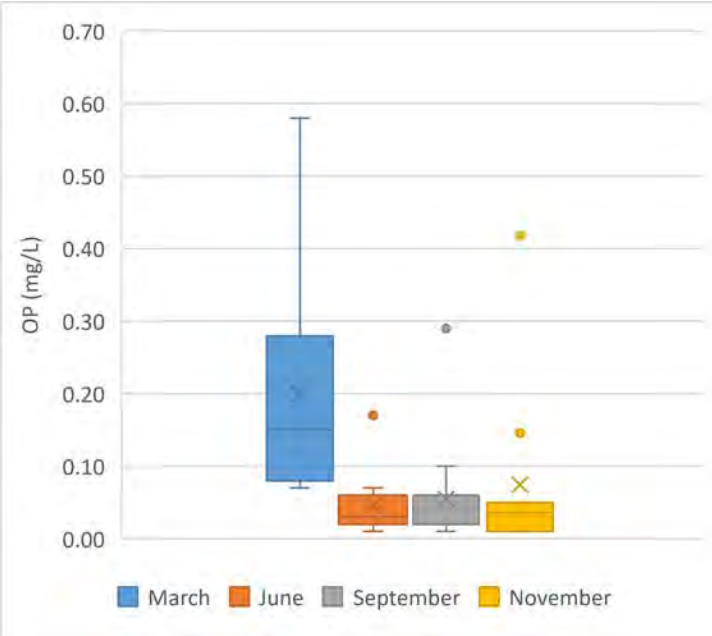


FIGURE 5-9 SEASONAL VARIANCE OF ORTHOPHOSPHATE IN CUTLER RESERVOIR

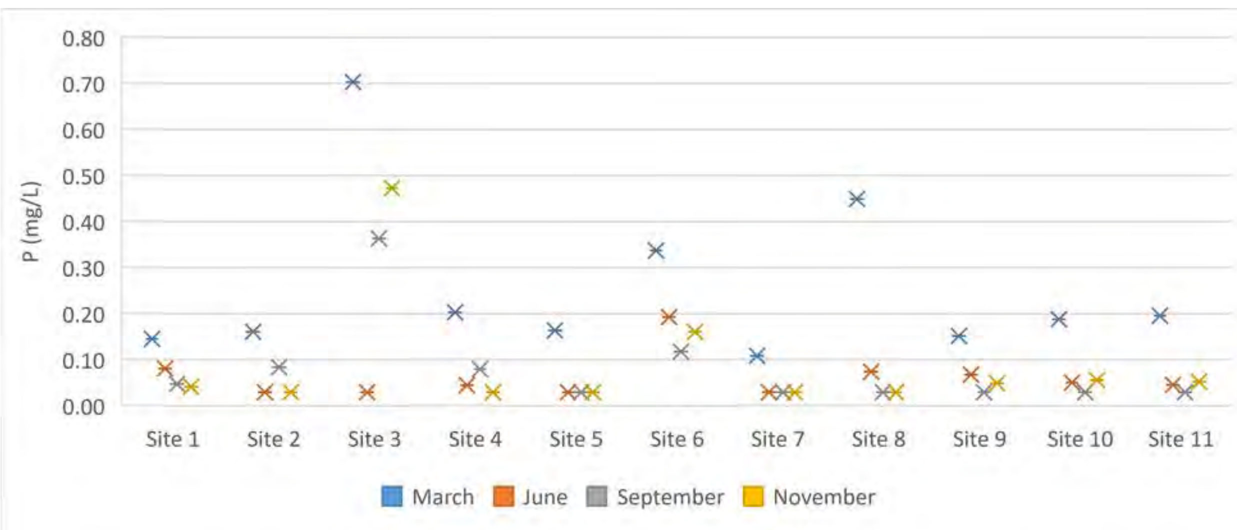


FIGURE 5-10 PLOTTED TOTAL PHOSPHORUS IN CUTLER RESERVOIR ACROSS ALL SITES BY SEASON

OP is a form of organic P and is often used as a standard indicator of water-quality health. OP results from plants converting inorganic P to organic P or animals excreting organic P. A substantial fraction of TP in Cutler Reservoir is in the form of OP. Measurements of TP and OP in the water column were analyzed to determine if OP is driving the higher concentrations of TP using a linear regression (Figure 5-11). The high concentrations of TP were mostly organic P and not inorganic P (R^2 =0.98). While some of the OP may be a result of decomposed plant material from the large wetland areas in and around the reservoir, it is likely that much of the OP is a result of external loading, given the location and history of the various wastewater inputs to the reservoir and its tributaries.

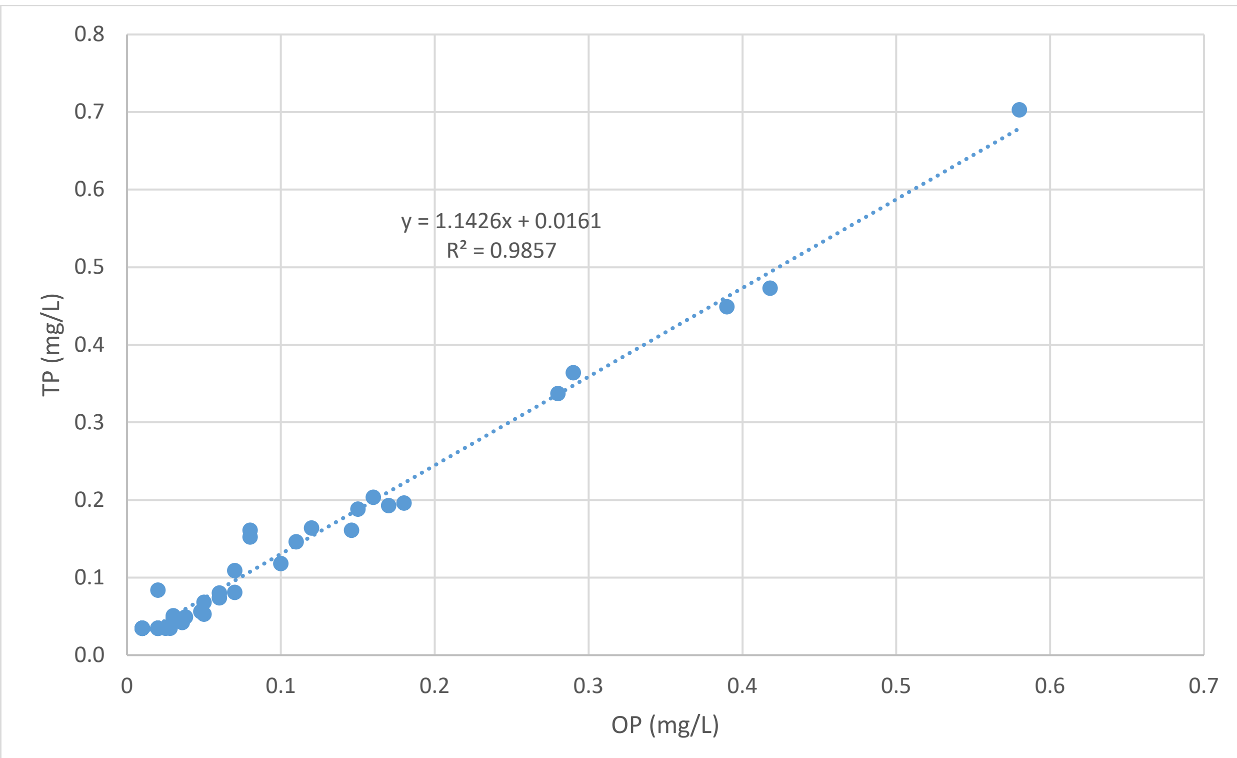


FIGURE 5-11 TOTAL PHOSPHORUS VERSUS ORTHOPHOSPHATE LINEAR RELATIONSHIP ILLUSTRATING THE CONNECTION OF HIGH TOTAL PHOSPHORUS CONCENTRATIONS DRIVEN BY HIGH ORTHOPHOSPHATE CONCENTRATIONS

To determine if higher P concentrations observed in summer were due to internal loading, a two-tailed sample of means (T-test) was used to compare concentrations of DTP in the water column with concentrations in the interstitial voids of the sediment (DTP_{sed}). Higher concentrations in the DTP_{sed}, would indicate that some biomechanism was mobilizing P and releasing it through the sediment/water interface. Using DTP in this test instead of TP reduced potential error created from measuring high TP concentrations due to resuspension created by a bed disturbance.

DTP_{sed} was significantly higher in June (p=0.015) (Table 5-2). A significant difference was expected in September based on Sondergaard et al. (2003, 2001) studies of sediment P release, but the results were not statistically significant (p= 0.29). Typical summer trends of internal P loading may be masked by high concentrations from external inputs of P to Cutler Reservoir.

TABLE 5-2 RESULTS OF THE TWO-TAILED T-TEST TO CHECK FOR SIGNIFICANCE BETWEEN DISSOLVED TOTAL PHOSPHORUS IN THE WATER COLUMN AND DISSOLVED TOTAL PHOSPHORUS IN THE INTERSTITIAL SEDIMENTS

MARCH	DTP WATER	DTP SED
Mean	0.225545455	0.383273
Variance	0.030360673	0.825452
Observations	11	11
Pearson Correlation	0.847056513	-
Hypothesized Mean Difference	0	-
df	10	-
t Stat	-0.682423824	-
P(T<=t) one-tail	0.255234483	-
t Critical one-tail	1.812461123	-
P(T<=t) two-tail	***0.510468966***	-
t Critical two-tail	2.228138852	-
JUNE	**DTP WATER**	**DTP SED**
Mean	0.053509091	0.413136
Variance	0.001357297	0.166182
Observations	11	11
Pearson Correlation	-0.000894316	-
Hypothesized Mean Difference	0	-
df	10	-
t Stat	-2.913774672	-
P(T<=t) one-tail	0.00773222	-
t Critical one-tail	1.812461123	-
P(T<=t) two-tail	***0.015464441***	-
t Critical two-tail	2.228138852	-

SEPTEMBER	DTP WATER	DTP SED
Mean	0.07237	0.4486
Variance	0.008329358	1.321483
Observations	10	10
Pearson Correlation	0.991365705	-
Hypothesized Mean Difference	0	-
df	9	-
t Stat	-1.123302505	-
P(T<=t) one-tail	0.145189255	-
t Critical one-tail	1.833112933	-
P(T<=t) two-tail	***0.290378509***	-
t Critical two-tail	2.262157163	-
NOVEMBER	**DTP WATER**	**DTP SED**
Mean	0.103954545	0.101391
Variance	0.034299035	0.015317
Observations	11	11
Pearson Correlation	0.948216326	-
Hypothesized Mean Difference	0	-
df	10	-
t Stat	0.108434228	-
P(T<=t) one-tail	0.457898076	-
t Critical one-tail	1.812461123	-
P(T<=t) two-tail	***0.915796153***	-
t Critical two-tail	2.228138852	-

Bold text are the P value at a 95 percent confidence interval.

5.4.2 SEDIMENT PHOSPHORUS

Resuspension of sediments, whether from a natural force (e.g., scour from high inflows, fish movement, or wind events) or some human-mediated mechanical force (e.g., reservoir management or recreational activity) may result in high P concentrations in the water column. TP was measured from bed sediments as TP_{sed}, and DTP was measured from water in the interstitial voids of the sediment as $DTP_{sed.}$ (Table 5-3).

TP_{sed} was similar in concentration across all seasons. Although higher concentrations were measured in March, they were not significantly higher (Figure 5-11). The higher late-winter concentrations could be due to reduced P release from sediment and a potential increase in the accumulated sediment load over the winter. DTP_{sed} followed a seasonal pattern similar to those observed in studies of other P-rich systems (Sondergaard et al. 2001). This pattern includes an increase from internal loading that may occur over periods of low biological activity during the winter months. The seasonal pattern continues in warmer seasons, when increased biological activity causes a release of P from the sediments (Figure 5-12).

TABLE 5-3 TOTAL PHOSPHORUS MEASURED IN THE SEDIMENT AND DTP_{SED} MEASURED IN THE INTERSTISTIAL VOIDS OF THE SEDIMENT

TOTAL DISSOLVED PHOSPHORUS SEDIMENT (MG/L)					TOTAL PHOSPHORUS SEDIMENT (MG/KG)				
Site	March	June	September	November	Location	March	June	September	November
1	0.10	0.44	0.06	0.08	Site 1	773.2	704.3	701.8	725.9
2	0.03	0.03	0.03	0.03	Site 2	723.7	660.7	660.1	680.4
3	**3.12**	0.38	**3.71**	0.46	Site 3	**1087**	824.6	**1150**	**977.8**
4	0.13	**1.18**	0.34	0.10	Site 4	967.1	937	917.1	860.9
5	0.13	0.07	0.03	0.03	Site 5	754.6	653.1	610.6	642.7
6	0.19	0.32	0.17	0.15	Site 6	1269	838	957.7	773
7	0.10	0.03	0.03	0.03	Site 7	871.9	866.8	683.2	945.4
8	0.13	0.29	0.03	0.07	Site 8	1084	**1004**	973	621.5
9	0.07	0.45	0.03	0.06	Site 9	715.9	746.1	574.4	611
10	0.09	0.18	0.04	0.04	Site 10	698.1	769.1	731.1	643.4
11	0.13	1.17		0.05	Site 11	842.3	851.9	788.4	707.8
Min	0.033	0.03	0.03	0.03	Min	698.1	653.1	574.4	611
First Quartile	0.094	0.123	0.03	0.036	First Quartile	739.15	725.2	671.65	643.05
Median	0.128	0.321	0.035	0.061	Median	842.3	824.6	731.1	707.8
Third Quartile	0.132	0.446	0.140	0.089	Third Quartile	1,025.55	859.35	937.4	816.95
Max	3.12	1.182	3.708	0.4585	Max	1,269	1,004	1,150	977.8
Median	0.38	0.41	0.45	0.10	Median	889.71	805.05	795.22	744.53
Range	3.087	1.152	3.678	0.4285	Range	570.9	350.9	575.6	366.8

Note: Red highlighted values indicate J-flagged data.

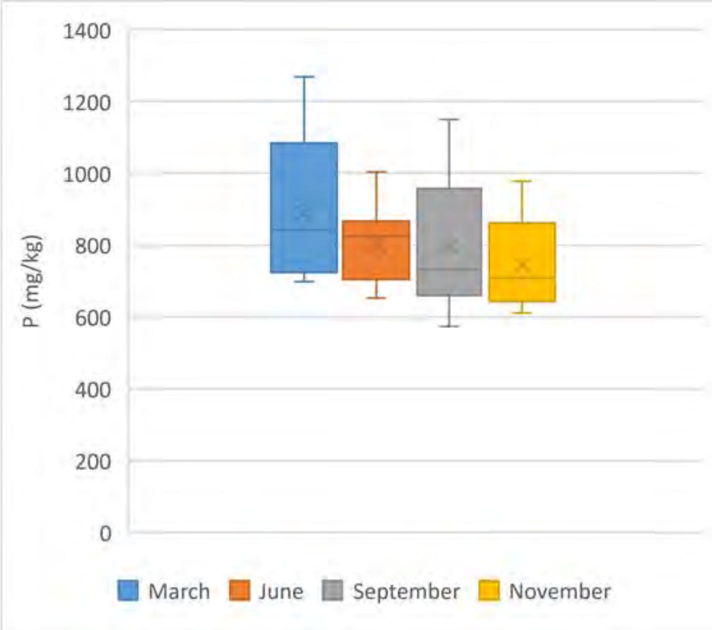


FIGURE 5-12 SEASONAL VARIANCE OF PHOSPHORUS IN CUTLER RESERVOIR SEDIMENT

Variability across sample sites was substantial, with concentrations ranging from a high at Site 6 (1,150 mg/kg) to a low at Site 9 (574.4 mg/kg; Table 5-3 and Figure 5-13). Sites 3, 6, and 8 had concentrations above 1,000 mg/kg, and Site 3 recorded three of the highest concentrations during the study period.

A single-factor analysis of variance (ANOVA) was conducted to test the variability of P in the bed sediment among sites. The results showed a significant difference among means, with a P value of 0.0002 (Table 5-4). To determine which sites were significantly different, a post-hoc Tukey test was conducted (Table 5-5). Results of the test showed Site 3 (Swift Slough) was significantly different from Sites 1, 2, 5, 9, and 10, and Site 6 (Benson Marina) was significantly different from Site 5 and 9.

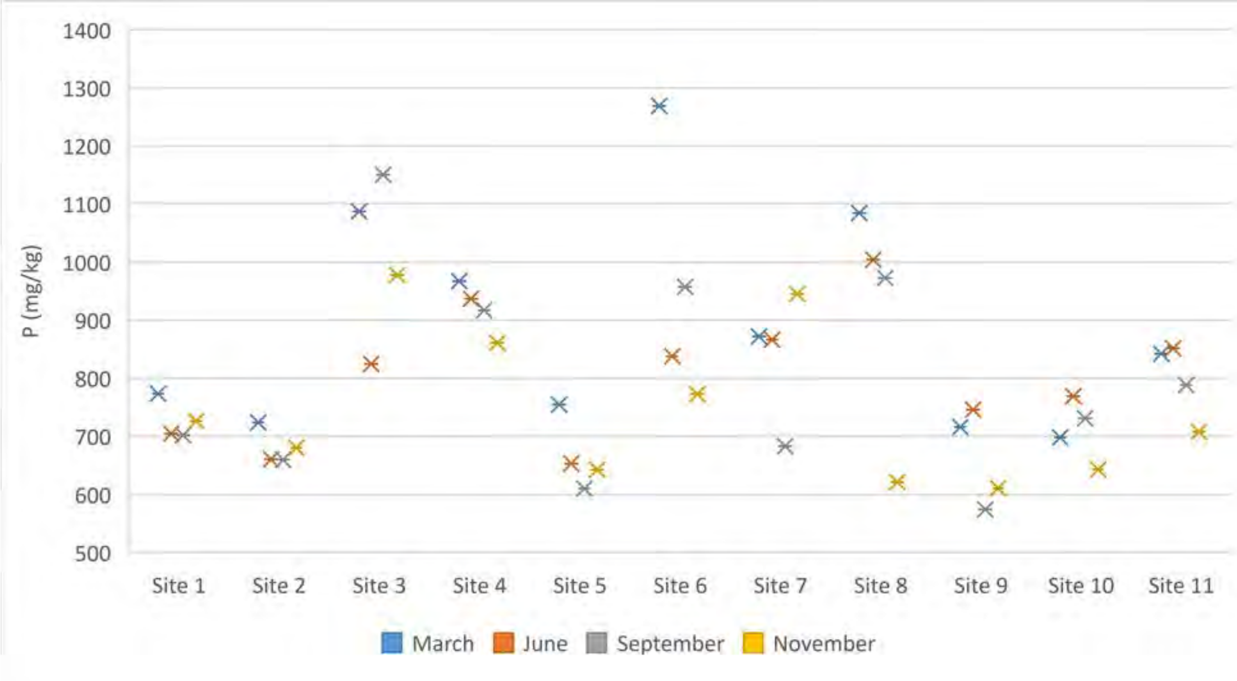


FIGURE 5-13 TOTAL PHOSPHORUS MEASURED ACROSS CUTLER RESERVOIR AT EACH SITE

TABLE 5-4. OUTPUT TEST RESULTS FOR TP_{SED} TO TEST FOR SIGNIFICANCE USING A SINGLE FACTOR ANOVA

GROUPS	COUNT	SUM	AVERAGE	VARIANCE		
Site 1	4	2,905.2	726.3	1,094.673		
Site 2	4	2,724.9	681.225	890.783		
Site 3	4	4,039.4	1,009.85	20,312.970		
Site 4	4	3,682.1	920.525	2,002.509		
Site 5	4	2,661	665.25	3,875.390		
Site 6	4	3,837.7	959.425	48,445.989		
Site 7	4	3,367.3	841.825	12,472.642		
Site 8	4	3,682.5	920.625	4,1953.896		
Site 9	4	2,647.4	661.85	6,750.897		
Site 10	4	2,841.7	710.425	2,838.156		
Site 11	4	3,190.4	797.6	4,365.087		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	657,088.952	10	65,708.895	4.985	**0.00021**	2.133
Within Groups	435,008.975	33	13,182.090	-	-	-
Total	1,092,097.927	43	-	-	-	-

TABLE 5-5 RESULTS FOR THE TUKEY HONESTLY SIGNIFICANT DIFFERENCE TEST

GROUP 1	GROUP 2	DIFFERENCE	N (GROUP 1)	N (GROUP 2)	Q (HSD)	TEST
Site 1	Site 2	45.1	4	4	280.32	FALSE
Site 1	Site 3	283.6	4	4	280.32	**TRUE**
Site 1	Site 4	194.2	4	4	280.32	FALSE
Site 1	Site 5	61.1	4	4	280.32	FALSE
Site 1	Site 6	233.1	4	4	280.32	FALSE
Site 1	Site 7	115.5	4	4	280.32	FALSE
Site 1	Site 8	194.3	4	4	280.32	FALSE
Site 1	Site 9	64.5	4	4	280.32	FALSE
Site 1	Site 10	15.9	4	4	280.32	FALSE
Site 1	Site 11	71.3	4	4	280.32	FALSE
Site 2	Site 3	328.6	4	4	280.32	**TRUE**
Site 2	Site 4	239.3	4	4	280.32	FALSE
Site 2	Site 5	16.0	4	4	280.32	FALSE
Site 2	Site 6	278.2	4	4	280.32	FALSE
Site 2	Site 7	160.6	4	4	280.32	FALSE
Site 2	Site 8	239.4	4	4	280.32	FALSE
Site 2	Site 9	19.4	4	4	280.32	FALSE
Site 2	Site 10	29.2	4	4	280.32	FALSE
Site 2	Site 11	116.4	4	4	280.32	FALSE
Site 3	Site 4	89.3	4	4	280.32	FALSE
Site 3	Site 5	344.6	4	4	280.32	**TRUE**
Site 3	Site 6	50.4	4	4	280.32	FALSE
Site 3	Site 7	168.0	4	4	280.32	FALSE
Site 3	Site 8	89.2	4	4	280.32	FALSE
Site 3	Site 9	348.0	4	4	280.32	**TRUE**
Site 3	Site 10	299.4	4	4	280.32	**TRUE**
Site 3	Site 11	212.3	4	4	280.32	FALSE
Site 4	Site 5	255.3	4	4	280.32	FALSE
Site 4	Site 6	38.9	4	4	280.32	FALSE
Site 4	Site 7	78.7	4	4	280.32	FALSE
Site 4	Site 8	0.1	4	4	280.32	FALSE
Site 4	Site 9	258.7	4	4	280.32	FALSE
Site 4	Site 10	210.1	4	4	280.32	FALSE
Site 4	Site 11	122.9	4	4	280.32	FALSE
Site 5	Site 6	294.2	4	4	280.32	**TRUE**
Site 5	Site 7	176.6	4	4	280.32	FALSE
Site 5	Site 8	255.4	4	4	280.32	FALSE
Site 5	Site 9	3.4	4	4	280.32	FALSE
Site 5	Site 10	45.2	4	4	280.32	FALSE
Site 5	Site 11	132.4	4	4	280.32	FALSE
Site 6	Site 7	117.6	4	4	280.32	FALSE
Site 6	Site 8	38.8	4	4	280.32	FALSE
Site 6	Site 9	297.6	4	4	280.32	**TRUE**
Site 6	Site 10	249.0	4	4	280.32	FALSE
Site 6	Site 11	161.8	4	4	280.32	FALSE
Site 7	Site 8	78.8	4	4	280.32	FALSE
Site 7	Site 9	180.0	4	4	280.32	FALSE

GROUP 1	GROUP 2	DIFFERENCE	N (GROUP 1)	N (GROUP 2)	Q (HSD)	TEST
Site 7	Site 10	131.4	4	4	280.32	FALSE
Site 7	Site 11	44.2	4	4	280.32	FALSE
Site 8	Site 9	258.8	4	4	280.32	FALSE
Site 8	Site 10	210.2	4	4	280.32	FALSE
Site 8	Site 11	123.0	4	4	280.32	FALSE
Site 9	Site 10	48.6	4	4	280.32	FALSE
Site 9	Site 11	135.8	4	4	280.32	FALSE
Site 10	Site 11	87.2	4	4	280.32	FALSE

To test the background levels of P that are naturally occurring in valley deposits and may be imported into Cutler Reservoir, three surface soil samples were collected during the bank-stability analysis. The sites included: Benson Railroad Trail and Fishing Bridge near Site 4, Benson area (composite) near Site 6, and Clay Slough near Site 8. Results show the three samples have a range of P from 620 to 730 mg/kg (Table 5-6). The mean of three bank samples was 693 mg/kg. In comparison, mean P concentration of bed sediments was 808 mg/kg. These data suggest that naturally-occurring P in soils surrounding the reservoir may be an additional source of sediment P.

$CaCO_3$ has been shown to bind P in polluted waters. Experimental tests have shown a 70-percent reduction in water-column P concentration is possible with the addition of $CaCO_3$ (Yanamadala 2005). $CaCO_3$ in core samples from deeper sediment deposits indicated that the soil is comprised of 16.7 to 44.6 percent $CaCO_3$ (Table 4-3). P in deeper sediments is likely immobilized by this level of calcium.

Through the study period, four sites were measured for cation exchange capacity (CEC) (Table 5-7). CEC is mostly used in agricultural soil testing to measure the total holding capacity of cations (positively charged), which in turn influences the mobility of anions (negatively charged) in the form of plant nutrients such as calcium, potassium, magnesium, nitrogen, and P. This study employed the CEC test to measure concentrations of calcium and water-soluble calcium ions. Water soluble-calcium acts as an ion filter, bonding P and removing it from the water column, which in turn reduces reactive P in the water (Yanamadala 2005). Results show a range of 55 to –321.8 mg/kg in available water-soluble calcium cations in the soil, which if released could actively bond with P in the water column.

TABLE 5-6 SAMPLES FROM THE BANK OF CUTLER RESERVOIR DURING THE BANK STABILITY STUDY AND ANALYZED FOR PHOSPHORUS.

USU ID	IDENTIFICATION	TEXTURE	SAND	SILT	CLAY	P	P
			-------------------%-----------------			%	mg/kg
2438	Composite*	Silty Clay	10	42	48	0.062	620
2439	Clay Slough	Silty Clay	1	48	51	0.073	730
2440	Downstream of Trail Fishing Bridge	Silty Clay Loam	0	65	35	0.073	730

NOTE: *Note the composite sample is a series of grab samples taken from the banks in the Benson Marina Area.

TABLE 5-7 CATION EXCHANGE CAPACITY RESULTS FROM CUTLER SHOWING CALCIUM AND WATER SOLUBLE CALCIUM

				----------AMMONIUM ACETATE EXTRACTION--				--------------------------WATER SOLUBLE CATIONS-------					
USU ID	Site	Date	Capacity	Calcium	Potassium	Magnesium	Sodium	Calcium	Magnesium	Sodium	Potassium	Boron	Sulfur
			cmol/kg	------------------------mg/kg------------------------				--------------------------------------mg/kg------------------------------					
0559	4	3/12/2020	24.8	5,476.0	208.9	797.4	76.9	321.8	128.8	60.9	24.8	0.1	126.5
0560	7	3/12/2020	21.7	4,678.0	345.9	749.7	168.3	305.9	162.2	122.1	37.6	0.3	292.8
0561	9	3/12/2020	7.7	3,731.0	128.8	290.0	53.5	98.8	46.7	42.6	16.2	0.1	102.6
0562	11	3/12/2020	15.3	4,487.0	508.9	611.5	155.3	241.7	113.0	91.6	27.1	0.2	161.2
1603	4	6/1/2020	8.0	5,527.0	209.0	861.0	85.2	145.9	55.1	47.5	23.2	0.1	121.9
1606	7	6/1/2020	18.5	4,895.0	353.6	782.1	175.5	280.6	133.9	91.9	30.2	0.2	154.8
1608	9	6/1/2020	11.7	4,286.0	181.7	412.5	64.2	163.2	60.8	35.8	18.8	0.1	127.7
1610	11	6/1/2020	18.8	4,718.0	470.3	618.6	130.9	186.3	80.1	61.5	21.9	0.1	104.0
2475	4	9/1/2020	26.4	5,405.0	213.9	884.2	86.8	221.4	99.5	51.5	20.1	0.2	105.6
2477	7	9/1/2020	10.3	3,922.0	175.4	474.3	88.5	79.6	66.1	37.9	12.1	0.1	74.3
2512	9	9/1/2020	4.8	3,488.3	92.4	303.0	58.1	55.0	39.3	36.5	8.9	0.1	71.2
2514	11	9/1/2020	16.1	4,348.3	452.5	817.6	173.2	160.0	118.7	84.6	19.1	0.2	142.0
3686	4	11/2/2020	21.1	5,617.5	183.4	719.6	83.9	301.6	111.0	53.5	19.5	0.1	114.2
3689	7	11/2/2020	17.2	5,114.5	501.0	1,123.5	241.9	303.9	207.7	136.6	32.5	0.2	256.1
3691	9	11/2/2020	20.2	5,024.5	1,394.7	777.1	381.0	162.3	88.2	92.6	18.4	0.2	137.1
3693	11	11/2/2020	10.1	4,476.5	217.0	508.0	143.5	247.9	133.3	94.6	26.1	0.2	305.6

6.0 SUMMARY

The Sediment Study, as conducted and documented in this ISR, fulfills the study content and methods approved by FERC's Study Plan Determination (SPD), and fills the data gaps for the reservoir sediment composition and distribution issues identified by FERC in Scoping Document 1 (SD1) and Scoping Document 2 (SD2). Specifically, this study provides an assessment of sediment composition, sediment distribution and depth within the reservoir, and phosphorous concentrations and dynamics in sediment. These results provide sufficient input for the analysis of the potential effects of future Project operations on these variables in the Cutler Project Boundary. Analysis of potential effects of future Project operations will be provided in the DLA. No additional or future studies are proposed.

6.1 SEDIMENT COMPOSITION CORE SAMPLING

In total, 62 core samples were collected across Cutler Reservoir to examine sediment deposition and composition. While the focus of sediment data collection was to provide input to the sediment transport model, these results also provided insight into how distribution of sediment size class occurs within the reservoir. Larger sand particles were more prevalent in the deeper sediments and along the thalweg of the historic inundated river channel, where water velocities were higher. Finer sediments were found further from the historic channel and in areas closer to the dam. The location and size-class of sediments were used in the hydraulic model to accurately predict mobilization under a range of operating conditions.

In the more open, shallower areas of the reservoir, much of the surface sediment was unconsolidated. It is likely that little mobilization would occur in these areas under a wide range of reservoir level changes due to low water velocities. However, sediment deposits in these shallow areas are very susceptible to recreational impacts from boats and other natural conditions, such as wind and fish activity. Given the unconsolidated sediment structure, it is likely that resuspension occurs in response to human-mediated and natural mechanical disturbances that in turn can affect water quality.

Testing some of the samples for a range of constituents such as RCRA metals, pesticides, and PCB showed that Cutler Reservoir sediment is generally not toxic. While some metals were detected, most samples included concentrations that require no further discussion. Arsenic was detected and exceeded the carcinogenic risk under both residential and commercial thresholds. However, even with potential resuspension, ingestion of bed sediments to a degree that posed a risk or hazard to the public is unlikely. No pesticides or PCBs were detected.

The sediment data collected was sufficient for the modeling conducted to confidently predict mobilization of bed sediments. The constituents analysis demonstrated that little contamination is present in the sediment.

6.2 DISTRIBUTION OF SEDIMENT IN CUTLER RESERVOIR

Based on study results, distribution of sediment deposits in the reservoir is highly variable, with sediment depths across the reservoir ranging from 0 to more than 90 feet. The inundated historic channels of both the Bear and Logan/Little Bear Rivers have been filled completely in some areas, with sediment deposits exceeding 22 feet at several locations. Sediment deposits have created bars and islands in some locations where the channels once flowed historically.

Areas with little deposition are mostly constriction points, such as bridge crossings and parts of the reservoir where the current channel lies on top of old inundated river benches. These areas are likely to see very little downcutting, due to the cohesive nature of the soil and higher content of fine materials such as clay.

Open-water portions of the reservoir, such as around Clay Slough, have become controlling features that slow water movement and limit the variability of upstream water surface elevations, particularly when elevations drop at Cutler Dam. Other water-surface-controlling features were noted during the 2019 reservoir drawdown (October 26 to November 16, 2019) upstream of the Newton Bridge, where a riffle formed as the active channel ran perpendicular to the historic channel and eroded the sediment deposits located there. This river bench feature now constitutes the hydraulic control of water surface elevation between Clay Slough and Newton Bridge.

Cutler Canyon has maintained its original channel form, which includes some of the deeper areas in the reservoir. As deposition has occurred on the inundated historic river benches and sides of the canyon, this has allowed more energy to stay within the channel, which maintains water depth. Based on the hydraulic modeling (Appendix G), it is clear that Wheelon Dam influences much of the deposition upstream of this site. Core measurements immediately upstream of

Wheelon Dam indicated as little as 46 inches of deposition. Corroborating the data in Appendix G, removal of the Wheelon Dam and associated sediment deposit would provide minimal increases in reservoir volume as the total deposition attributed to this controlling feature would amount to a small fraction of the 580 acre-feet of accumulated sediments mapped from Wheelon Dam to Newton Bridge.

Overall, Cutler Dam is not the cause of deposition but its presence influences redistribution of the deposition that is seen today. The estimates of deposition and sediment data provide PacifiCorp with information to make appropriate and prudent management decisions, to aide in management of future imports of sediment, and to help maintain additional agricultural and recreational opportunities for the public.

6.3 PHOSPHORUS DISTRIBUTION IN SEDIMENT

P has been a driving factor for management decisions regarding Cutler Reservoir water quality for a variety of entities, including PacifiCorp, Utah Department of Environmental Quality/Utah Division of Water Quality, and other private landowners in the watershed. These decisions include measures to reduce incoming P loads into Cutler Reservoir in response to the TMDL (UDWQ 2010). However, as data has shown, there are instances where existing P concentrations greatly exceed water quality indicator values. These concentrations appear to be due to inflows that continue to import excessive P into both the water column and ultimately the bed sediments, which supports a cycle of diminished water quality conditions.

Across 250 lakes examined by Sondergaard et al. (2001), TP was typically low in the winter and higher in the summer when biomechanical mechanisms release P from bed sediments. This pattern is counter to what was observed on Cutler Reservoir, where March samples had significantly higher TP concentrations compared to summer conditions. These results suggest that a different mechanism is driving P levels in Cutler Reservoir, and high variability is not a result of internal loading. The higher concentrations in March likely are a result of external loading.

Linear regression of TP and OP generates an R^2 value of 0.98, suggesting the vast majority of P in Cutler is organic. Concentrations of OP were very similar to DTP. It is uncertain what proportion of P is labile or refractory P. Both forms can be generated internally by the decay of plant material or imported into the system from wastewater discharge facilities and other local sources of excessive P (e.g., agricultural sources and meat, egg, and cheese processing/producing facilities located in the watershed).

P concentrations in the reservoir during warmer periods were significantly lower compared to colder periods of the year, and concentrations at most sites measured in 2020 for this study were less than pollution-indicator levels. Any biomechanical mechanism (e.g., microbial processes) driving summertime P loading would be optimized during the warm season. In spite of the small sample size, there is evidence and data to suggest that sediment release of P does occur in the summer season. The amount of this release appears to be relatively small, however, based on observed water-column concentrations of DTP.

P concentrations in the sediment at most sites were similar to background levels measured in bank samples. Sample measurements from Sites 3 and 6, however, were significantly higher than any other site, measuring in excess of 1g/kg of P in soil. This suggests that a large of amount of P has been deposited and bound to bed sediments in this area. It is unclear why Site 4, between Sites 3 and 6, was lower, but it may be the result of potentially higher velocities and lower settling rates that transport and ultimately deposit sediment at Site 6.

Measurements of $CaCO_3$ and CEC were used to measure the water-soluble fraction of calcium. Based on these measurements, it is likely that the vast majority of P in bed sediments is chemically bound by the calcium. As demonstrated by Yanamadala (2005), a substantial amount of P can be bound and biologically unavailable in the water column. Additional analysis and studies would be needed to determine the fraction of P that is bound to calcium in Cutler Reservoir.

Water quality results ultimately indicate that although a substantial amount of P is present in bed deposits, this does not automatically result in substantial summertime internal loading to the water column. Water quality measurements suggest that much of the P is chemically bound. Colder water temperatures reduce biological uptake, which results in more P available for adsorption into the bed sediments.

Natural events such as wind, high flows, and fish activity can resuspend and mobilize sediment, as can human recreational activities in shallow areas. Fluctuations in reservoir elevations could potentially have similar changes if water velocities were increased to a point where shear strength was exceeded. While these types of events could increase TP in the water column, they would not necessarily translate to an increase in dissolved bio-available P. A potential option to reduce the P load in Cutler Reservoir would be to exchange the water in the reservoir more frequently, particularly during colder periods when higher concentrations are observed. Such water exchanges might limit future deposition of P to the bed and reduce the continual cycle of loading.

This study provided sufficient data for DLA analysis of impacts associated with the potential Project operations changes. It also provided evidence of a smaller summertime internal load than likely expected.

7.0 REFERENCES

Clyde, Calvin G. 1953. Sediment Movement in Bear River, Utah. Thesis submitted for Degree of Civil Engineer, Graduate Division, University of California. Berkeley, California. June 1953.

Mears, J.D. and W.A. Wurtsbaugh (editors) 2009. Limnological Analyses of Cutler Reservoir and Dingle Marsh with Respect to Eutrophication. Aquatic Ecology Practicum Class Report, College of Natural Resources, Utah State University. 100 p.

PacifiCorp. 2020. 2018 Water Quality Analysis and Summary Report for Cutler Reservoir. Prepared by SWCA Consultants for PacifiCorp. May 2020.

Perry, Lee Tom. Brigham Young University. Tom Perry Special Collections, Harold B. Lee Library, Brigham Young University, Provo, UT.

Somers, Ray. 1894. Utah State University Digital Collections. Logan, UT.

Søndergaard, M., Jensen, J.P., Jeppesen, E. 2003. Role of internal loading on phosphorus in shallow lakes. Hydrobiologia. 506-508: 135-145.

Søndergaard, M., Jensen, J.P., and Jeppesen, E. 2001. Retention and internal loading of phosphorus in shallow, eutrophic lakes. *The Scientific World* 1, 427–442.

U.S. Environmental Protection Agency (USEPA). 2017. *Regional Screening Levels (RSLs), User's Guide (June 2017)*.

https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide-June-2017.

U.S. Environmental Protection Agency (USEPA). 1983. *Methods for chemical analysis of water and wastes.* 2nd ed. Method 365.2. U.S. Environmental Protection Agency, Washington, DC.

Utah Division of Water Quality (UDWQ). 2010. *Middle Bear River and Cutler Reservoir Total Maximum Daily Load* (TMDL). Prepared by SWCA Environmental Consultants, Salt Lake City, Utah.

Waddell, K.M., Gerner, S.J., Thiros, S.A., Giddings, E.M., Baskin, R.L., Cederberg, J.R., and Albano, C.M.. 2003. Water quality in the Great Salt Lake Basins, Utah, Idaho, and Wyoming, 1998-2001, U.S. Geological Survey Circular 1236.

Utah Geological Survey (UGS). 1937. Aerial photographs of portions of Cutler October and November 1937. Downloaded March 2017, https://geodata.geology.utah.gov/imagery.

Wurtsbaugh, W.A., B.J. Abbott., and D. Epstein (editors). 2008. Comparative Limnological Analysis of Cutler Reservoir and Dingle Marsh with Respect to Eutrophication. Aquatic

Ecology Practicum Class Report, College of Natural Resources, Utah State University. 71 p.

Wurtsbaugh, W.A. and R. Lockwood (editors) 2007. Comparison of Limnological Characteristics in Cutler Reservoir (Utah) near the Inflows of the Logan River and the Logan Wastewater Treatment Plant. Aquatic Ecology Practicum Class Report, College of Natural Resources, Utah State University. 100 p

Yanamadala, V. 2005. Calcium Carbonate Phosphate Binding Ion Exchange Filtration and Accelerated Denitrification Improve Public Health Standards and Combat Eutrophication in Aquatic Ecosystems, Water Environ Res. 2005; 77(7): 3003–3012.

ATTACHMENT H-1

SEDIMENT CORE LOGS

Project: **Cutler Relicense**	**Log of Boring 1**
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/20**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **7.9 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.45 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 1 Little Bear 41.74045675, -111.9547491**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
4407.45	0		Site 1							Lab Sample see results
					OL		Silts, highly organic. Consistent texture throughout. Moisture content decreases with depth. Shear value 0.06 kg/cm2.			
4402.45	5									
4397.45	10									
4392.45	15									
4387.45	20									
4382.45	25									
4377.45	30									

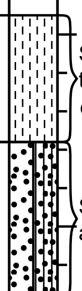
C:\Users\nauticlew\AppData\Local\Temp\borings_temp\tmpfile.bgs[(master 2 lab).tpl]

Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 2
Sheet 1 of 1

Date(s) Drilled **7/20**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **11.8 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.45 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 2 Logan River 41.74207489, -111.9516243**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
4407.45	0									
4402.45	5				OL		Silts, highly organic. Consistent texture throughout. Moisture content decreases with depth. Shear value 0.02 kg/cm2.			
			Site 1		SP-SM		Silt and sand grading to fine sands with little silt and well sorted			Lab Sample see results
4397.45	10									
4392.45	15									
4387.45	20									
4382.45	25									
4377.45	30									



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Project: **Cutler Relicense**	# Log of Boring 3
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/20**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **5.7 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.45 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 3 Marsh 41.74846462, -111.9506483**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
4407.45	0									
4402.45	5				SM-CH		Top silt and fine sand shallow to clay, very dense with low moisture content at surface. Impenetrable, suspected native clay and potentially old river channel bottom. Consistent with NRCS soil description.			
4397.45	10									
4392.45	15									
4387.45	20									
4382.45	25									
4377.45	30									

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 4
Sheet 1 of 1

Date(s) Drilled **7/21**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **6.8 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 4 Marsh 41.75171651, -111.9472884**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
4407.49	0									
4402.49	5				OL		Top 12 inches is unconsolidated loose silt with full saturation 34" to bottom silt with little organics. Shear Value of 0.1 kg/cm2.			
4397.49	10									
4392.49	15									
4387.49	20									
4382.49	25									
4377.49	30									

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Project: **Cutler Relicense**	Log of Boring 5
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/21**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **12.1 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 5 Marsh 41.75466754 -111.9481068**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
4407.49	0									
					OL		Top 2.5 soft silt with high water content, semi-dense silt with same structure as above in the following 2 feet of ayer. Shear Value of 0.1 kg/cm2 in top 2.5 feet.			
4402.49	5									
					ML		organic to inorganic silts and fines, some fine sand throughout transitioning to finer unsorted sands at the bottom.			
4397.49	10				SP		poorly graded sands with few fines.			
4392.49	15									
4387.49	20									
4382.49	25									
4377.49	30									

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Project: **Cutler Relicense**	Log of Boring 6
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/21**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **5.2 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 6 Marsh 41.75607075, -111.9436299**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
4407.49	0									
					OL		Highly organic, very soft and unconsolidated silts			
					OH		organic silt and clay, soft, shear value 0.08 kg/cm2			
4402.49	5				OH		hard clay, shear value, 0.12 kg/cm2.			
4397.49	10									
4392.49	15									
4387.49	20									
4382.49	25									
4377.49	30									

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 7
Sheet 1 of 1

Date(s) Drilled **7/21**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **5.2 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 7 Marsh 41.75889098, -111.9413856**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
4407.49	0									
					OL		Organic silt, 0-10" unconsolidated, from 10-22" more compacted, shear value 0.08 kg/cm2.			
					OH		Organic clay and silt, medium hard, shear value 0.14 kg/cm2.			
4402.49	5									
4397.49	10									
4392.49	15									
4387.49	20									
4382.49	25									
4377.49	30									

Project: **Cutler Relicense** Project Location: **Cutler Reservoir** Project Number: **P-2420**	Log of Boring 8 **Sheet 1 of 1**

Date(s) Drilled **7/21**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **4 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 8 Marsh 41.76371348, -111.9452218**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
4407.49	0									
					OL		Organic silt, unconsolidated, shear value 0.02 kg/cm2.			
					OH		Clay, medium hard, shear value 0.12 kg/cm2.			
4402.49	5									
4397.49	10									
4392.49	15									
4387.49	20									
4382.49	25									
4377.49	30									

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Project: **Cutler Relicense** Project Location: **Cutler Reservoir** Project Number: **P-2420**	Log of Boring 9 **Sheet 1 of 1**

Date(s) Drilled **7/21**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **3.7 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 9 Marsh 41.76558737, -111.9512161**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.49	0							
							Hard clay impenetrable with Vibe core. Native bottom or log. ∇	
4402.49	5							
4397.49	10							
4392.49	15							
4387.49	20							
4382.49	25							
4377.49	30							

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Project: **Cutler Relicense** Project Location: **Cutler Reservoir** Project Number: **P-2420**	Log of Boring 10 **Sheet 1 of 1**

Date(s) Drilled **7/21**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **4.7 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 10 Marsh 41.76228623, -111.9538688**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.49	0							
					OL		Unconsolidated Silt	
					OL		Consolidated silt deposits, shear value 0.01 kg/cm2.	
					CL		Medium stiff clay, native material. shear value 0.01 kg/cm2	
4402.49	5							
4397.49	10							
4392.49	15							
4387.49	20							
4382.49	25							
4377.49	30							

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Project: **Cutler Relicense**	**Log of Boring 11**
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/21**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **12.3 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 11 Marsh 41.76638961, -111.9523125**	

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Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.49	0							
					OL		Unconsolidated silts	
4402.49	5		11					
					OL		Consolidated silt deposits, shear value 0.011 kg/cm2.	
					ML		Fine silt sands grading towards fine sand near bottom.	
4397.49	10							
4392.49	15							
4387.49	20							
4382.49	25							
4377.49	30							

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Project: **Cutler Relicense**	Log of Boring 12
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/21**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **4.3 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 12 Marsh 41.77019624, -111.9512162**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.49	0							
					OL		Unconsolidated silts	
					CL		Clay deposits.	
					CH		Hard Clay	
4402.49	5							
4397.49	10							
4392.49	15							
4387.49	20							
4382.49	25							
4377.49	30							

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Project: **Cutler Relicense**	Log of Boring 13
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/21**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **4.8 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 13 Marsh 41.76940414, -111.9458173**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.49	0							
					OL		Unconsolidated silts	
					CL		Hard clay deposits	
4402.49	5							
4397.49	10							
4392.49	15							
4387.49	20							
4382.49	25							
4377.49	30							

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Project: **Cutler Relicense**	**Log of Boring 14**
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/22**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **10 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 14 Marsh 41.77333939, -111.9453667**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.49	0							
4402.49	5				OL		Unconsolidated silts on top, consolidated silts, calcium deposits (shells) shear value 0.03kg.cm2.	
					CL		Hard clay deposits, bed material.	
4397.49	10							
4392.49	15							
4387.49	20							
4382.49	25							
4377.49	30							

Project: **Cutler Relicense** Project Location: **Cutler Reservoir** Project Number: **P-2420**	Log of Boring 15 **Sheet 1 of 1**

Date(s) Drilled **7/23**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **13.1 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 15 Marsh 41.77600317, -111.9466066**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.49	0							
4402.49	5							
					OL		Unconsolidated silts on top 1.5 ft, consolidated silts below to, value 0.5 kg.cm2.	
4397.49	10				SM		Silt sand mixture, shear value 0.08 kg/cm2	
					SW		well graded sands fine to medium in size	
4392.49	15							
4387.49	20							
4382.49	25							
4377.49	30							

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Project: **Cutler Relicense**	Log of Boring 16
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/23**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **5.6 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 16 Marsh 41.77916909, -111.9430827**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.49	0							
					OL		Unconsolidated silts on top 1ft, consolidated silts below.	
4402.49	5				OH		Inorganic clay, original native bed material.	
4397.49	10							
4392.49	15							
4387.49	20							
4382.49	25							
4377.49	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 17
Sheet 1 of 1

Date(s) Drilled **7/23**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **12.7 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 17 Marsh 41.78099349, -111.9438063**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.49	0							
4402.49	5				OL		Unconsolidated silts on top 4 inches, consolidated silts below. shear value .11 kg/cm2	
4397.49	10				SM		Sandy silt, old deposition from early cutler	
4392.49	15							
4387.49	20							
4382.49	25							
4377.49	30							

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Project: **Cutler Relicense** Project Location: **Cutler Reservoir** Project Number: **P-2420**	Log of Boring 18 **Sheet 1 of 1**

Date(s) Drilled **7/23**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **13.8 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 18 Marsh 41.78476328, -111.9442673**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.49	0							
					OL		Unconsolidated silts on top 9 inches, consolidated silts below. shear value .08 kg/cm2	
4402.49	5							
4397.49	10				SM		Fine sand with some silt. shear value 0.08 kg/cm2	
					SW		Sand, well graded medium in size	
4392.49	15							
4387.49	20							
4382.49	25							
4377.49	30							

Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 19

Sheet 1 of 1

Date(s) Drilled **7/23**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **10.3 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 19 Marsh 41.78681133, -111.9502883**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.49	0							
4402.49	5				OL to SM		No core recovered. Silt grading to fine sandy silt.	
4397.49	10							
4392.49	15							
4387.49	20							
4382.49	25							
4377.49	30							

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Project: **Cutler Relicense** Project Location: **Cutler Reservoir** Project Number: **P-2420**	Log of Boring 20 **Sheet 1 of 1**

Date(s) Drilled **7/23**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **6.2 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 20 Marsh 41.78498871, -111.9542869**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.49	0							
4402.49	5				OL		Unconsolidated silt in top 4 inches. Consolidated below.	
					OH		Hard clay, native material	
4397.49	10							
4392.49	15							
4387.49	20							
4382.49	25							
4377.49	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 21
Sheet 1 of 1

Date(s) Drilled **7/23**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **6.8 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 21 Marsh 41.78788339, -111.9552016**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.49	0							
4402.49	5				CH-OH		Clays top medium plasticity, bottom high plasticity, shear value in upper region 0.15 kg/cm2.	
4397.49	10							
4392.49	15							
4387.49	20							
4382.49	25							
4377.49	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 22
Sheet 1 of 1

Date(s) Drilled **7/23**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **14.3 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 22 Marsh 41.78788339, -111.9552016**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.49	0							
4402.49	5							
4397.49	10				OL		Unconsolidated silt in the upper 13 inches. Consolidated below become stiff near the bottom.	
4392.49	15							
4387.49	20							
4382.49	25							
4377.49	30							

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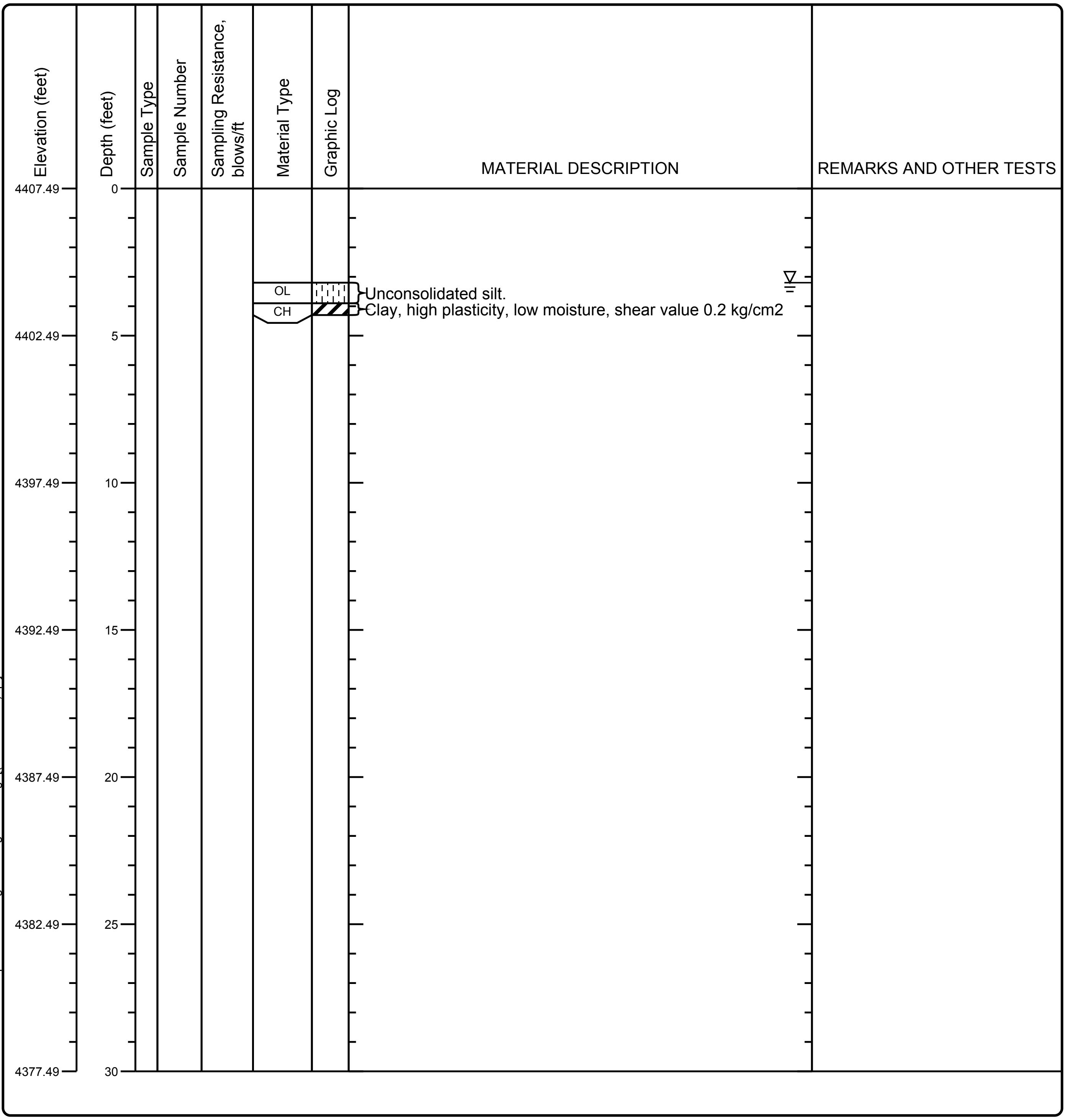
Project: **Cutler Relicense**	**Log of Boring 23**
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/23**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **4.2 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 23 Benson 41.79271861, -111.9573339**	



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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 24
Sheet 1 of 1

Date(s) Drilled **7/23**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **12.2 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.49 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s)	Hammer Data
Borehole Backfill	Location **Site 24 Benson 41.79475296, -111.9555909**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.49	0							
					OL		Unconsolidated silt upper 7 inches. Consolidated below	
4402.49	5				SM		Silt and sand	
4397.49	10							
4392.49	15							
4387.49	20							
4382.49	25							
4377.49	30							

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Project: **Cutler Relicense** Project Location: **Cutler Reservoir** Project Number: **P-2420**	Log of Boring 25 **Sheet 1 of 1**

Date(s) Drilled **7/24**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **12.7 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.5 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 25 Benson 41.79791187, -111.9527869**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
4402.45	5				OL		Silts, highly organic. Consistent texture throughout. Moisture content decreases with depth.	
4397.45	10							
4392.45	15							
4387.45	20							
4382.45	25							
4377.45	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 26
Sheet 1 of 1

Date(s) Drilled **7/24**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **5.8 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.5 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 26 Benson 41.8018845, -111.9572728**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
					OL		Silts, highly organic. Consistent texture throughout core. Moisture content decreases with depth.	
4402.45	5							
4397.45	10							
4392.45	15							
4387.45	20							
4382.45	25							
4377.45	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 27
Sheet 1 of 1

Date(s) Drilled **7/24**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **10.7 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.5 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 27 Benson 41.8055528, -111.9597781**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
4402.45	5				OL		Silts, highly organic. Consistent texture throughout core.	
					SM		Silt and fine sand. Shear value 0.03 cm/kg	
					SP		fine sand	
4397.45	10				CL		Clay medium plasticity. Shear Value 0.15 cm/kg	
4392.45	15							
4387.45	20							
4382.45	25							
4377.45	30							

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Project: **Cutler Relicense** Project Location: **Cutler Reservoir** Project Number: **P-2420**	Log of Boring 28 **Sheet 1 of 1**

Date(s) Drilled **7/24**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **6.9 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.5 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 28 Near Confluence 41.81101719, -111.9581537**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
4402.45	5							
					CH		Clay medium stiff, native material	
4397.45	10							
4392.45	15							
4387.45	20							
4382.45	25							
4377.45	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 29
Sheet 1 of 1

Date(s) Drilled **7/24**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **14.9 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.5 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 29 River Confluence 41.81042845, -111.9535924**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
4402.45	5							
4397.45	10							
					SP-SC		Sand poorly sorted, medium fine to fine.	
4392.45	15							
4387.45	20							
4382.45	25							
4377.45	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 30
Sheet 1 of 1

Date(s) Drilled **7/24**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **12.3 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.5 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 30 River 41.80805983, -111.9512919**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
4402.45	5							
4397.45	10				SM-SC		Fine sand intermixed with some silt, not well sorted.	
4392.45	15							
4387.45	20							
4382.45	25							
4377.45	30							

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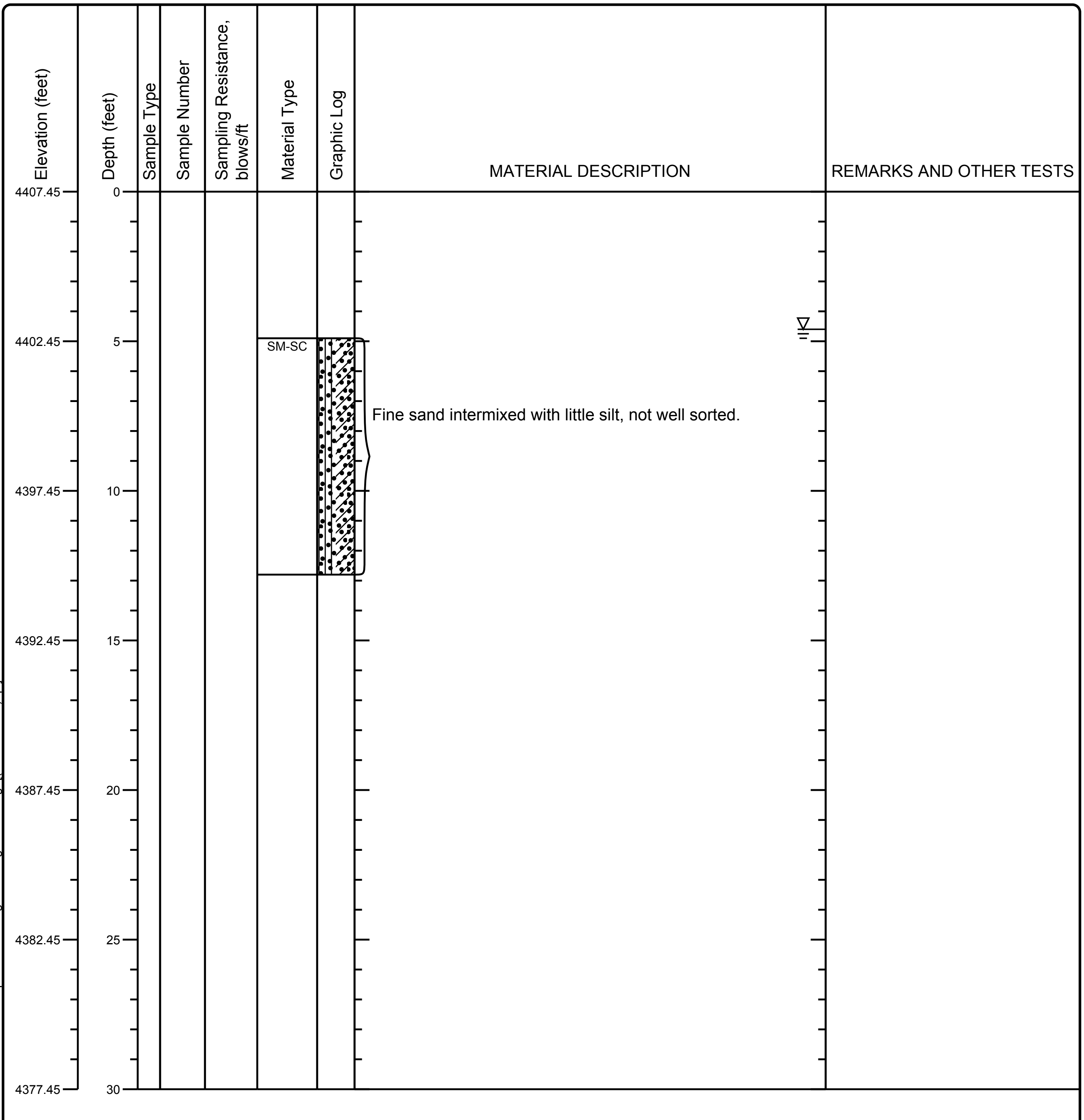
Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 31
Sheet 1 of 1

Date(s) Drilled **7/24**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **12.8 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.5 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 31 River 41.80512521, -111.941014**	



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Project: **Cutler Relicense** Project Location: **Cutler Reservoir** Project Number: **P-2420**	Log of Boring 32 **Sheet 1 of 1**

Date(s) Drilled **7/24**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **15.9 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.5 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 32 River 41.80576481, -111.9271167**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
4402.45	5							
4397.45	10				SM-SC		Fine sand intermixed with little silt, not well sorted.	
4392.45	15							
4387.45	20							
4382.45	25							
4377.45	30							

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Project: **Cutler Relicense**	Log of Boring 33
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/24**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **14.3 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.5 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 33 River 41.80033179, -111.9322043**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
4402.45	5							
					SM-SC		Fine sand intermixed with little silt, not well sorted. Tan / grey in color.	
4397.45	10							
4392.45	15							
4387.45	20							
4382.45	25							
4377.45	30							

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Project: **Cutler Relicense**	Log of Boring 34
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/24**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **6.3 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.5 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 34 River 41.80439061, -111.9507569**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
4402.45	5							
					SC		Clay with sand medium stiff. Light grey	
4397.45	10							
4392.45	15							
4387.45	20							
4382.45	25							
4377.45	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 35
Sheet 1 of 1

Date(s) Drilled **7/27**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **11.6 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.68 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 35 Reservoir 41.81186086, -111.9521828**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
4402.45	5				SM		Silt sand, olive grey	
					SM-ML		Silt sand to mostly sand, very fine layered. Shear value 0.11 kg/cm2 in mostly silt section of layer compact near bottom. Dark grey	
4397.45	10							
4392.45	15							
4387.45	20							
4382.45	25							
4377.45	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 36

Sheet 1 of 1

Date(s) Drilled **7/27**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **23 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.68 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 36 Reservoir 41.81637075, -111.953514**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
4402.45	5							
4397.45	10							
4392.45	15							
					CL-OL		silt clay some sand	
4387.45	20							
					OL		organic silts some sand	
					SP		sand lower clean sand little fines, upper not well sorted some fines	
4382.45	25							
4377.45	30							

Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 37
Sheet 1 of 1

Date(s) Drilled **7/27**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **7.3 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.68 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 37 Reservoir 41.82386165, -111.9521358**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
4402.45	5							
					CL-OL		inorganic clay, light grey, shear value 0.18	
4397.45	10							
4392.45	15							
4387.45	20							
4382.45	25							
4377.45	30							

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Project: **Cutler Relicense**	Log of Boring 38
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/27**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **14.7 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.68 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 38 Reservoir 41.82688763, -111.9581306**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
4402.45	5				SM		sand not well sorted, mostly fine, silt throughout	
4397.45	10							
4392.45	15							
4387.45	20							
4382.45	25							
4377.45	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 39
Sheet 1 of 1

Date(s) Drilled **7/27**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **5.3 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.68 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 39 Reservoir 41.82719411, -111.9636355**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
4402.45	5				CH		inorganic clay medium stiff grey, shear value 0.19	
4397.45	10							
4392.45	15							
4387.45	20							
4382.45	25							
4377.45	30							

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Project: **Cutler Relicense**	Log of Boring 40
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/27**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **15.3 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.68 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 40 Reservoir 41.82609882, -111.9653848**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
4402.45	5							
					OL		unconsolidated muck	
					SP-SM		Sand fine to medium fine, some silt, not well sorted	
4397.45	10							
					SW		well sorted clean sand medium, little fine sand	
4392.45	15							
4387.45	20							
4382.45	25							
4377.45	30							

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Project: **Cutler Relicense** Project Location: **Cutler Reservoir** Project Number: **P-2420**	Log of Boring 41 **Sheet 1 of 1**

Date(s) Drilled **7/27**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **12.1 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.68 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 41 Reservoir 41.82526443, -111.9717662**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.45	0							
4402.45	5							
					SM		fine sand, some silt, poorly sorted.	
4397.45	10							
4392.45	15							
4387.45	20							
4382.45	25							
4377.45	30							

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Project: **Cutler Relicense**	Log of Boring 42
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/28**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **17.2 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.8 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 42 Reservoir 41.82767258, -111.975698**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.8	0							
4402.8	5							
					SM		fine sand, some silt on top, poorly sorted. bottom cleaner sand, fine, some medium	
4397.8	10							
4392.8	15							
4387.8	20							
4382.8	25							
4377.8	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 43
Sheet 1 of 1

Date(s) Drilled **7/28**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **5.2 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.8 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 43 Reservoir 41.82989245, -111.975822**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.8	0							
4402.8	5				CH		medium stiff clay, grey in color shear value 0.17 kg/cm	
4397.8	10							
4392.8	15							
4387.8	20							
4382.8	25							
4377.8	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 44
Sheet 1 of 1

Date(s) Drilled **7/28**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **16.8 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.8 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 44 Reservoir 41.82887978, -111.978044**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.8	0							
4402.8	5							
					SM		fine sand with silt	
4397.8	10							
					SM		mostly fine sand	
4392.8	15				SW		clean sand mostly medium sand, some gravelly sand at bottom of core	
4387.8	20							
4382.8	25							
4377.8	30							

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Project: **Cutler Relicense** Project Location: **Cutler Reservoir** Project Number: **P-2420**	# Log of Boring 45 **Sheet 1 of 1**

Date(s) Drilled **7/28**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **8.5 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.8 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 45 Reservoir 41.8274333, -111.9809806**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.8	0							
					OL		silt, black organic	
4402.8	5				SM		mostly fine sand	
					ML		light clay, depositional loess inorganic, possibly early deposition.	
4397.8	10							
4392.8	15							
4387.8	20							
4382.8	25							
4377.8	30							

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Project: **Cutler Relicense**	# Log of Boring 46
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/28**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **6.6 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.8 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 46 Reservoir 41.82951896, -111.985959**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.8	0							
4402.8	5				SC		sand clay mix, combination of possible bank material and fine sand	
4397.8	10							
4392.8	15							
4387.8	20							
4382.8	25							
4377.8	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 47

Sheet 1 of 1

Date(s) Drilled **7/28**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **5.9 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.8 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 47 Reservoir 41.83288238, -111.9863567**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.8	0							
					SM		mostly fine sand, some silt, organic,	
4402.8	5							
					CL		inorganic clay bottom, native layer	
4397.8	10							
4392.8	15							
4387.8	20							
4382.8	25							
4377.8	30							

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Project: **Cutler Relicense**	Log of Boring 48
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/28**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **16.3 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.8 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 48 Reservoir 41.83280877, -111.9910322**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.8	0							
4402.8	5							
4397.8	10				SM		fine sand, some silt, not well sorted	
4392.8	15							
4387.8	20							
4382.8	25							
4377.8	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 49
Sheet 1 of 1

Date(s) Drilled **7/29**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **18.3 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.7 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 49 Reservoir 41.83389332, -111.9926401**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.8	0							
4402.8	5							
4397.8	10				SM		fine sand, silt throughout, not well sorted, dark grey	
4392.8	15				SW		clean sand, fine	
4387.8	20							
4382.8	25							
4377.8	30							

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Project: **Cutler Relicense**	Log of Boring 50
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/29**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **10.7 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.7 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 50 Reservoir 41.83710509, -111.9947768**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.8	0							
					OL		silt sand, some organics, shear value 0.06 kg/cm	
4402.8	5							
					SC		fine sand, clay, and some silt	
					SC		mostly clay, some very fine sand	
4397.8	10				SM		fine sand, some silt	
4392.8	15							
4387.8	20							
4382.8	25							
4377.8	30							

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Project: **Cutler Relicense**	Log of Boring 51
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/29**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **8.4 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.7 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 51 Reservoir 41.83953109, -112.0002631**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.8	0							
4402.8	5				OL		silt very unconsolidated near top	
					OL		dense silt clay, little sand, shear value 0.1 kg/cm	
4397.8	10							
4392.8	15							
4387.8	20							
4382.8	25							
4377.8	30							

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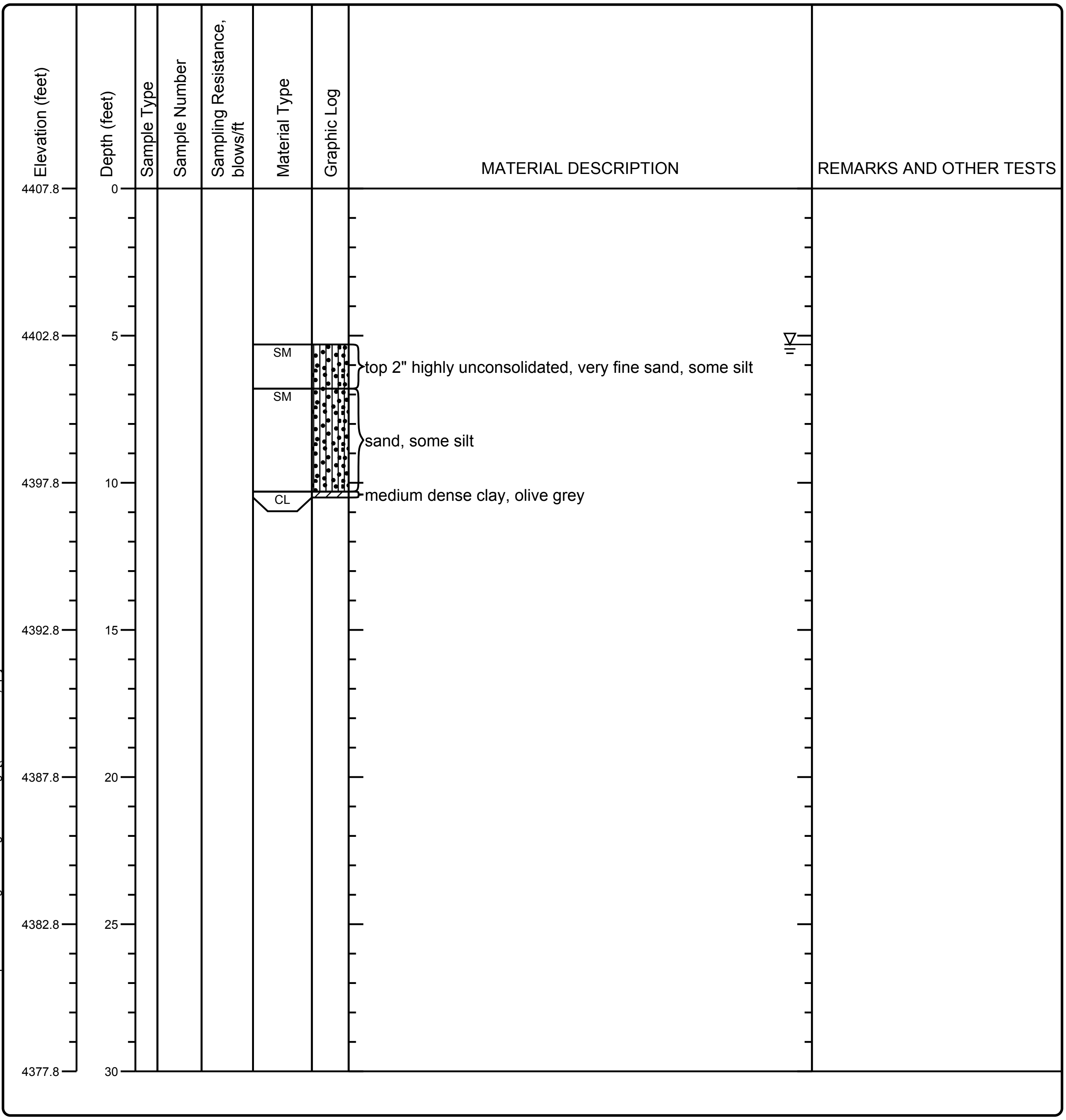
Project: **Cutler Relicense**	# Log of Boring 52
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/29**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **10.5 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.7 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 52 Reservoir 41.84123139, -111.9994219**	



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Project: **Cutler Relicense**	# Log of Boring 53
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/29**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **17.8 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.7 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 53 Canyon 41.84307293, -112.0020478**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.8	0							
4402.8	5							
4397.8	10				SM		very fine sand, some silt	
					SM		fine sand, more silt then sand	
					SM		fine sand, silt	
4392.8	15						fine sand, some medium sand, clean, mostly well sorted	
4387.8	20							
4382.8	25							
4377.8	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 54
Sheet 1 of 1

Date(s) Drilled **7/29**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **18.5 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.7 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 54 Canyon 41.84701218, -112.0055646**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.8	0							
4402.8	5							
4397.8	10							
					SM		fine sand, silt, organic. top unconsolidated	
					SM		fine sand, silt, more sand than silt	
4392.8	15							
					SW		sand, mostly medium, some fine sand, well sorted clean.	
4387.8	20							
4382.8	25							
4377.8	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 55

Sheet 1 of 1

Date(s) Drilled **7/29**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **17.9 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.7 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 55 Canyon 41.85073928, -112.0102056**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.8	0							
4402.8	5							
4397.8	10							
4392.8	15				OL		silt and fine sand, organic. top unconsolidated	∇
					SM		fine sand, little silt, not well sorted	
					SW		sand, mostly medium, well sorted clean.	
4387.8	20							
4382.8	25							
4377.8	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 56
Sheet 1 of 1

Date(s) Drilled **7/29**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **21.4 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.7 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 56 Canyon 41.85270616, -112.01764**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.8	0							
4402.8	5							
4397.8	10							
4392.8	15							
					OL		silt and clay, mostly fines, some organics	
					SW-SM		fine sand with fines grading to cleaner medium sand at bottom.	
4387.8	20							
4382.8	25							
4377.8	30							

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Project: **Cutler Relicense** Project Location: **Cutler Reservoir** Project Number: **P-2420**	Log of Boring 57 **Sheet 1 of 1**

Date(s) Drilled **7/30**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **20.8 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.6 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 57 Canyon 41.84234002, -112.0384157**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.6	0							
4402.6	5							
4397.6	10				OL		silt and clay, some very fine sand fines, some organics	
4392.6	15							
4387.6	20							
4382.6	25							
4377.6	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 58
Sheet 1 of 1

Date(s) Drilled **7/30**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **30.5 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.6 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 58 Canyon 41.83947289, -112.0407784**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4407.6	0							
4402.6	5							
4397.6	10							
4392.6	15							
	16–30				OL		silt and clay, some very fine sand fines, some organics	
4387.6	20							
4382.6	25							
4377.6	30							

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Log of Boring 59
Sheet 1 of 1

Date(s) Drilled **7/30**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **28.5 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.6 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 59 Canyon 41.83821105, -112.0423071**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
4387.6	20				OL		silt and clay, some very fine sand, some organics			

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Project: **Cutler Relicense** Project Location: **Cutler Reservoir** Project Number: **P-2420**	Log of Boring 60 **Sheet 1 of 1**

Date(s) Drilled **7/30**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **16 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.6 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 60 Canyon 41.83805171, -112.0443761**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
4407.6	0									
4402.6	5									
	8				OL		silt and clay, some very fine sand, some organics			
4397.6	10									
4392.6	15									
4387.6	20									
4382.6	25									
4377.6	30									

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Project: **Cutler Relicense** Project Location: **Cutler Reservoir** Project Number: **P-2420**	Log of Boring 61 **Sheet 1 of 1**

Date(s) Drilled **7/30**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **22 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.6 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 61 Canyon 41.8458975, -112.0368683**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
4407.6	0									
4402.6	5									
4397.6	10									
	12				OL		silt and clay, some very fine sand, some organics			
4392.6	15									
4387.6	20				SW-SM		fine sand with silt, grading to cleaner larger well sorted sand			
4382.6	25									
4377.6	30									

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Project: **Cutler Relicense**	Log of Boring 62
Project Location: **Cutler Reservoir**	**Sheet 1 of 1**
Project Number: **P-2420**	

Date(s) Drilled **7/30**	Logged By **Jose/ Justin**	Checked By **Justin**
Drilling Method **Vibecore-D**	Drill Bit Size/Type **3" Core**	Total Depth of Borehole **22.8 feet bgs**
Drill Rig Type **Raft Mounted**	Drilling Contractor	Approximate Surface Elevation **4407.6 msl**
Groundwater Level and Date Measured **na**	Sampling Method(s) **Grab**	Hammer Data
Borehole Backfill	Location **Site 62 Canyon 41.84975222, -112.0349459**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
4407.6	0									
4402.6	5									
4397.6	10									
4392.6	15									
4387.6	20				OL		silt and clay, some very fine sand, some organics			
					SW		medium sand, clean, well graded, some small gravel			
4382.6	25									
4377.6	30									

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Project: **Cutler Relicense**
Project Location: **Cutler Reservoir**
Project Number: **P-2420**

Key to Log of Boring

Sheet 1 of 1

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7	8	9	10	11

COLUMN DESCRIPTIONS

1. Elevation (feet): Elevation (MSL, feet).
2. Depth (feet): Depth in feet below the ground surface.
3. Sample Type: Type of soil sample collected at the depth interval shown.
4. Sample Number: Sample identification number.
5. Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
6. Material Type: Type of material encountered.
7. Graphic Log: Graphic depiction of the subsurface material encountered.
8. MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
9. Water Content, %: Water content of the soil sample, expressed as percentage of dry weight of sample.
10. Dry Unit Weight, pcf: Dry weight per unit volume of soil sample measured in laboratory, in pounds per cubic foot.
11. REMARKS AND OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field personnel.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Low plasticity PEAT (OL)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Bulk Sample
3-inch-OD California w/ brass rings
CME Sampler
Grab Sample
2.5-inch-OD Modified California w/ brass liners
Pitcher Sample
2-inch-OD unlined split spoon (SPT)
Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
? Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

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Figure B-1

APPENDIX I
RECREATION RESOURCES INITIAL STUDY REPORT

RECREATION RESOURCES INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT

(FERC NO. 2420)

Prepared for:

PacifiCorp
Salt Lake City, UT

Prepared by:

ERM

River Science Institute

February 2021

RECREATION RESOURCES
INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT

(FERC NO. 2420)

Prepared for:

PacifiCorp
Salt Lake City, UT

Prepared by:

ERM

River Science Institute

February 2021

RECREATION RESOURCES
INITIAL STUDY REPORT

PACIFICORP

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RECREATION RESOURCES
INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

1.0 INTRODUCTION

PacifiCorp is owner, operator, and the Federal Energy Regulatory Commission (FERC) licensee for the Cutler Hydroelectric Project (FERC No. 2420) (Project). The Project is located on the Bear River and several tributaries in Cache Valley, Utah, between the Wasatch and Wellsville Mountains. Cutler Dam is located in Box Elder County, however most of the Project reservoir lies within Cache County. The Project reservoir is formed at the confluence of Spring Creek and the Bear, Logan, and Little Bear Rivers. PacifiCorp operates the Project under a 30-year license issued by FERC on April 29, 1994; the current license will expire on March 31, 2024. PacifiCorp initiated the formal relicensing process utilizing the Integrated Licensing Process (ILP) by filing the Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on March 29, 2019.

The relicensing process involves cooperation and collaboration amongst PacifiCorp, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local governments, non-governmental organizations (NGO), and interested individuals. PacifiCorp coordinated with stakeholders that included federal and state agencies, NGOs, and Native American tribes and tribal organizations to participate in several public meetings, workshops, scoping meetings, and a site visit. These meetings facilitated the identification of study needs to be addressed. Study scoping occurred from March 2019 through February 2020, when FERC issued the Study Plan Determination. PacifiCorp, FERC, and stakeholders identified the need for a Recreation Resource Study during the study scoping process.

2.0 PROJECT NEXUS AND RATIONALE FOR STUDY

When making a decision regarding re-issuance of a new license for the Project, FERC considers the recreational and other non-developmental values of the Project, as well as power and developmental values. The decision process includes FERC's determination of specifying any conditions that should be included in a new license to best improve or develop Project waters for all beneficial public uses. Reasonable consideration of the effects of continued Project operation pertaining to recreational opportunities and access in the Project Boundary is in the public interest.

3.0 REVIEW OF EXISTING INFORMATION

Existing management plans and reports were reviewed to develop a baseline understanding of current recreation resources and known recreation use trends in the Project Vicinity. Relevant management plans included the following:

- PacifiCorp Recreation Site Development Program for Cutler Hydroelectric Project (part of the 1995 PacifiCorp Cutler Resource Management Plan)
- PacifiCorp's FERC Form 80 Reports for Cutler Hydroelectric Project, most recently published in 2015
- PacifiCorp's Five-Year Monitoring Report series for Cutler Hydroelectric Project (PacifiCorp 2002, 2008, 2013, 2018)
- U.S. Fish and Wildlife Service's Bear River Migratory Bird Refuge Comprehensive Management Plan (USFWS 1997)
- Utah Department of Natural Resources' Final Bear River Comprehensive Management Plan. (Utah DNR 2017)
- 2014 Utah State Comprehensive Outdoor Recreation Plan (SCORP) (Utah DNR 2013)
- 2010 Utah Boating Program Strategic Plan (Utah DNR 2010)
- 2019 National Park Service Accessibility Report (NPS 2019)

4.0 STUDY OBJECTIVES

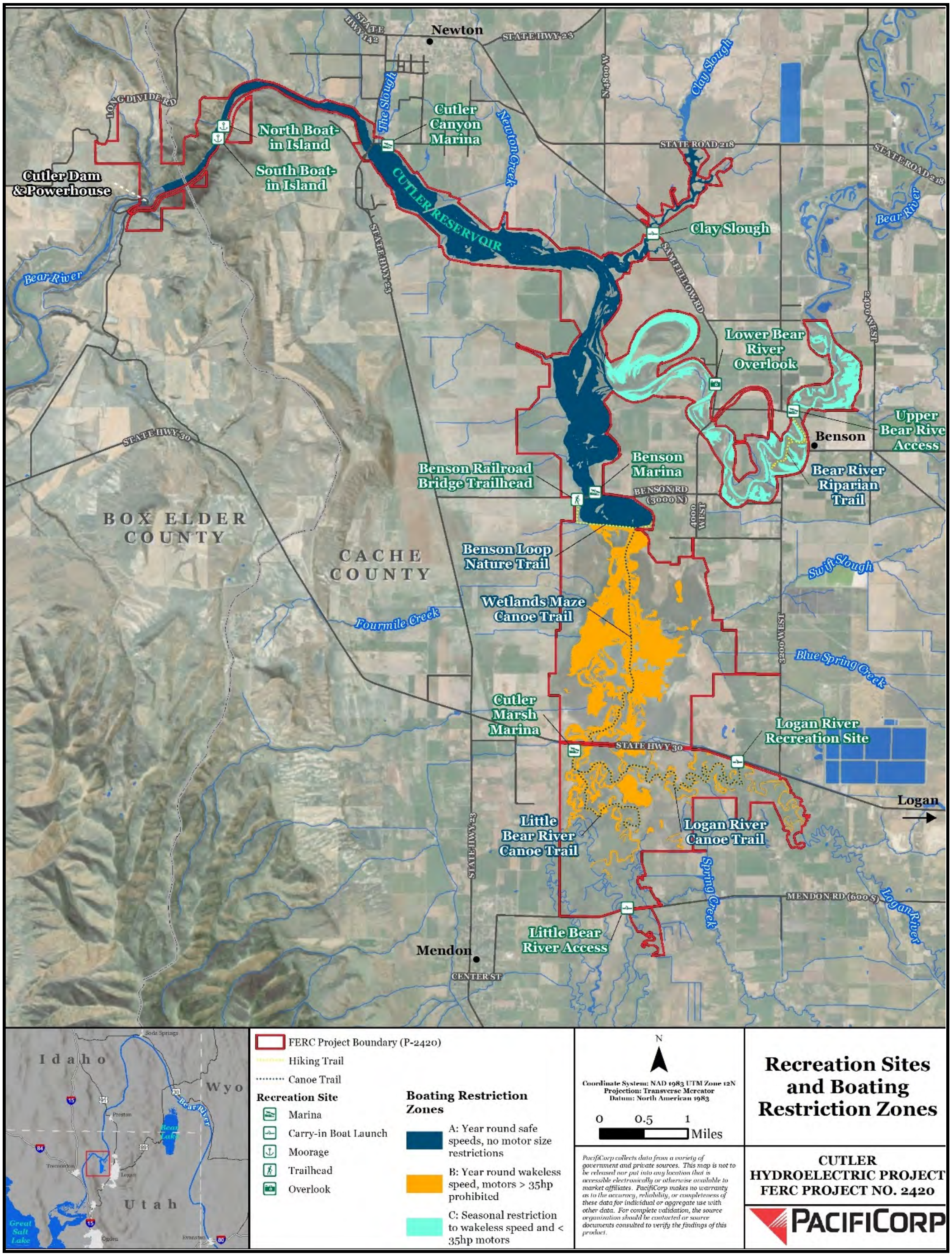
The goals of the Recreation Resources Study were to identify the existing recreation opportunities, facilities, and visitor use that may be affected by the operation of the Project, and to develop measures that could be implemented to mitigate Project effects and/or enhance recreation activities. The specific objectives to meet the goals of the study included:

- Describe existing recreation opportunities and facilities within the Project Boundary
- Quantify visitor use and carrying capacity for Project recreation facilities
- Evaluate if or how changes in Project operations could affect recreation opportunities, patterns in visitor use, public access to the reservoir, and recreation facility usability
- Identify current and projected trends in recreation based on recent or newly conducted surveys and interviews and consultation with stakeholders, regional and statewide plans, and other available data
- Evaluate how changes in Project operations may affect existing visual resource conditions in the vicinity of the Project
- Evaluate how other proposed ongoing actions may affect existing recreation facilities (i.e., widening State Road 30)

Aesthetic resources, including visual resource conditions, are addressed in the Land Use Study Report (ISR) (Appendix D of this ISR). The FERC-approved Revised Study Plan (RSP) includes an objective to evaluate the effects of PacifiCorp's potential proposed operations on recreation resources; however, this analysis is not included in this ISR. It will be presented in the Draft License Application (DLA), which will be submitted in late 2021.

4.1 STUDY AREA

The study area for the recreation resources (Figure 4-1) is the area inside the Project Boundary, including the portion of the Bear River immediately downstream of the powerhouse.



SOURCE: PACIFICORP 2018

FIGURE 4-1 RECREATION STUDY PLAN AREA

5.0 METHODS

This section describes the study methods for evaluating recreation opportunities, facilities, and visitor use in the Project Boundary under current operating conditions as well as for evaluating potential changes in Project operations. The study methods utilized are consistent with professional practices and FERC study requirements under the ILP and have been employed at other hydroelectric projects and recreation sites throughout the United States.

Recreation planners gathered information on recreation opportunities, facilities, and visitor use within the Project Boundary using a combination of data collection methods that included the following:

- Desktop recreation assessment
- Recreation site assessment
- Recreation use counts
- Structured interviews
- Visitor surveys
- Assessment of project operational changes

Using this information, PacifiCorp completed a recreation needs analysis, which will become the basis for the Recreation Management Plan for the new license. Each method is described below.

5.1 DESKTOP RECREATION ASSESSMENT

Initially, recreation planners completed a desktop recreation assessment to identify existing recreation opportunities and facilities in the study area using methods described by Whittaker, Shelby, and Gangemi (2005). The study area is defined as the Project's FERC Boundary, as shown above in Figure 4-1. Information sources for this assessment included local, state, and federal recreation plans (Section 3.0), recreation guidebooks, maps, tourist information, magazine articles, online descriptions of recreation opportunities and trips, reservoir elevation data, and fishing regulations. The assessment included existing comprehensive plans applicable to municipal, state, and federal lands adjacent to or near the study area. The information obtained in the desktop assessment was synthesized in a narrative summary describing recreation opportunities, facilities, and restrictions within the Project Boundary with accompanying maps.

5.2 RECREATION SITE ASSESSMENT

During the Project recreation site assessment, recreation planners observed the recreation opportunities and facilities identified during the desktop recreation assessment. Site visits were timed to coincide with conditions suitable for recreation activities for first-hand observations. During the site visits, recreation planners evaluated the potential effect of Project operations on recreation opportunities and facilities.

At each site, the recreation site assessment field form (Attachment I-1) was used to collect the following information:

- Recreation site name
- Recreation amenities
- Assessment of site condition
- Handicap accessibility
- Photographs
- Safety/security concerns

An analysis of physical capacity at each recreation site was completed. This analysis included an assessment of the physical space available versus actual use (based on use counts below, where available), comparing off-peak, peak use, and seasonal use patterns.

5.3 RECREATION USE COUNTS

Visitor use was monitored using a combination of traffic counters and trail counters at select sites. Visitor use data was supplemented with existing data from routine monitoring as specified in PacifiCorp's most recent Five-Year Resource Management Plan Monitoring Report (PacifiCorp 2018).

5.4 STRUCTURED INTERVIEWS

Structured interviews were conducted with stakeholders representing recreation organizations as well as individuals with direct knowledge of recreation activities and use patterns within and adjacent to the Project Area (Whittaker, Shelby, and Gangemi 2005, Whittaker et al. 1993). The structured interviews were used to develop the questions for the visitor survey. Where opportunities arose, structured interviews were planned with individuals pursuing recreation opportunities within the Project Boundary. Section 5.7 provides modifications resulting from the Coronavirus Disease 2019 (COVID-19) pandemic.

5.5 VISITOR SURVEY

The visitor survey was conducted online and designed to query respondents on recreation use patterns and recreation needs within the Project Boundary. The online survey was organized into four sections: 1) background demographic information; 2) recreation use patterns within the Project Boundary; 3) Cutler recreation facilities used; and 4) recreation needs. Recreation pursuits in the Project use patterns, facilities, and recreation needs were tallied from survey questionnaires. The survey questionnaire design followed accepted practices outlined in Whittaker, Shelby, and Gangemi (2005) and Whittaker et al. (1993).

The survey questions were developed based on information gathered during the structured interviews. Prior to survey implementation, the survey instruments were pre-tested, and refined for clarity, as necessary. The pre-test included a total of 10 to 15 completed surveys intended to receive feedback on readability, length, and general understanding of the survey content. As necessary, minor changes to the survey were made to make the survey easier to complete and/or understand.

The online survey was open to all members of the public with the intent of getting a broad participant demographic. PacifiCorp announced the availability of the online survey to stakeholders on the Project service and mail list as well as the Project website. In addition, postcards were placed at recreation facility sign boards at the Project explaining the purpose of the survey and giving a link to the survey portal. This open-ended distribution method does not permit calculation of a survey response rate, and an online survey sample size was not established.

5.6 ASSESSMENT OF PROPOSED PROJECT OPERATIONAL CHANGES

Potential future Project operational changes and associated changes in reservoir pool elevations were evaluated to determine potential effects on recreation opportunities, facilities, and visitor use. Cutler Reservoir was topographically mapped using a combination of light detection and ranging (LiDAR) and bathymetry. Drones were used during the fall 2019 drawdown to document changes in wetted perimeter corresponding to distinct reservoir elevations at Cutler recreation sites. Field crews marked the wetted perimeter daily with non-permanent survey paint when there was a change in reservoir elevation during the drawdown. Drones captured still photos along a pre-programmed flight path to document lateral changes in wetted perimeter distance across a range of reservoir elevations. Survey markers with established grids were used to measure changes in lateral distance.

Recreation planners used the drone photos as well as the LiDAR and bathymetry data to evaluate reservoir access at existing boat ramps and carry-in boat launches under various Project operational regimes and the associated reservoir water elevations. The study analyzed potential changes in water-based recreation opportunities associated with changes in reservoir pool elevations such as motorized and non-motorized navigation. The analysis considered the seasonality of proposed operational changes relative to recreation use as well as the rate of reservoir drawdown.

5.7 MODIFICATIONS TO METHODS

The onset of the COVID-19 pandemic in March 2020 delayed the implementation schedule for structured interviews; therefore, the visitor survey was developed and initiated prior to conducting the structured interviews. Contrary to the method described in the FERC-approved study plan, the structured interviews were not needed to design the visitor survey. Instead, study plan authors relied on information gathered from stakeholders at relicensing meetings in combination with recreation site visits and informal interviews at recreation sites with recreation users to design the visitor survey. Information gathered during structured interviews was used to provide detail in the recreation use assessment. The COVID-19 pandemic may have altered visitor use statistics at the Project; a summary of the 2019 COVID-19 restrictions during 2019 is provided in Section 7.1.

Although aesthetic resources were mentioned in the methods section of the recreation RSP, this resource was included in the Land Use ISR (Appendix D of this ISR).

6.0 RESULTS

The results are organized by the respective methods described in Section 5 of this report.

6.1 DESKTOP RECREATION ASSESSMENT

Based on a desktop review, this section presents a summary of the recreation opportunities and facilities in the study area.

6.1.1 RECREATION OPPORTUNITIES

The Project offers a broad range of no-fee recreation opportunities available to the public year-round. Spring, summer, and fall recreation opportunities include motorized and non-motorized boating; swimming; waterskiing; fishing; hunting for waterfowl, upland bird, and big game species; trapping; hiking; wildlife watching; birding; photography; and picnicking. Numerous recreation opportunities extend into the winter depending on the severity of the season. Periodic ice cover can restrict some open-water recreation opportunities while creating new activities such as ice-fishing and ice-skating. Upland bird and waterfowl hunting and trapping continue into the winter months as determined by state and PacifiCorp hunting and trapping regulations.

6.1.2 DEVELOPED RECREATION SITES

Under the current license, PacifiCorp implemented a recreation site development program to improve public access and develop recreation facilities within the Project Boundary (PacifiCorp 2002). As part of this program, PacifiCorp has developed and maintains 13 recreation sites in the Project Boundary (Table 6-1). These recreation sites provide a range of amenities.

Two hiking trails are located within the Project Boundary: the Benson Railroad Bridge Trail and the Bear River Riparian Trail. PacifiCorp maintains these trails for pedestrian use with parking available at the respective trailheads.

In addition to the recreation sites, three water trails are managed for recreation in the Project Boundary: Little Bear River Canoe Trail, Logan River Canoe Trail, and Wetland Maze Canoe Trail.

TABLE 6-1 DEVELOPED RECREATION SITES AT CUTLER HYDROELECTRIC PROJECT

SITE NAME	DAY-USE ONLY	PARKING	RESTROOMS	PICNIC TABLE	BARBECUE GRILL	PAVILION	SWIMMING AREA	DOCK	CONCRETE BOAT RAMP	CARRY-IN BOAT LAUNCH	ANGLING	TRAIL
Bear River Riparian Trail	•	•	•									•
Benson Marina	•	•	•	•	•	•	•	•	•		•	
Benson Railroad Bridge Trailhead	•	•										•
Benson Railroad Bridge Trail	•	•									•	•
Clay Slough	•	•								•	•	
Cutler Canyon Marina	•	•	•	•	•	•		•	•		•	
Cutler Marsh Marina	•	•	•	•		•		•	•		•	
Little Bear River Access	•	•	•							•	•	
Logan River Recreation Site	•	•	•					•		•	•	

SITE NAME	DAY-USE ONLY	PARKING	RESTROOMS	PICNIC TABLE	BARBECUE GRILL	PAVILION	SWIMMING AREA	DOCK	CONCRETE BOAT RAMP	CARRY-IN BOAT LAUNCH	ANGLING	TRAIL
Lower Bear River Overlook	•	•										
North Boat-in Island	•							•			•	
South Boat-in Island	•							•			•	
Upper Bear River Access	•	•	•	•				•	•		•	

6.1.3 RESTRICTIONS TO RECREATION

Recreation facilities allow day use only. Camping is not permitted at any of the recreation facilities. Recreation facilities have the following hours of operation:

- April 1–September 30, 5:00 a.m. to 10:00 p.m.
- October 1–March 31, 5:00 a.m. to 7:00 p.m.

PacifiCorp, Utah State Parks, and the Utah Division of Wildlife Resources adopted three boater use zones for the Project waters (Figure 4-1): North Boater Zone A, South Boater Zone B, and Bear River Boater Zone C (PacifiCorp 2018). These zones are codified in Utah state law (R651-205-17)[1]. Watercraft size and operation limits prescribed for each zone help maintain unique recreation opportunities, public safety, and wildlife habitat. In the North Boater Zone A, there are no restrictions on motor size or speed, outside of state boater safety regulations and standards. In the South Boater Zone B, motor size is restricted to a maximum of 35 horsepower (hp) and wakeless speeds year-round. In the Bear River Boater Zone C, motor size is restricted to a maximum of 35 hp and wakeless speeds from the last Saturday in September to March 31, annually, but is open to all watercraft and safe speeds from April 1 to the end of September.

6.2 RECREATION SITE ASSESSMENT

The recreation site assessment included an inventory of the Project recreation sites to evaluate site condition, handicap access, and visitor use impacts. The recreation site assessments were conducted at the 11 developed recreation sites accessible from shore (Table 6-2). Dispersed use areas such as water trails or remote locations accessible only by boat were not included in the recreation site assessment.

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[1] R651-205-17. Cutler Reservoir. The use of motors whose manufactured listed horsepower is more than 35 horsepower is prohibited, and a vessel may not be operated at a speed greater than wakeless speed at any time in the area south of the Benson Railroad Bridge. A vessel may not be operated at a speed greater than wakeless speed from the last Saturday in September through March 31st in the Bear River, east of the confluence with the reservoir.

TABLE 6-2 RECREATION SITES EVALUATED, PACIFICORP LANDOWNER

Site Type	Recreation Site	Type of Evaluation			
		Inventory	Condition	Handicap Accessibili	Use Impact
Trail	Bear River Riparian Trail		x		x
Trail	Benson Railroad Bridge Trail	x	x		x
Parking	Benson Railroad Bridge Trailhead	x	x	x	x
Parking	Lower Bear River Overlook	x	x	x	x
Marina	Benson Marina	x	x	x	x
Marina	Cutler Canyon Marina	x	x	x	x
Marina	Cutler Marsh Marina	x	x	x	x
Walk-in	Clay Slough	x	x	x	x
River access	Upper Bear River Access	x	x	x	x
River access	Little Bear River Access	x	x	x	x
River access	Logan River Recreation Site	x	x	x	x
Boat-in	North Boat-in Island				
Boat-in	South Boat-in Island				

6.2.1 RECREATION SITE CONDITION

The inventory of the available recreation amenities at recreation sites recorded 243 total amenities across 10 of the 13 recreation sites (Table 6-3); the three canoe trails have no amenities and were not included. Amenities assessed included entrance signs, regulatory signs, information boards, picnic tables, grills, trash receptacles, pavilions/shelters, restrooms, in-site paths, standard parking spaces, trailer parking spaces, entrance roadways, boat ramps, docks, designated swimming areas, and designated trails. All recreation sites except the boat-in sites have a regulatory sign and information board. Benson Marina has the most amenities.

The condition of individual recreation amenities was evaluated during the recreation site assessment. Evaluation criteria were applied for each type of recreation site amenity (Table 6-4). The assessment categories were poor, fair, good, and excellent condition. The report includes ratings for individual amenities within a site as well as an overall site rating (Table 6-5).

The assessment of recreation amenity condition indicated that most are in good to excellent condition. Cutler Marsh Marina was in the best condition of the 10 sites evaluated with all amenities listed as excellent. The Benson Railroad Bridge Trail had the lowest condition rating of all the Project recreation sites with an average rating of 2.7 (between fair and good); this trail also had the fewest number of amenities from which to calculate the average. Information boards and regulatory signs at most recreation sites were more often listed in poor condition. Factors influencing the rating for signs included discoloration from sun, structural materials degrading and vandalism in the form of graffiti, and at the Little Bear River Access, bullet holes.

6.2.2 VISITOR USE IMPACTS

The recreation site assessment included an inventory of visitor use impacts to amenities and the site overall. The recreation site assessment field form included a list of site variables, questions, and response choices to evaluate visitor use impacts. Visitor use impacts were scored on a scale of 1 to 3 as described below:

1. Low: Few, if any evidence of, use impacts are observed at each site.
2. Moderate: Several signs/evidence of use impact, but not extensive or widespread impacts.
3. High: Extensive evidence of use impact; widespread use with many impacts evident.

Overall, visitor use impacts were minimal across the 11 recreation sites inventoried (Table 6-6). Nine instances of visitor use impacts were observed across the 11 sites. Visitor use impacts included vandalism, small amounts of littering, a fire ring, as well as bare ground and loss of vegetation. Vandalism was observed at four sites. Graffiti was observed at Benson Marina and Cutler Marsh Marina. Signs were vandalized at Little Bear River Access. At Cutler Canyon Recreation Site, vandalism was observed on the restroom, picnic tables, dock, and signs. Litter was observed at four sites. The litter was in trace or small amounts, usually less than a handful. Four sites recorded high loss of ground vegetation associated with visitor use. Three sites showed low loss of vegetation and use in small areas. One site had medium loss of vegetation with bare areas around fire rings and other areas. Nine sites have barriers installed to prevent vehicle access to parts of the site. None of the barriers were moved.

TABLE 6-3 NUMBER OF RECREATION AMENITIES

RECREATION FEATURE	**BENSON RAILROAD BRIDGE TRAIL**	**BENSON MARINA**	**BENSON RAILROAD BRIDGE TRAILHEAD**	**CLAY SLOUGH**	**CUTLER CANYON RECREATION SITE**	**CUTLER MARSH MARINA**	**LITTLE BEAR RIVER ACCESS**	**LOGAN RIVER RECREATION SITE**	**LOWER BEAR RIVER OVERLOOK**	**UPPER BEAR RIVER ACCESS**	**NUMBER OF SITES WITH FEATURES**	**TOTAL FEATURES**
Entrance sign	1	1		1	1	2	1	1	1	1	**9**	**10**
Regulatory sign	1	7	1	1	4	6	2	5	3	3	**10**	**33**
Information board	1	2	1	1	1	2	1	1	1	1	**10**	**12**
Picnic tables		7			2	6			1		**4**	**16**
Grills		4			2	2					**3**	**8**
Trash receptacle		2	1	1	1	2	1		1	1	**8**	**10**
Pavilion/shelter		1				1					**2**	**2**
Restroom		2		1	2	2		1	1	2	**7**	**11**
In-site paths		1	1	1	1	1		1			**6**	**6**
Standard parking spaces		23	4	4	12	19	4	5	4	10	**9**	**85**
Trailer parking spaces		5			10	10				3	**4**	**28**
Entrance roadway		2		1	2	1		1	1	1	**7**	**9**
Boat ramp		1			1	1				1	**4**	**4**
Dock		2			1	1		1		1	**5**	**6**
Designated swimming area		1									**1**	**1**
Designated trails			1							1	**2**	**2**
Total features	**3**	**61**	**9**	**11**	**40**	**56**	**9**	**16**	**13**	**25**	**91**	**243**

TABLE 6-4 AMENITY CONDITION EVALUATION CATEGORIES AND CRITERIA

CONDITION RATING	CONDITION DESCRIPTION	EXAMPLES OF CONDITION BY AMENITY TYPE			
		VEHICLE PARKING (SURFACE PAVING ON VEHICLE SPURS AND PARKING AREAS)	AMENITIES (TABLES, GRILLS, BOAT RAMPS, DOCKS, TRAILS AND TRAILHEADS)	BUILDINGS (PUBLIC RESTROOMS AND OUTDOOR RECREATION STRUCTURES)	SIGNS (PROJECT AND RECREATION SIGNS)
1 – Poor	All or most facilities are in disrepair and in need of immediate reconditioning or replacement. Current conditions create safety hazards and impact function. Little evidence of recent maintenance.	Widespread areas of cracking, eroding edges, potholes, visible subgrade.	Splitting or rotten boards or planks, missing bolts or fasteners, overgrown or impassable trail tread, rutted or eroded trail surface.	Rot, leaks, sagging roofs, holes in exterior.	Signs do not exist, sign panels are bent/broken, posts, or supports are broken, holes in panels.
2 – Fair	Need for improved maintenance and repair in some areas. No major safety concerns. Repairs should be made, but are not needed immediately.	Limited areas of cracking, eroding edges, potholes, striping faded or lacking, curbs/wheel stops missing or damaged.	Loose bolts or boards, rusted or bent grills, dock boards loose, dock floatation or anchoring in disrepair, early signs of vegetation encroaching on trail width and height, limited areas of trail tread erosion.	Surfaces need painting, roof shingles need replacement or repair, inoperable lock, door hinge in disrepair.	Sign panels are faded, loose bolts or posts, some text not readily legible.
3 – Good	All facilities in good condition and well maintained. No significant signs of disrepair or aging.	Surfacing still consistent and intact, striping visible but slightly faded, no cracking or potholes.	Materials not clearly new, but fully operable, fasteners and grills secure, boards and planking secure, no signs of damage observed, clear trail tread/width, no signs of vegetation encroachment on trail width and height.	Minor signs of weathering, but in functional condition. Facilities operable and only need minor maintenance.	Minor signs of weathering, but are fully intact, legible, and secure.
4 – Excellent	All facilities are new, near new, or recently reconditioned and well maintained.	Newly surfaced or resurfaced with clear striping.	New materials, newly built or restored trail surface with clearly defined vegetation clearances.	Newly installed or reconditioned structure.	New sign panels and posts are present.

TABLE 6-5 CONDITION OF RECREATION AMENITIES

Recreation Feature	Benson Railroad Bridge Trail	Benson Marina	Benson Railroad Bridge Trailhead	Clay Slough	Cutler Canyon Recreation Site	Cutler Marsh Marina	Little Bear River Access	Logan River Recreation Site	Lower Bear River Overlook	Upper Bear River Access	Average Condition
Entrance sign	3	3	NP	4	4	4	4	3	3	3	**3.4**
Regulatory sign	3	3	3	4	3	4	2	3	3	3	**3.1**
Information board	2	2	2	3	3	4	2	3	2	4	**2.7**
Picnic tables	NP	4	NP	NP	3	4	NP	NP	4	NP	**3.8**
Grills	NP	3	NP	NP	4	4	NP	NP	NP	NP	**3.7**
Trash receptacle	NP	4	4	4	4	4	4	NP	4	4	**4.0**
Pavilion/shelter	NP	4	NP	NP	NP	4	NP	NP	NP	NP	**4.0**
Restroom	NP	4	NP	4	4	4	4	4	4	4	**4.0**
In-site paths	NP	4	4	2	4	4	NP	4	NP	NP	**3.7**
Standard parking spaces	NP	4	4	4	4	4	4	4	4	4	**4.0**
Trailer parking spaces	NP	4	NP	NP	4	4	NP	NP	NP	4	**4.0**
Entrance roadway	NP	4	4	4	4	4	4	4	4	4	**4.0**
Boat ramp	NP	3	NP	NP	4	4	NP	NP	NP	4	**3.8**
Dock	NP	2	NP	NP	2	4	NP	4	NP	4	**3.2**
Designated swimming area	NP	4	NP	NP	NP	NP	NP	NP	NP	NP	**4.0**
Designated trails	NP	NP	4	NP	NP	NP	NP	NP	NP	NP	**4.0**
Average condition	**2.7**	**3.5**	**3.6**	**3.6**	**3.6**	**4.0**	**3.4**	**3.6**	**3.5**	**3.8**	**3.6**

Note; 1 – Poor, 2 – Fair, 3 – Good, 4 – Excellent

NP: amenity not present for rating at recreation site

TABLE 6-6 USE IMPACT OF RECREATION FEATURES

VARIABLE	QUESTION	BENSON RAILROAD BRIDGE TRAIL	BENSON MARINA	BENSON RAILROAD BRIDGE TRAILHEAD	CLAY SLOUGH	CUTLER CANYON RECREATION SITE	CUTLER MARSH MARINA	LITTLE BEAR RIVER ACCESS	LOGAN RIVER RECREATION SITE	LOWER BEAR RIVER OVERLOOK	UPPER BEAR RIVER ACCESS	TOTAL IMPACTS
Facilities	Have the restrooms, picnic tables, pavilion, signs, and/or docks been vandalized?	N	Y	N	N	Y	Y	Y	N	N	N	**4**
Litter	In general, is litter found at this site?	Y	Y	N	N	N	Y	N	N	Y	N	**4**
Dump	Does this site get used as a dump (not just litter from camping)?	N	N	N	N	N	N	N	N	N	N	**0**
Fire rings	Are there user-created fire rings present?	Y	N	N	N	N	N	N	N	N	N	**1**
Bare ground	Does the site show signs of extensive use and loss of ground vegetation outside the designated site?	Y	Y	N	Y	N	N	Y	N	N	N	**4**
ATV/OHV[1]	Does the site show signs of ATV/OHV use?	N	N	N	N	N	N	N	N	N	N	**0**
Vehicle access barriers	Are there management-placed barriers to prevent vehicle access to parts of the site?	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	**0**
	Have people moved the vehicle access barriers?	NA	N	N	N	N	N	N	N	N	N	**0**

[1] = ATV = all-terrain vehicle; OHV = off-highway vehicle

6.2.3 ASSESSMENT OF ACCESSIBILITY AT RECREATION SITES

The inventory and evaluation of Project recreation sites included an assessment of handicap accessibility/function at each site including the amenities at the site (e.g., restroom, picnic tables, grills, docks, parking). The handicap accessibility assessment was completed at all sites except trails, water trails, and boat-in sites, utilizing an Americans with Disabilities Act (ADA) compliance checklist (USAB 2015; USDOJ 2010) adapted for outdoor recreation facilities. Collectively, the Project recreation sites provide opportunities for persons with disabilities and generally meet ADA standards. Recreation amenities such as parking, restrooms, and picnic tables have been designed specifically to accommodate ADA needs. The assessment identified the need for more signage at some of the sites designating handicap parking spaces. At some of the sites, physical constraints such as steep topography limit the ability to provide ADA-compliant access to all of the recreation amenities such as carry-in boat launches or floating docks that fluctuate with changes in reservoir water surface elevation (WSE). The National Park Service (NPS) conducted an assessment of ADA accessibility of recreation sites at the Cutler Project in 2019. The assessment report identified improvements that could be made at individual sites to improve access for persons with disabilities. A summary of potential ADA improvements proposed to be added to specific sites will be presented in the DLA.

Assessment for accessibility categories and a summary of findings are provided below along with the accessibility standard for each category (in italics).

- Route of Travel and Accessible Approach/Entrance - *People with disabilities should be able to arrive on the site, approach any buildings (where applicable), and enter as freely as everyone else. At least one route of travel should be safe and accessible for everyone, including people with disabilities.* In this category, all sites were found to include a route of travel to access recreation amenities at respective sites such as restrooms, picnic tables, grills, and pavilions. Recommended improvements include widening the access route at Clay Slough from 31 inches to 36 inches to meet ADA standards and locating access routes closest to the recreation amenities

- Ramps (other than Boat Ramps) - *Slope is given as a ratio of the height to the length. 1:12 means for every 12 inches along the base length of the ramp, the height increases one inch. For a 1:12 maximum slope, at least one foot of ramp length is needed for each inch of height.* Only one of the recreation sites, Lower Bear River Overlook, exceeded the ADA slope standard on the path to the picnic table. At all other sites slopes to recreation amenities conformed with the standard. The concrete pad connecting the access route to the restroom to the at Benson Marina and the Upper Bear River Access has an abrupt edge greater than ¼ inch. Beveling the abrupt edge would improve the route of travel.

- Parking and Drop off Areas - *At least 1 of every 8 accessible spaces must be van accessible (with a minimum of one van-accessible space in all cases*). An adequate number of accessible parking spaces was available at most recreation sites. Signage designating handicap parking was inconsistent. Signs and markings on the ground should be established to designate handicap- and van-accessible parking at each recreation site.

- Boat Ramps and Docks - *Boat ramps and docks need to consider slope, route of travel and safety railings for a person using a wheelchair or other disabilities.* Four recreation sites include boat ramps suitable for launching trailered boats and docks at the Project: Cutler Marsh Marina, Benson Marina, Cutler Canyon Recreation Site, and Upper Bear River Access. The slope to the dock at Benson Marina meets ADA standards. The docks at Cutler Marsh Marina and the Upper Bear River Access function as floating docks allowing debris floating down the respective rivers to pass under and around the dock. The elevation of the docks fluctuates with changes in WSE. In turn, the slope of the hinged ramps connecting the docks to the mainland changes limiting the ability to meet ADA slope standards. The topography of the Cutler Canyon Recreation Site constrains the ability to meet ADA slope standards for access to the dock and boat ramp. The Little Bear River Access and Logan River Recreation Site contain docks designed for launching carry-in boats only. Steep banks down to these tributaries limit the ability to provide access meeting ADA slope standards.

- Circulation/Access to Picnic Tables and Grills - *Ideally, at least one picnic table and grill should be accessible to people with disabilities. If there is a pavilion with picnic tables* *then one table should be ADA accessible.* All four sites with picnic tables were found to have an accessible route of travel, and most include wheelchair seating.

- Usability of Restrooms - *Restrooms should be accessible to people with disabilities and easily identifiable, e.g., tactile and visual signage identifying restrooms.* Project recreation sites with restrooms were fully accessible.

6.3 RECREATION USE COUNTS

Visitor use was monitored using TRAFx vehicle or trail counters deployed at nine recreation sites (all sites except for the Lower Bear River Overlook and the boat-in access areas and canoe trails) from April 23, 2020, through November 1, 2020 (Table 6-7).

TABLE 6-7 VISITOR USE COUNTS AT CUTLER RECREATION SITES

NUMBER	DESIGNATED RECREATION SITES	TYPE OF COUNTER
1	Bear River Riparian Trail	Trail counter
2	Benson Railroad Bridge Trail	Trail counter
3	Benson Marina	Vehicle counter
4	Clay Slough	Vehicle counter
5	Cutler Canyon Marina	Vehicle counter
6	Cutler Marsh Marina	Vehicle counter
7	Little Bear River Access	Vehicle counter
8	Logan River Recreation Site	Vehicle counter
9	Upper Bear River Access	Vehicle counter

6.3.1 VEHICLE COUNTERS AND VISITOR USE ESTIMATES

Vehicle counters were installed at the main entrances of respective recreation sites. Vehicles use the same road to enter and exit each of the recreation sites. As a result, a vehicle is double counted for a single visit; however, vehicle counts were adjusted to obtain the correct total number of vehicles per site per day. Vehicle counts were tabulated for each month at the respective sites (Table 6-8). Visitor counts were estimated for each recreation site using the vehicle count data (Table 6-9). Vehicle occupancy rates of 2.4 people per vehicle during non-peak season and 2.7 during peak season (PacifiCorp 2015) were used to tabulate the total number of visitors. Peak season was from Memorial Day weekend (May 22, 2020) to Labor Day weekend (September 7, 2020).

Data were downloaded monthly from each counter and underwent a QA/QC check. Counter malfunctions were identified early at several sites during the QA/QC check and counters were re-deployed resulting in minimal data loss at individual sites. The Upper Bear River Access counter failed to launch on the initial deployment on April 23, 2020. The counter was re-launched on May 8, 2020, and continued to collect vehicle counts through the remainder of the deployment period. The Clay Slough counter failed to launch on the initial deployment April 23, 2020. The counter was also re-launched on May 8, 2020. During the QA/QC data check in early June, it was determined that the Clay Slough counter was over-counting vehicles from May 8 to June 7, 2020, due to its proximity to the county road. The counter was moved on June 8, eliminating over-counting from that date forward. The Cutler Canyon Marina counter was flooded on September 1, 2020. The counter was removed from the location to dry before re-deploying. As a result, no data were collected on September 1, 2020, at Cutler Canyon Marina. The Logan River access counter failed to launch properly when deployed after data download on September 30, resulting in no data collected in the month of October.

The Cutler Project had 45,145 total vehicles and an estimated 116,962 visitors for the seven combined recreation sites with traffic counters from April 23 through November 1, 2020. Benson Marina was the most popular site with 43,286 estimated visitors from April to October (Figure 6-1). Clay Slough had the least visits with 6,160 estimated visitors, but this estimate uses data from June 8 to November 1, whereas visitor use at the other sites includes visitor use in May and part of April.

Estimated visitation to the Project was highest in July for the seven counted recreation sites: 8,935 vehicles and an estimated 24,123 visitors (Figure 6-2). Benson Marina had the highest estimated visitation each month over the seven-month period compared to the other recreation sites (Figure 6-3). Benson Marina visitation estimates were substantially higher in July compared to May and October. Visitation appeared to be more evenly distributed across the seven-month period at the other recreation sites.

Visitor use estimates were calculated for the peak and non-peak season weekends, respectively. Peak season was Memorial Day weekend through Labor Day weekend. The peak holiday weekend was the Fourth of July weekend, with the most visits on July 3 with 449 vehicles and 1,212 visitors for the combined Project sites. On that weekend, visitor use was greatest at Benson Marina with 517 estimated visitors on July 3. The non-peak weekend with the highest visitor use was May 9 with 368 vehicles counted and 883 visitors estimated. The non-peak weekend visitor use was greatest at Benson Marina site with 165 estimated visitors on May 9. It is unknown at this point (as no national or regional comparison studies are available) what if any effect the on-going COVID-19 pandemic may have had on Cutler recreation use statistics (refer to Section 7.1 of this ISR). In fact, the study period to date has completely overlapped with the pandemic (the RSP was approved February 2020 and implementation began as planned in April 2020; COVID-19 effects in Utah largely began in March 2020 and continue to date). Comparisons of any relevant COVID-19 effects to recreation resources may be available for future analysis that will be presented in the DLA.

TABLE 6-8 VEHICLE COUNTS AT CUTLER RECREATION SITES

RECREATION SITE	APRIL*	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	TOTAL
Benson Marina	749	2,827	2,888	3,385	2,928	2,203	1,750	**16,730**
Clay Slough	**	**	475**	572	627	394	284	**2,352**
Cutler Canyon Marina	176	831	784	1,093	1,005	586**	344	**4,819**
Cutler Marsh Marina	234	1,021	894**	952	760	601	802	**5,264**
Little Bear River Access	264	964	964	1,077	963	790	949	**5,971**
Logan River Access	301	1,148	1,096	1,034	1,005	937	**	**5,521**
Upper Bear River Access	**	636	790	824	693	838	720	**4,501**
Total	**1,724**	**7,427**	**7,891**	**8,937**	**7,981**	**6,349**	**4,849**	**45,158**

*April data collection limited to April 23–30, 2020
**Vehicle counter error identified. Data removed from calculations at sites listed below for respective dates:
Clay Slough Access April 23 to June 8
Cutler Canyon Marina September 1
Cutler Marsh Marina June 7 and June 16
Logan River Access October 1 to October 31
Upper Bear River Access April 23 to May 8

TABLE 6-9 ESTIMATED VISITOR COUNTS AT CUTLER RECREATION SITES

RECREATION SITE	APRIL*	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	TOTAL
Benson Marina	1,798	7,094	7,798	9,140	7,906	5,428	4,199	**43,363**
Clay Slough Access	**	**	1,281**	1,543	1,692	973	680	**6,169**
Cutler Canyon Marina	421	2,101	2,115	2,950	2,712	1,439**	824	**12,562**
Cutler Marsh Marina	560	2,559	2,414**	2,569	2,051	1,475	1,924	**13,552**
Little Bear River Access	632	2,395**	2,603	2,907	2,599	1,944	2,278	**15,358**
Logan River Access	722	2,864	2,958	2,792	2,713	2,292	**	**14,341**
Upper Bear River Access	**	1,616	2,133	2,223	1,871	2,047	1,728	**11,618**
Total	**4,133**	**18,629**	**21,302**	**24,123**	**21,544**	**15,598**	**11,633**	**116,963**

Visitor counts are based on occupancy rates of 2.4 people per vehicle in April, May, September, and October and 2.7 people per vehicle in June through August.
*April data collection limited to April 23–30, 2020
**Vehicle counter error identified. Incorrect counts removed from calculations at sites listed below for respective dates:
- Clay Slough Access May 8 to June 8
- Cutler Canyon Marina September 1
- Cutler Marsh Marina June 7 and June 16
- Little Bear River Access May 21
- Logan River Access October 1 to October 31

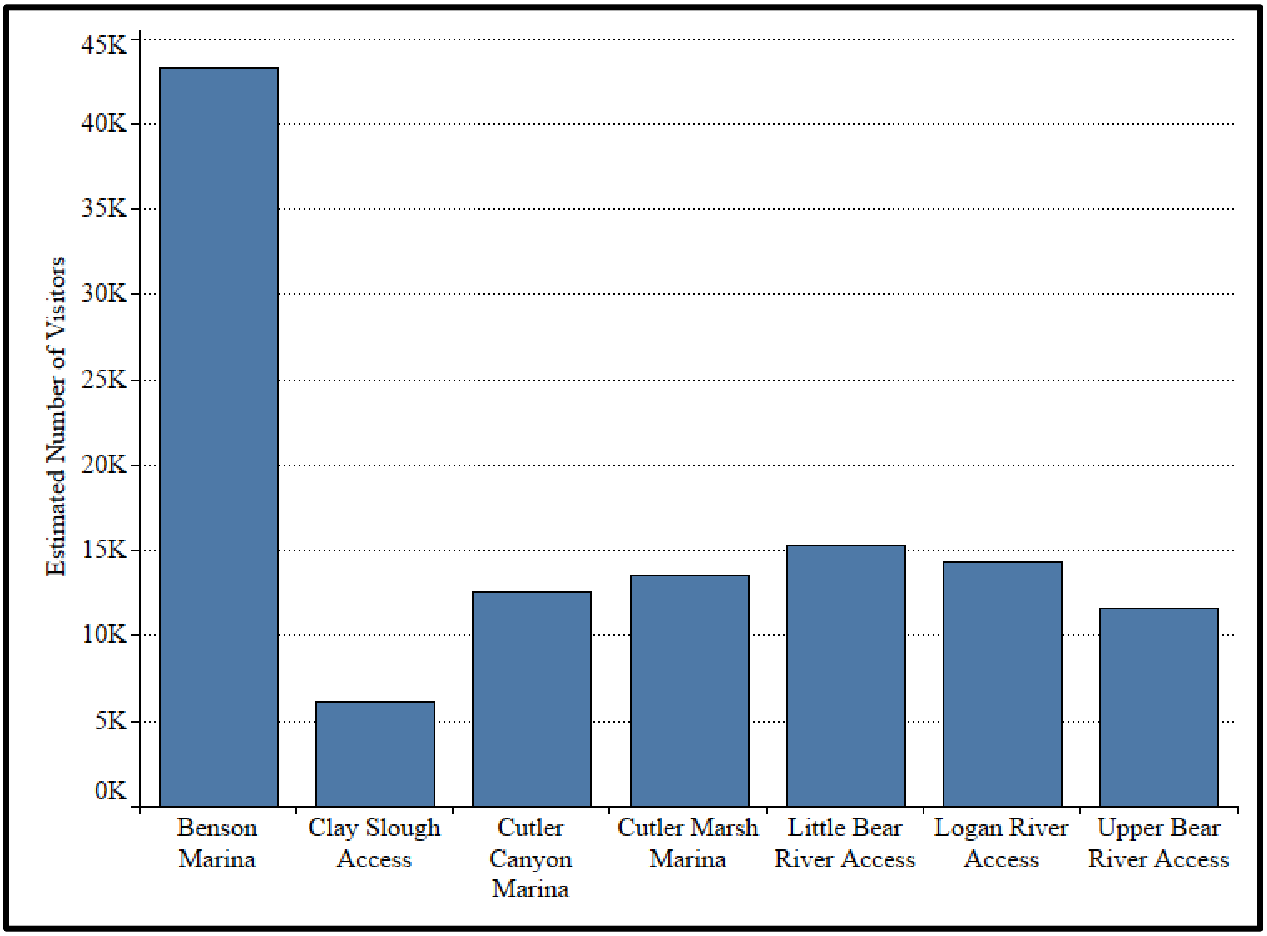

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FIGURE 6-1 TOTAL ESTIMATED VISITORS BY RECREATION SITE, APRIL–OCTOBER 2020

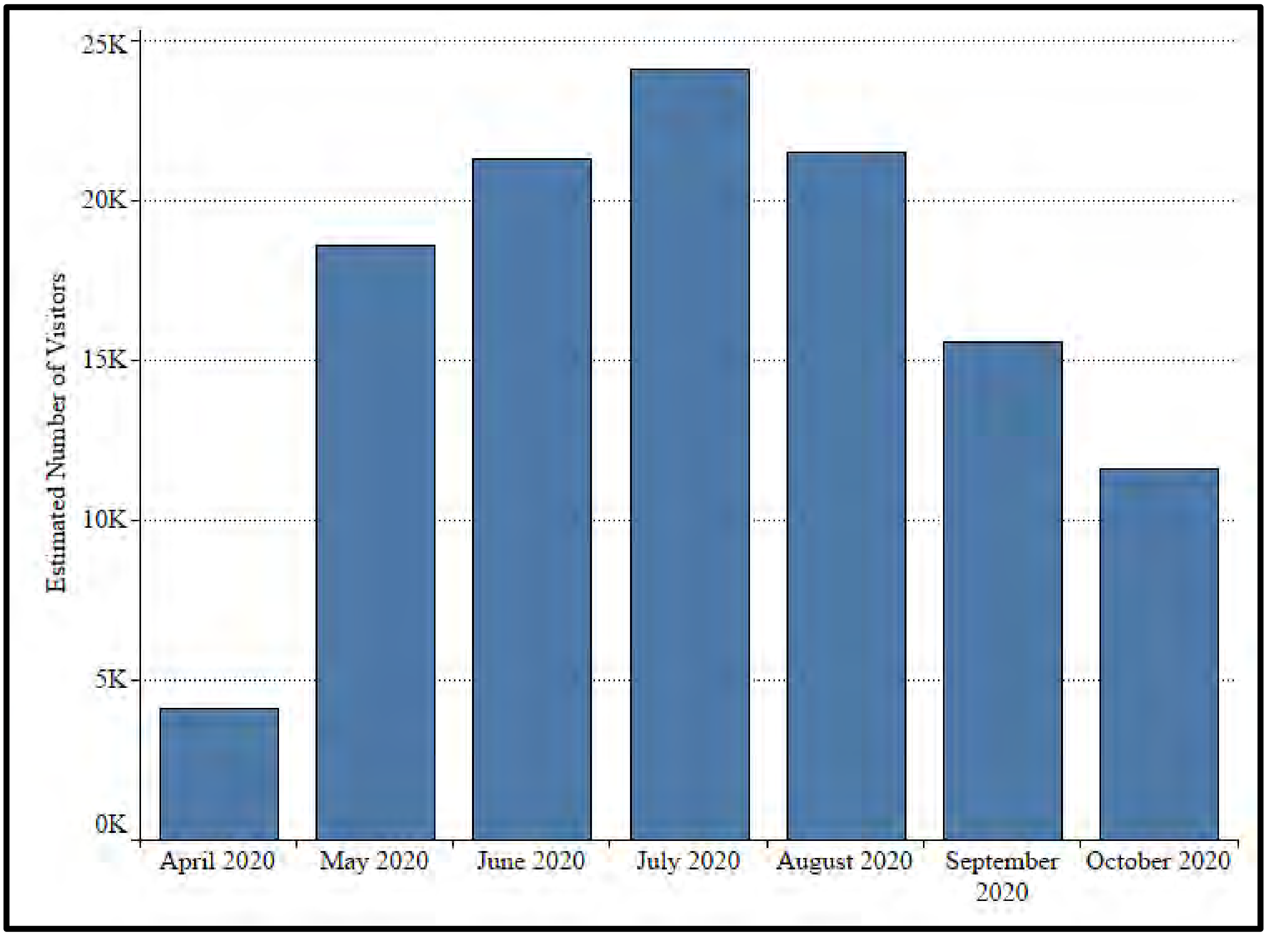

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FIGURE 6-2 MONTHLY ESTIMATED VISITORS FOR COMBINED RECREATION SITES, APRIL–OCTOBER 2020

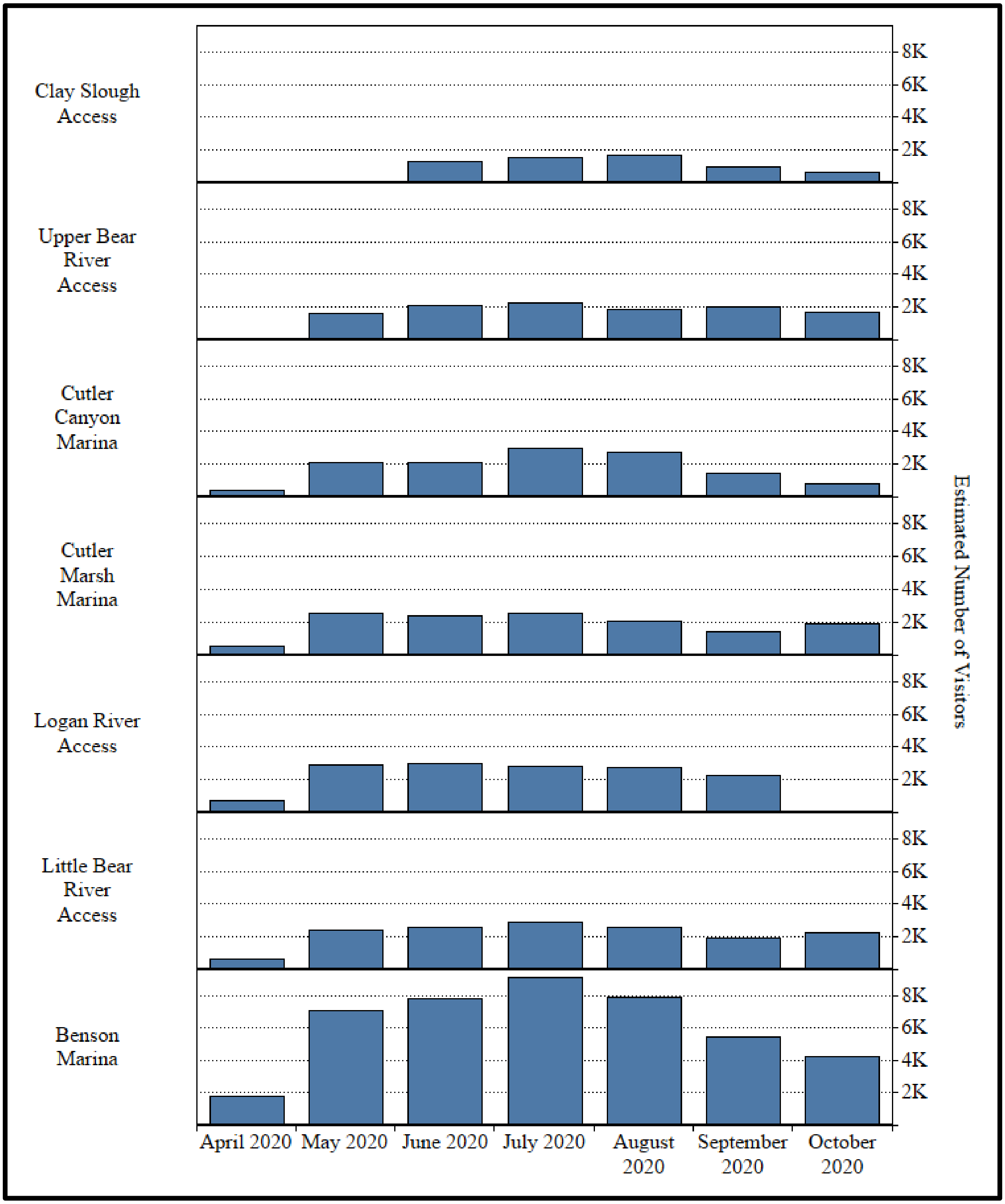

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FIGURE 6-3 MONTHLY ESTIMATED VISITORS BY RECREATION SITE, APRIL–OCTOBER 2020

6.3.2 TRAIL COUNTERS

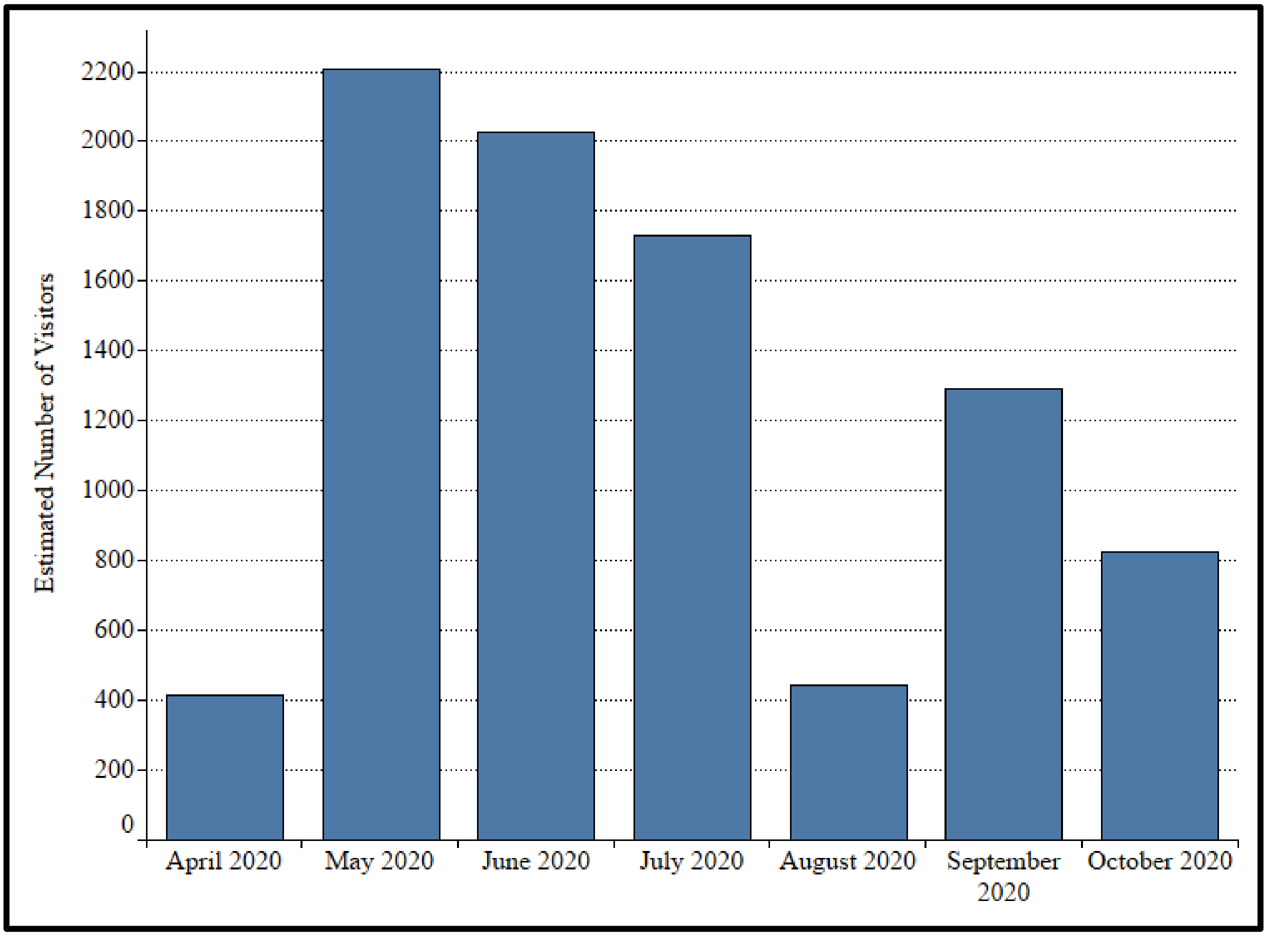
Trail counters were installed on the Benson Railroad Bridge Trail and the Bear River Riparian Trail. The trails are 1.55 and 1.17-miles-long, one-way, respectively. Both trails start and end at the same location (i.e., out-and-back-configurations), respectively, and as a result, the raw trail user numbers were double counted. Raw data were adjusted to obtain the total number of trail users per trail (Table 6-10). Trail counter data recorded from August 12 to August 31 at Benson Railroad Bridge Trail was excluded from analysis due to a counter malfunction. Similarly, the Bear River Riparian Trail counter had errors on May 30 and June 26. Data collection errors are identified in Table 6-10 and excluded from total counts.

TABLE 6-10 CORRECTED NUMBER OF TRAIL USERS AT CUTLER HIKING TRAILS

RECREATION TRAIL	APRIL*	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	TOTAL
Benson RR Bridge Trail	372	2,035	1,868	1,632	359**	1,248	747	8,260
Bear River Riparian Trail	41	172**	232**	99	87	45	79	680
Total	**413**	**2,207**	**2,028**	**1,731**	**445**	**1,293**	**825**	**8,940**

*April data collection limited to April 23–30, 2020
**Trail counter error identified. Data errors removed from calculations at sites listed below for respective dates:
Benson Railroad (RR) Bridge Trail from August 12 to August 31
Bear River Riparian Trail May 30 and June 26

Benson Railroad Bridge Trail had more use than the Bear River Riparian Trail through the entire year with 8,260 visitors compared to 680 visitors. Trail use was highest in May with 2,207 visitors counted (Figure 6-4). The counters were not deployed until April 23, so the data for April only account for approximately 25 percent of the entire month. The majority of data from the Benson Railroad Bridge Trail in August were not included in the analysis, so the estimated values for that month are lower than actual visitation. Of the months with complete data, October had the lowest estimated trail use with 825 visits. Both trails are adjacent to active waterfowl and pheasant hunting areas, and lower trail use in those areas may reflect a decrease by trail users due to the proximity to active hunting recreation areas.



*April data collection limited to April 23–30, 2020
*Trail counter errors removed from calculations at sites listed below for respective dates:
Benson Railroad (RR) Bridge Trail from August 12 to August 31
Bear River Riparian Trail May 30 and June 26

FIGURE 6-4 MONTHLY CORRECTED TRAIL USE ESTIMATES* AT BENSON RAILROAD BRIDGE TRAIL AND BEAR RIVER RIPARIAN TRAIL

6.3.3 RECREATION SITE PARKING CAPACITY ANALYSIS

The total number of available parking spaces was compared to the peak and non-peak vehicle counts to assess the parking capacity of the Project recreation sites. From April to October there is an average of 13.5 daylight hours a day at the Project (Timeanddate.com 2020). Recreation users visit the Project on average for 3 hours (Section 6.5, Visitor Survey). Using the average visitation length, a parking space would allow for 4.5 vehicle rotations per day. The total number of parking spaces for the Project sites where vehicle counters were installed is 105, resulting in an estimated daily capacity of 474 vehicles. Benson Railroad Bridge Trailhead and Lower Bear

River Overlook were not included in the estimate of parking capacity since vehicle counters were not deployed at these locations.

On July 3, 2020, the highest recreation use day during the peak season, the total number of vehicles was 449, which is below the estimated daily capacity for the Project (Table 6-11). Estimated daily parking capacity was exceeded on the peak day at four recreation sites: Benson Marina, Clay Slough Access, Little Bear River Access, and Logan River Access. The daily average number of vehicle visits for the seven combined recreation sites with vehicle counters, 266 during the peak season and 208 during the non-peak season, was less than the 474 total parking capacity of the Project. The average daily vehicle count at Little Bear River Access and Logan River Recreation Site exceeded the estimated capacity during the peak and non-peak seasons. All other sites had average vehicle counts below the estimated daily parking capacity.

TABLE 6-3 NUMBER OF RECREATION AMENITIES NUMBER OF VEHICLES ON PEAK VISITATION DAY AND DAILY AVERAGE FOR EACH SITE

RECREATION SITE	TOTAL VEHICLES ON PEAK DAY (JULY 3, 2020)	DAILY AVERAGE NUMBER OF VEHICLES DURING PEAK SEASON	DAILY AVERAGE NUMBER OF VEHICLES DURING NON-PEAK SEASON	NUMBER OF PARKING SPACES	ESTIMATED DAILY PARKING CAPACITY
Benson Marina	192	99	70	28	126
Clay Slough Access	22	16	8	4	18
Cutler Canyon Marina	98	31	17	22	99
Cutler Marsh Marina	55	29	25	29	131
Little Bear River Access	26	32	29	4	18
Logan River Access	27	34	34	5	23
Upper Bear River Access	31	25	25	13	59
All Sites	**451**	**266**	**208**	**105**	**464**

6.4 STRUCTURED INTERVIEWS

Structured interviews were conducted with five individuals between September and November 2020. Interviewees were asked a pre-established set of questions, available in Attachment 2. Interviewees cumulatively had experience with all developed recreation sites within the Project Boundary and had been using the Project for recreation for periods ranging from 3 to over 35 years, respectively. In addition to personal recreation at the Project, some interviewees also belonged to groups focused on recreation and conservation including Wasatch Widgeons and Bridgerland Audubon Society. Cumulatively, interviewees used both upland and reservoir recreation opportunities in the Project including hunting, fishing, birdwatching, canoeing, flatwater kayaking, motorized recreational boating, walking and hiking, and education. Overall, amenities supported by the Project used by interviewees included boat ramps, picnic tables, docks, parking lots, and restrooms.

All interviewees stated that the number of recreation sites provided by the Project and the amenities available seemed adequate to support the recreation demands. Some commented that the developed recreation sites accommodate heavier use than Cutler Reservoir should support. Over time, interviewees have generally observed increased recreation use, but have not observed the need for additional recreation sites. Interviewees noted that they have pursued the same recreation activities during the timeframe they have visited the Project. Many commented that more motorized boats have been using the reservoir recently than did historically. Interviewees observed increased recreation use in 2020, attributing the increase to changes in behavior resulting from the COVID-19 pandemic (Section 7.1).

6.5 VISITOR SURVEY

PacifiCorp conducted an online visitor survey designed to query respondents on recreation use patterns and recreation needs within the Project Boundary. The survey consisted of 31 questions organized into four sections:

- Background demographic information
- Recreation use patterns in the Project Boundary
- Cutler recreation facilities used
- Recreation needs

Survey questions were developed in March 2020 based on observations of recreation use at Project recreation sites coupled with informal interviews with recreation users, communication with PacifiCorp staff, and contractors that manage and maintain Project recreation sites, and previous FERC Form 80 data. Nine beta testers completed 31 surveys in April providing feedback on survey questions, figures, length, and general understanding. Survey questions and format were modified based on beta testing input prior to launch. A copy of the final survey questions is included in Attachment I-3.

PacifiCorp launched the visitor survey on April 30, 2020. Stakeholders were notified of the visitor survey through direct email notification, announcements, and a link on the Project website (https://www.pacificorp.com/energy/hydro/cutler.html), and through 8.5- x 11-inch posters installed at Project recreation sites. All forms of communication included the internet address to access the visitor survey (https://www.surveymonkey.com/r/S2SLXXH). Posters included a QR scan code link to the survey.

On May 15, 2020, PacifiCorp notified 238 stakeholders registered on the Project mail list and opting in for Project email notification that the visitor survey was open. A reminder email encouraging participation in the visitor survey was sent on August 4, 2020, and October 1, 2020. Email distribution to stakeholders was tracked with each survey notification. Incorrect email addresses were identified in the spreadsheet. Where possible, correct email addresses were obtained from stakeholders and the survey announcement resent. The stakeholder email notification and posters at Project recreation sites are included in Attachment I-4 to this ISR appendix.

One hundred and twenty-one individuals completed the survey. Programming permitted one survey completion per person. The typical time to complete the survey was 10 minutes. The survey had a 73 percent completion rate. The age of respondents was mostly older, with 37 percent of respondents over the age of 65, and 25 percent aged 55 to 65 (Table 6-4). Respondents were primarily male, with 74 percent of respondents identifying as male and 26 percent of respondents identifying as female. Ninety-one percent of the respondents had previously visited the Cutler Hydroelectric Project and 98 percent of those respondents said they were likely to return to the Cutler Hydroelectric Project. All survey respondents identified their primary residence as Utah, with 88 percent in Cache County, 4.6 percent in Davis County, 3.3 percent in Box Elder County, and 4 percent in another county in Utah.

TABLE 6-11 AGE OF SURVEY RESPONDENTS

AGE	NUMBER OF RESPONDENTS	PERCENT
Under 18	0	0%
18-24	4	3%
25-34	7	6%
35-44	21	18%
45-54	13	11%
55-64	28	24%
65+	43	37%

On average, online survey respondents have been visiting the Project for 22 years and most visit multiple times annually (Table 6-5). May through September are the most popular months to visit the Project (Figure 6-6). Visitation is steady throughout the week, with the most visits on Saturday and the least on Sunday (Figure 6-7). Most survey respondents visit the Project in the morning between 8 AM and noon (Figure 6-8), with a typical visit lasting 2 to 4 hours (Figure 6-9).

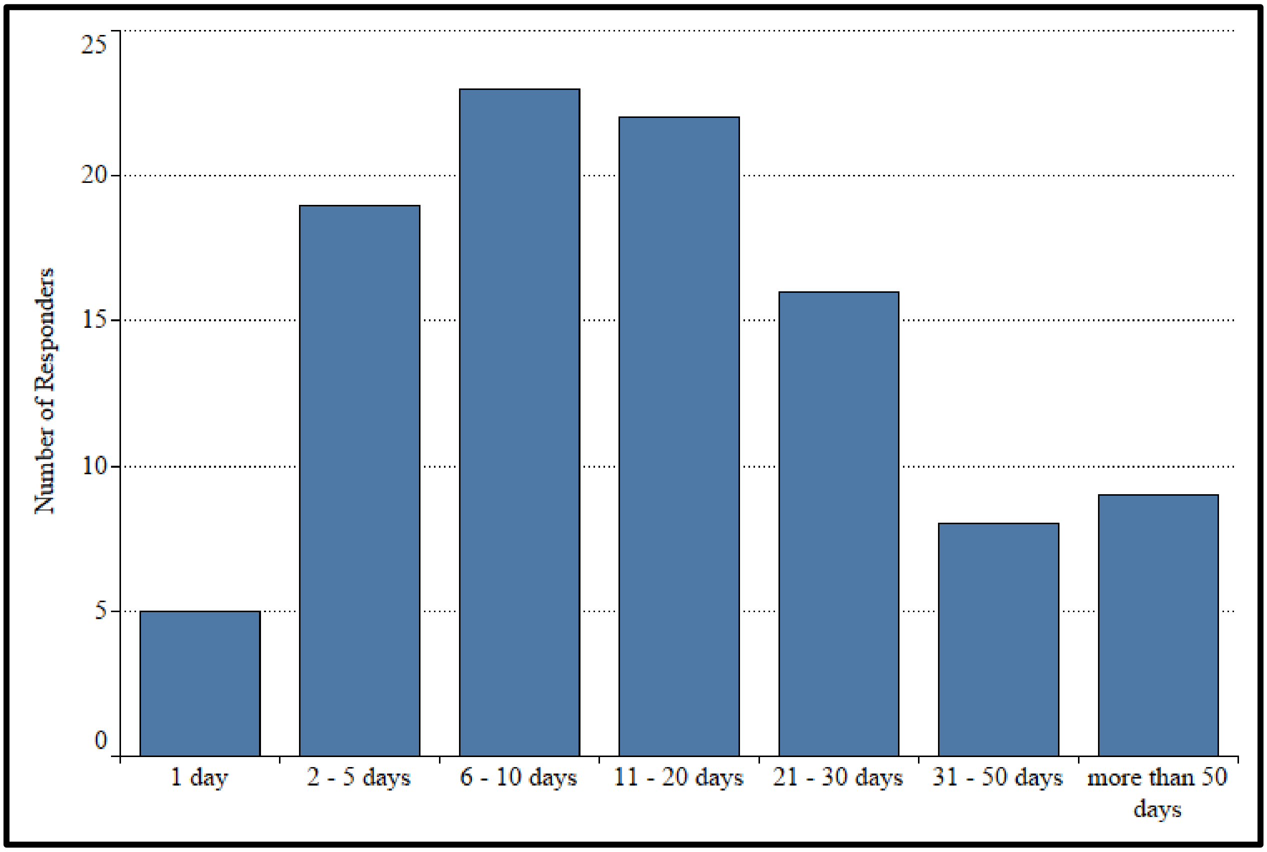


FIGURE 6-5 ANNUAL NUMBER OF DAYS SPENT VISITING THE PROJECT, PER ONLINE SURVEY RESPONDENTS

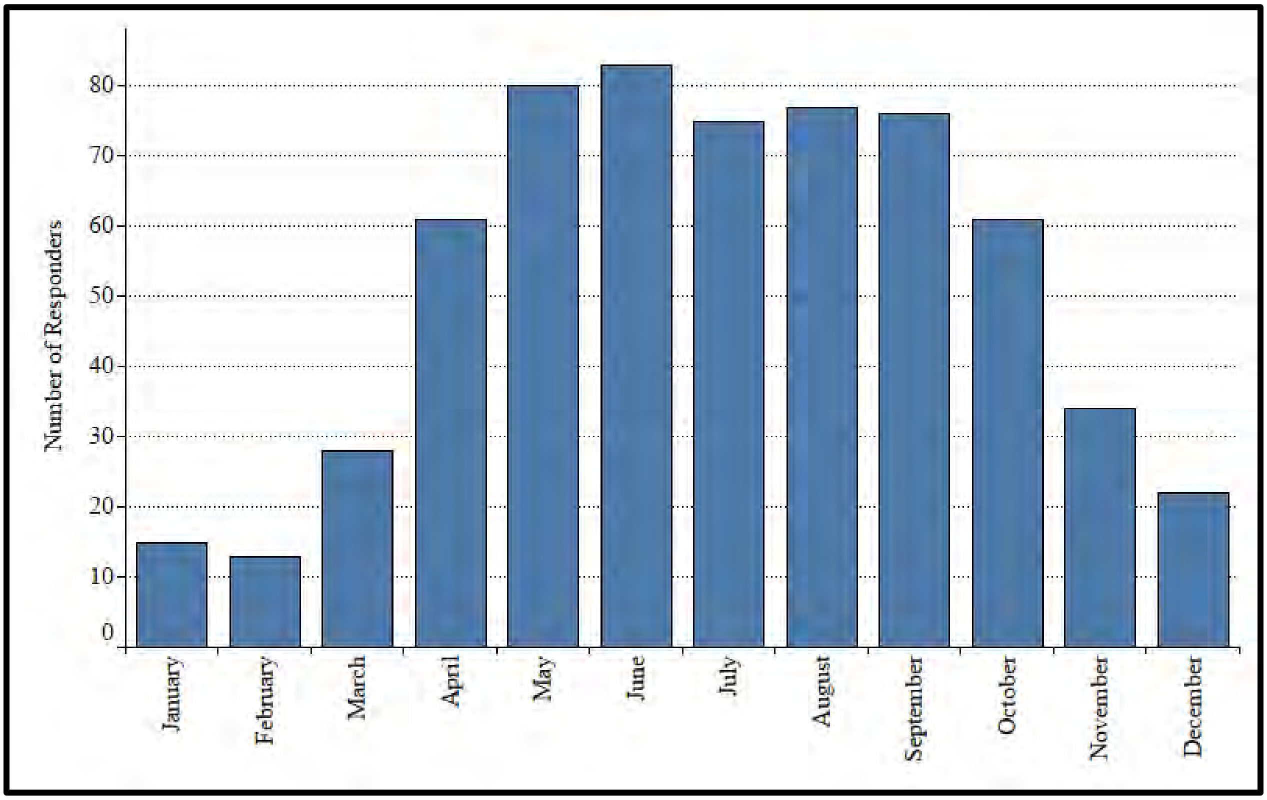


FIGURE 6-6 PROJECT VISITATION BY MONTH, PER ONLINE SURVEY RESPONDENTS

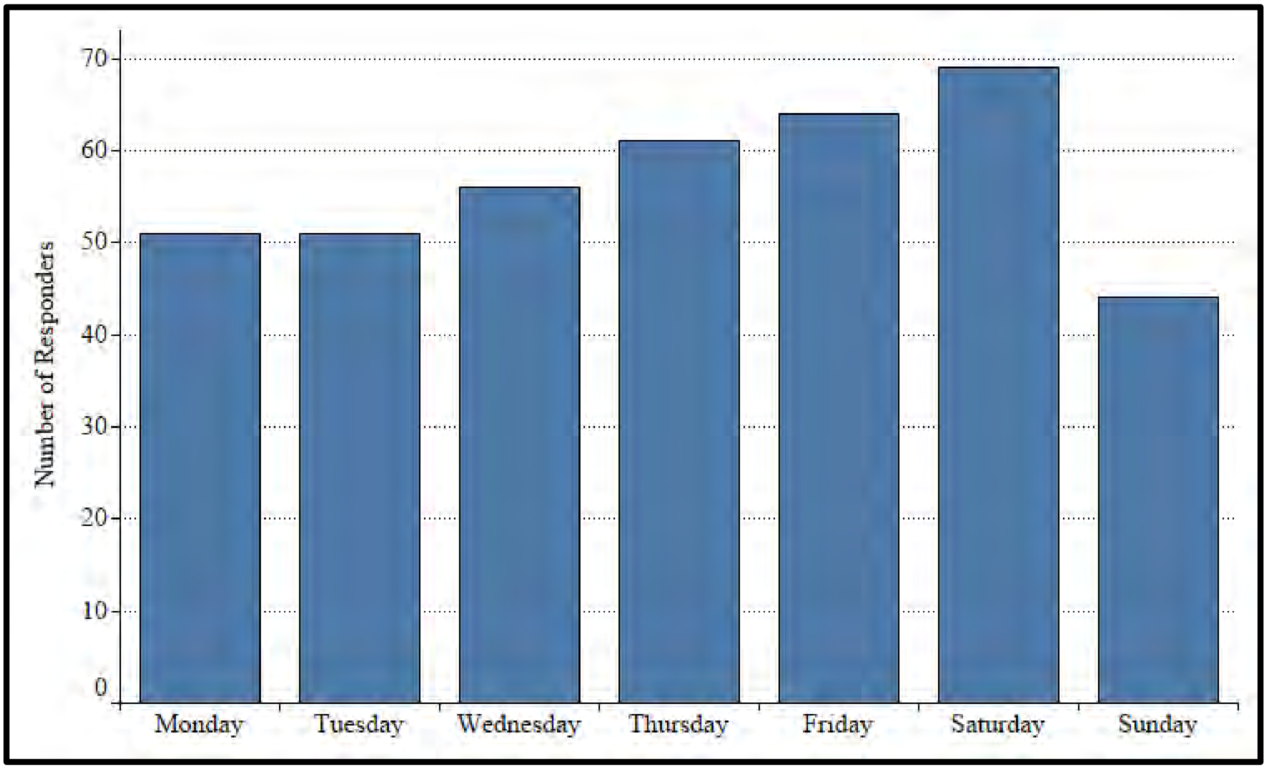


FIGURE 6-7 DAY OF THE WEEK VISITS TO THE PROJECT, PER ONLINE SURVEY RESPONDENTS

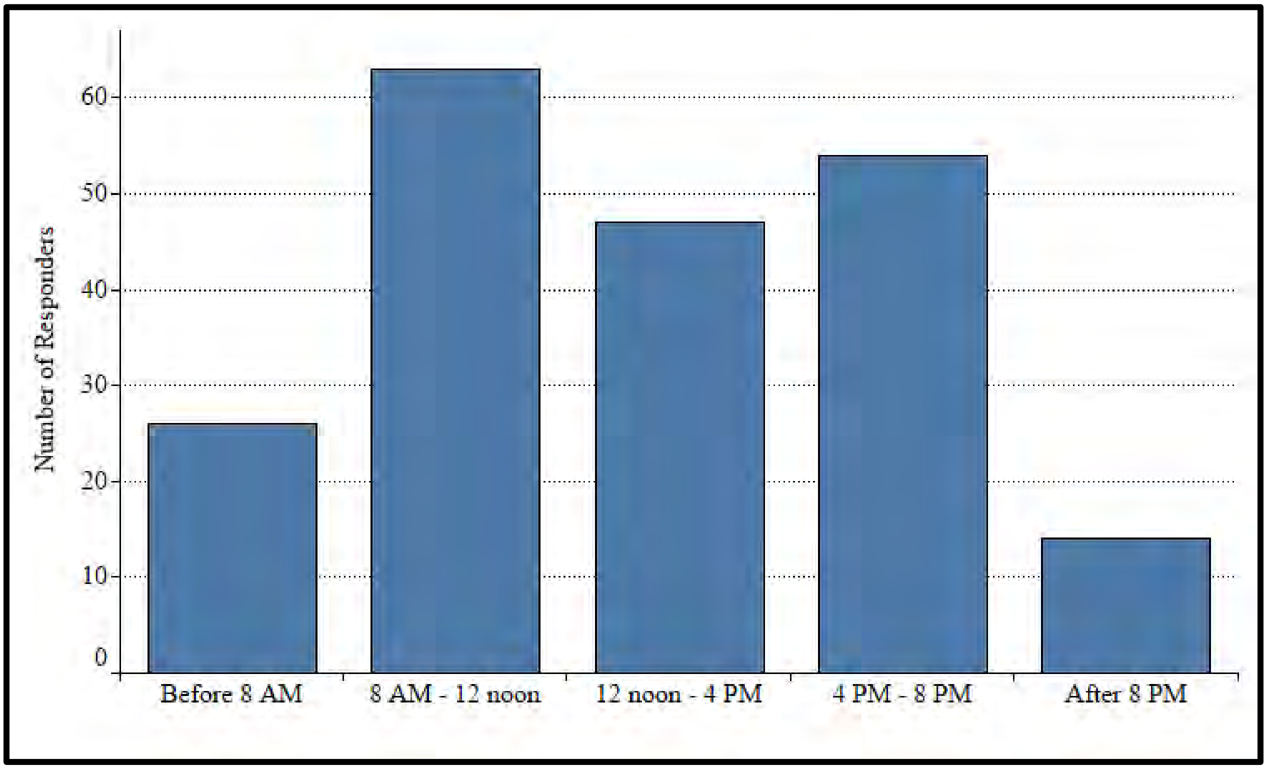


FIGURE 6-8 TIME OF DAY FOR PROJECT VISITS, PER ONLINE SURVEY RESPONDENTS

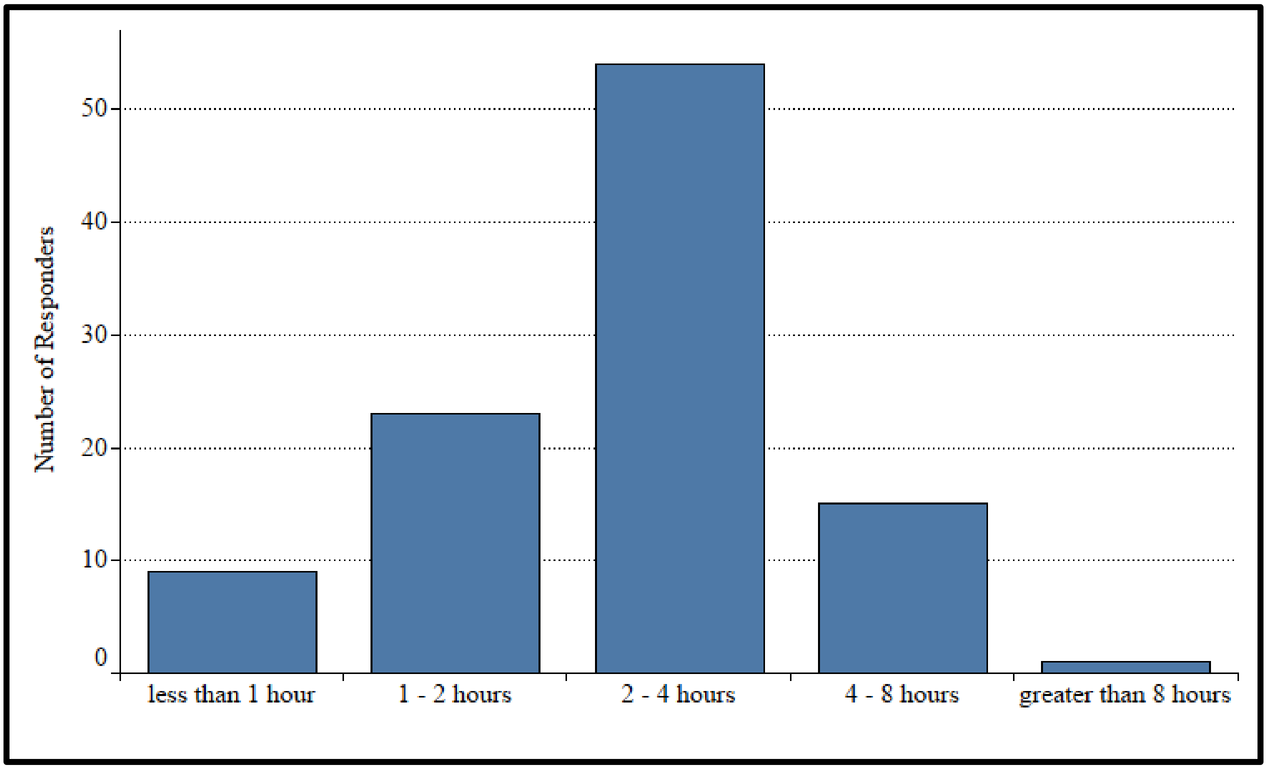


FIGURE 6-9 DURATION OF PROJECT VISITS, PER ONLINE SURVEY RESPONDENTS

When asked why they visit the developed recreation sites at the Project, online survey respondents selected the following non-exclusive choices: to recreate on Cutler Reservoir (59 percent), close proximity to work or home (50 percent), to spend time with family or friends (48 percent), and because they like the recreation sites (42 percent) (Figure 6-10). Benson Marina was the most popular developed recreation site at the Project (Figure 6-10) as indicated in survey responses and supported with the vehicle counts. When respondents rated types of recreation site amenities by importance, vehicle parking was the most important. Carry-in boat launch, trash receptacles, and restrooms also were considered important (Figure 6-11). The quality of the facilities was rated good or excellent by 87 percent of respondents, consistent with the results collected in the recreation site assessments and structured interviews. Restrooms, trash receptacles, and vehicle parking were identified as the top three additional amenities respondents believe are needed at the recreation sites (Figure 6-12).

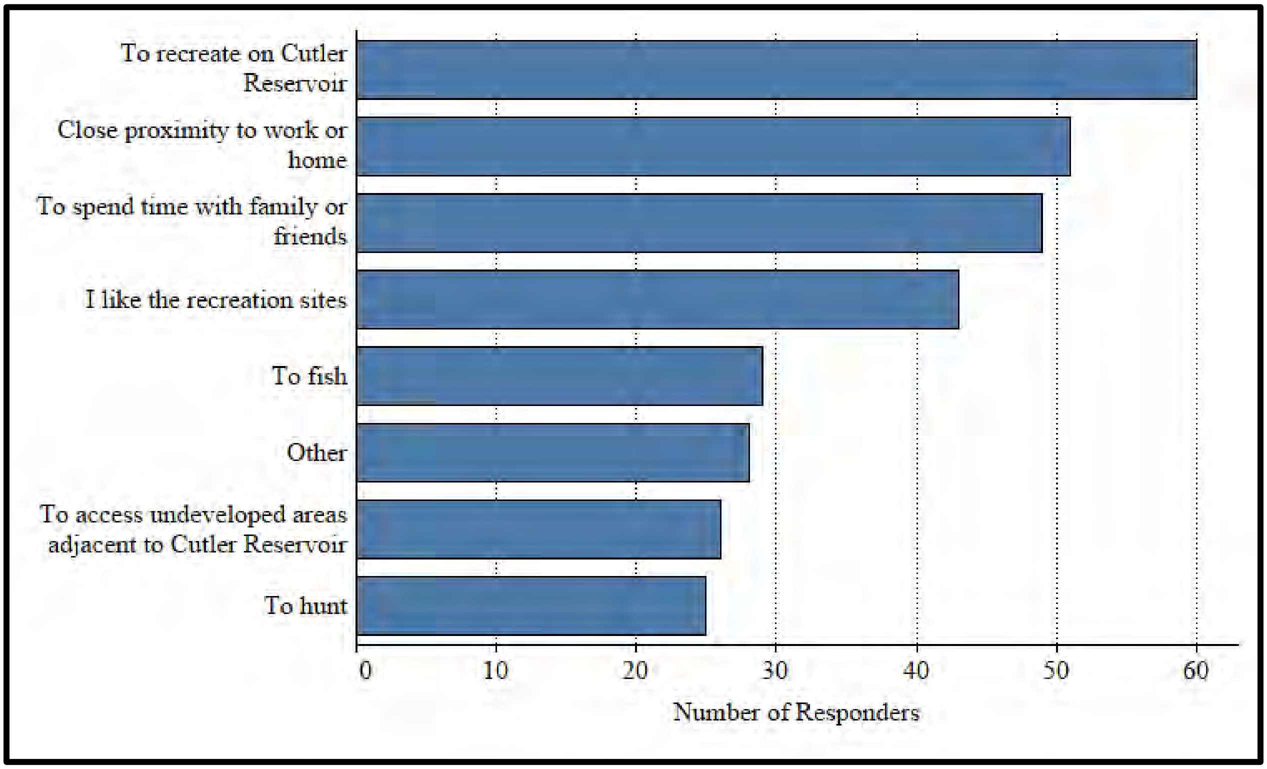


FIGURE 6-10 WHY DO YOU VISIT THE PROJECT RECREATION SITES? PER ONLINE SURVEY RESPONDENTS

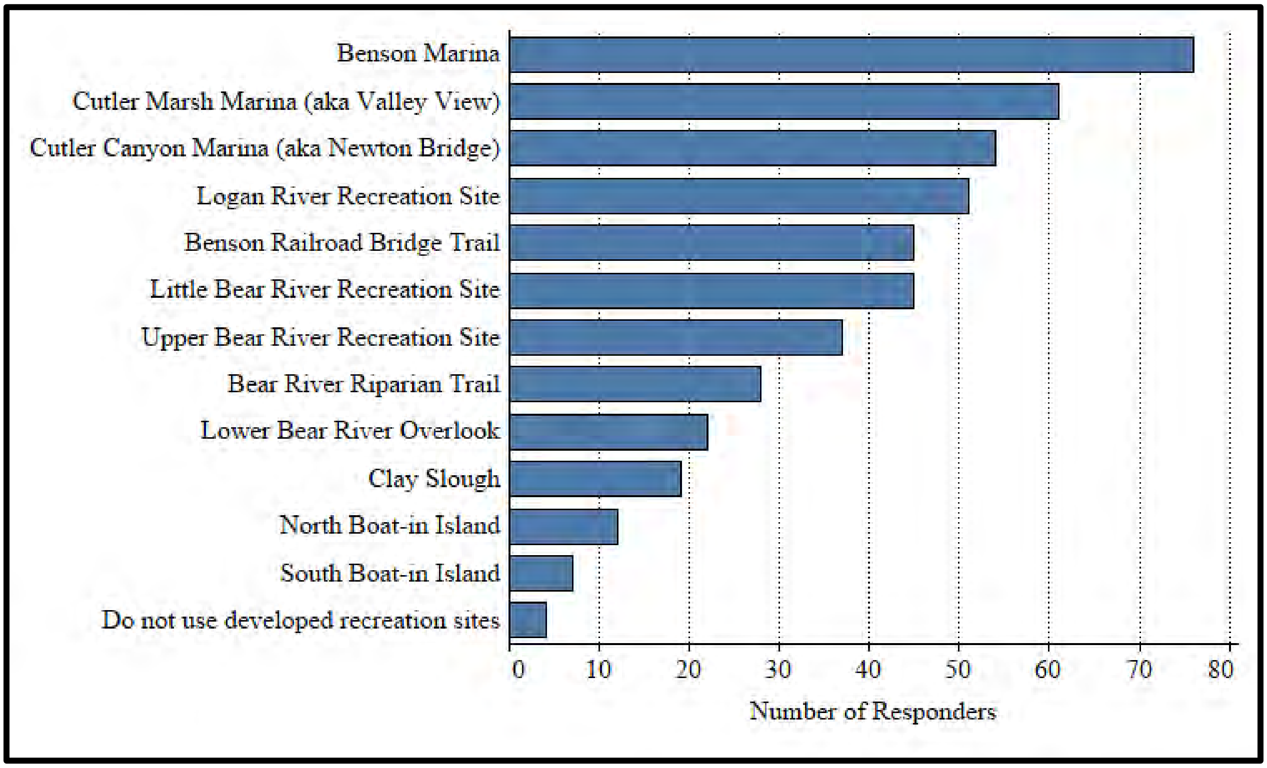


FIGURE 6-11 RECREATION SITES USED BY VISITORS, PER ONLINE SURVEY RESPONDENTS

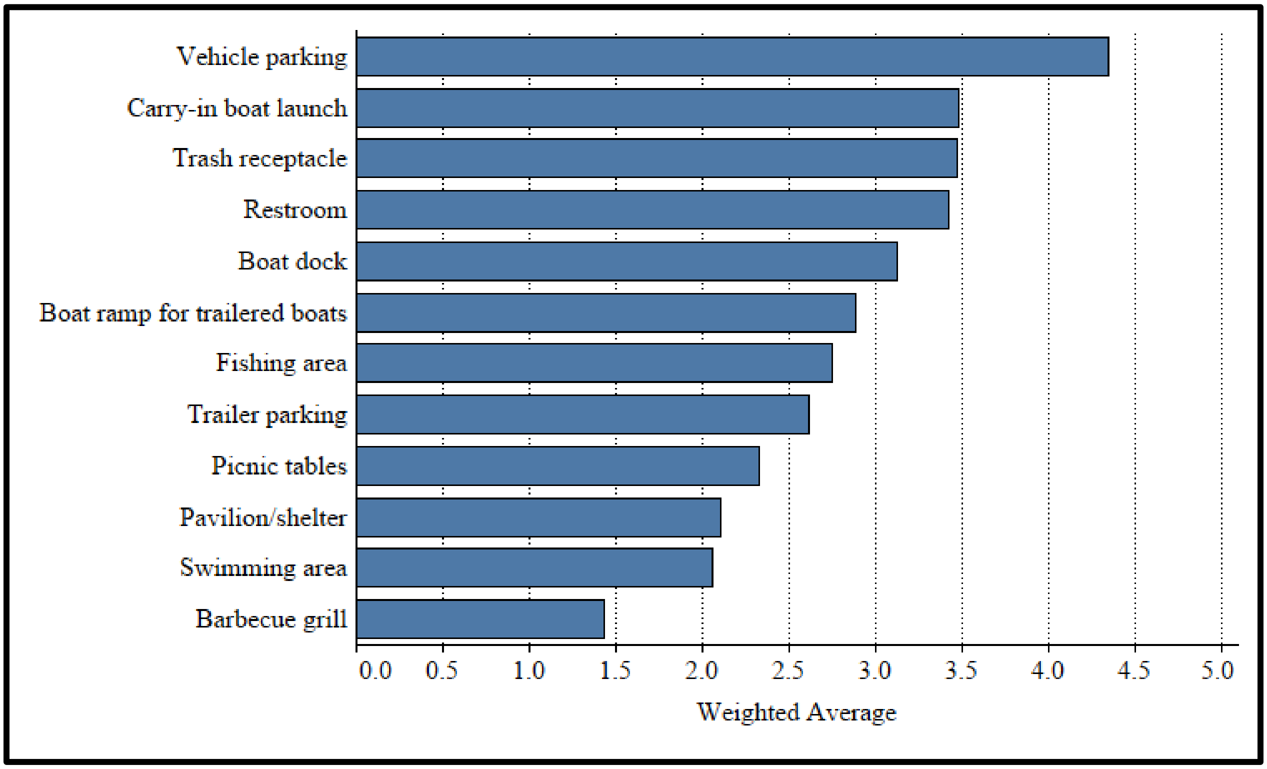


FIGURE 6-12 IMPORTANCE OF RECREATION SITE AMENITIES, PER ONLINE SURVEY RESPONDENTS

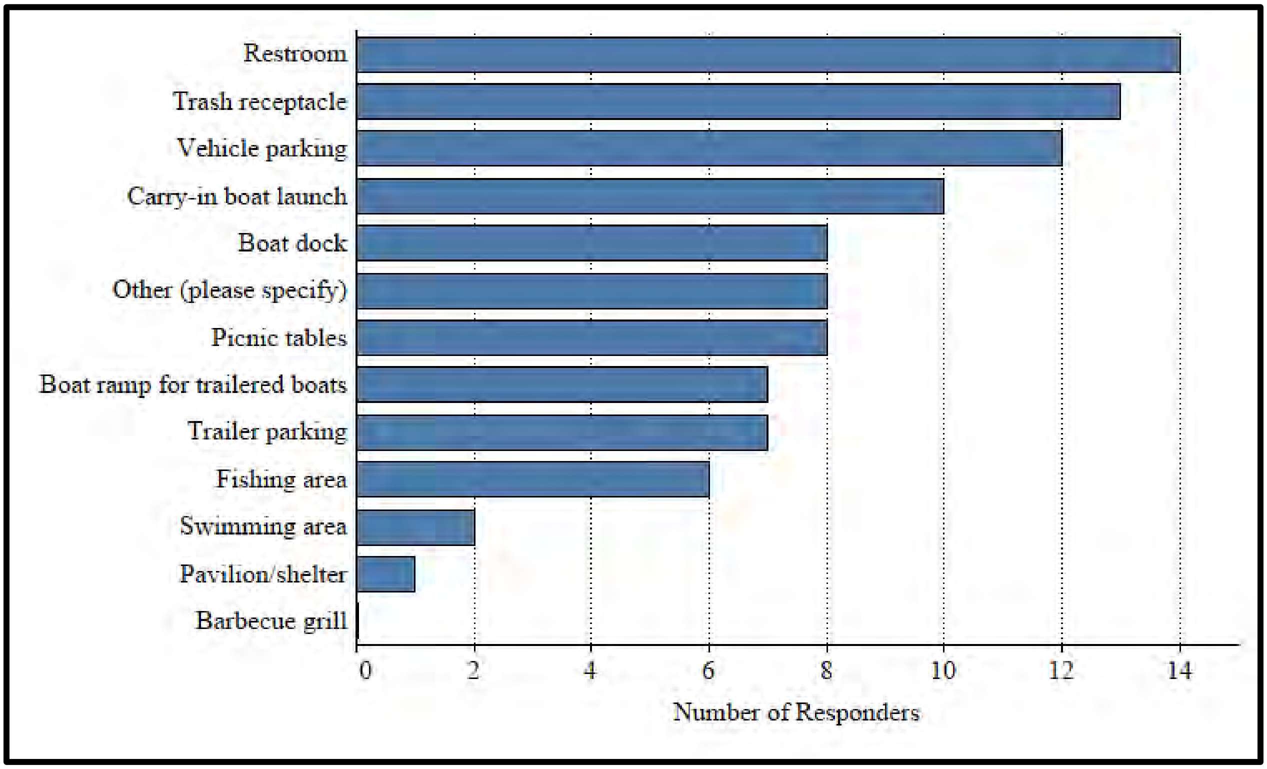


FIGURE 6-13 ADDITIONAL AMENITIES NEEDED AT RECREATION SITES, PER ONLINE SURVEY RESPONDENTS

The three most popular activities for which respondents pursue at the Cutler Hydroelectric Project are birding/wildlife viewing, non-motorized boating, and hiking/walking. (Table 6-12). Forty-five percent of respondents indicated that actions or behaviors by others interfere with the enjoyment of their desired activity. Respondents listed motorized boating, water levels, and hunting as the top three issues preventing them from participating in their preferred activity (

Table 6-13). When responding to a survey question on reservoir water elevations, 67 percent of respondents said the water level of Cutler Reservoir affects their ability to participate in motorized and non-motorized boating. Respondents indicated that abnormally low reservoir levels during periods of dam maintenance limit boating opportunities on the reservoir. When reservoir levels are above normal during spring run-off, larger boats are not able to pass under bridges.

TABLE 6-12 RECREATION ACTIVITIES, PER ONLINE SURVEY RESPONDENTS

RECREATION ACTIVITY	NUMBER OF RESPONDENTS	PERCENT
Birding/wildlife viewing	66	65%
Non-motorized boating	58	57%
Hiking/walking	48	47%
Photography	38	37%
Fishing	33	32%
Waterfowl hunting	22	22%
Motorized boating	18	18%
Picnicking	17	17%
Upland bird hunting	16	16%
Water skiing	14	14%
Dog training	14	14%
Outdoor education or research	13	13%
Swimming	9	9%
Other	8	8%
Big game hunting	2	2%
Trapping	1	1%

TABLE 6-13 ISSUES PREVENTING RECREATIONAL ACTIVITY, PER ONLINE SURVEY RESPONDENTS

ISSUE TOPIC	NUMBER OF RESPONDENTS	PERCENT
Motorized boating	12	27%
Water levels	8	18%
Hunting	7	16%
Access	3	7%
Personal	2	5%
Potential harmful effects of eating game fish	2	5%
Boat ramp condition	2	5%
Weather	2	5%
Water Quality Concern	2	5%
Parking	1	2%
Crowding	1	2%
Vandalism	1	2%
Boat restrictions	1	2%

6.6 ASSESSMENT OF PROJECT OPERATIONAL CHANGES—FALL DRAWDOWN

Seven recreation sites were evaluated during the 2019 fall drawdown (a full drawdown extending over 21 feet at Cutler Dam) using a combination of aerial photos from drones, marking wetted perimeters, and populating a recreation site field form designed to assess site function relative to intended recreational purpose (Table 6-14).

Recreation sites were visited daily over a 10-day period commencing on October 25, 2019 (Table 6-15). The fall 2019 reservoir drawdown lowered the reservoir beyond the potential future proposed Project operations. Cutler Dam elevation on October 28, 2019 was 4,404.58 feet, approximately 0.4 feet lower than the proposed minimum of 4405.0 feet in the extended range. The October 28, 2019 field observations represent the most similar conditions to the proposed minimum reservoir elevation, albeit 0.4 feet lower. Recreation site observations from October 25 through 28, 2019 were used because the Cutler Dam reservoir elevations on those dates are the most applicable to assess conditions under future proposed future Project operations.

TABLE 6-14 CUTLER RECREATION SITES EVALUATED DURING FALL 2019 DRAWDOWN

CUTLER RECREATION SITE	LOCATION	DATA COLLECTED		
		DRONE PHOTOS	WETTED PERIMETER	FIELD FORM
Cutler Marsh Marina	Main Reservoir Sites	x	x	x
Benson Marina		x	x	x
Cutler Canyon Marina		x	x	x
Clay Slough		x	x	x
Little Bear River Access	Tributary Sites	x	x	x
Logan River Recreation Site		x	x	x
Upper Bear River Access		x	x	x

TABLE 6-15 RECREATION SITE DATA COLLECTION DURING FALL 2019 DRAWDOWN

FIELDWORK	OCT. 25	OCT. 26	OCT. 27	OCT. 28	OCT. 29	OCT. 30	OCT. 31	NOV. 1	NOV. 2	NOV. 3
Drone flight	x	x	x	x	n/a	x	x	x	n/a	x[1]
Mark wetted perimeter with survey paint*	x	x	x	x	x	x	x	x	x	x
Assess recreation site function	x	x	x	x	x	x	x	x	x	x

*If wetted perimeter had not changed, then it was not remarked. If previous day's perimeter had washed away, perimeter was remarked.
[1]Drone flights at Benson Marina and Cutler Marsh Marina only. Sites not flown this day: Cutler Canyon Marina, Clay Slough, Little Bear River Access, Logan River Recreation Site, Upper Bear River Access.

Drones with pre-programmed flight paths were used to capture aerial images each day of the drawdown at recreation sites, which documented changes in wetted perimeter relative to boat ramps, docks, and shoreline areas. Aerial images were not collected on October 29 and November 2, 2019, because visibility was less than the 3 miles required by the Federal Aviation Administration's Part 107 requirements for drone flights (14 CFR § 107.51(c) and (d)). Drone flights on November 3, 2019, captured imagery for Benson Marina and Cutler Marsh Marina only.

The wetted perimeter was marked on boat ramps each day prior to drone flights with non-permanent survey paint to delineate successive lateral changes in wetted perimeter over time using aerial images. The wetted perimeter survey paint markings captured a range of reservoir elevation drawdowns and associated effects on recreation access at individual recreation sites.

The reservoir elevations at respective recreation sites were calculated using the 2D hydraulic model for the proposed future Project operations under the normal (elevation 4,407.5 to 4,406.5 feet) and extended (elevation 4,406.5 to 4,405.0 feet) ranges; (see also Section 1.3 of this ISR). Field observations during the fall 2019 drawdown were used to evaluate conditions at individual recreation sites using the 2D hydraulic model elevations. Overall, the seven recreation sites monitored in the fall 2019 drawdown will continue to function within their intended design purpose of providing access to Cutler Reservoir. Trailered boat access at Cutler Canyon Marina was reduced to smaller boats when reservoir elevations were less than the 4405.0 feet minimum in the proposed extended operating range.

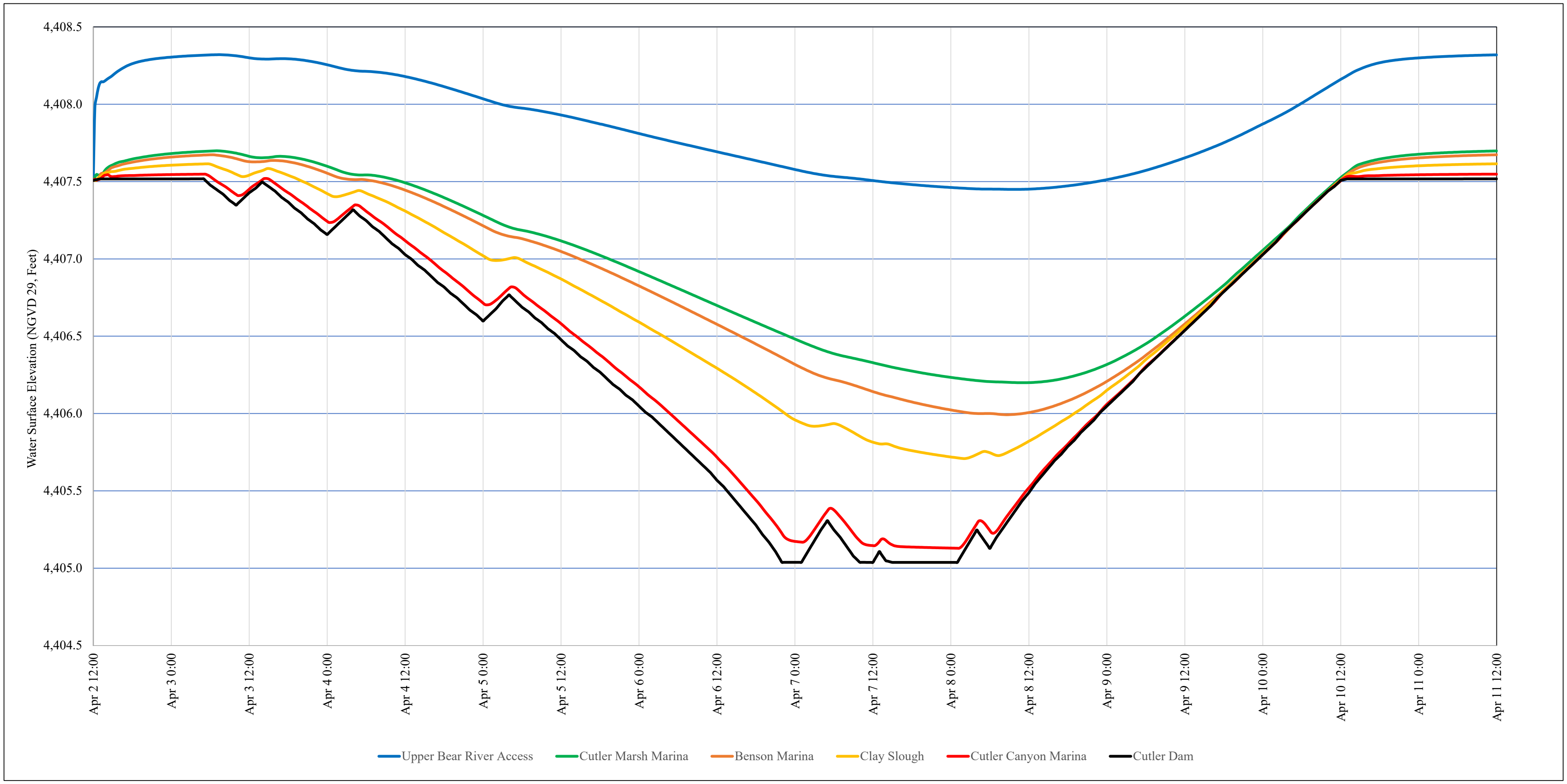
WSEs at the recreation sites on Cutler Reservoir do not respond uniformly across the reservoir with changes in elevation at Cutler Dam (Table 6-16). Water surface elevations at recreation sites located in the southern end of Cutler Reservoir (upstream) of the Benson railroad bridge decrease far less compared to sites in the northern end of the reservoir (downstream).

The condition of respective recreation sites under the proposed future Project operations is described below. Data collected on shoreline boundaries, water depths, and recreation features designed to provide water access at respective recreation sites during the fall 2019 full-reservoir drawdown were used to assess conditions under the proposed future Project operations. Photographs and field measurements documented from October 25 through 28, 2019 are included in the summaries for each recreation site.

TABLE 6-16 RECREATION SITE WATER SURFACE ELEVATIONS RELATIVE TO PROPOSED PROJECT OPERATIONS

CUTLER RECREATION SITE	LOCATION	RESERVOIR OPERATING RANGE (FT)		RECREATION SITE FUNCTIONING	
		NORMAL	EXTENDED	NORMAL	EXTENDED
		4407.5 - 4406.5***	4406.5 - 4405.0***	4407.5 - 4406.5***	4406.5 - 4405.0***
Cutler Marsh Marina	Reservoir Sites****	4407.5-4406.9	4406.9-4406.2	Yes	Yes
Benson Marina		4407.5-4406.8	4406.8-4406.0	Yes	Yes
Clay Slough		4407.5-4406.7	4406.7-4405.7	Yes	Yes
Cutler Canyon Marina		4407.5-4406.5	4406.5-4405.1	Yes	Partial
Little Bear River Access	Tributary Sites****	4407.5-4406.9	4406.9-4406.2	Yes	Yes
Logan River Recreation Site		4407.5-4406.9	4406.9-4406.2	Yes	Yes
Upper Bear River Access**		4408.3-4407.5	4407.5	Yes	Yes

*Little Bear River Access and Logan River Recreation Site are inside the Project Boundary, but outside the model boundary. Therefore, the operating range for Little Bear River Access and Logan River Recreation sites were taken from Cutler Marsh Marina, the closest model location; Little Bear and Logan River site operating range WSEs may be higher due to their location on tributaries upstream of Cutler Reservoir.
**Upper Bear River Access operating range WSE is higher due to its location on the Bear River upstream of Cutler Reservoir
*** (as measured at Cutler Dam)
****(WSE in feet at each site)



*All model results based on assumed duration of the event: 9 days or 216 hours.
**All model results based on assumed tributary inflow of 1,046.5 cfs and ground water inflow of 285.5 cfs.
***Little Bear River Access and Logan River Recreation Site are inside the Project Boundary, but outside the model boundary. Operating range taken from Cutler Marsh Marina, the closest model location; all three are located south of Utah SR30. Little Bear and Logan River site operating range WSEs may be higher due to their location on tributaries upstream of Cutler Reservoir.

FIGURE 6-14 WATER SURFACE ELEVATION AT RECREATION SITES UNDER THE PROPOSED EXTENDED RANGE OF PROJECT OPERATIONS

6.6.1 CUTLER CANYON MARINA

Cutler Canyon Marina contains a boat dock and concrete ramp suitable for trailered boats Photo 6-1) as well as numerous other shore-based recreation amenities. Cutler Canyon Marina provides access to the North Boater Zone (Reservoir Management Unit) where there are no restrictions on motor size or speed outside of state boater safety regulations.

The ramp and boat dock continued to function as intended under the proposed normal range of Project operations based on field observations on October 27, 2019 (Photo 6-2) when Cutler Dam elevation was 4406.24, slightly below the proposed normal range of proposed operations (elevation 4407.5 to 4406.5 feet). The wetted perimeter, marked with white survey paint in the photo, receded approximately 7 linear feet on October 27 compared to October 25, 2019.Water depth was still sufficient at the ramp for launching boats and using the boat dock.

On October 28, 2019, the wetted perimeter receded approximately 25 feet 8 inches linearly compared to October 25, 2019 (Photo 6-3). The end of the boat ramp was exposed at the wetted perimeter. Small boats were able to launch into 18 inches of water at the end of the ramp but larger boats could no longer launch. The last third of the dock was floating for boats to utilize. Using the 2D hydraulic model, the minimum WSE at Cutler Canyon Marina during proposed operations will be 4405.1 feet, 0.2 foot higher than conditions observed on October 28, 2019.

PHOTO 6-1 CUTLER CANYON MARINA BOAT RAMP AND DOCK, OCTOBER 25, 2019 (AT FULL POOL)

PHOTO 6-2 CUTLER CANYON MARINA BOAT RAMP AND DOCK, OCTOBER 27, 2019 (JUST BELOW MINIMUM NORMAL OPERATION ELEVATION RANGE)

PHOTO 6-3 CUTLER CANYON MARINA BOAT RAMP AND DOCK, OCTOBER 28, 2019 (JUST BELOW MINIMUM EXTENDED OPERATION ELEVATION RANGE)

6.6.2 CLAY SLOUGH

Clay Slough provides parking, restroom, and undeveloped access to the reservoir shoreline (Photo 6-4). The site does not have a ramp to launch boats although it was designed to allow car-top and carry-in boats to utilize this site to access Cutler Reservoir.

The wetted perimeter decreased 3 feet 7 inches on October 28, 2019 (just below the minimum proposed operating range) compared to the wetted perimeter on October 25, 2019 (at full pool). Bank stabilization rocks and mud were exposed along the shoreline on October 28, 2019 (Photo 6-5). The site continued to provide access for carry-in boats on the October 28, 2019 field visit.

PHOTO 6-4 CLAY SLOUGH, OCTOBER 25, 2019 (AT FULL POOL)

PHOTO 6-5 CLAY SLOUGH, OCTOBER 28, 2019 (JUST BELOW MINIMUM EXTENDED OPERATION ELEVATION RANGE)

6.6.3 BENSON MARINA

Benson Marina contains a concrete boat ramp suitable for trailered boats, two docks, and a small swimming beach (Photo 6-6), as well as numerous other shore-based recreation amenities. Benson Marina provides direct access to the North Boater Zone where there are no restrictions on motor size or speed outside of state boater safety regulations, and is adjacent to the South Boater Zone which has year-round restrictions on both motor size and speed, per Utah law and PacifiCorp regulation.

The boat ramp and swim area continued to function as intended under the proposed normal and extended range of Project operations based on field observations during the fall 2019 drawdown period (Photo 6-7). Water depth was sufficient at the ramp for launching boats and using the boat dock at all levels in the proposed range. The dock at the swim beach was partially exposed but depths were sufficient for swimming. The wetted perimeter decreased 10 feet 9 inches (linearly) on October 28, 2019 compared to the wetted perimeter on October 25, 2019 prior to the drawdown (at reservoir full-pool elevations). Cutler Dam elevation on October 28, 2019 was 4,404.58 feet, approximately 0.4 feet lower than the proposed extended range elevation.

PHOTO 6-6 BENSON MARINA BOAT RAMP AND SWIMMING AREA, OCTOBER 25, 2019 (AT FULL POOL)

PHOTO 6-7 BENSON MARINA BOAT RAMP AND SWIMMING AREA, OCTOBER 28, 2019 (JUST BELOW MINIMUM EXTENDED OPERATION ELEVATION RANGE)

6.6.4 UPPER BEAR RIVER ACCESS

The Upper Bear River recreation site contains a concrete boat ramp suitable for trailered boats and a dock (Photo 6-8), as well as other amenities. The site provides direct access to the Bear River upstream of Cutler Reservoir (this area is also accessible by boat from the nearby Benson Marina via the confluence of the reservoir and river). Boating restrictions in the Upper Bear River, designated as Boater Zone C, include a motor size restriction of 35 hp maximum and wakeless speeds from the last Saturday in September to March 31, annually, but open to all watercraft and safe speeds from April 1 to the last Saturday in September.

Future proposed Project operations in the normal and extended range are not expected to influence WSE at the Upper Bear River Access. The Upper Bear River Access was visited daily during the fall 2019 drawdown period to document potential changes in wetted perimeter and evaluate the usability of the boat ramp and dock providing access to the Bear River. The wetted perimeter width, delineated with white survey paint in Photo 6-9, decreased 6 feet linearly at the launch shoreline between October 25, 2019 (at essentially full pool) and October 28, 2019 (just below the minimum elevation of the proposed extended operation range). The concrete boat ramp was covered with mud up to the ordinary highwater mark. The mud bottom was exposed as the wetted perimeter receded, but the ramp continued to function for launching trailered boats. The dock also continued to function as intended on October 28, 2019.

PHOTO 6-8 UPPER BEAR RIVER BOAT RAMP, OCTOBER 25, 2019 (AT FULL POOL)

PHOTO 6-9 UPPER BEAR RIVER BOAT RAMP, OCTOBER 28, 2019 (JUST BELOW MINIMUM EXTENDED OPERATION ELEVATION RANGE)

6.6.5 CUTLER MARSH MARINA

Cutler Marsh Marina contains a concrete boat ramp suitable for trailered boats and dock (Photo 6-10), along with other amenities. The site, located directly adjacent to and upstream of State Highway 30 (on the south side of the highway), provides access to the southern end of Cutler Reservoir near the confluence of the Little Bear and Logan Rivers. Cutler Marsh Marina is a popular launch site for canoers spring through fall, and waterfowl hunters in the fall. Cutler Marsh Marina is located in the South Boater Zone where motor size is restricted to a maximum of 35 hp and wakeless speeds year-round.

The boat ramp continued to function as intended under the proposed normal and extended range of Project operations based on field observations during the fall 2019 drawdown period (Photo 6-11). Water depth was sufficient at the ramp for launching boats and the boat dock. Boats were observed launching at Cutler Marsh Marina during data collection efforts on October 28, 2020, which was at an elevation just below the proposed extended minimum reservoir elevation range.

The wetted perimeter decreased 8 linear feet on October 28, 2019 compared to the wetted perimeter on October 25, 2019 prior to the drawdown (at essentially full pool). Areas of previously submerged shoreline were exposed on the downstream side of the boat ramp.

PHOTO 6-10 CUTLER MARSH MARINA BOAT RAMP, OCTOBER 25, 2019 (AT FULL POOL)

PHOTO 6-11 CUTLER MARSH MARINA BOAT RAMP, OCTOBER 28, 2019 (JUST BELOW MINIMUM EXTENDED OPERATION ELEVATION RANGE)

6.6.6 LITTLE BEAR RIVER ACCESS

Little Bear River Access includes a set of wooden stairs providing access to the undeveloped shoreline of the Little Bear River (Photo 6-12). The access is suitable for carry-in boats only. The launch connects to the Little Bear River Canoe Trail and Cutler Reservoir farther downstream.

Future proposed Project operations in the normal and extended range are not expected to influence WSE at Little Bear River Access. The Little Bear River Access was visited daily during the fall 2019 drawdown period to document potential changes in wetted perimeter and water depth resulting in potential access limitations. The carry-in boat launch at Little Bear River Access continued to meet the design function during fall 2019 through the minimum proposed extended range for future Project operations. The wetted perimeter width, delineated with white survey paint in Photo 6-13, decreased 2 linear inches at the launch shoreline between October 25, 2019, and October 28, 2019.

PHOTO 6-12 LITTLE BEAR RIVER ACCESS, OCTOBER 25, 2019 (AT FULL POOL)

PHOTO 6-13 LITTLE BEAR RIVER ACCESS, OCTOBER 28, 2019 (JUST BELOW MINIMUM EXTENDED OPERATION ELEVATION RANGE)

6.6.7 LOGAN RIVER RECREATION SITE

The Logan River Recreation Site provides access to the Logan River via a side channel (Photo 6-14). The recreation site includes a dock suitable for carry-in boats only. The site does not have a ramp and is not suitable for launching trailered boats.

The Logan River Recreation Site remained useable for launching carry-in boats throughout the drawdown period. The wetted perimeter reached the maximum drawdown on October 28, 2019 (Photo 6-15). The wetted perimeter decreased 1 foot 7 inches linearly. The change in WSE increased the angle of the ramp to the floating dock but did not deter use. Areas of submerged shoreline were exposed near the ramp. The site remained useable for carry-in watercraft.

PHOTO 6-14 LOGAN RIVER ACCESS SITE, OCTOBER 25, 2019 (AT FULL POOL)

PHOTO 6-15 LOGAN RIVER ACCESS SITE, OCTOBER 28, 2019 (JUST BELOW MINIMUM EXTENDED OPERATION ELEVATION RANGE)

7.0 SUMMARY

The outcome of the recreation study as presented in this ISR satisfies the content and methods approved by FERC's Study Plan Determination and fills the data gaps for recreation resources identified by FERC in Scoping Document 1 and Scoping Document 2. Specifically, this study provides an assessment of Project recreation sites, visitor use, recreation opportunities in the Project Boundary, and needs of additional recreation resources. Study data is sufficient to conduct analysis of potential effects of future Project operations on recreation within the Cutler Project Boundary. Analysis of potential effects of future Project operations will be provided in the DLA. No additional or future studies are proposed.

7.1 COVID-19 PANDEMIC TRENDS IN UTAH

COVID-19 began to spread in the United States beginning in March 2020. Due to continuous changes in state regulations and social guidelines, COVID-19 is expected to have affected visitor counts for 2020. Visits to the Project in 2020 were 51 percent higher than visits in 2014 (PacifiCorp 2015) for the equivalent period April through October (Figure 7-1). While the population of Utah has grown by 9 percent (269,000) over the last 6 years (United States Census Bureau 2020), the increase in visitation is likely also due to more time spent outside with COVID-19 restrictions limiting indoor activities and organized sports, similar to most other recreation sites regionally and nationally.

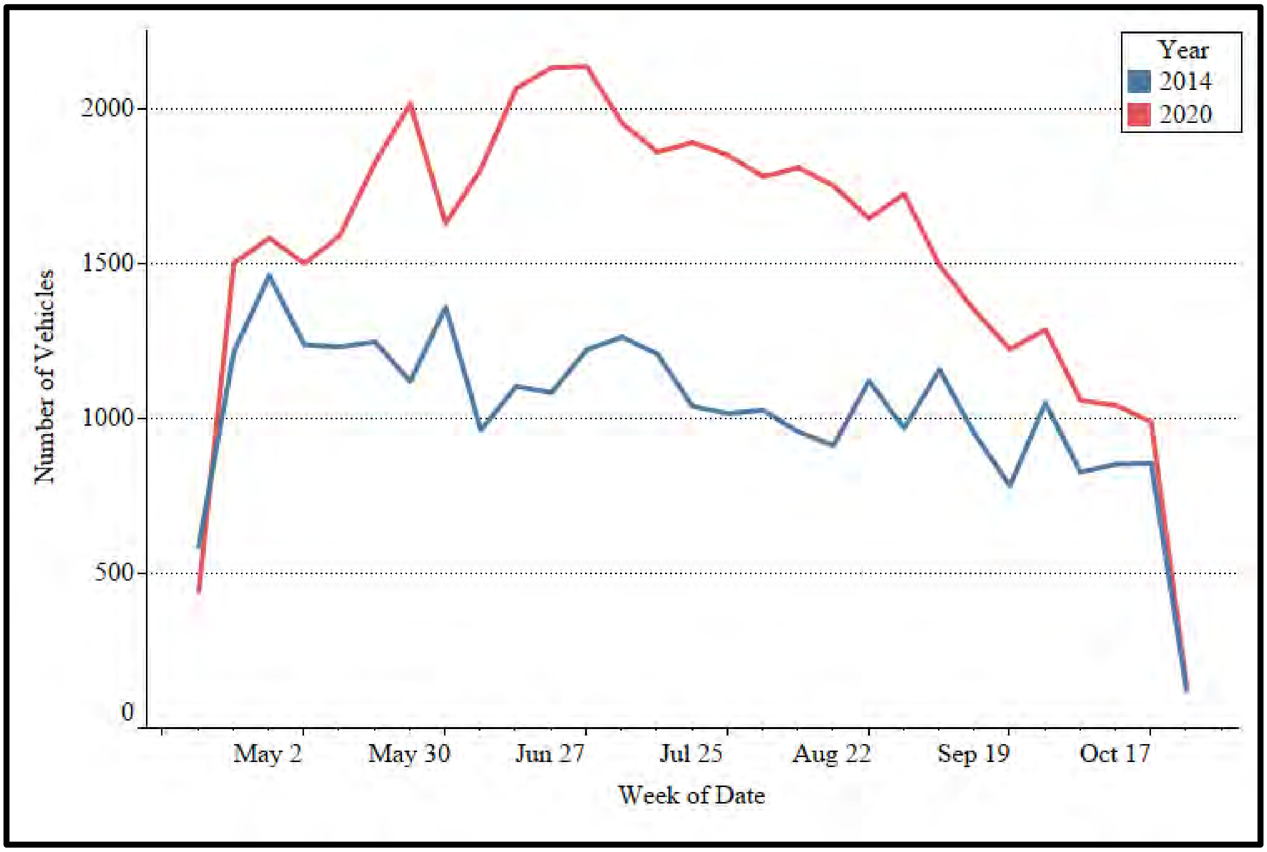


FIGURE 7-1 VEHICLE COUNTS IN 2014 COMPARED TO 2020 FOR COMPARABLE PERIODS IN CALENDAR YEAR

Utah has had a shifting response to COVID-19 as cases have fluctuated (Figure 7-2). From March 12 to April 14 a series of restrictions were placed across the state as new cases increased. From April 22 to June 19, more openings and easing of restrictions occurred as cases appeared to be steady (Table 7-1). When cases gradually increased after June 19, the Governor extended a mandate on face coverings only in state facilities and denied further openings in counties on July 10. No counties had restrictions loosened until September 4. Following September 4, new daily cases began to spike, leading to the Governor placing Utah under a State of Emergency on September 21. No new restrictions or openings occurred from September 4 to November 1. None of the restrictions or openings appear to correlate with visitations to the Cutler recreation sites.

Source Johns Hopkins 2020

FIGURE 7-2 COVID-19 CASES IN UTAH COMPARED TO RESTRICTIONS AND OPENINGS OVER TIME

TABLE 7-1 DETAILS OF OPENINGS AND CLOSING POLICY DECISIONS IN UTAH[2]

DATE	OPENING OR CLOSING POLICY	DETAILS
3/6/2020	Closing	Governor Herbert declared a State of Emergency, which is part of the state's preparedness plan and came at the recommendation of The Governor's COVID-19 Task Force.
3/16/2020	Closing	The Governor announced that Utah's public schools would implement a 2-week dismissal, or soft closure, starting Monday, March 16. The dismissal was designed to help implement social distancing and slow the spread of novel coronavirus in Utah communities.
3/17/2020	Closing	The Utah Department of Health ordered all restaurants and bars to close dining rooms, effective March 18.
3/23/2020	Closing	The Governor, State Superintendent, and Acting Commissioner of Technical Education announced that Utah's K-12 public schools would extend their dismissal through May 1, 2020.

[2] As of 12/22, According to the Johns Hopkins University (JHU) Coronavirus data where Emi pulls the summarized data from (https://coronavirus.jhu.edu/data/state-timeline/new-confirmed-cases/utah/55) there have been no new policy decisions since 11/23.

DATE	OPENING OR CLOSING POLICY	DETAILS
3/24/2020	Closing	The Utah Department of Health announced restrictions on non-urgent medical, dental, and veterinary procedures.
3/27/2020	Closing	The Governor issued a Stay Safe, Stay Home Directive to provide further guidance to individuals and businesses regarding hygiene, gatherings, travel, and outdoor recreation.
4/1/2020	Closing	The Governor issued an Executive Order, extending the closure of dine-in service at food establishments until April 15.
4/13/2020	Closing	The Governor extended the Stay Safe Stay Home directive until May 1.
4/14/2020	Closing	The Governor and State Superintendent announced an extension on the soft closure of public schools until the end of the school year.
4/22/2020	Opening	The Governor directed the Utah Department of Health to update its public health order, allowing for the resumption of some elective procedures pursuant to established guidelines.
4/30/2020	Opening	The Governor issued an Executive Order, placing the State of Utah under moderate risk protocols beginning May 1. The order stipulated that individuals in high-risk categories should continue to follow high-risk protocols.
5/6/2020	Opening	The Governor signed an Executive Order, clarifying guidelines in the moderate- and low-risk phases of the Utah Leads Together reopening plan.
5/15/2020	Opening	The Governor issued an Executive Order, moving much of the state to a Low Health Risk Status effective on May 16, 2020. The order clarified that Grand County, Summit County, and Wasatch County would remain at an Orange Health Risk.
5/22/2020	Opening	The Governor, in consultation with the Utah Department of Health, issued an Executive Order, moving Summit and Wasatch Counties to Yellow, or Low Health Risk Status.
5/22/2020	Opening	The Governor, in consultation with the Utah Department of Health, approved requests for the municipalities of Bluff and Mexican Hat to transition to Orange, or Moderate Health Risk.
5/27/2020	Opening	The Governor issued an Executive Order, updating guidelines for areas under a Low Health Risk designation. The order specifically addressed social gatherings, education, businesses, travel, and events.
5/29/2020	Opening	The Governor, in consultation with the Utah Department of Health and Local Health Departments, issued an Executive Order, moving Grand County, West Valley City, and Magna to Low Health Risk Status.

DATE	OPENING OR CLOSING POLICY	DETAILS
6/5/2020	Closing	The Governor extended the current health risk status, issued on May 29. The public health risk remained at Orange in Salt Lake City, Bluff, and Mexican Hat, and Yellow in all other areas.
6/12/2020	Opening	The Governor, in consultation with local health authorities and the Utah Department of Health, issued an Executive Order moving Kane County to the New Normal Health Risk Status, and moving Bluff and Mexican Hat to the Low Health Risk Status.
6/19/2020	Opening	The Governor approved requests from nine counties to transition to Green, or "New Normal" Health Risk Status. The approved counties were Beaver, Daggett, Duchesne, Emery, Garfield, Millard, Piute, Uintah, and Wayne.
7/10/2020	Closing	The Governor extended an Executive Order that mandated face coverings be worn in all state facilities. The Governor also extended Utah's Health Risk Status, leaving Salt Lake City in Moderate Risk, 10 counties in Normal Risk, and the rest of the state in Low Risk.
8/21/2020	Closing	Gov. Gary R. Herbert issued seven Executive Orders extending the State of Emergency in the state.
9/4/2020	Opening	Gov. Gary R. Herbert issued an Executive Order moving Salt Lake City to the Low Level of Restriction Status, or Yellow. The order also moves Sevier County to the Minimal Level of Restriction Status, or Green.
9/21/2020	Closing	Gov. Gary R. Herbert issued an Executive Order that will again place Utah under a State of Emergency.
11/9/2020	Closing	Gov. Gary R. Herbert declared a new State of Emergency to address hospital overcrowding. The order places the entire state under a mask mandate, limits casual social gatherings to household-only, and puts all extracurricular activities, including athletic and intramural events, on hold
11/23/2020	Closing	The Utah Department of Health released a new public health order with additional restrictions such as a face mask mandate for social events (except private gatherings and religious services) and at work, restrictions on some organized sports and activities, and mandatory testing in college

Source: Johns Hopkins 2020

8.0 REFERENCES

Federal Energy Regulatory Commission (FERC). 2004. A Guide to Understanding and Applying the Integrated Licensing Process Study Criteria.

Johns Hopkins. 2020. "Impact of Opening and Closing Decisions in Utah, New Cases." Coronavirus Resource Center. Accessed: November 12, 2020. Retrieved from: coronavirus.jhu.edu/data/state-timeline/new-confirmed-cases/utah.

National Park Service. 2019. Memo RE: Cutler Hydroelectric Project, FERC #2420-054 regarding ADA accessibility. To: FERC, From: Hugh Osborne, IMR Hydropower Assistance Program. July 22, 2019.

PacifiCorp. 1995. Resource Management Plan for the Cutler Hydroelectric Project (FERC No. 2420). PacifiCorp, Salt Lake City, Utah. Retrieved from: https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/hydro/cutler/1995_7_1_CutlerRmp1.pdf

PacifiCorp. 2002. Resource Management Plan Five-Year Implementation and Monitoring Report for the Cutler Hydroelectric Project (FERC Project No. 2420), 1995-2002. PacifiCorp, Salt Lake City, Utah. Accessed: November 29, 2018. Retrieved from: https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/hydro/cutler/1995_2002_Cutler_Report.pdf

PacifiCorp. 2008. Resource Management Plan Five-Year Implementation and Monitoring Report for the Cutler Hydroelectric Project (FERC Project No, 2420), 2003-2007. PacifiCorp, Salt Lake City, Utah. Retrieved from: https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/hydro/cutler/2003_2007_Cutler_Report.pdf

PacifiCorp 2013. Resource Management Plan Five-Year Implementation and Monitoring Report for the Cutler Hydroelectric Project (FERC Project No, 2420), 2008-2012. PacifiCorp, Salt Lake City, Utah. Retrieved from: https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/hydro/cutler/2008_2013_Cutler_Report.pdf

PacifiCorp. 2015. Licensed Hydropower Development Recreation Form. FERC Form 80. Retrieved from: https://elibrary.ferc.gov/eLibrary/filedownload?fileid=13819584.

PacifiCorp. 2018. Resource Management Plan Five-Year Monitoring Report for the Cutler Hydroelectric Project (FERC No. P-2420), 2013-2017. PacifiCorp, Salt Lake City, Utah. Retrieved from: https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/hydro/cutler/04272020_Cutler_RMP-5yr_Monitor.pdf

Timeanddate.com. 2020 "Salt Lake City, Utah, USA—Sunrise, Sunset, and Daylength, November 2020." Accessed: November 12, 2020. Retrieved from: www.timeanddate.com/sun/usa/salt-lake-city.

U.S. Fish and Wildlife Service (USFWS). 1997. Bear River Migratory Bird Refuge Comprehensive Management Plan.

United States Access Board (USAB). 2015. Architectural Barriers Act (ABA) Standards (2015). Washington, D.C.

United States Census Bureau. 2020. QuickFacts: Utah. Accessed: November 12, 2020. Retrieved from: https://www.census.gov/quickfacts/UT/.

United States Department of Justice (USDOJ). 2010. 2010 ADA Standards for Accessible Design. Washington, D.C. September 15, 2010.

Utah Department of Natural Resources (Utah DNR). 2010. Utah Boating Program Strategic Plan 2010. Division of Utah State Parks and Recreation. Accessed December 19, 2018. Retrieved from: https://stateparks.utah.gov/stateparks/wp-content/uploads/sites/26/2015/03/BoatingStrategicPlan2010.pdf.

Utah Department of Natural Resources (Utah DNR). 2013. 2014 Utah State Comprehensive Outdoor Recreation Plan. Division of Utah State Parks and Recreation. September 2013. Accessed: December 19, 2018. Retrieved from: https://stateparks.utah.gov/stateparks/wp-content/uploads/sites/26/2015/04/SCORP20141.pdf

Utah Department of Natural Resources (Utah DNR). 2017. Final Bear River comprehensive management plan and record of decision. Division of Forestry, Fire, and State Lands.

Whittaker, D., B. Shelby, and J.T. Gangemi. 2005. Flows and Recreation: A Guide to Studies for River Professionals. Hydropower Reform Coalition, Washington, DC.

Whittaker, D., B. Shelby, W. Jackson, and R. Beschta. 1993. Instream flows for recreation: a handbook on concepts and research methods. U.S. Department of Interior, National Park Service, Anchorage, AK.

ATTACHMENT I-1

RECREATION SITE ASSESSMENT FIELD FORM

Cutler Recreation Site Assessment: Amenity Inventory and Condition Form

Recreation Site:		**Date:**	
Surveyors:			

Recreation Feature	Present			Type/material (circle/insert)	Condition Assessment (check one)				Comment
	Yes	No	#		1-poor	2-fair	3-good	4-excellent	
Entrance Sign				(metal, wood, plastic, other)					
Regulatory Sign				(metal, wood, plastic, other)					
Information Board				(metal, wood, plastic, other)					
Picnic tables				(metal, wood, plastic, concrete, other)					
Grills									
Trash receptacle									
Pavilion/Shelter				(metal, wood)					
Restroom				(CXT, concrete block, wood, portable, other)					
In-site paths				(paved, concrete, gravel, dirt, wood chips)					
Potable water									
Standard Parking spaces				(paved, concrete, gravel, dirt)					
Trailer Parking spaces				(paved, concrete, gravel, dirt)					
Entrance roadway				(paved, concrete, gravel, dirt)					
Boat Ramp				(paved, concrete, gravel, dirt)					
Dock				(Type: floating, pier, other)(Material: wood, plastic, concrete)					
Designated fishing area				(Type: shoreline, floating, pier, other)(Material: wood, plastic, concrete)					
Designated swimming Area				(Type: sand, gravel, rocks) (Materials: bouys, rope, signs)					
Designated Trails				(paved, concrete, gravel, dirt, wood chips)					

Cutler Recreation Site Assessment: Use Impacts Form

Recreation Site:		**Date:**	
Surveyors:			

Variable	Question	No	Yes	Answer choices (circle all that apply)				
Facilities	Have the restrooms, picnic tables, pavilion, signs and/or docks been vandalized?			graffiti	damage to restroom	damage to picnic tables	dock vandalized	signs vandalized
Litter	In general, how much litter is found at this site?			Trace amounts (< handful)	Small (about handful)	Medium (5 gallon bucketful)	Large (~33 gallon garbage bag)	Excessive (> 33 gallon garbage bag)
Dump	Does this site get used as a dump (not just litter from camping)?			List items dumped:				
Fire rings	Are there user created fire rings present?			If yes, report number of user created fire rings _________				
Bare ground	Does the site show signs of extensive use and loss of ground vegetation outside the designated site?			low: small areas	Medium: bare areas around fire rings and other areas		Large: large contiguous areas, trails and satelite use areas	
ATV/OHV	Does the site show signs of ATV/OHV use?							
Vehicle access barriers	Are there management-placed barriers to prevent vehicle access to parts of the site?							
	Have people moved the vehicle access barriers							

Cutler Recreation Site Assessment: Site Photos

Recreation Site:		Date:	
Surveyors:			

Item No.	Feature/Amenity	Photo No.	Description
1			
2			
3			
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Cutler Recreation Site Assessment - ADA Assessment

Recreation Site:			**Date:**	
Surveyors:				**Page _______ of ________**
Facility Component	**Yes**	**No**		**Possible Solutions (check those that apply)**
Route of Travel --Accessible Approach/Entrance: People with disabilities should be able to arrive on the site, approach the building, and enter as freely as everyone else. At least one route of travel should be safe and accessible for everyone, including people with disabilities				
Is there a route of travel that does not require the use of stairs?				Add a ramp if the route of travel is interrupted by stairs.
				Add an alternative route on level ground.
Is the route of travel stable, firm and slip-resistant?				Repair uneven paving.
				Fill small bumps and breaks with beveled patches.
				Replace gravel with hard top.
Is the route at least 36 inches wide?				Change or move landscaping, furnishings, or other features that narrow the route of travel.
width (inches)				Widen route.
Can all objects protruding into the circulation paths be detected by a person with a visual disability using a cane? (In order to be detected using a cane, an object must be within 27 inches of the ground. Objects hanging or mounted overhead must be higher than 80 inches to provide clear head room. It is not necessary to remove objects that protrude less than 4 inches from the wall.)				Move or remove protruding objects.
				Add a cane-detectable base that extends to the ground.
distance from wall/height (inches)				Place a cane-detectable object on the ground underneath as a warning barrier.
Do curbs on the route have curb cuts at drives, parking, and drop-offs?				Install curb cut.
				Add small ramp up to curb.
Is the threshold edge 1/4-inch high or less, or if beveled edge, no more than 3/4-inch high?				If there is a single step with a rise of 6 inches or less, add a short ramp
height (inches)				If there is a threshold greater than 3/4-inch high, remove it or modify it to be a ramp.
Ramps (other than Boat Ramps) (ADAAG 4.8): Slope is given as a ratio of the height to the length. 1:12 means for every 12 inches along the base of the ramp, the height increases one inch. For a 1:12 maximum slope, at least one foot of ramp length is needed for each inch of height.				
Are the slopes of pathways no greater than 1:12 (or 8.3 %)?				Lengthen ramp to decrease slope.
				Relocate ramp.
Slope (height/length as %)				
Are ramps needed at this site to access recreation amenities, e.g., restroom, picnic tables, pavilion, or docks?				If available space is limited, reconfigure ramp to include switchbacks.
				Relocate ramp.
Parking and Drop-Off Areas (ADAAG 4.6): At least one of every 8 accessible spaces must be van accessible (with a minimum of one van-accessible space in all cases).				
Are an adequate number of accessible parking spaces available (8 feet wide for car plus 5-foot access aisle)? The table below gives the ADAAG requirements for new spaces construction and alterations (for lots with more widths than 100 spaces, refer to ADAAG).				Reconfigure a reasonable number of spaces by repainting stripes
number of accessible spaces				
Total Spaces - Accessible Spaces 1 to 25 --------- 1 space 26 to 50 --------2 spaces 51 to 75 --------3 spaces 76 to 100 ------4 spaces				
Is there a van-accessible site (8-foot-wide space, with minimum 8-foot- wide access aisles, and 98 inches of vertical clearance, available for lift-equipped vans)?				Reconfigure to provide van-accessible space(s).
width/vertical clearance (feet/inches)				
number of van-accessible spaces				
Are the access aisles part of the accessible route to the accessible entrance?				Add curb ramps.
				Reconstruct sidewalk.
Are the accessible spaces closest to the accessible entrance?				Reconfigure spaces.
Are accessible spaces marked with the International Symbol of ccessibility?				Add signs, placed so that they are not obstructed by cars.
Are there signs reading “Van Accessible” at van spaces?				Add signs, placed so that they are not obstructed by cars.
Is there an enforcement procedure to ensure that accessible parking is used only by those who need it?				Implement a policy to check periodically for violators and report them to the proper authorities.
Boat Ramps and Docks: Boat ramps and docks need to consider slope, route of travel and safety railings for a person using a wheelchair or other disabilities.				
Is there a boat dock?				
Is the boat dock accessible for individuals with disabilities?				Reconfigure dock for ADA access
Is dock $\geq$ 36" width?				Replace with wider dock
Dock width (inches)				
Does the dock have a secure railing on both sides?				Add safety railing to docks
Are railings sturdy, and between 34 and 38 inches high?				Secure handrails in fixtures.
height (inches)				Adjust height of railing if not between 30 and 38 inches.
Is the width between railings or curbs on dock at least 36 inches?				Adjust width of curbs/dock if not between 36 and 38 inches.
width (inches)				
Is the shoreline slope to the dock < 1:12?				Remodel or relocate ramp.
length (inches)				
rise (inches)				

Cutler Recreation Site Assessment - ADA Assessment

Facility Component	Yes	No		Possible Solutions (check those that apply)
Recreation Site:			**Date:**	
Surveyors:				**Page _______ of ________**
Are ramps to the dock non-slip?				Add non-slip surface material.
Circulation--Access to Picnic Tables and Grills: Ideally, at least one picnic table and grill should be accessible to people with disabilities. If there is a pavilion with picnic tables then one table should be ADA accessible.				
Does the picnic area include accessible route of travel?				Add ramps or lifts.
Are all public spaces on an accessible route of travel?				Provide access to recreation amenities along an accessible route of travel.
Is the accessible route to all public spaces at least 36 inches wide?				Move tables and grills to make more room.
width (inches)				
Is there a 5-foot circle or a T-shaped space for a person using a wheelchair to reverse direction?				
width (inches)				
Are the aisles between picnic tables at least 36 inches wide?				
Are there picnic tables for wheelchair seating?				Rearrange tables to allow room for wheelchairs in seating areas throughout the area. Remove some fixed seating.
Are the tops of tables or counters between 28 and 34 inches high?				Lower part or all of high surface. Provide auxiliary table or counter
height (inches)				
Are knee spaces at accessible tables at least 27 inches high, 30 inches wide, and 19 inches deep?				Replace or raise tables.
height/width/depth (inches)				
Usability of Rest Rooms: Rest rooms should be accessible to people with disabilities and easily identifiable, e.g., tactile and visual signage identifying rest rooms				
Are accessible rest rooms identified with signs?				Add accessible signage, placed to the side of the door, 60 inches to centerline (not on the door itself).
Are pictograms or symbols used to identify accessible rest rooms?				Add pictograms and symbols
Are raised characters and braille used to identify accessible rest rooms?				Add supplementary letter signage with raised characters and braille.
Is at least one rest room (either one for each sex, or unisex) fully accessible?				Reconfigure rest room. Combine rest rooms to create one unisex accessible rest room.
Is the doorway at least 32 inches clear?				Install offset (swing-clear) hinges
				Widen the doorway.
On the pull side of doors, next to the handle, is there at least 18 inches of clear wall space so that a person using a wheelchair or crutches can get near to open the door?				Reverse the door swing if it is safe to do so.
clear space (inches)				Move or remove obstructing partitions.
Is the threshold edge 1/4-inch high or less, or if beveled edge, no more than 3/4-inch high?				Reduce threshold height through use of matts or other materials
Is the door handle no higher than 48 inches and operable with a closed fist?				Lower handle.
(The "closed fist" test for handles and height controls: Try opening the door or operating the control using only one hand, held in a fist. If you can do it, so can a person who has limited use of his or her hands.)				Replace inaccessible knob with a lever or loop handle.
height (inches)				Retrofit with an add-on lever extension.
Can doors be opened without too much force (exterior doors reserved; maximum is 5 lbf for interior doors)?				Adjust the door closers and oil the hinges.
(You can use an inexpensive force meter or a fish scale to measure the force re- quired to open a door. Attach the hook end to the doorknob or handle. Pull on the ring end until the door opens, and read off the amount of force required. If				Install power-assisted or automatic door openers
you do not have a force meter or a fish scale, you will need to judge subjectively whether the door is easy enough to open.)				Install lighter doors.
If the door has a closer, does it take at least 3 seconds to close?				Adjust door closer.
seconds				
In the restroom, are there grab bars behind and on the side wall nearest to the toilet?				Add grab bars.
Is the toilet seat 17 to 19 inches high?				Install raised seat.
height (inches)				
Does the entry configuration provide adequate maneuvering space for a person using a wheelchair? (A person in a wheelchair needs 36 inches of clear width for forward movement, and a 5-foot diameter or T-shaped clear space to make turns. A minimum				Rearrange furnishings such as chairs and trash cans.
distance of 48 inches clear of the door swing is needed be- tween the two doors of an entry vestibule.)				Move or remove obstructing partitions.

ATTACHMENT I-2

STRUCTURED INTERVIEW QUESTIONS

CUTLER RECREATION STUDY – STRUCTURED INTERVIEWS

Interviewee:_______________________________

Date:_______________________

Interviewer:________________________________

Background:
This interview is a component of the FERC relicensing of PacifiCorp's Cutler Hydroelectric Project on the Bear River and Cutler Reservoir. We are conducting interviews with stakeholders who are familiar with and use the recreation facilities at Cutler Reservoir and those who represent recreation organizations. The goals of the Recreation Resources Study are to identify the existing recreation opportunities, facilities, and visitor use that may be affected by operation of the Project, and develop measures that could be implemented to mitigate Project effects and/or enhance recreation activities. Recreation sites supported by the project include trailheads, boater access, and other facilities such as (list) and also use of the general reservoir and river areas for recreation, such as (list)

Recreation Sites
Bear River Riparian Trail
Benson Marina
Benson Railroad Bridge Trail
Clay Slough
Cutler Canyon Marina
Cutler Marsh Marina
Little Bear River Access
Logan River Recreation Site
Lower Bear River Overlook
North Boat-in Island
South Boat-in Island
Upper Bear River Access
Dispersed Recreation
Cutler Reservoir North Boating Zone (A)
Cutler Reservoir South Boating Zone (B)
Bear River Boating Zone (C)
Little Bear River Canoe Trail
Logan River Canoe Trail
Wetlands Canoe Trail
Upland Areas

1. Do you visit Cutler reservoir and the adjacent uplands managed by PacifiCorp?
2. What types of recreation/activities do you typically do at Cutler? Anything additional done by the group you represent?
3. When you go to Cutler Reservoir, do you utilize the developed recreation sites? (can list again)
    a. Which recreation sites do you use?
    b. What type of recreation/activities?
    c. Which amenities are most important to you at the recreation sites?
    d. Have you noticed any additional amenities needed at the recreation sites? If yes, please list
4. Do you utilize the undeveloped areas to Recreate/pursue your activities (Cutler reservoir and adjacent uplands)?
    a. Which undeveloped areas do you use?
    b. What type of recreation / activities do you pursue in these areas?
5. How long have you been coming to Cutler?
6. Are there specific times of year that you come to Cutler?
7. Have you observed conflicts between recreation users at Cutler? Please describe.
8. Are the type of recreation / activities you pursue and/or observe others pursuing changing or staying the same at Cutler?
9. Pre-COVID-19, did the number of people using Cutler Reservoir and adjacent areas appear to be staying the same, increasing, or decreasing? (How has recreation usage changed in 2020?)
10. Are there any types of recreation that seem under or over served by the facilities at Cutler?
11. Have your recreation activities / use patterns changed at Cutler Reservoir during the Pandemic?
12. Have you taken the Cutler Visitor Survey?
13. Are you a member of a group or organization whose members recreate on Cutler Reservoir and adjacent uplands?
14. Has the Cutler Visitor Survey been circulated among your group/organization?

ATTACHMENT I-3

VISITOR SURVEY

Welcome to the visitor survey for the Cutler Hydroelectric Project.

The purpose of this visitor survey is to gather information about your visits and recreation activities at the Cutler Hydroelectric Project. The information gathered will help guide current and future management of recreation opportunities, sites, and facilities for visitors to the Cutler Project. The visitor survey is part of a Recreation Resources Study for PacifiCorp's Cutler Hydroelectric Project Federal Energy Regulatory Commission (FERC) relicensing.

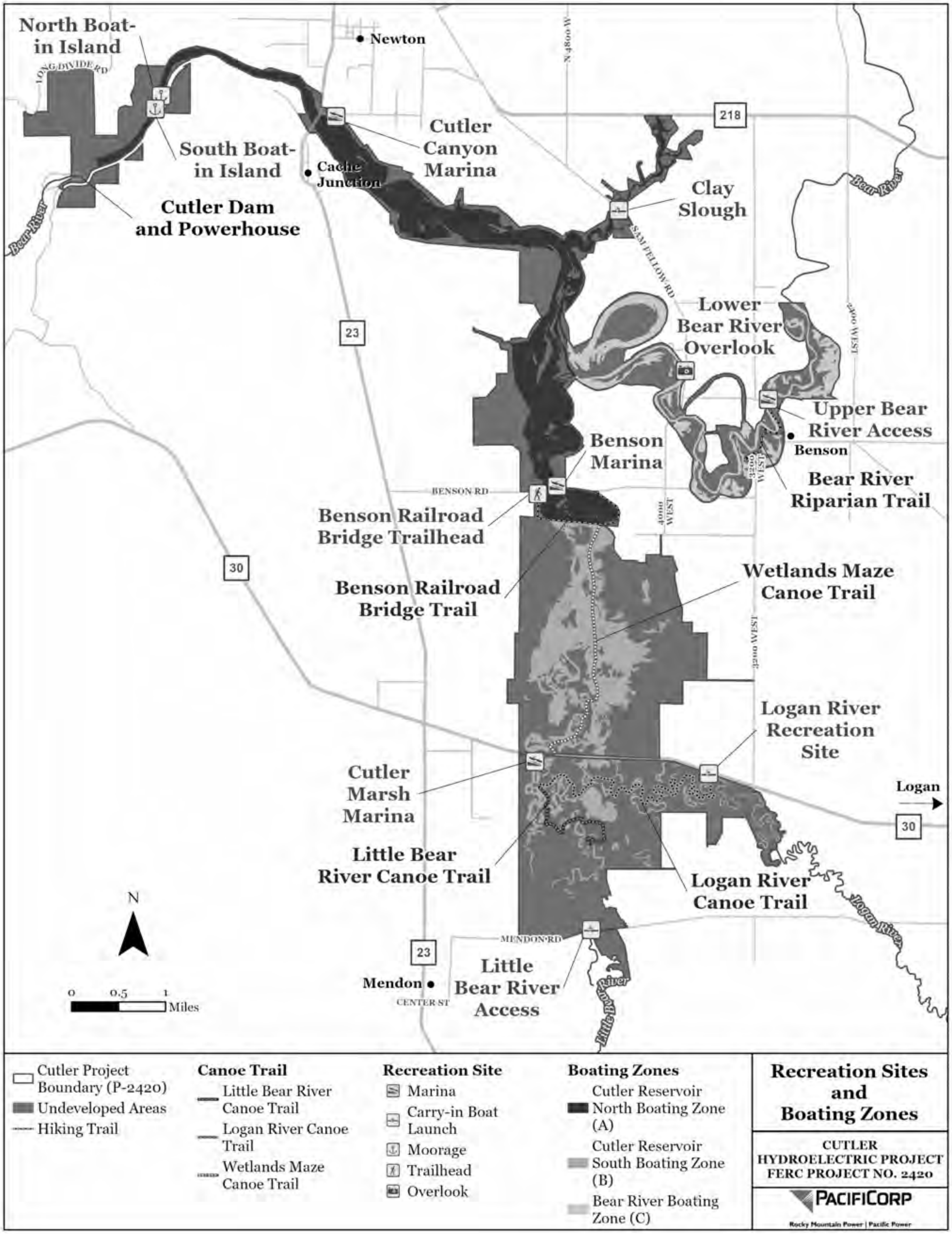
As you complete the survey, base responses on YOUR visits and direct experience at the Cutler Hydroelectric Project. Consider how you use the developed recreation sites as well as the undeveloped areas. A map is provided below identifying the developed recreation sites and the undeveloped areas at the Cutler Hydroelectric Project. Please familiarize yourself with the Cutler Hydroelectric Project before answering the survey questions.

The Cutler Hydroelectric Project offers a broad range of no-fee recreation opportunities available to the public year-round during daylight hours. PacifiCorp maintains 15 recreation sites at Cutler Reservoir, which include boat launches, parking areas, picnic sites, canoe trails, and hiking trails. In addition to the developed recreation sites, the public can access the undeveloped areas in the Cutler Hydroelectric Project boundary encompassing 9,115 acres to pursue a wide range of recreation activities including but not limited to hunting, fishing, motorized boating, non-motorized boating, bird watching, photography, and dog walking, etc.

Thank you for taking the time to complete this survey, your input is greatly appreciated. This online survey is best viewed using a computer screen. Question formats are not ideal for smaller screens such as mobile devices.

Participation in this visitor survey is important to the study's success. Please encourage others to participate in this survey.

Developed recreation sites and undeveloped areas at the Cutler Hydroelectric Project.



1. Please enter the 5-digit zip code for your primary residence.

5-digit zip code if residing in the USA

Country name for individuals residing outside the USA

2. Please provide the age of the individual completing this survey using the ranges provided below.

- ◯ Under 18
- ◯ 18-24
- ◯ 25-34
- ◯ 35-44
- ◯ 45-54
- ◯ 55-64
- ◯ 65+

3. What is your gender?

- ◯ Male
- ◯ Female
- ◯ Prefer not to specify

* 4. Have you ever been to the Cutler Hydroelectric Project?

◯ Yes

◯ No

* 5. Which reason best describes why you have NEVER been to the Cutler Hydroelectric Project. (select one).

- I did not know there were recreation opportunities in this area
- The recreation sites and/or opportunities do not interest me
- I spend time visiting other locations
- Other (please explain)

6. How many years have you been visiting the Cutler Hydroelectric Project?

7. In general, how many days per year do you visit the Cutler Hydroelectric Project?

- 1 day
- 2 - 5 days
- 6 - 10 days
- 11 - 20 days
- 21 - 30 days
- 31 - 50 days
- more than 50 days

8. When do you typically visit the Cutler Project? (select all that apply)

- January
- February
- March
- April
- May
- June
- July
- August
- September
- October
- November
- December

9. What day(s) of the week do you typically visit the Cutler Project? (select all that apply)

- Monday
- Tuesday
- Wednesday
- Thursday
- Friday
- Saturday
- Sunday

10. What time(s) of day do you most like to visit the Cutler Project? (select all that apply)

- Before 8 AM
- 8 AM - 12 noon
- 12 noon - 4 PM
- 4 PM - 8 PM
- After 8 PM

11. On average, how long (hours) is a typical visit? (select one)

- less than 1 hour
- 1 - 2 hours
- 2 - 4 hours
- 4 - 8 hours
- greater than 8 hours

12. Why do you visit the developed recreation sites and/or undeveloped areas at the Cutler Hydroelectric Project? (select all that apply)

- [ ] Close proximity to work or home
- [ ] To hunt
- [ ] I like the recreation sites
- [ ] To fish
- [ ] To recreate on Cutler Reservoir
- [ ] To spend time with family or friends
- [ ] To access undeveloped areas adjacent to Cutler Reservoir
- [ ] Other (please specify)

13. What type of recreation activities do you pursue at the Cutler Hydroelectric Project? (select all that apply)

- [ ] Motorized boating
- [ ] Birding/wildlife viewing
- [ ] Fishing
- [ ] Water skiing
- [ ] Hiking/walking
- [ ] Big game hunting
- [ ] Non-motorized boating
- [ ] Photography
- [ ] Upland bird hunting
- [ ] Swimming
- [ ] Outdoor education or research
- [ ] Waterfowl hunting
- [ ] Picnicking
- [ ] Dog training
- [ ] Trapping
- [ ] Other (please specify)

14. Which of these recreation activities is your primary / most common activity at the Project? (select one)

- ○ Motorized boating
- ○ Birding/wildlife viewing
- ○ Fishing
- ○ Water skiing
- ○ Hiking/walking
- ○ Big game hunting
- ○ Non-motorized boating
- ○ Photography
- ○ Upland bird hunting
- ○ Swimming
- ○ Outdoor education or research
- ○ Waterfowl hunting
- ○ Picnicking
- ○ Dog training
- ○ Trapping
- ○ Other (please specify)

* 15. Do the actions or behaviors of any other users interfere with your enjoyment at the Cutler Hydroelectric Project?

- ○ Yes
- ○ No

16. What type of actions or behaviors interfere with your enjoyment? (select only those that apply)

	Proximity	Loudness	Safety
Motorized boating	☐	☐	☐
Non-motorized boating	☐	☐	☐
Motorized vehicles	☐	☐	☐
Hunting	☐	☐	☐
Drugs and/or alcohol use	☐	☐	☐
Firearms	☐	☐	☐
Drones	☐	☐	☐

Other (please specify)

* 17. Does anything prevent you from participating in your desired activity at the Cutler Hydroelectric Project?

- Yes
- No
- Sometimes

18. Please specify what prevents you from participating in your activity and the location.

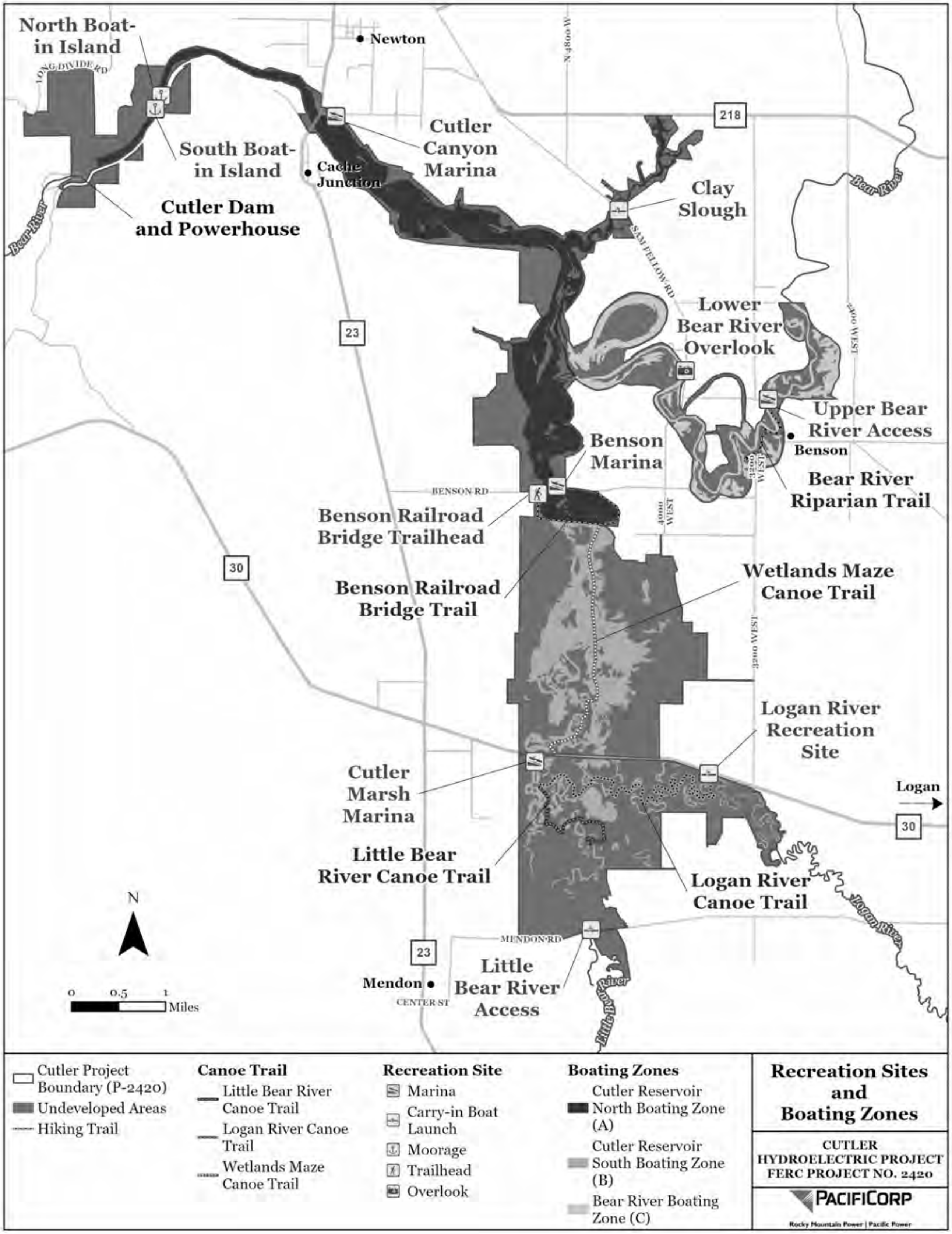
19. Are you likely to return to the Cutler Hydroelectric Project in the future?

- ◯ Yes, likely
- ◯ No, unlikely
- ◯ Not sure

20. PacifiCorp maintains a number of developed recreation sites at the Cutler Hydroelectric Project. Using the map below, please indicate which developed recreation sites you use. (select all the developed sites you visit)

- ☐ Bear River Riparian Trail
- ☐ Benson Marina
- ☐ Benson Railroad Bridge Trail
- ☐ Clay Slough
- ☐ Cutler Canyon Marina (aka Newton bridge)
- ☐ Cutler Marsh Marina (aka Valley View)
- ☐ Little Bear River Recreation Site
- ☐ Logan River Recreation Site
- ☐ Lower Bear River Overlook
- ☐ North Boat-in Island
- ☐ South Boat-in Island
- ☐ Upper Bear River Recreation Site
- ☐ Do not use developed recreation sites

Developed recreation sites and undeveloped areas at the Cutler Hydroelectric Project.



21. Please identify the type of facilities that are important for you at developed recreation sites.

	Not at all important	Slightly important	Moderately important	Very important	Extremely important	Do not use
Restroom	◯	◯	◯	◯	◯	◯
Trash receptacle	◯	◯	◯	◯	◯	◯
Picnic tables	◯	◯	◯	◯	◯	◯
Pavilion/shelter	◯	◯	◯	◯	◯	◯
Barbecue grill	◯	◯	◯	◯	◯	◯
Vehicle parking	◯	◯	◯	◯	◯	◯
Trailer parking	◯	◯	◯	◯	◯	◯
Boat ramp for trailered boats	◯	◯	◯	◯	◯	◯
Carry-in boat launch	◯	◯	◯	◯	◯	◯
Boat dock	◯	◯	◯	◯	◯	◯
Swimming area	◯	◯	◯	◯	◯	◯
Fishing area	◯	◯	◯	◯	◯	◯

Other (please specify)

22. How would you rate the quality of the facilities at the developed recreation sites?

◯ Excellent

◯ Very good

◯ Good

◯ Fair

◯ Poor

* 23. Do you believe additional facilities are needed at the developed recreation sites?

◯ Yes

◯ No

◯ Not sure

24. Please specify what additional facilities you believe are needed at the developed recreation sites. (check all that apply).

- [ ] Restroom
- [ ] Barbecue grill
- [ ] Carry-in boat launch
- [ ] Trash receptacle
- [ ] Vehicle parking
- [ ] Boat dock
- [ ] Picnic tables
- [ ] Trailer parking
- [ ] Swimming area
- [ ] Pavilion/shelter
- [ ] Boat ramp for trailered boats
- [ ] Fishing area
- [ ] Other (please specify)

* 25. Which of the following most closely reflects your opinion concerning the number of developed recreation sites at the Cutler Hydroelectric Project?

- ◯ There are too many developed recreation sites
- ◯ The current number of developed recreation sites is sufficient
- ◯ More developed recreation sites are needed

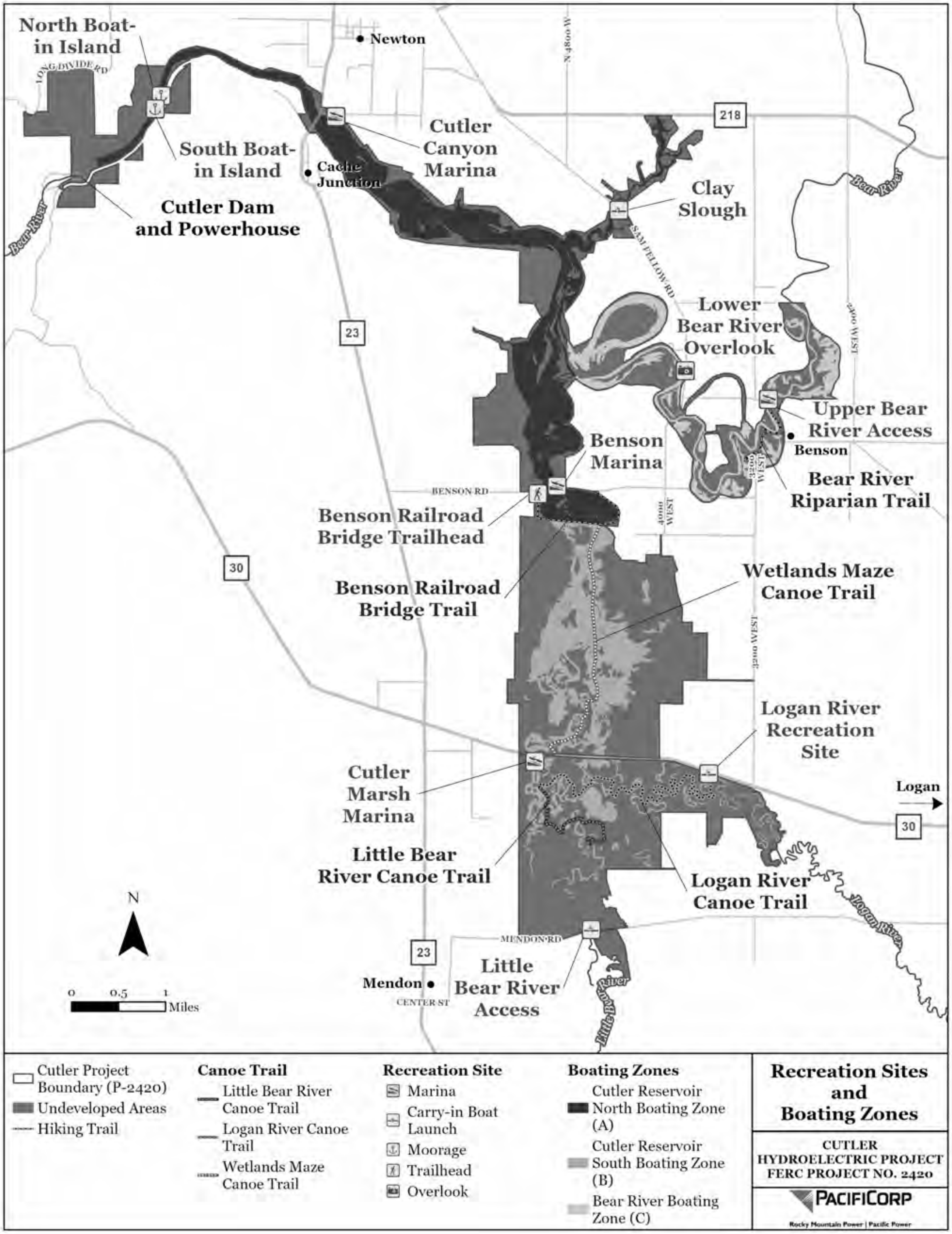
26. If you believe additional developed recreation sites are needed at the Cutler Hydroelectric Project, please specify what type of sites. (select all that apply)

- ☐ Sites with hiking trails
- ☐ Fishing access sites
- ☐ Sites for bird and wildlife viewing
- ☐ Sites with ramps for launching trailered boats
- ☐ Sites for launching carry-in boats
- ☐ Sites for swimming
- ☐ Sites for hunting access
- ☐ Other (please describe)

27. PacifiCorp owns 9,115 acres of land in the Cutler Hydroelectric Project boundary available for public use on and directly adjacent to Cutler Reservoir. Using the area names on the map below, please indicate which areas you visit. (select all the areas you visit)

- ☐ Cutler Reservoir North Boating Zone (A)
- ☐ Cutler Reservoir South Boating Zone (B)
- ☐ Bear River Boating Zone (C)
- ☐ Little Bear River Canoe Trail
- ☐ Logan River Canoe Trail
- ☐ Wetlands Maze Canoe Trail
- ☐ Undeveloped areas adjacent to Cutler Reservoir
- ☐ Don't use these areas

Developed recreation sites and undeveloped areas at the Cutler Hydroelectric Project.



28. In general for your combined trips to the Cutler Hydroelectric Project, how crowded do you feel at the following locations? (rate one per row)

	Never crowded	Sometimes crowded	Always crowded	Do not use
Developed recreation sites	◯	◯	◯	◯
On Cutler Reservoir	◯	◯	◯	◯
On lands adjacent to Cutler Reservoir	◯	◯	◯	◯

* 29. Does the water level of Cutler Reservoir affect your ability to participate in recreation activities?

- ◯ Yes
- ◯ No
- ◯ Not applicable, my activities are not dependent on reservoir water levels

30. Which of your activities have been affected by Cutler Reservoir water levels?

31. Please share any additional comments on your visits and recreation activities at the Cutler Hydroelectric Project.

Thank you for participating in the visitor survey for the Cutler Hydroelectric Project. PacifiCorp will publish the results of this study in a technical report that will be available on our website at: https://www.pacificorp.com/energy/hydro/cutler.html

ATTACHMENT I-4

VISITOR SURVEY ANNOUNCEMENTS

EMAIL NOTIFICATION TO PROJECT STAKEHOLDERS

Dear Stakeholder,

PacifiCorp is conducting a visitor survey as part of the Recreation Resources Study for the relicensing of the Cutler Hydroelectric Project. The purpose of the visitor survey is to gather information about visits and recreation activities that occur on the lands and waters associated with the Cutler Project. The information gathered will help guide current and future management of recreation opportunities, sites, and facilities for visitors to the Project.

Please participate in the visitor survey if you have visited the Cutler Reservoir and/or Project lands. The visitor survey is an online survey. The survey is best viewed using a computer screen. Question formats are not suited for smaller screens such as mobile devices.

You can access the visitor survey here: Cutler Visitor Survey

Thank you for taking the time to complete this survey, your input is greatly appreciated. Participation in this visitor survey is important to the study's success. Please encourage others to participate in this survey. The survey will be open from May 1 through November 30, 2020.

If you need additional information, please contact:

Eve Davies, Cutler Relicensing Project Manager
Renewable Resources, PacifiCorp
1407 West North Temple, Ste. 110
Salt Lake City, Utah 84116
801-220-2245
cutlerlicense@gmail.com

Visitor survey posters installed on information sign at Project recreation sites

VISITOR SURVEY

CUTLER HYDROELECTRIC PROJECT

FERC PROJECT NO. 2420

PacifiCorp is conducting a visitor survey as part of the Recreation Resources Study for the relicensing of Cutler Hydroelectric Project. The purpose of the visitor survey is to gather information about visits and recreation activities that occur on the lands and waters associated with the Cutler Project. The information gathered will help guide current and future management of recreation opportunities, sites, and facilities for visitors to the Project.

Please participate in the visitor survey if you have visited the Cutler Reservoir and/or Project lands. The visitor survey is an online survey. The survey is best viewed using a computer screen. Question formats are not well suited for smaller screens such as mobile devices.

Thank you for taking the time to complete this survey, your input is greatly appreciated. Participation in this visitor survey is important to the study's success. Please encourage others to participate in this survey. The survey is open May 1 through November 30, 2020.

You can access the visitor survey here:
https://www.surveymonkey.com/r/S2SLXXH

If you have questions please contact:
Eve Davies, Cutler Relicensing Project Manager
Phone: (801) 220-2245
Email: cutlerlicense@gmail.com

APPENDIX J
CULTURAL RESOURCES INITIAL STUDY REPORT

CULTURAL RESOURCES INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT

(FERC NO. 2420)

Prepared for:

PacifiCorp
Salt Lake City, UT

Prepared by:

SWCA
ENVIRONMENTAL CONSULTANTS

February 2021

CULTURAL RESOURCES
INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT

(FERC NO. 2420)

Prepared for:

PacifiCorp
Salt Lake City, UT

Prepared by:

SWCA
ENVIRONMENTAL CONSULTANTS

February 2021

CULTURAL RESOURCES
INITIAL STUDY REPORT

CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

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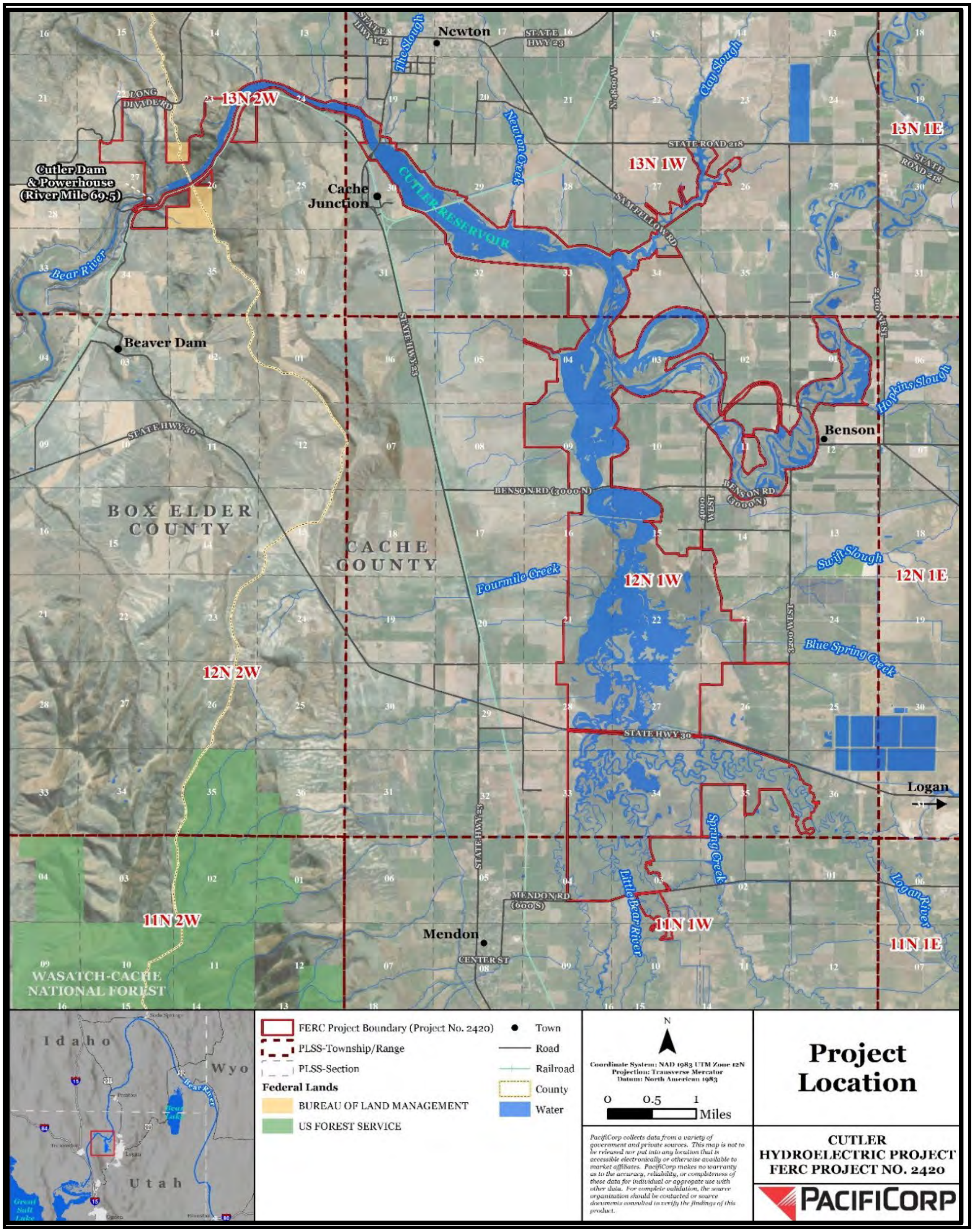
CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

1.0 INTRODUCTION

PacifiCorp is the owner, operator, and licensee for the Federal Energy Regulatory Commission (FERC) Cutler Hydroelectric Project (Project) (FERC Project No. 2420). The Project is located on the Bear River in western Cache Valley, Utah, between the Wasatch and Wellsville Mountains. Cutler Dam is located in Box Elder County; however, most of the Project reservoir lies within Cache County. The Project reservoir is formed at the confluence of Spring Creek and the Bear, Logan, and Little Bear Rivers (Figure 1-1). PacifiCorp operates the Project under a 30-year license issued by the FERC on April 29, 1994; the current license will expire on March 31, 2024. PacifiCorp initiated the formal relicensing process utilizing the Integrated Licensing Process (ILP) by filing the Notice of Intent (NOI) and Pre-Application Document (PAD) with FERC on March 29, 2019.

The relicensing process involves cooperation and collaboration between PacifiCorp, as licensee, and a variety of stakeholders including state and federal resource agencies, state and local government, non-governmental organizations (NGO), and interested individuals. PacifiCorp coordinated with stakeholders throughout the study scoping process, public meetings, workshops, scoping meetings, and a site visit. These meetings facilitated the identification of study needs to be addressed. Study scoping occurred in March 2019 through February 2020 when FERC issued the Study Plan Determination. PacifiCorp, FERC and stakeholders identified the potential need for a cultural resources study during the study scoping process.



Source: PacifiCorp 2018

FIGURE 1-1 CUTLER PROJECT LOCATION MAP

2.0 PROJECT NEXUS AND RATIONALE FOR STUDY

Existing information concerning the subject of this study report is summarized in Section 6.12 of the PAD. As described in the PAD and with only limited cultural resources inventories conducted within the Project Boundary, a few archaeological and historic architectural resources are known to exist within the FERC Project Boundary (not all of which have been formally documented) (PacifiCorp 2019). For this reason, it was expected that there are additional historic and archaeological sites within this area that have not been previously recorded. Based on the previously documented cultural resources in the Project Boundary and an understanding of the area's prehistory and history, it was expected that undocumented historic and archaeological sites will be related to a variety of prehistoric, ethnohistoric, and historic activities, including Native American occupation and Euro-American exploration, settlement, irrigation, and transportation.

Because the cultural resources inventory within the Project Boundary was limited, an additional inventory was needed to determine what cultural resources the Project's existing and potential future operations may impact and what the nature of those impacts might be.

The nexus between Project operations and effects on cultural resources is discussed in Section 7.1.11 of the PAD. As noted, current operations under the existing license and potential future operations under the relicensing could have impacts on cultural resources due to fluctuating reservoir levels and wave action from wind-blown or human-caused waves, either of which may result in erosion of cultural resources located along shorelines. To the extent that river flow fluctuations downstream of Cutler Dam are increased under the proposed operations, erosional effects on cultural resources may increase. Historic resources (e.g., those that comprise the Cutler Hydroelectric Power Plant Historic District [District] or significant irrigation canals) require continued maintenance, repair, upgrading, or removal to meet safety and operational requirements, and those activities may alter important historical characteristics of these resources. Wheelon Dam may be altered or removed at some point as a result of future safety and/or operational requirements. Recreational use may have either unintentional (e.g., trampling) or intentional (e.g., looting or vandalism) impacts on cultural resources. And finally, agricultural activities conducted on Project lands under PacifiCorp's agricultural leasing program may affect archaeological or historic resources.

Relicensing requirements related to cultural resources are anticipated to be implemented primarily through an Historic Properties Management Plan (HPMP), which will specify management actions designed to resolve all existing and potential Project-related adverse effects on historic properties. Study results will directly inform the HPMP by more completely identifying the cultural resources that will be subject to management actions outlined in the HPMP, and by indicating what management actions will be most useful for avoiding, minimizing, or mitigating effects on cultural resources.

3.0 STUDY OBJECTIVES

The goals and objectives of this study are to more completely identify those cultural resources that are potentially subject to effects from Project existence and operations under the renewed license. Better understanding of the nature of these resources will inform the management actions to be outlined in the HPMP.

Three general categories of studies related to cultural resources were proposed: archaeological, historic architectural, and ethnographic. The information obtained from these studies includes that contained in standard cultural resource recording forms (e.g., Utah Archaeology Site Forms [UASFs], an amended National Register Registration Form), consisting of locational and descriptive information about each identified resource and its setting, as well as an evaluation of its National Register of Historic Places (NRHP) eligibility with the applicable NRHP significance criterion/a noted. In addition, further information on the general historic and prehistoric context of cultural resources in the area was obtained to assist in NRHP eligibility evaluations. If an ethnographic inventory is requested by participating tribes, the information will be obtained by a qualified ethnographer in coordination with participating tribes. This information, as well as resource recording forms, will be included in reports that meet FERC and Utah Division of State History (UDSH, which houses the Utah State Historic Preservation Office [SHPO]) guidelines for archaeological and historic architectural studies.

3.1 STUDY AREA

In the Cultural Resources Study Plan (PacifiCorp 2020), PacifiCorp proposed, and FERC agreed, that per FERC guidance (FERC 2008), the Project's area of potential effects (APE) for purposes of Section 106 consultation would be defined as the Project Boundary, plus any areas upstream or downstream of the Project Boundary that planned hydraulic modeling indicates may be affected by changes in river flow regime and related erosional concern spots. In October 2019 the Utah SHPO concurred with this definition of the APE (Utah SHPO Case Number 10-2019-19693).

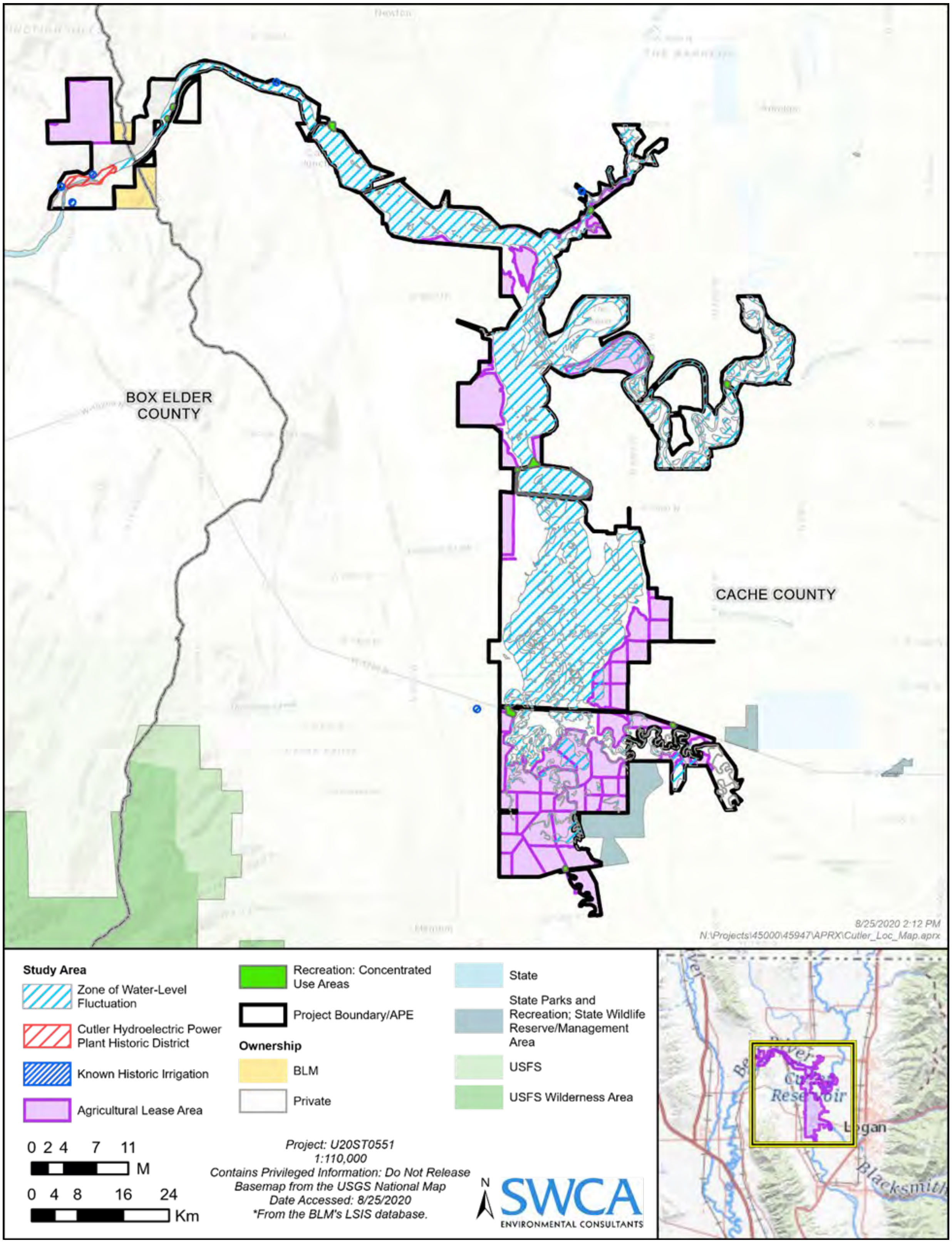
The study areas for archaeological and historic architectural studies consisted of those portions of the APE where direct effects on historic properties from proposed Project operations, proposed capital improvements, or other Project-related activity may be anticipated. These study areas are listed in Table 3-1 , and a brief rationale for each is provided below. The study area and Project Boundary are shown in Figure 3-1. Figure 1-1 does not include any upstream or downstream areas of erosional concern for the following reasons:

- Hydraulic modeling and Land Use studies (ISR Appendices G and D) have since confirmed that areas upstream of the Project Boundary are not influenced by changes in reservoir surface elevation.
- Potential for bank erosion downstream of the Project Boundary is not yet known, but will be identified in the Draft License Application (DLA).
- The entire APE will be subject to management actions, such as protection, mitigation, and enhancement (PM&E) measures, construction monitoring procedures, and discovery protocols.
- If the DLA identifies downstream areas of erosional concern, and subsequent PM&E measures such as bank stabilization are required, cultural resource requirements for those actions in the APE will be specified in the HPMP along with all other management actions.

TABLE 3-1 STUDY AREAS FOR STUDY COMPONENTS

PROJECT COMPONENT	STUDY AREA	STUDY TYPE
Project operations (fluctuating reservoir levels)	Shoreline and riverbanks within the zone of water level fluctuation	Archaeological: Intensive-level survey during the fall 2019 drawdown of portions of the reservoir shoreline and riverbanks within the zone of water level fluctuation in the Project Boundary.
	Wheelon Dam site	Historic architectural: intensive-level documentation and evaluation of dam during fall 2019 drawdown
Capital improvements	Cutler Hydroelectric Power Plant Historic District	Historic architectural: Amendment to National Register Registration Form
Recreational use: Concentrated use areas	Marinas, boat launches, and hiking trails listed in Cutler Hydroelectric Project PAD (Project PAD Table 6-22)	Archaeological: Intensive-level survey of these plus a 100-foot buffer, or a 100-foot-wide corridor for trails
Recreational use: Boating	Shoreline in North Boater Zone A[1] and Bear River Boater Zone C[2]	Covered by the intensive-level archaeological shoreline survey described above
Irrigation	Known irrigation pumps/canal intakes and undocumented segments of known canals within the Project Boundary	Archaeological: Intensive-level survey of these plus a 100-foot buffer, or a 100-foot-wide corridor for canals
Agricultural leasing	Agricultural lease areas	Archaeological and historic architectural: Reconnaissance-level survey

[1] The area north of the Benson Railroad Trail/Fishing Bridge and west of the confluence with the Bear River.
[2] The Bear River area, east of the confluence with Cutler Reservoir (including the "horseshoe area").



Source: SWCA 2010

FIGURE 3-1 CULTURAL STUDY AREA

Proposed Project operations include fluctuating reservoir levels, with a lower low-elevation limit and slightly increased tolerance range than under the current license. The study area for potential effects from proposed Project operations was the zone of proposed water-level fluctuation along the reservoir shoreline and riverbanks as well as the Wheelon Dam site, which may be altered or removed at some point as a result of future safety and/or operational requirements.

Proposed capital improvements consist of like-for-like replacement of the spillway gates and flowline supports (as needed) and installation of a new retaining wall between the flowline and the river near the base of the dam to protect the flowline from being undermined in high flow events. These improvements will occur within the District, and the study area for potential effects from these improvements is therefore the District.

Other Project-related activities with potential to affect historic properties are recreation, irrigation, and agricultural leasing.

Land-based recreation occurs within the Project Boundary at locations such as marinas, boat launches, and hiking trails, and has the potential to affect cultural resources in areas where recreational use of land is concentrated. Such areas—specifically, those recreation facilities listed in the Project PAD Table 6-22—plus an appropriate buffer constituted one study area for recreational effects.

Boating is another type of recreational activity within the Project Boundary, and this may affect cultural resources through wave action along the shoreline. This is likely only a potential effect in Cutler Reservoir boating restriction zones A and C because wakeless speeds are required year-round in zone B. The study area for the potential effects of boating was therefore the shoreline within zones A and C. This study area was subsumed by the one described above for operational water-level fluctuations.

Irrigation occurs in and around the Project Boundary associated both with PacifiCorp's Agricultural Lease Program and with fulfillment of non-Project-related irrigation water rights. Irrigation pumps and other irrigation infrastructure are present at many locations along the reservoir's edge, and many irrigation canals are present in and around the Project Boundary. The study area for potential effects on historic irrigation-related resources was the locations of known such resources plus a 100-foot buffer, or a 100-foot-wide corridor for canals.

Finally, PacifiCorp's Agricultural Lease Program has some potential to affect historic properties, and the study area for such effects consisted of leased areas.

4.0 METHODS

The methods for the cultural resource study were tailored to one or more of the different study areas and types of potential effects.

4.1 ARCHAEOLOGICAL INTENSIVE-LEVEL SURVEY

The Archaeological intensive-level survey (ILS) was conducted for the zone of proposed water-level fluctuation along the shoreline, as well as for the marinas, boat launches, and hiking trails listed in the Project PAD Table 6-22, and for known irrigation pumps or canal intakes and undocumented segments of known canals within the Project Boundary. To maximize accessibility and visibility, an archaeological ILS was conducted during the fall 2019 drawdown for areas that were exposed and reasonably accessible, including portions of the shoreline, recreational areas (marinas, boat launches, and hiking trails), and irrigation infrastructure (pumps, canal intakes, and canals) that are normally inundated by the reservoir. The reservoir shoreline, riverbanks, recreational areas, and irrigation infrastructure in the Project Boundary that were not surveyed during the 2019 drawdown were surveyed during the first study season.

The ILS area for the shoreline was defined in the study plan as the land along the shoreline between the elevations of 4,392.5 feet and 4,410.0 feet, excluding areas classified in the U. S Fish and Wildlife Service National Wetlands Inventory (USFWS NWI) (USFWS 2020) as freshwater emergent wetland (PAD 2019; PAD Figure 6-14). The elevation zone between 4,392.5 feet and 4,410.0 feet equates to the mechanical limits of the reservoir operating range plus a buffer of 2 vertical feet above and below this range. This full range was not reached during the drawdown event; therefore, only land along the shoreline that was exposed during the drawdown (4,410.0 feet to 4,404.7 feet) was surveyed. Although the full mechanical limit plus the 2 vertical feet below was not exposed and could not be surveyed, PacifiCorp's current proposed normal (elevation 4,407.5 to 4,406.5) and extended (elevation 4,406.5 to 4,405.0) operating ranges was surveyed. Proposed operations are discussed in detail in Section 1.3 of the ISR. Areas of freshwater emergent wetland were excluded from the survey due to inaccessibility and limited ground visibility due to dense vegetation cover, even during the reservoir drawdown.

It is further noted that the presence of such vegetation within freshwater emergent wetlands may alleviate any impacts to archaeological resources from fluctuating reservoir levels and wave action.

A 100-foot buffer around each recreational area and known piece of irrigation infrastructure was surveyed, with the exception of hiking trails and irrigation canals, for which a 100-foot-wide corridor centered on the trail or canal was surveyed. Some known irrigation-related features were identified in the review of existing information conducted for the PAD (PacifiCorp 2019; PAD Section 6.12.1). Prior to the survey, aerial imagery, historic topographic maps, and other accessible and applicable existing information were used to identify additional irrigation pumps, canal intakes, or canals within the Project Boundary that required survey. Any canal segments that have been adequately documented as archaeological sites within the last 10 years were excluded from the survey.

The ILS was conducted as a pedestrian archaeological survey following methods outlined in UDSH's *Archaeological Compliance Guidance* (UDSH 2019). The methods include: 1) using 15-meter survey transect intervals, re-survey any areas last surveyed 10 or more years ago, 2) use of Bureau of Land Management (BLM) archaeological site and isolated find definitions, and 3) record linear sites following Utah Professional Archaeological Council guidelines (UPAC 2008). All archaeological sites identified during the survey were recorded on UASFs. Any site that had standing architecture present also had a UASF prepared for the architectural features. No shovel probing or other forms of subsurface testing were conducted. All fieldwork and reporting were supervised by a professional archaeologist that met the Secretary of the Interior's Professional Qualifications Standards for Archaeology and held a valid Public Lands Policy Coordination Office archaeological Principal Investigator permit.

4.2 Historic Architectural Intensive-level Survey

An architectural ILS was conducted for the historic Wheelon Dam which had not previously undergone formal historic architectural documentation. The Wheelon Dam historic architectural ILS consisted of a field visit and archival research to collect information following methods outlined in UDSH's *Intensive Level Survey Standard Operating Procedures* for Section 106 undertakings (USHPO 2015a). This included collecting information necessary for completing a Utah Historic Site Form (UHSF) including a location map and sketch map; photographs and drawings of the dam; an architectural description of the dam; the history of the dam's construction and use, with a summary of historical sources consulted to obtain the construction and use information; and an evaluation of the dam's eligibility for the NRHP. Preliminary documentation for the Wheelon Dam was conducted during the fall 2019 drawdown; the dam, which was inundated by Cutler Reservoir, was exposed during the drawdown. Due to safety and access constraints of documenting the historic dam during the drawdown, a drone was used to capture high-resolution images and video footage not otherwise available. Information and records held by PacifiCorp and any other readily available primary or secondary source documents relating to the history and use of the dam was consulted to prepare a thorough history and context. Online sources were consulted for additional information about the dam (e.g., http://digitalnewspapers.org, the Library of Congress, and other relevant primary and secondary sources). All fieldwork and reporting was supervised by a professional architectural historian who met the Secretary of the Interior's Professional Qualifications Standards for Architectural History.

4.3 HISTORIC ARCHITECTURAL NATIONAL REGISTER REGISTRATION FORM AMENDMENT

An Amendment to the District's NRHP nomination form, which dates to 1989, was prepared and consisted of a field visit and archival research to collect information following the guidelines of the National Register Bulletin *How to Complete the National Register Registration Form* (rev. 1997) (NPS 1997), and the updated photography and mapping policies for the form (NPS 2013). The entire 1989 nomination form, including the Narrative Description and Statement of Significance, was updated to reflect present-day standards and requirements for NRHP nomination forms. During the field visit, the current condition and integrity of each component of the District was documented. The District and its components were photographed to meet current NRHP digital photo policies. Information was collected to create two maps for submission with the NRHP nomination form: a location map depicting the District within the context of its surrounding area, and a detail map depicting the components of the District.

Archival research involved the collation and synthesis of existing historical information from available sources, such as those described above under the historic architectural ILS study. An updated NRHP eligibility evaluation was prepared for the District, and each component of the District was evaluated to clarify whether it contributes to the District's NRHP eligibility; these evaluations follow the guidelines of the National Register Bulletin *How to Apply the National Register Criteria for Evaluation* (rev. 1997) (NPS 1990). Evaluations take into account previous recommendations as well as observations from the field visit. All changes from the previous nomination form were noted in the new nomination form. All fieldwork and reporting was supervised by a professional architectural historian who met the Secretary of the Interior's Professional Qualifications Standards for Architectural History.

4.4 ARCHAEOLOGICAL AND HISTORIC ARCHITECTURAL RECONNAISSANCE-LEVEL SURVEY

An archaeological and historic architectural reconnaissance-level survey (RLS) was conducted for agricultural lease areas. These areas have likely been substantially disturbed by past agricultural activities, and the potential for intact cultural resources within them is therefore likely lower than similar but undisturbed areas. The level of effort for study of these areas was scaled to this potential and consists of an RLS designed to identify any resources that remain intact, which are likely to be large and easily visible, such as building foundations or standing structures.

To conduct this study, professional archaeologists and architectural historians traveled through and around the Project Boundary on roads in vehicles and, where feasible, along the reservoir shoreline in boats, to look for cultural resources within agricultural lease areas. Any archaeological resources found were documented and evaluated for NRHP eligibility in the same manner as resources identified in the archaeological ILS (i.e., a UASF was prepared). Any historic architectural resources found were documented and evaluated for NRHP eligibility following methods outlined in UDSH's *Reconnaissance Level Survey Standard Operating Procedures* for Section 106 undertakings (USHPO 2015b). This included collecting information necessary for completing a Reconnaissance Survey Form and photographic documentation using high-resolution digital photography. NRHP eligibility evaluations for historic architectural resources identified in the RLS follow UDSH guidance, which consists solely of evaluating whether they meet age and integrity requirements and not historical research to assess their significance. Measures for further management of any historic architectural resources that are identified as "eligible" in this manner may be specified in the HPMP to be developed for the Project. All fieldwork and reporting was supervised by a professional archaeologist who met the Secretary of the Interior's Professional Qualifications Standards for Archaeology and held a valid Public Lands Policy Coordination Office archaeological Principal Investigator permit, and by a professional architectural historian who met the Secretary of the Interior's Professional Qualifications Standards for Architectural History.

4.5 ETHNOGRAPHIC INVENTORY

Pending tribal participation, an ethnographic inventory will be conducted in coordination with participating tribes to identify historic properties in the proposed APE that have religious and cultural significance to the tribes.

Although there are no tribal lands in or near the Project Boundary, the following tribes are associated with the larger region where the Project is located:

- Northwestern Band of Shoshone Nation
- Shoshone-Bannock Tribes
- Ute Indian Tribe
- Skull Valley Band of Goshute

The tribes listed above were asked to participate in the ethnographic inventory. If any or all of the tribes agree to participate, a qualified ethnographer will work closely with the participants to identify and appropriately document tribal resources in the proposed APE during the first study season.

5.0 RESULTS

5.1 EXISTING INFORMATION

On May 21, 2020, using the Sego system at the UDSH, SWCA Environmental Consultants (SWCA) archaeologist and geographic information system (GIS) specialist conducted an update to the file search completed for the PAD. The file search identified previous cultural resource projects and previously documented archaeological sites within 0.5 mile of the Project Boundary including the study area. Nineteen previous cultural resource surveys were within 0.5 mile of the Project Boundary (Table 5-1).

TABLE 5-1 PREVIOUS CULTURAL RESOURCES SURVEY PROJECTS WITHIN 0.5 MILE OF THE PROJECT BOUNDARY

PROJECT NUMBER	PROJECT TITLE	ORGANIZATION
U77BL00012	Cutler Dam Transmission Line	BLM
U84BL0536	Cutler Reservoir Disposal	BLM
U86BC0464	Cutler Reservoir Retention and Access	BYU - Office of Public Archaeology
U86SJ0745	Bridge Replacement Benson Utah	Sagebrush Archaeological Consultants
U90SJ0397	Bridge Replacement on SR-30	Sagebrush Archaeological Consultants
U95UC0235	DWR Land Exchange	UDSH-Antiquities
U10ST0695	Syringa Fiber Optic Riverside to Logan	SWCA
U11ST0607	N/A	N/A
U13HY0881	A CRA For The Wellsville Mendon Conservation District Lining And Piping Project Cache County Utah	Certus Environmental Solutions LLC
U13ZP0596	An Archaeological Resources Inventory for the Logan Wastewater Treatment Facility Project	Project Engineering Consultants LTD
U14HY0787	PacifiCorp Cutler East Canal Culvert	Certus Environmental Solutions LLC
U16HK0765	Archaeological Survey of the SR-30; SR-23 to SR-252 Project Near Logan, Cache County, Utah	HDR, Inc.
U16SH1161	Cultural Resources Inventory of NRCS Utah Project No. 748D43160SY, Cache County, Utah	NRCS Utah
U16SH1178	Cultural Resources Inventory of NRCS Utah Project No. 748D43160JW, Cache County, Utah	NRCS Utah
U16SH1186	Cultural Resources Inventory of NRCS Utah Project No. 748D431600T, Cache County, Utah	NRCS Utah
U16SH1196	Cultural Resources Inventory of NCRS Utah Project No. 748D431506J, Cache County, Utah	NRCS Utah
U16SH1197	Cultural Resources Inventory of NCRS Utah Project No. 748D43150WM, Cache County, Utah	NRCS Utah
U16SH1202	Cultural Resources Inventory of NRCS Utah Project No. 748D431501W, Cache County Utah	NRCS Utah
U19HO0107	A Cultural Resource Inventory of the Newton Lateral Piping Project, Cache County, Utah	Bighorn Archaeological Consultants

Source SWCA 2010

Note: Project titles, report titles, and contractor names appear as listed by the UDSH's Sego system and have not been edited. DWR = Division of Wildlife Resources, CRA = Cultural Resources Assessment, BYU = Brigham Young University, NRCS = Natural Resources Conservation Service
N/A = No information available in Sego.

Previous surveys resulted in the discovery and recordation of six historic sites and one unknown (missing site form) site (Table 5-2). Three of those sites are located within or adjacent to (within 200 feet of) the Project Boundary; all three are historic. The Utah Department of Heritage and Arts' (UDAM) scanned document database was searched and a request was made to the Utah SHPO, but no site form could be located for 42CA765 (Table 6.2). However, a site form for 42CA178 includes maps indicating that it covers the same area labeled as 42CA765 in Sego.

TABLE 5-2 PREVIOUSLY DOCUMENTED SITES WITHIN 0.5 MILE OF THE PROJECT BOUNDARY

SITE NUMBER	SITE CLASS	SITE TYPE	SITE NAME	NATIONAL REGISTER OF HISTORIC PLACES ELIGIBILITY
42BO1507*	Historic	Canal	Hammond East Branch Canal	Eligible
42CA174	Historic	Canal	Wellsville-Mendon Lower Canal	Eligible
42CA178	Historic	Canal	Cow Pasture Canal	Not eligible
42CA185	Historic	Farmstead	Kidman Farmstead	Eligible
42CA195*	Historic	Canal	Newton Branch of the West Cache Canal	Eligible
42CA211*	Historic	Ditch	–	Not eligible
42CA765†	N/A	N/A	N/A	N/A

Source: SWCA 2010
Note: N/A = No information available in SEGO.
* Previously recorded site or segment is located within or adjacent to the Project Boundary.
† No site form available; appears to be a segment of 42CA178 located in the Project Boundary.

In addition to these measures, SWCA conducted supplemental research, consulting the Utah Division of Water Rights Canals dataset (Utah Division of Water Rights 2020) to identify canals within or adjacent to the Project Boundary that had not previously been recorded as archaeological sites or historic architectural resources but were likely historic (Table 5-3). In addition to the Hammond East Branch and Wellsville-Mendon Lower Canals discussed above, the West, North Benson, West Benson, and Benson-Bear Lake Canals are all located within or adjacent to the Project Boundary.

TABLE 5-3 CANALS IN THE UTAH DIVISION OF WATER RIGHTS CANALS DATASET LOCATED WITHIN 0.5 MILE OF THE PROJECT BOUNDARY

CANAL NAME	NOTES
West Main Canal (West Canal)*	Begins at Cutler Dam; runs downstream on the north side of the river. Partially recorded within the study area as 42BO1182.
Hammond Main Canal (Hammond East Bench Canal, East Canal)*	Begins at Cutler Dam; runs downstream on the south side of the river. Partially recorded within the study area as 42BO1507.
West Cache Newton Branch Canal	New segment recorded within the study area as 42CA195.
King Irrigation Canal	–
North Benson Canal*	Segment recorded within the study area as 42CA143.
West Benson Canal*	Segment is not in the study area and was not recorded.
Benson Bear Lake Canal*	Segment is not in the study area and was not recorded.
Wellsville Mendon Lower Canal*	Segment recorded within the study area as 42CA174.
Logan River BSF Main Canal	–

Source: SWCA 2010

Note: Canal names appear as listed in the Utah Division of Water Rights Canals dataset and have not been edited.

* Canal falls within or adjacent to the Project Boundary.

GIS layers and General Land Office (GLO) plat maps were examined for possible cultural resources. The GIS layers, available from state and federal agencies, included properties eligible for or listed on the NRHP, Utah historic trails, Utah historic districts, historical topographic maps, and other historical aerial imagery. Multiple buildings, a house, Cutler Dam and associated facilities, two railroad lines, five irrigation canals and ditches, and multiple named and unnamed roads were identified on GLO and U. S. Geological Survey (USGS) historical topographic maps of the study area (Table 6.4). Several small local roads and buildings visible on maps could not be re-located during the survey, but previously recorded segments of the Hammond East Branch Canal (42BO1507) and an unnamed ditch (42CA211) were revisited, and previously unrecorded segments of the West Canal (42BO1182), the Wellsville-Mendon Lower Canal (42CA174), the Cow Pasture Canal (42CA178) were newly recorded, along with a number of roads and railroad segments that were not previously recorded (Table 5-4).

TABLE 5-4 FEATURES IDENTIFIED ON GENERAL LAND OFFICE PLAT MAPS, HISTORICAL TOPOGRAPHIC MAPS, AND OTHER HISTORICAL DATA SOURCES IN THE PROJECT BOUNDARY

MAP LOCATION/NAME	AUTHOR	YEAR	MAP TYPE	RESOURCE TYPE IN STUDY AREA	RECORDED AS
Township (T) 13 North (N), Range (R) 1 West (W)	Stewart	1877a	GLO	Road from Newton to Logan	42CA236
				House	–
				Unnamed roads	–
T13N, R2W	Stewart	1877b	GLO	Newton Road	–
Logan	USGS	1916	1:125,000 series	Oregon Short Line Railroad	42CA235
				Oregon Short Line Railroad spur	42CA231
				Road	42CA236
				Road	42CA232
				Road	42CA230
				Road	42CA229
				Multiple buildings	–
				Unnamed roads	–
Wellsville	USGS	1962	1:24,000 Series	State Route (SR) 30	42CA230
				Canal	42CA178
				Canal	42CA174
				Road	42CA229
				Unnamed roads	–
Cutler Dam	USGS	1964a	1:24,000 Series	Hammond Main Canal	42BO1507
				West Side Canal	42BO1182
				SR 23	42CA233
				Union Pacific Railroad (UPRR)	42CA235
				Cutler Dam, powerhouse, substation, and buildings	In architecture report
				Ditch	42CA211
Newton	USGS	1964b	1:24,000 Series	UPRR	42CA235
				Old railroad grade	42CA231
				Road	42CA236
				Canal	42CA237
				Road	42CA232
				Unnamed roads	–
Ogden	USGS	1964c	1:250,000 Series	UPRR	42CA235
				Dismantled railroad	42CA231
				Road	42CA236
				Road	42CA232
				SR 69	42CA230
				Road	42CA229

Note: – = Resource was not relocated during the survey.

In addition, anecdotal information was gathered on a possible Pony Express stop and prehistoric river bluff sites. These locations for potential cultural resources were identified by PacifiCorp's license manager, Eve Davies (personal communication, July 2020), based on local resident knowledge that was passed on to her. The site noted as possibly associated with the Pony Express was recorded as 42CA234, but historical research indicates it is not a site related to the Pony Express. The potential prehistoric river bluff sites were not observed during the survey.

5.2 ARCHAEOLOGICAL RESOURCES

SWCA conducted an archaeological ILS of the Cutler Reservoir drawdown area shorelines (i.e., the zone of water level fluctuation), as well as recreation boating zones, during the reservoir drawdown conducted in October and November of 2019 to support preliminary relicensing studies. In June and July of 2020, SWCA archaeologists conducted a survey of the remaining study area components (i.e., an archaeological ILS of recreational concentrated use areas and irrigation infrastructure, and an archaeological RLS of agricultural lease areas). During the 2019 reservoir drawdown survey, efforts were made to conduct surveys of any areas with visibility constraints or areas that could not be safely accessed by pedestrians; for example, mud or water inundation areas that could not support a pedestrian survey were mechanically surveyed from a boat or Marsh Master (tracked vehicle) and isolated areas were mechanically surveyed with high-resolution drone imagery. In areas of dense vegetation archaeologists focused on areas of erosion, cut banks, and vegetation-free areas with higher surface visibility.

Twenty-one archaeological sites and seven isolated cultural resources were identified during the archaeological surveys. A full archaeological report meeting UDSH guidelines and format, including general cultural context, location maps for resources identified during survey, and the UASFs for the 21 sites, is provided in Attachment J-1.

5.2.1 ISOLATED OCCURRENCES AND ISOLATED FEATURES

The archaeological survey resulted in the identification of two Isolated Occurrences (IOs) and five Isolated Features (IFs) (Table 5-5). All of the isolated cultural resources date to the general historic period. IOs consist of aqua glass and a boat, and IFs consist of transportation-related resources such as a road, a bridge, and a culvert as well as a generator station, a cluster of cars, a historic structure, and a berm.

TABLE 5-5 ISOLATED OCCURRENCES IDENTIFIED IN THE STUDY AREA

IO Number	Field Number	Isolate Type	Isolate Description	UTM Coordinates
IO-01	DS-IO-01	Historic artifact	The isolate is a single broken aqua glass insulator with no maker's mark. The isolate is located below the normal water level in Cutler Reservoir.	4633695 mN 415587 mE
IO-02	DS-IO-02	Historic artifact	The isolate is a badly corroded triangular boat with a wood frame and iron hull. The hull was originally held to the wood frame by 3-inch rivets, but they have separated from the hull due to corrosion and rotting wood. The boat measures 141-inches-long by 56-inches-wide. The height of the boat is unknown as it is almost completely buried in sediment. The isolate is located on a bar in the Bear River below the normal water level in Cutler Reservoir and is presumed to date to the historic period.	4631659 mN 418224 mE
IF-01	HW-IF-01	Historic road	The isolate consists of a northeast-southwest-trending two-track road in the Cutler Hydroelectric Power Plant Historic District. The isolate runs from the Cutler power plant to the Wheelon substation, and it measures 1,053-feet-long and 13-feet-wide. It does not appear on any available historic maps and its age is unknown, but it is presumed to date to the historic period based on the age of the Cutler power plant.	4631838 mN 421373 mE
IF-02	KM-IF-01	Historic car cluster	The isolate consists of cluster of three cars in various stages of structural decay surrounded by various tires. One is a Ford and the other two models are unknown. The isolate is located on the west bank of Cutler Reservoir. The cars are located below the normal water level in Cutler Reservoir and appear to have been dumped into the reservoir; they are not held in place on the shore as an erosion control feature. The cars themselves were produced during the Historic period, but the date when they were deposited in the river is unknown.	417337 mE 4631812 mN
IF-03	RJ-IF-01	Historic culvert	The isolate is a culvert that runs between two of the braided channels of the Bear River approximately 0.5 mile north of Benson School in Benson, Utah. The culvert consists of two corrugated metal pipes that are 2-1/2-feet in diameter. The south side of the culvert has a square face. The north side of the culvert is exposed culvert metal of unknown thickness. The culvert is buried with no concrete casing. There are no associated artifacts and the culvert does not appear on any available historical maps. The isolate's age is unknown, but it is presumed to date to the historic period.	4628258 mN 424976 mE

IO Number	Field Number	Isolate Type	Isolate Description	UTM Coordinates
IF-04	RJ-IF-02	Historic structure	The isolate is a wooden structure with an unknown function. The structure has milled wooden lumber collapsed around the base, with two standing log posts that are 6-inches in diameter. One log is approximately 8-feet-tall, and the other is approximately 6-feet-tall. The posts are held together with two milled lumber crossbeams attached with machine-cut nails and square lag bolts that are approximately 1-foot-long. A third post is leaning against one of the crossbars. The nails are rusted, but new nails also exist. A colorless glass bottle base fragment with liquor codes but no maker's mark is located near the feature, but as the bottle cannot be dated, it is unclear whether it is of historic age or modern. The age of the feature is also unknown but, based on its partial collapse, it is presumed to date to the historic period. This was recorded as an isolate as no definitive age of the structure or the bottle base fragment could be discerned.	4628975 mN 420742 mE
IF-05	RJ-IF-03	Historic berm	The isolate is a segment of berm with twin ditches on either side, transecting a high floodplain area just south of the confluence of the Logan River and the Little Bear River. The berm is 7-feet-wide while the entire feature, including ditches, is 13-feet-wide. The height varies but is roughly 1-1/2 feet. The berm may connect to an access road to the east and appears to continue west and south beyond this documented segment, dividing the Little Bear River floodplain from the Logan River floodplain. The berm follows the high ground along the south bank of the Logan River, and as it travels east, the depressions become deeper, with the northern ditch widening to 8 feet and the southern ditch widening to 9 feet. The northern ditch is deeper than the southern ditch. There is a concrete culvert with a corrugated metal lining located near the midpoint of the feature. The isolate does not appear on any available historic maps, its age is unknown, and it does not appear to be associated with a larger system of water control in the area.	4621465 mN 412367 mE

5.2.2 ARCHAEOLOGICAL SITES

Seven archaeological sites were revisited and/or updated with a newly recorded segment, and 14 new sites were recorded (Table 6.2.2.1). Three of the newly recorded sites—42CA225 (Wheelon Dam), 42CA228 (Wheelon hydroelectric facilities), and 42CA227 (Wheelon power poles)—are also recorded as a non-contiguous historic district for architectural resources of the District (Section 5.3). NRHP eligibility evaluations criterion/a, and relevant study area components are also summarized in Table 5-6.

TABLE 5-6 ARCHAEOLOGICAL SITES IDENTIFIED IN THE STUDY AREA (NEW AND PREVIOUS)

SITE NUMBER	SITE TYPE	SITE DESCRIPTION	ELIGIBILITY EVALUATION, CRITERION/A	RELEVANT STUDY AREA COMPONENT
42BO1182	Historic	West Canal	Eligible, A and C	Irrigation
42BO1507	Historic	Hammond East Branch Canal	Eligible, A and C	Irrigation
42CA143	Historic	Benson Canal	Eligible, A and C; non-contributing element	Irrigation
42CA174	Historic	Wellsville-Mendon Lower Canal	Eligible, A	Irrigation and Agricultural Lease Areas
42CA178	Historic	Cow Pasture Canal	Not eligible	Irrigation and Agricultural Lease Areas
42CA195	Historic	Newton Branch, West Cache Canal	Not eligible	Irrigation
42CA211	Historic	Ditch	Not eligible	Irrigation
42CA224†	Historic	Erosion Control	Not eligible	Irrigation
42CA225†	Historic	Wheelon Dam	Eligible, A and C	Project Operations
42CA226†	Historic	Water Control	Not eligible	Irrigation
42CA227†	Historic	Wheelon Power Poles	Not eligible	Capital Improvements
42CA228†	Historic	Wheelon Hydroelectric Facilities	Eligible, A	Capital Improvements
42CA229†	Historic	Mendon Road	Eligible, A	Recreation: Concentrated Use
42CA230†	Historic	SR 30/SR 69	Eligible, A	Recreation: Concentrated Use
42CA231†	Historic	Benson Branch of Oregon Short Line Railroad	Not eligible	Recreation: Concentrated Use
42CA232†	Historic	Black Rock Road	Not eligible	Recreation: Concentrated Use
42CA233†	Historic	SR 23	Not eligible	Recreation: Concentrated Use

SITE NUMBER	SITE TYPE	SITE DESCRIPTION	ELIGIBILITY EVALUATION, CRITERION/A	RELEVANT STUDY AREA COMPONENT
42CA234†	Historic	Foundation and Spring	Not eligible	Agricultural Lease Areas
42CA235†	Historic	Pocatello Mainline, Oregon Short Line Railroad	Eligible, A	N/A*
42CA236†	Historic	Newton to Logan Road	Not eligible	Recreation: Concentrated Use
42CA237†	Historic	Benson-Bear Lake Canal	Not eligible	Irrigation

*Site does not intersect with a Study Area component, but is adjacent to the Project Boundary, and updated site documentation was conducted per UDSH's Archaeological Compliance Guidance (UDSH 2019)

† Site was newly recorded for the Project

5.3 HISTORIC ARCHITECTURE RESOURCES

Fieldwork for the historic architectural survey (i.e., RLS of agricultural lease areas, ILS documentation of the Wheelon Hydroelectric Complex, and amendment to District's National Register Registration Form) was conducted June 29–July 1, 2020, and July 31, 2020. The results of the survey are summarized in this section. A full RLS report, ILS form for the Wheelon Hydroelectric Complex, and an amended National Register registration form for the District are provided in Attachment J-2. All meet UDSH guidelines and format standards, including general cultural context, and location maps for resources identified during survey.

5.3.1 INTENSIVE LEVEL SURVEY: WHEELON HYDROELECTRIC COMPLEX

The Wheelon Hydroelectric Complex encompasses a significant area around what is now the District. It includes Wheelon Dam, the West and Hammond Canals north of the Cutler Dam, the historic Wheelon substation, a bridge over the Bear River, and the remains of the Wheelon generating plant, including storage buildings, housing, and livestock shelters. Wheelon Dam and the historic northeast portions of the West and Hammond Canals are typically submerged beneath Cutler Reservoir. The Wheelon Hydroelectric Complex is recommended as eligible for the NRHP.

5.3.2 NATIONAL REGISTER REGISTRATION FORM AMENDMENT: CUTLER HYDROELECTRIC POWER PLANT HISTORIC DISTRICT

The historic resources of the District (amended) represent an intact hydroelectric station dating to 1927. The amended District includes 17 contributing resources. Despite minor changes to some of the resources and the District boundary, the District as a whole remains intact, with buildings, structures, and, in some cases, equipment, remaining functionally unchanged since the plant began operation almost a century before.

The District (amended) is significant at the state level under Criterion A for its association with events that have made a significant contribution to the broad patterns of Utah's history in relation to the themes of industry and engineering and under Criterion C in relation to the theme of architecture for the way in which 1) it embodies the distinctive characteristics of a hydroelectric facility established by Utah Power and Light (UP&L), a predecessor company to PacifiCorp, during the early Twentieth Century, and 2) as a significant and distinguishable entity whose components may lack individual distinction—namely, a historic district. Its period of significance is 1925 to 1927.

5.3.3 RECONNAISSANCE-LEVEL SURVEY

For the RLS, properties were documented using SWCA field forms that are designed to include the information contained in the SHPO RLS form (UDSH 2020). SWCA documented all parcels with historic-age architectural resources that were identified using a desktop analysis of aerial imagery; a literature review was also conducted for the survey area but no previous architectural surveys or recorded resources were noted. SWCA drove all major and secondary roads in the survey area to locate and document any additional resources that, based on SWCA's professional opinion, were of historic age based on architectural type, style, and materials. To aid in the identification of historic-age properties, SWCA observed the survey area from points outside the survey area that provided good visibility of the areas inside. SWCA documented any resources of historic age visible from the public right-of-way.

In accordance with UDSH guidelines, documentation consisted of examining and photographing the exteriors of the resources on each property, noting the architectural type and style of each resource and additions and alterations that would affect historic integrity and therefore the eligibility of resources and property for the NRHP. Construction dates for each resource and any additions or alterations were based on literature review results, when available; more often, they were based on SWCA's professional opinion, derived from an observation of building type, style, material, and construction method.

In all, seven parcels with historic-age architectural resources were documented within the agricultural lease areas (Table 5-7). The entirety of each parcel intersects or is immediately adjacent to the agricultural lease areas and FERC Project Boundary, but none of the architectural resources are located within the agricultural lease areas or FERC Project Boundary. The parcel was included in the results because the whole parcel is evaluated and not just the architectural resources in the parcel. Of these seven parcels, none were previously recorded. The current parcel number, UDSH rating, relevant NRHP eligibility criterion/a, construction date, period, and primary use are listed in Table 5-7.

TABLE 5-7 SUMMARY OF ARCHITECTURAL RESOURCES OF HISTORIC AGE IN AGRICULTURAL LEASE AREAS

CURRENT PARCEL NUMBER	STREET ADDRESS	UTAH DIVISION OF STATE HISTORY RATING	NATIONAL REGISTER OF HISTORIC PLACES ELIGIBILITY (CRITERION/A)	CONSTRUCTION DATE	PERIOD	PRIMARY USE
11-005-0009	4301 West 600 South, Young Ward	Eligible/Contributing (EC)	Eligible (Criterion A)	1930	Great Depression Period (1929−1940)	Agricultural (general)
11-007-0012	?5400 West 600 South, Wellsville	Non-contributing (NC)	Not eligible	Ca. 1950	Postwar Period (1945−present)	Agricultural (animal facility)
12-004-0004	?5600 West 4000 North, Peter	NC	Not eligible	Ca. 1900	Industry and Growth Period (1890−1929)	Residential
12-003-0005	?2899 North 4100 West, Benson	NC	Not eligible	Ca. 1900	Industry and Growth Period (1890−1929)	Agricultural (general)
12-027-0009	?1500 North 3200 West, Benson	NC	Not eligible	Ca. 1950	Postwar Period (1945−present)	Agricultural (animal facility)
12-027-0006	?1841 North 3200 West, Benson	NC	Not eligible	Ca. 1950	Postwar Period (1945−present)	Agricultural (animal facility)
15-053-0010	5152 North 4800 West, Smithfield	NC	Not eligible	Ca. 1950 (1981)*	Postwar Period (1945−present)	Residential

* The main building dates to 1981 but the historic age resources are likely ca. 1950.

One of the seven parcels with resources of historic age in the survey area is recommended as eligible/contributing (EC) while the remaining parcels are recommended as non-contributing (NC) (Table 5-8). Two parcels (29 percent) date to the Industry and Growth Period (1890−1929); one (14 percent) dates to the Great Depression Period (1929−1940) and four (57 percent) date to the Postwar Period (1945−present).[1]

Of the two parcels dating to 1890−1929, the primary use for one was residential; the other parcel's primary use was agricultural (general). The residential parcel is a single residence, a single cell-type log cabin in the Early Twentieth Century: other style. The agricultural parcel

[1] One parcel, Parcel #15-053-0010, had a primary building dating to 1981 and two outbuildings dating to ca. 1950. It has therefore been included in the Postwar Period (1945−present).

contains a miscellaneous-type shed building in other/unclear style. The agricultural parcel also contains a storage building/loafing shed and a silo (Table 5-8 and

Table 5-9).

TABLE 5-8 CLASSIFICATION OF PARCELS BY TYPE, 1890−1929, IN AGRICULTURAL LEASE AREAS

TYPE	NUMBER	PERCENT OF PROPERTIES*
Single cell	1	50
Shed - Miscellaneous	1	50

* Percent rounded to nearest whole number.

TABLE 5-9 CLASSIFICATION OF PROPERTIES BY STYLE, 1890–1929, IN AGRICULTURAL LEASE AREAS

STYLE	NUMBER	PERCENT OF PROPERTIES*
Other/Unclear style	1	50
Early Twentieth Century: Other	1	50

* Percent rounded to nearest whole number.

The parcel dated to 1929−1940 was primarily used for agricultural (general), with a single-family residential as a secondary use. The main building is a residence in the box bungalow style. The parcel contains multiple other historic-age buildings and structures, including a large barn (barn [other]-type), a double cell-type log building, and two silos; it also contains four non-historic buildings and structures.

All of the parcels dating from 1945 to the present were used for agriculture (animal facilities). Typologically, the parcels are a single residence, a corral, a loafing shed, and a shed (miscellaneous). The single residence was in the Late Twentieth Century: other style. Two of the other parcels were of other/unclear style and one had no specific style (Table 5-10 and Table 5-11).

TABLE 5-10 CLASSIFICATION OF PARCELS BY TYPE, 1945–PRESENT, IN AGRICULTURAL LEASE AREAS

TYPE	NUMBER	PERCENT OF PROPERTIES*
Ranch with Garage	1	25
Loafing Shed	1	25
Corral	1	25
Shed (Miscellaneous)	1	25

* Percent rounded to nearest whole number.

TABLE 5-11 CLASSIFICATION OF SINGLE RESIDENCES BY STYLE, 1945–PRESENT, IN THE AGRICULTURAL LEASE AREAS

STYLE	NUMBER	PERCENT OF PROPERTIES*
Late Twentieth Century (Other)	1	25
Other/Unclear style	2	50
Not applicable	1	25

* Percent rounded to nearest whole number.

5.4 ETHNOGRAPHIC INVENTORY

Consulting party letters of invitation and follow-up phone calls and emails were sent to the following tribes:

- Shoshone-Bannock Tribe
- Northwestern Band of Shoshone Nation
- Skull Valley Band of Goshute Indians
- Ute Tribe

The tribes were invited to participate in an ethnographic inventory. As of February 4, 2021, none of the tribes have responded to letters, phone calls, or emails. The study plan states that if any of the tribes agree to participate, a qualified ethnographer will work closely with the participants to identify and appropriately document tribal resources in the proposed APE during the first study season. Because no tribes have responded to PacifiCorp’s request to participate during the first study season, an ethnographic inventory will not be conducted for the study. However, coordination with tribes will continue for purposes of Section 106 consultation.

6.0 SUMMARY

This cultural resource study was conducted as specified in the FERC Study Plan Determination, and no modifications to the study methods or approach have been proposed. The study has achieved the study plan goals and objectives to more completely identify cultural resources that are potentially subject to effects from Project operations under the renewed license, and to better understand the nature of resources to inform management actions to be outlined in the HPMP. There are no remaining cultural resource data gaps and the results are sufficient to conduct impact and effect analysis for the DLA. The results of the study are sufficient to facilitate FERC's and PacifiCorp's consultation obligations under Section 106 regarding the identification of historic properties and the assessment and resolution of adverse effects. For these reasons, no future studies are proposed.

7.0 REFERENCES

Federal Energy Regulatory Commission (FERC). 2008. Preparing Environmental Documents: Guidelines for Applicants, Contractors, and Staff. Federal Energy Regulatory Commission, Office of Energy Projects, Division of Hydropower Licensing. September 2008. Page A-9. Available online.

National Park Service (NPS). 2013. https://www.nps.gov/nr/publications/bulletins/photopolicy/Photo_Policy_update_2013_05_15.pdf

National Park Service (NPS). 1997. https://www.nps.gov/nr/publications/bulletins/nrb16a/

National Park Service (NPS). 1990. https://www.nps.gov/nr/publications/bulletins/nrb15/ PacifiCorp. 2020.

PacifiCorp. 2018. Cutler Hydroelectric Project FERC Project No. 2420. Maps created in 2018.

PacifiCorp. 2019. Cutler Hydroelectric Project FERC Project No. 2420 Pre-Application Document Volume I – Main Document. March 2019.

PacifiCorp. 2020. Cutler Hydroelectric Project FERC Project No. 2420. Revised Technical Study Plans. January 2020.

SWCA Environmental Consultants (SWCA). 2020. Cutler Hydroelectric Project, FERC No. 2420, Revised Technical Study Plans, Volume III. Prepared for PacifiCorp.

U.S. Fish and Wildlife Service (USFWS). 2020. National Wetlands Inventory. Available at: https://www.fws.gov/wetlands/.

Utah Division of State History (UDSH). 2020. Reconnaissance Level Survey: Guidelines for Archaeological Resources. Available at: https://history.utah.gov/wp-content/uploads/2020/08/PRES_RLS-Guidelines-2020.pdf. Accessed August 19, 2020.

Utah Division of State History (UDSH). 2019. *Archaeological Compliance Guide: Utah State Historic Preservation Office & Antiquities Section*. Available at: https://history.utah.gov/wp-content/uploads/2019/07/ARCH_UTSHPO-Archaeological-Guidance_July2019.pdf. Accessed August 19, 2020.

Utah Division of Water Rights. 2020. Canal Safety program and Canal Inventory. Available at: https://waterrights.utah.gov/canalinfo/default.asp.

Utah Professional Archaeological Council (UPAC). 2008. *Linear Sites: Guidance for Identifying and Recording under Section 106 of the National Historic Preservation Act.* Available at: https://3b62362a-29dd-453d-92fa-19f5f23b1943.filesusr.com/ugd/82f96c_c901a7a7da6d4242ad7083a2392dc393.pdf. Accessed August 19, 2020.

Utah State Historic Preservation Office (USHPO). 2015a. Intensive Level Survey Standard Operating Procedures (For Section 106 Purposes Only). Revised March 2015. Document on file, Utah Division of State History.

Utah State Historic Preservation Office (USHPO). 2015b. Utah State Historic Preservation Office (2015). Reconnaissance Level Survey Standard Operating Procedures (For Section 106 Purposes Only). Revised March 2015. Document on file, Utah Division of State History.

FILE UNDER SEPARATE COVER IN VOLUME II

PRIVILEGED

ATTACHMENT J-1

ARCHAEOLOGY REPORT

FILE UNDER SEPARATE COVER IN VOLUME II

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ATTACHMENT J-2

ARCHITECTURE REPORT