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Electronically filed August 17, 2021

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
825 First Street, N.E.
Washington, D.C. 20426

Subject: Cutler Hydroelectric Project (FERC Project No. 2420)
Filing of the Updated Study Report and
Notice of Intent to File Draft License Application

Dear Secretary Bose:

Pursuant to 18 CFR §5.15(f), PacifiCorp is filing this Updated Study Report (USR) package with the Federal Energy Regulatory Commission (FERC). Additionally, pursuant to 18 CFR §5.16(c), PacifiCorp has elected to file a Draft License Application (DLA); this letter is PacifiCorp's notice of intent to file a DLA as required by 18 CFR §5.15(f).

The Cutler Hydroelectric Project (Project) is located on the Bear River, in Box Elder and Cache counties, Utah. The current license is set to expire on March 31, 2024. PacifiCorp filed a Pre-Application Document (PAD) and Notice of Intent (NOI) to seek a new license for the Project on March 29, 2019. PacifiCorp subsequently hosted public meetings, workshops, and the FERC's scoping meeting and a site visit, to which adjoiners, members of the public, federal and state agencies, non-government organizations, and Native American tribes and tribal organizations were invited. PacifiCorp began some preliminary studies in November 2019.

In February 2020, the FERC issued its final Study Plan Determination (SPD), and PacifiCorp began the first year of studies. PacifiCorp has now completed all nine resource studies. Seven of the nine studies were completed in 2020. At the time of PacifiCorp's Initial Study Report (ISR) filing on February 8, 2021, two studies, *Shoreline Habitat Characterization* and *Land Use*, were still in progress. Both studies are now completed. This USR contains ISR Supplemental Information (Appendix A), a report on the *Shoreline Habitat Characterization* study (Appendix B), and a report on the *Land Use* study (Appendix C).

On April 9, 2021, the United States Fish and Wildlife Service (USFWS) submitted written comments via the FERC e-filing system, primarily regarding potential sediment accumulation and deposition resulting from the proposed change in Project operation. Comment letters were also received from the Utah Rivers Council and the Bridgerland Audubon Society. On May 5, 2021, PacifiCorp filed a response to comments received on the ISR. Some additional information was developed in response to the ISR comments. PacifiCorp's responses intended to clarify aspects of the ISR Sedimentation Study (primarily, although the supplemental information also addresses several other concerns detailed in the three comment letters), and are included in Appendix A as Attachments A-1 through A-6. Following additional discussion between the USFWS and PacifiCorp staff, and submittal of PacifiCorp's responses and supplemental information, the

USFWS filed an additional clarifying letter with the FERC regarding their initial ISR comment response.

Attachment A-1	Aerial Photos Representative of Cutler Reservoir Inundation Boundaries at Elevations Lower Than the Lowest Limit of Extended Range Operations
Attachment A-2	Total Suspended Solids Charts
Attachment A-3	Map of Water Quality Sampling Locations
Attachment A-4	Photos of Cutler Reservoir Bed and Banks During the Fall 2019 Maximum Drawdown Conditions
Attachment A-5	Velocity Maps
Attachment A-6	Calibrated Cross Section Map

Following the submittal of this USR, including the supplemental information listed above and the two now-completed study reports, PacifiCorp has scheduled a USR stakeholder meeting for August 31, 2021; currently we are planning to conduct the meeting in-person. Due to the ongoing global pandemic caused by Coronavirus Disease (COVID-19), PacifiCorp will be following the Center for Disease Control's COVID-19 protocols, as well as taking additional hygiene measures, for in-person meetings. The meeting notification and agenda for the USR meeting were distributed to stakeholders via email on August 3, 2021. PacifiCorp will also provide updates on the FERC relicensing process and schedule, review the process moving towards filing of the DLA, and brainstorm future potential protection, mitigation, and enhancement measures with stakeholders. Supporting materials will be available on the PacifiCorp public relicensing website prior to the meeting. Pursuant to 18 CFR §5.15(c)(2)-(7), within 15 days of the USR meeting, PacifiCorp will file a meeting summary. Within 30 days stakeholders may file any comments or disagreements concerning the USR meeting summary, or request modifications to ongoing studies, as well as request additional information gathering. Such requests to modify existing studies or to complete additional information gathering are subject to the criteria set forth in 18 CFR §5.15(d) and §5.15(e). Following the comment period for the USR, PacifiCorp intends to file the DLA with the Commission in early November 2021.

This USR is being submitted in accordance with FERC's ILP regulations and describes PacifiCorp's overall progress in implementing the FERC-approved Revised Study Plan and SPD, and an explanation of variances from the SPD (if warranted).

The letter has been filed electronically. The security classification for each component in this packet is shown in the Enclosure list below. If you have any questions concerning these documents, please contact Eve Davies at 801-220-2245.

Sincerely,

Mark Sturtevant
Mark Sturtevant (Aug 11, 2021 11:03 PDT)

Mark Sturtevant
Vice President, Renewable Resources

ed:bb

Encl:	Appendix A – ISR Supplemental Information	Public
	Appendix B – Shoreline Habitat Characterization Study USR	Public
	Appendix C – Land Use Study USR	Public

eFile:	Kimberly D. Bose, Secretary via eLibrary at www.ferc.gov
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APPENDIX A

ISR SUPPLEMENTAL INFORMATION

ATTACHMENT A-1

AERIAL PHOTOS REPRESENTATIVE OF CUTLER RESERVOIR INUNDATION BOUNDARIES AT ELEVATIONS LOWER THAN THE LOWEST LIMIT OF EXTENDED RANGE OPERATIONS

The fall 2019 full drawdown lowered Cutler Reservoir well below the lower limit of the proposed Project extended operations; that is, the full drawdown lowered the reservoir almost 20 feet below the lowest limit of the proposed extended operating range, water surface elevation (WSE) 4,405.0 as measured at Cutler Dam (NGVD29 projection). Full pool at Cutler is approximately 4,407.5 WSE at Cutler Dam. As the full 2019 drawdown began, Cutler Dam elevation on October 28 was 4,404.58 feet, approximately 0.4 foot lower than the proposed minimum limit of 4,405.0 feet in the extended range. Therefore, the October 28 field observations represent the most similar conditions to the proposed minimum reservoir elevation, albeit 0.4 foot lower. Recreation site observations on October 28 were used because the Cutler Dam reservoir elevations on those dates are the most applicable to assess conditions regarding areas of potential reservoir desiccation under future proposed Project operations.

Photo 1. Cutler Marsh Marina Recreation Site (located in the South Marsh Management Unit) on October 28, 2019, Cutler Dam WSE 4,404.58, 0.4 foot below the lower limit of the proposed extended operation range.

Photo 2. Benson Marina Recreation Site (located in the Reservoir Management Unit) on October 28, 2019, Cutler Dam WSE 4,404.58, 0.4 foot below the lower limit of the proposed extended operation range.

Photo 3. Clay Slough Recreation Site (also located in the Reservoir Management Unit) on October 28, 2019, Cutler Dam WSE 4,404.58, 0.4 foot below the lower limit of the proposed extended operation range.

Photo 4. Cutler Canyon Recreation Site (located at the boundary of the Reservoir and Canyon Management Units) on October 28, 2019, Cutler Dam WSE 4,404.58, 0.4 foot below the lower limit of the proposed extended operation range.

ATTACHMENT A-2

TOTAL SUSPENDED SOLIDS CHARTS

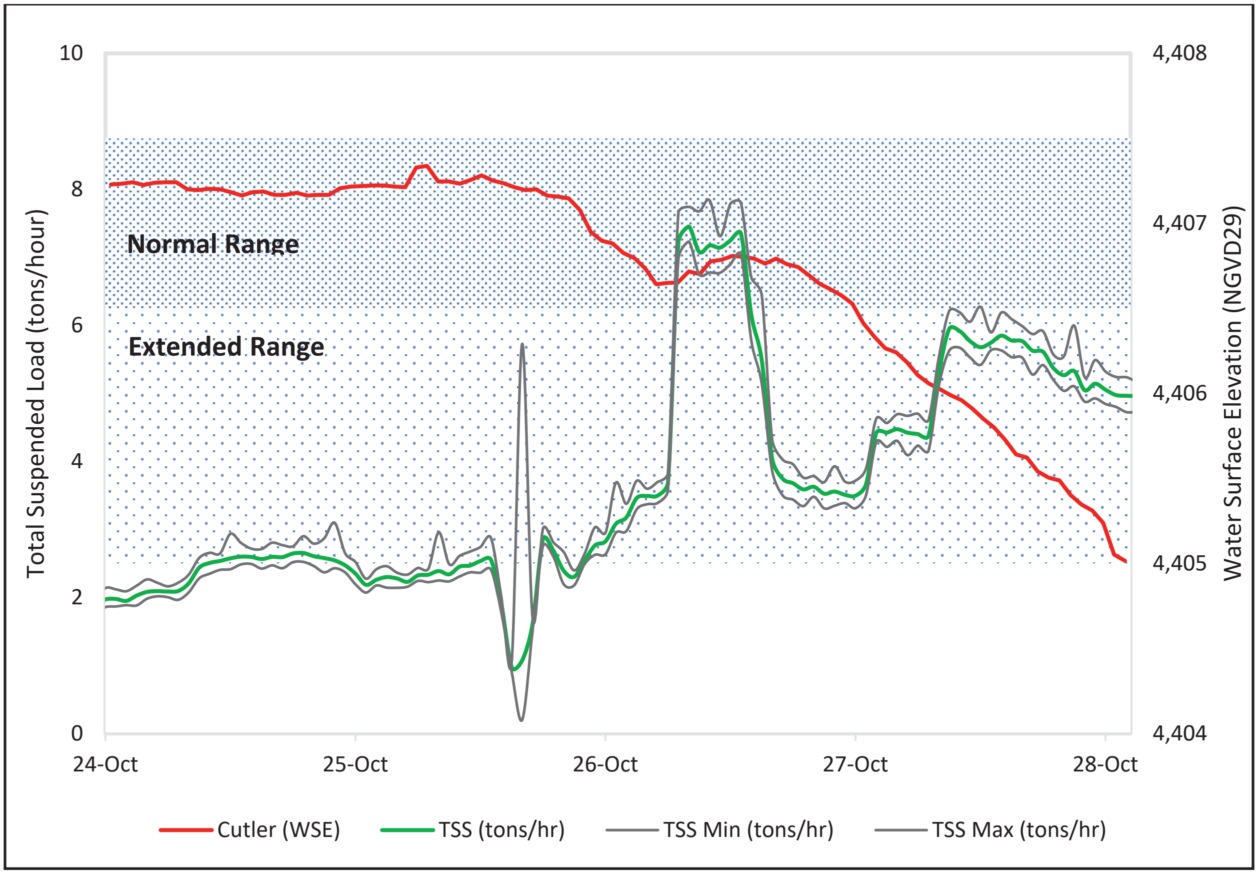


Figure 1. Calculated hourly loads at the PacifiCorp gauge downstream of powerhouse during the 2019 drawdown. Hourly load is calculated with turbidity data collected from a Troll 9500 sonde deployed prior to the drawdown. The total suspended load (TSS) vs turbidity relationship (see Figure 3 of this attachment) is used along with flow data from the gauge to calculate the hourly sediment loads. Water surface elevation (WSE) at Cutler Dam during the drawdown is plotted on the secondary Y axis. The proposed normal operating range (4,407.5 to 4,406.5) is depicted in the upper fine pattern box. The proposed extended operating range (4,406.5 to 4,405.0) is delineated in the lower patterned fill. During the drawdown, sediment loads remain low and stable through the extended operating range lower limit of 4,405.

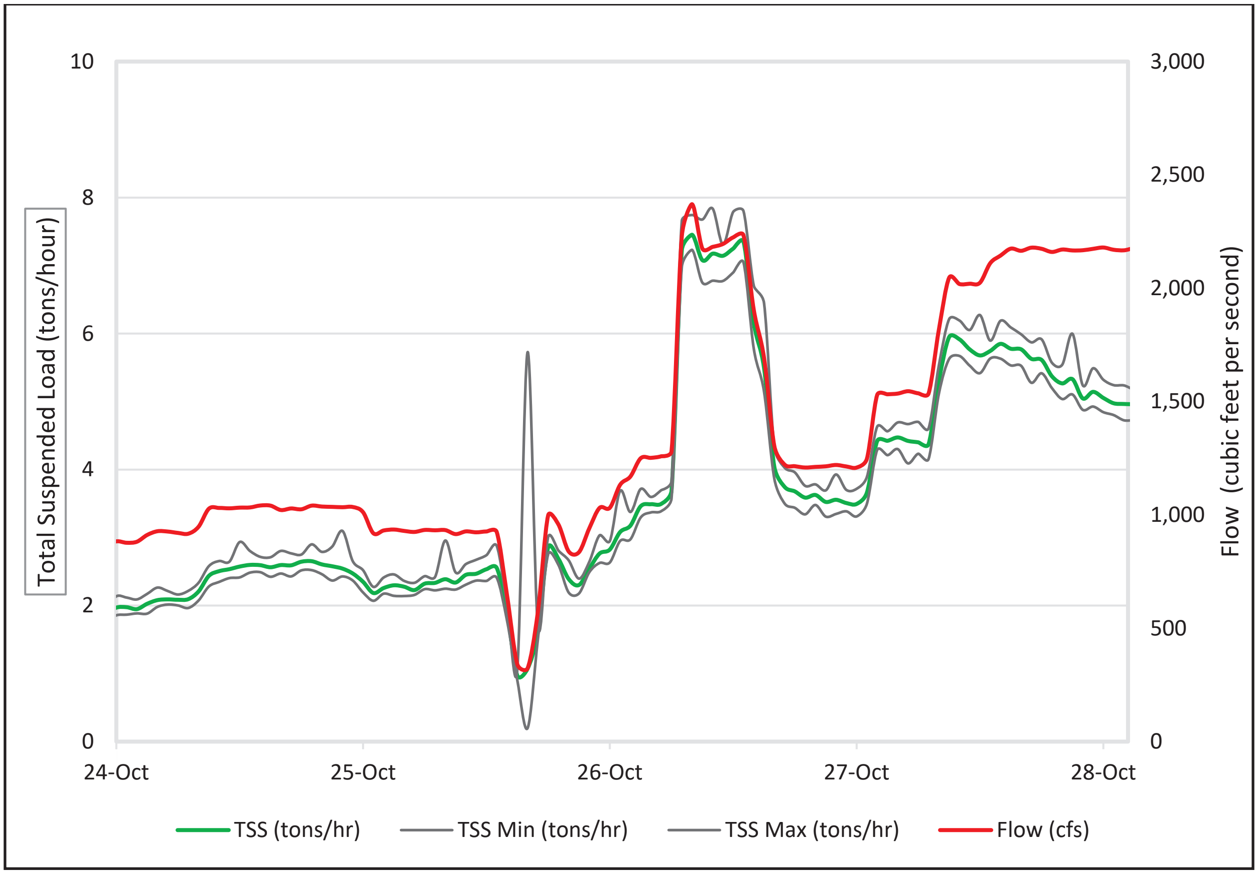


Figure 2. Sediment load and discharge during the 2019 drawdown when water surface elevations at Cutler were within the proposed normal and extended operation ranges. As flows increase, the sediment load is proportional to the flow.

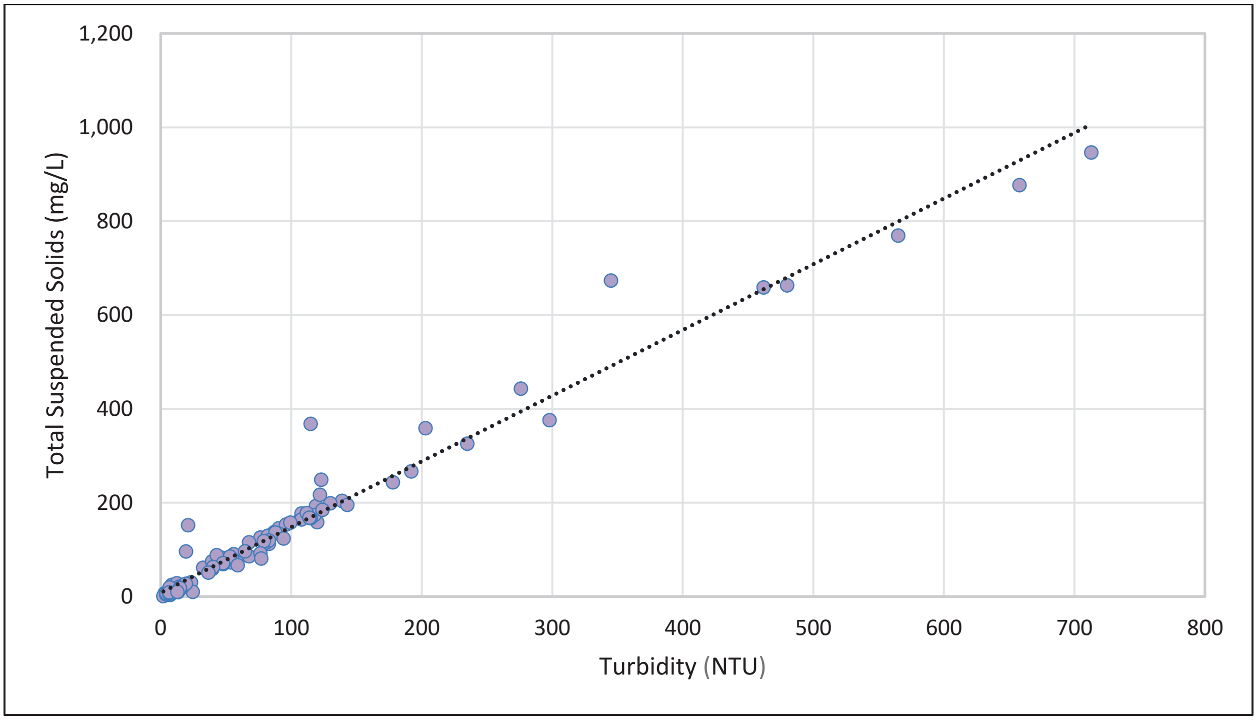
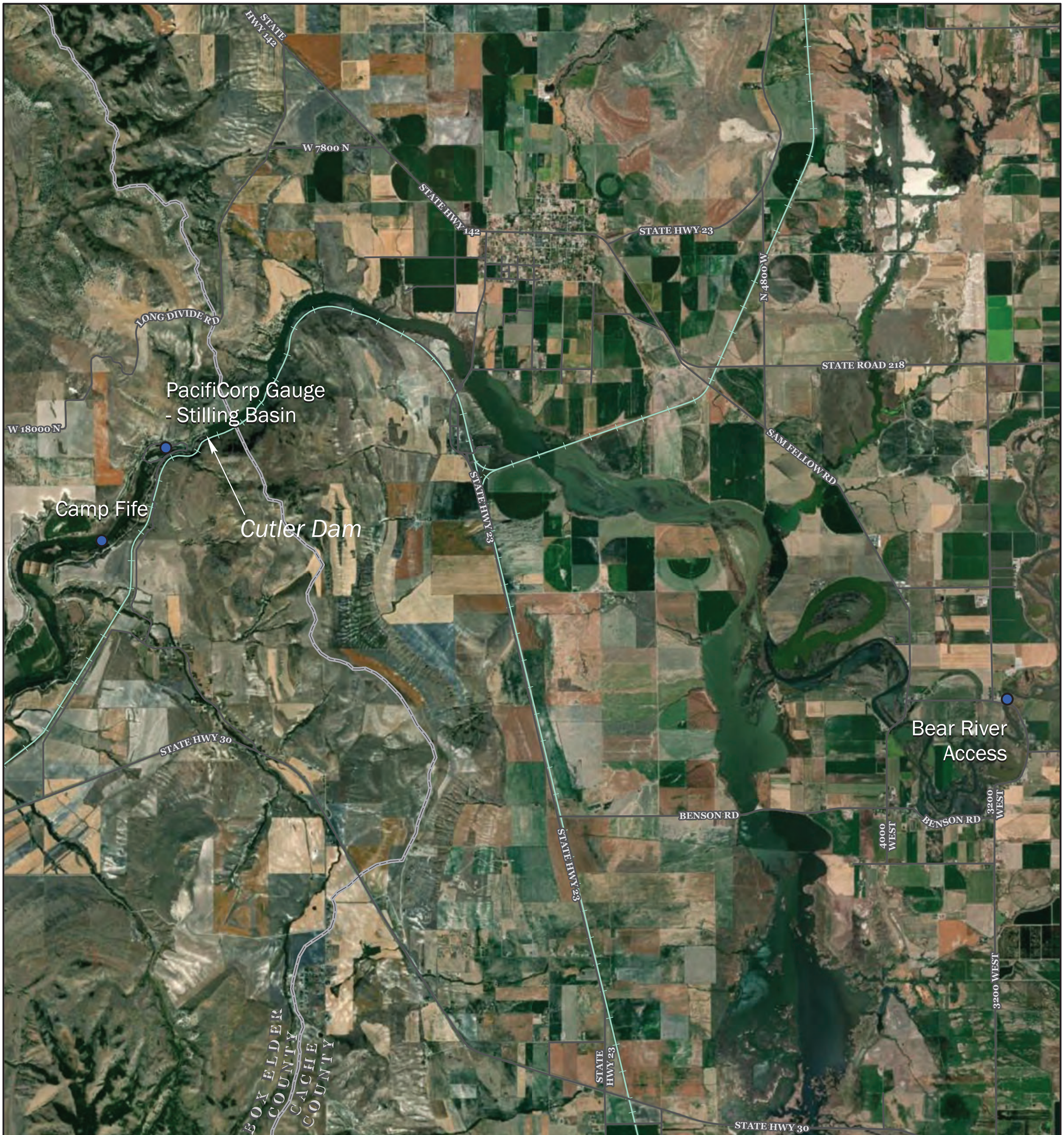


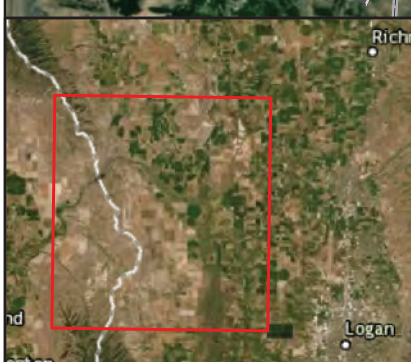
Figure 3. TSS and turbidity relationship developed from water samples collected in October and November 2019 during the full drawdown of Cutler Reservoir. A total of 130 paired samples were used to plot the relationship to develop the slope formula and calculate hourly loads from instantaneous turbidity measurements at the gauge downstream of the powerhouse. Paired TSS and turbidity data has an R2 = 0.9228, indicating a strong relationship.
mg/L = microgram per liter; NTU = Nephelometric Turbidity Unit

ATTACHMENT A-3

MAP OF WATER QUALITY (TSS)

SAMPLING LOCATIONS





Water Quality (TSS) Sampling Locations
Road
Railroad
County

N

Coordinate System:

0 2,500 5,000 Feet

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Water Quality (Total Suspended Solids) Sampling Locations

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP

ATTACHMENT A-4

PHOTOS OF CUTLER RESERVOIR BED AND BANKS DURING THE FALL 2019 MAXIMUM DRAWDOWN CONDITIONS

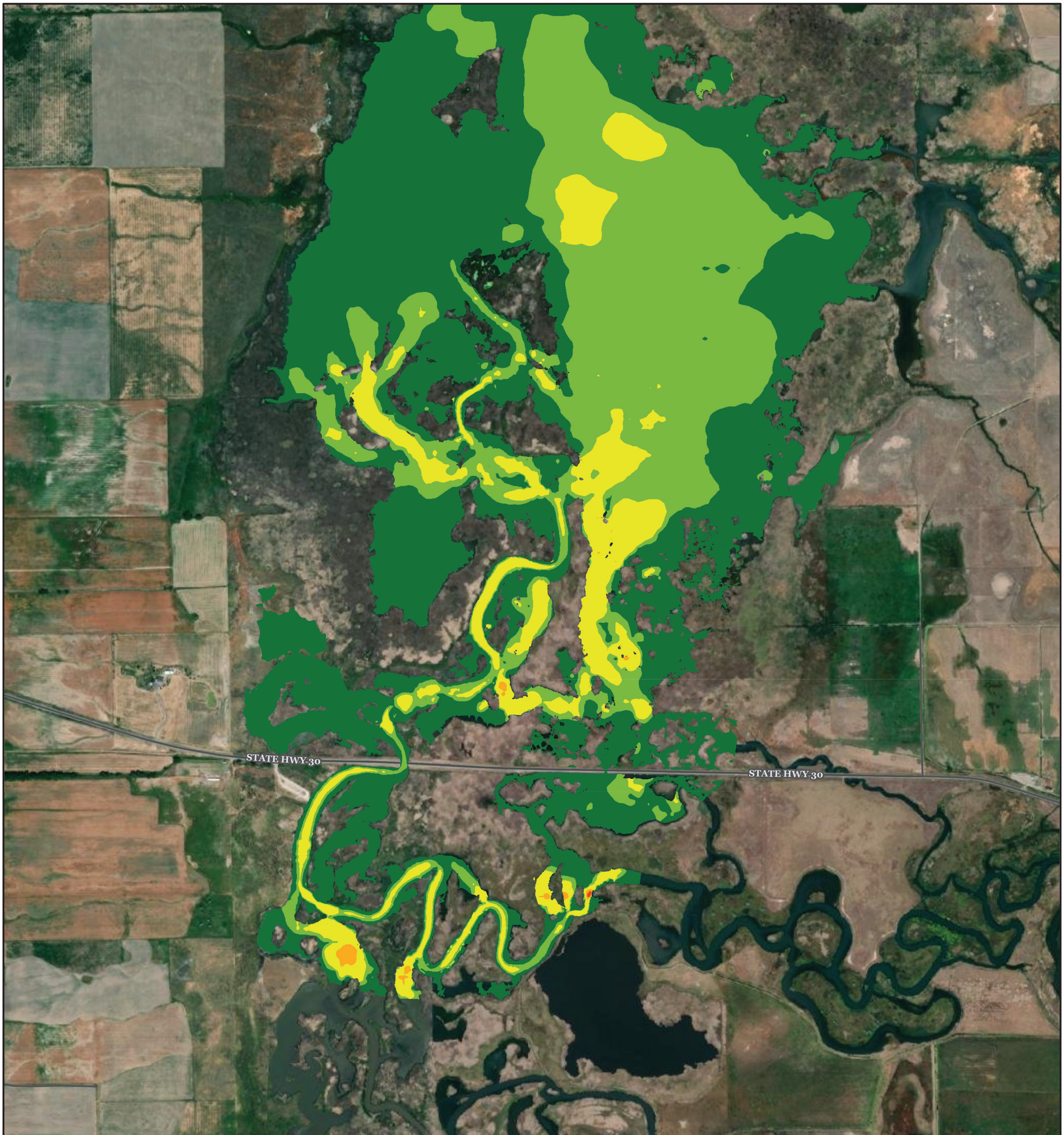
Photo 1. Looking downstream (westerly) towards Cutler Dam from the south side of Cutler Canyon during the 2019 full drawdown (November 4). Water surface elevation (WSE) at Cutler Dam was 4,386.97 (NGVD29), approximately 17 feet below the lowest proposed operating level of 4,405.0. Note that the majority of the bank longitudinally and laterally is stable under this extreme drawdown event except for a limited area delineated by the red square.

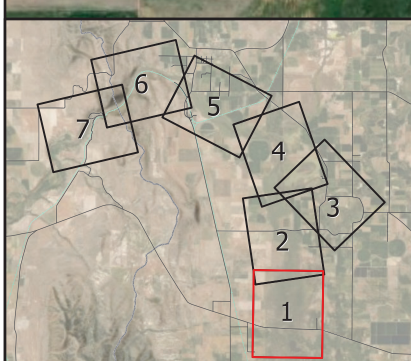
Photo 2. View downstream of Wheelon Dam, looking westerly through Cutler Canyon during the 2019 full drawdown (November 4). Cutler Dam WSE elevation is the same as Photo 1 (17 feet below the lowest proposed operating elevation). Note the stability of the exposed reservoir bed and banks. This area would be completely inundated at the lowest limit of the proposed extended Project operations at WSE of 4,405 feet at Cutler Dam.

Photo 3. Downstream of Newton Bridge looking upstream toward easterly bank with PacifiCorp's Cutler Canyon Recreation Site in the background. Note the lack of head-cutting in the exposed reservoir bed and along the wetted perimeter. WSE in this reach is hydraulically controlled by Wheelon Dam during the 2019 extreme drawdown event, approximately 17 feet below the lowest proposed operating limit. Photo taken on November 4, 2019, same WSE as Photos 1 and 2.

ATTACHMENT A-5

VELOCITY MAPS





Max Velocity Difference (ft/s)

- 0.000- 0.05
- 0.051 - 0.1
- 0.101 - 0.5
- 0.501 - 1
- 1.000 - 2

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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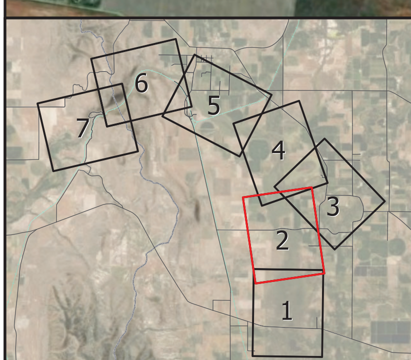
Difference In Operating Range Velocity

Sheet 1 of 7

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP



Max Velocity Difference (ft/s)

- 0.000- 0.05
- 0.051 - 0.1
- 0.101 - 0.5
- 0.501 - 1
- 1.000 - 2

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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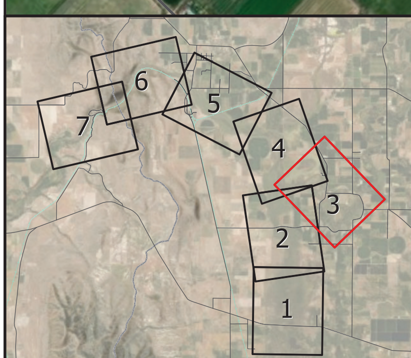
Difference In Operating Range Velocity

Sheet 2 of 7

CUTLER HYDROELECTRIC PROJECT
FERC PROJECT NO. 2420

PACIFICORP



Max Velocity Difference (ft/s)

- 0.000- 0.05
- 0.051 - 0.1
- 0.101 - 0.5
- 0.501 - 1
- 1.000 - 2

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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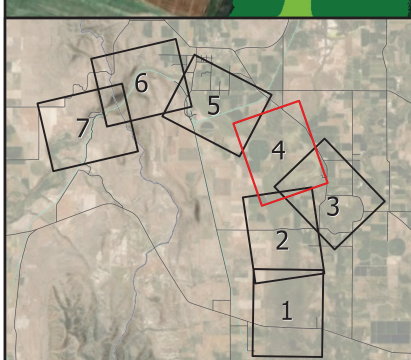
Difference In Operating Range Velocity

Sheet 3 of 7

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP



Max Velocity Difference (ft/s)

- 0.000- 0.05
- 0.051 - 0.1
- 0.101 - 0.5
- 0.501 - 1
- 1.000 - 2

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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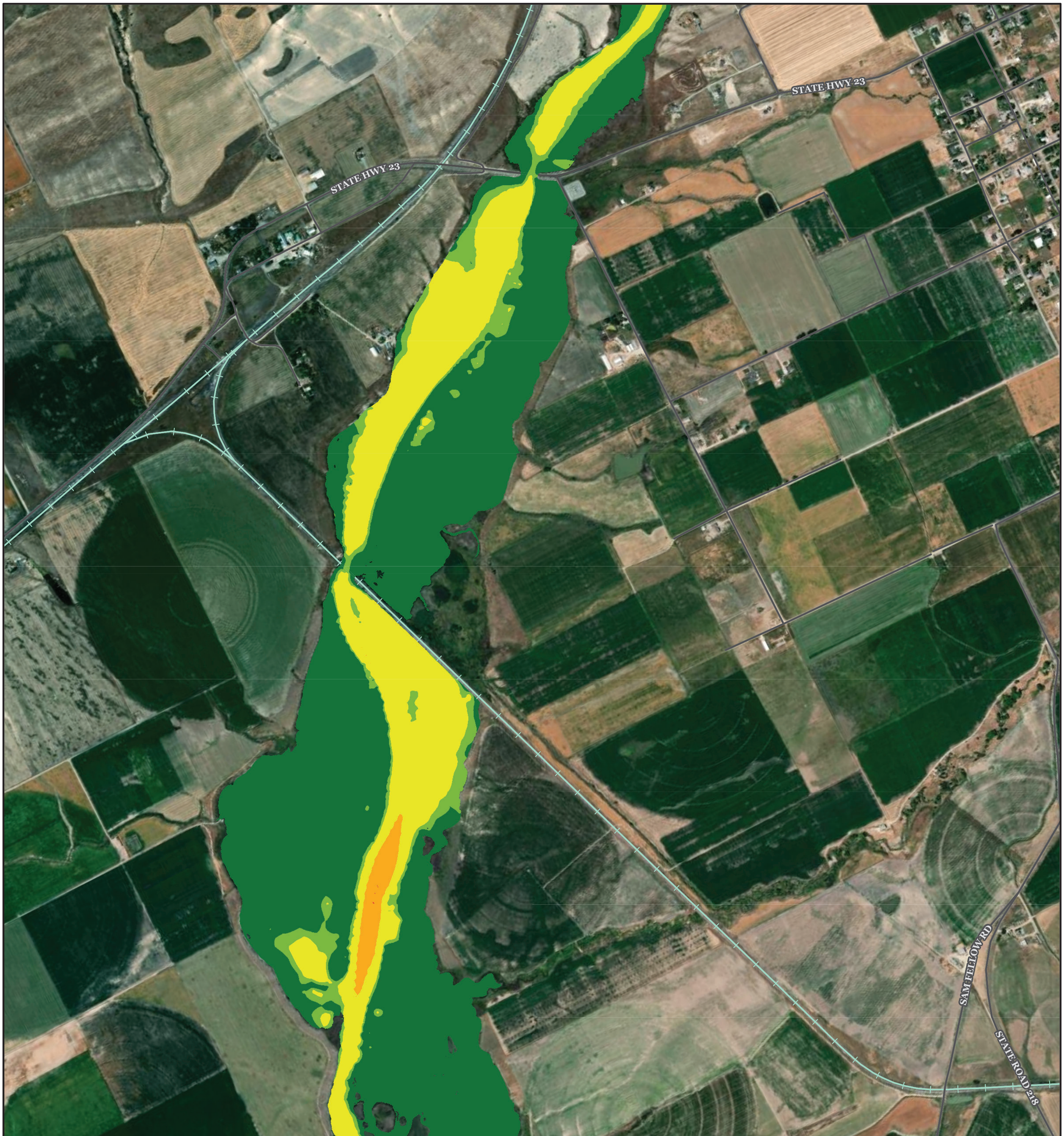
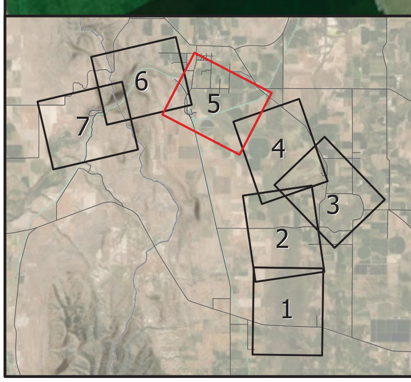
Difference In Operating Range Velocity

Sheet 4 of 7

CUTLER HYDROELECTRIC PROJECT
FERC PROJECT NO. 2420

PACIFICORP





Max Velocity Difference (ft/s)

- 0.000- 0.05
- 0.051 - 0.1
- 0.101 - 0.5
- 0.501 - 1
- 1.000 - 2

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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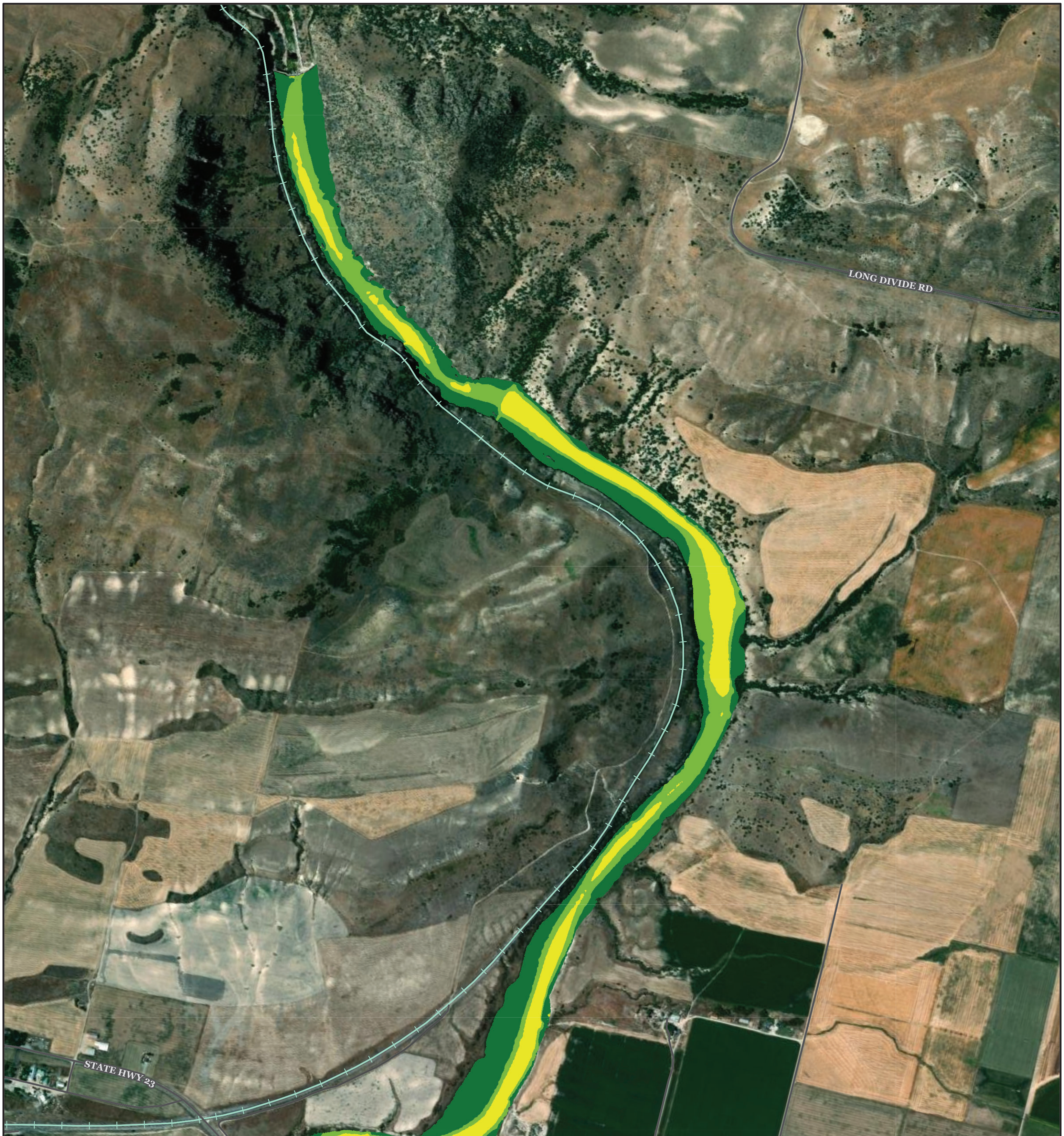
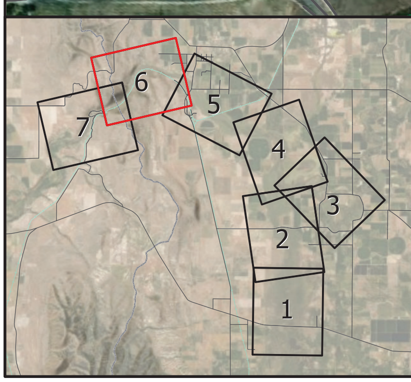
Difference In Operating Range Velocity

Sheet 5 of 7

CUTLER HYDROELECTRIC PROJECT
FERC PROJECT NO. 2420

PACIFICORP





Max Velocity Difference (ft/s)

- 0.000- 0.05
- 0.051 - 0.1
- 0.101 - 0.5
- 0.501 - 1
- 1.000 - 2

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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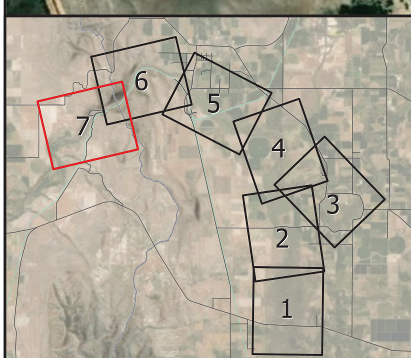
Difference In Operating Range Velocity

Sheet 6 of 7

CUTLER HYDROELECTRIC PROJECT FERC PROJECT NO. 2420

PACIFICORP



Max Velocity Difference (ft/s)

- 0.000 - 0.1
- 0.101 - 0.5
- 0.501 - 1
- 1.001 - 1.5
- 1.501 - 2

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

Difference In Operating Range Velocity

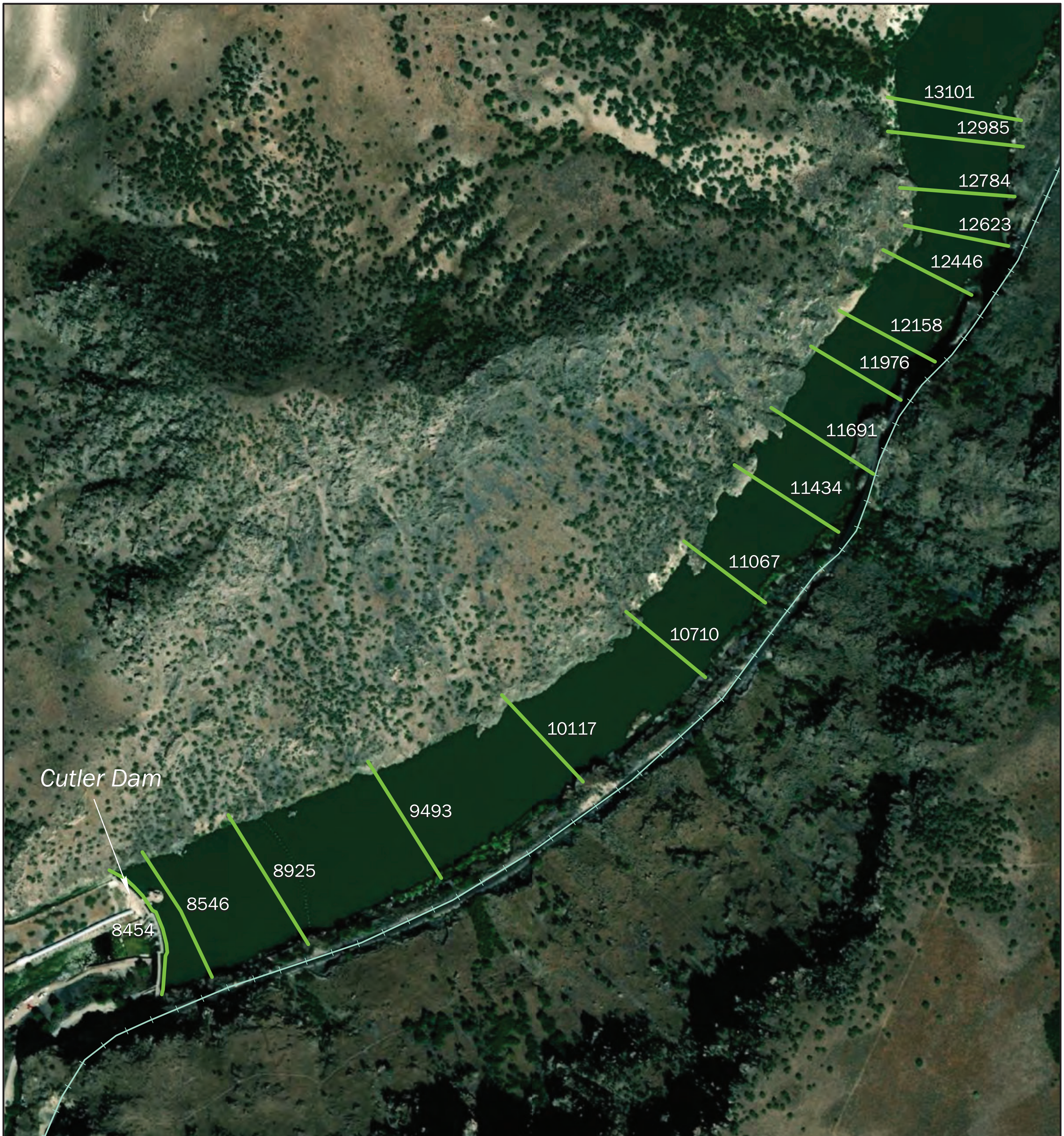
Sheet 7 of 7

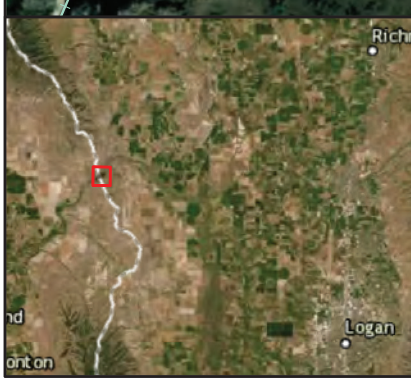
CUTLER HYDROELECTRIC PROJECT
FERC PROJECT NO. 2420

PACIFICORP

Attachment A-6

Calibrated Cross Section Map





Cross Sections with River Stationing
Road
Railroad

N

Coordinate System:

0 205 410 Feet

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Sediment Model Calibration Locations

CUTLER HYDROELECTRIC PROJECT
FERC PROJECT NO. 2420

PACIFICORP

APPENDIX B

SHORELINE HABITAT CHARACTERIZATION HABITAT UPDATED STUDY REPORT

SHORELINE HABITAT CHARACTERIZATION UPDATED STUDY REPORT

CUTLER HYDROELECTRIC PROJECT (FERC NO. 2420)

Prepared for:

PacifiCorp

Salt Lake City, UT

Prepared by:

Cirrus Ecological Solutions, LC

AUGUST 2021

SHORELINE HABITAT CHARACTERIZATION
UPDATED STUDY REPORT

CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

Prepared for:

PacifiCorp
Salt Lake City, UT

Prepared by:

Cirrus Ecological Solutions, LC

AUGUST 2021

SHORELINE HABITAT CHARACTERIZATION
UPDATED STUDY REPORT

CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

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SHORELINE HABITAT CHARACTERIZATION
UPDATED STUDY REPORT

CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

1.0 INTRODUCTION

The Cutler Hydroelectric Project (Project) Initial Study Report (ISR) was filed with the Federal Energy Regulatory Commission (FERC) on February 8, 2021. This Updated Study Report (USR) describes the objectives, methods, and results for Phase 2 of the Shoreline Habitat Characterization ISR. ISR Appendix C (PacifiCorp 2021) provides a detailed description of the Shoreline Study Phase 1 objectives, study area, methods, and results; Section 8.0 of the same appendix notes the potential need for a Phase 2 study.

2.0 PROJECT NEXUS AND RATIONALE FOR STUDY

ISR Appendix C describes the nexus between the future Project operations and shoreline resources (PacifiCorp 2021). Phase 2 was undertaken to:

- Determine which of the 55 potentially affected species listed in ISR Appendix C (PacifiCorp 2021), all of which are migratory bird species, actually occur in the study area during the proposed extended operating range (November through the end of March); and
- Provide more detailed information needed to assess potential impacts on local and regional populations for these species.

3.0 STUDY OBJECTIVES

The study objectives for Phase 2 of the Shoreline Habitat Characterization Study include:

- Assessment of the potential effects of water surface elevation 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.

ISR Appendix C (PacifiCorp 2021) provides a list of the study objectives addressed in Phase 1.

3.1 STUDY AREA

This USR addresses the study area inside the Federal Energy Regulatory Commission (FERC) Project Boundary and 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 habitat. ISR Appendix C (PacifiCorp 2021) provides a description of the full study area.

4.0 METHODS

Additional methodologies were needed to address the Phase 2 study objectives discussed in Section 3.0, and, in conjunction with the Phase 1 results reported in the ISR Appendix C (PacifiCorp 2021), to draw meaningful conclusions regarding effects on local and regional wildlife populations. These methodologies, described in detail below, can be summarized as follows:

- Migratory Bird Surveys: A practical methodology was devised to determine which of the 55 potentially affected migratory bird species actually occur in the study area and to indicate their abundance. To ensure this methodology yielded representative results, survey units were systematically identified for conducting bird-count surveys. Additionally, climatic conditions during the surveys were assessed to determine if conditions, specifically temperatures and resulting ice cover, were within normal range.

- Spatial Extent of Habitat Change: Phase 1 of this study demonstrated the potential magnitude of changes in habitat availability for the 55 potentially affected migratory bird species under current and proposed extended operating ranges (ISR Appendix C) (PacifiCorp 2021). In Phase 2 of the study, the spatial extent of the habitat changes between the two scenarios was derived in areas where substantial changes in habitat availability could occur. This information provided context for interpreting the bird survey results.

4.1 SURVEY UNITS

The output from the hydraulic model (ISR Appendix G) (PacifiCorp 2021) was used to select six survey units that were representative of the study area, because surveying the entire study area in the required time frame was not feasible. The survey units were representative of the types of bird habitat available in the study area, with some survey units composed of shallow water, some of deeper water, and some with a mix. These six units also displayed larger changes in habitat availability across water-depth classes when compared with many other areas of the reservoir under the proposed extended operating range modelled treatments. Additionally, the water levels of one survey unit located south of Benson Marina (Survey Unit 1) are likely influenced by groundwater exfiltration from the surrounding marsh and groundwater. During reservoir drawdowns under the current operating conditions, it is assumed that groundwater exfiltration helps to minimize the change in water levels south of Benson Marina, resulting in little to no observable change in water elevation. The groundwater exfiltration in this area was not included in the hydraulic model (ISR Appendix G) (PacifiCorp 2021) as it is difficult to quantify the quantity, timing, and location of all groundwater exfiltration within the reservoir during a drawdown event. Therefore, estimates of changes in water levels, and thus changes in foraging habitat availability in this unit are conservative, as they assume no groundwater input to the reservoir in the areas south of Benson Marina that would help mitigate against the effects of the drawdown at Cutler Dam. Given the selection of units that displayed larger changes in water levels, and the inclusion of a unit south of Benson Marina, which has larger predicted changes in water levels than are expected, these six survey units were useful as conservative representative examples of how foraging habitat of different depth classes in the study area could change under the proposed extended operating range.

4.2 SURVEY METHODS

The field surveys were designed using Integrated Waterbird Management and Monitoring Survey Methods (IWMM) (2017). This program, administered by the U.S. Fish and Wildlife Service (USFWS), was developed to monitor waterbirds across the country using a standardized method. Surveys were conducted during the season when differences between operating scenarios could occur, specifically November through the end of March. This corresponds to the non-breeding season for migratory birds, and therefore only specific portions of the IWMM program protocols were appropriate. Specifically, the methods described within the Standard Operating Procedure (SOP) 2: Waterbird and Unit Condition Survey section in the IWMM manual were applied (ISR Appendix C – Attachment C-1) (PacifiCorp 2021).

Briefly, application of the IWMM methodology involved the following steps:

1. Observation points were established such that a minimum of 70 percent of the survey unit was visible from the observation points. In practice, most units were generally 100 percent visible from the observation points.

2. Surveys were not conducted in weather that would obstruct the view of the survey unit from the observation points.
3. Survey units were visited weekly in a rotating order such that the same site was not visited on the same time of day each week.
4. Upon arrival at an observation point, two observers began counting visible waterbirds simultaneously, generally dividing up the waterbirds by species to avoid double-counting.
5. When all waterbirds visible from an observation point had been counted, other variables such as the current time and percentage of ice cover were recorded.
6. Steps 4 and 5 were repeated until all survey units and observation points had been visited and all waterbirds counted.

It is important to note that specific, individual birds were not identified. The same bird may have been counted multiple times across survey weeks, and potentially within the same survey day if birds were moving among locations during the survey. Efforts were made to avoid double counting birds in multiple survey units on the same day but determining individuals from week to week was not possible. Therefore, the final count of birds utilizing the various survey units during the five months of surveys does not necessarily represent a count of the number of individual birds that utilized the study area; many birds were likely counted repeatedly from week to week.

4.3 TEMPERATURE DATA

As freezing conditions set in over the winter, birds are less likely to find the open water foraging conditions they need and may leave an area if unsuitable foraging habitat cannot be found. Air temperature can be related to ice levels on the reservoir. Air temperature data for the reservoir for the past 30 years was obtained from the Utah Climate Center (2021). The 30-year timeline was selected to correspond to the length of the current 30-year license. This data was then compared to the air temperature data and ice coverage during the 2020–2021 survey period to evaluate whether the observed ice levels were representative of past and anticipated future conditions.

The Utah Climate Center (2021) was used to obtain daily temperature data for the Cutler Dam weather station (station ID USC00421918). The average temperature for each winter month from 1990 to 2020 was calculated from these values. Data from the Logan Cache weather station (station ID USW00094128) was used to supplement missing temperature data for the Cutler Dam station (2021).

4.4 SPATIAL EXTENT OF EFFECTS

The final task of this study was to evaluate shifts resulting from proposed extended reservoir operations in the location of suitable, species-specific habitat in the context of the survey data. The ISR identified 55 migratory bird species that are potentially present within the study area during the proposed extended reservoir operating range (November through the end of March). Each of these species utilizes specific water-depth classes for foraging depending on their foraging needs and adaptations (ISR Appendix C) (PacifiCorp 2021).

The distribution of water-depth classes across the study area varies in response to Project operations and associated fluctuations in water surface elevations. As demonstrated by the hydraulic modeling completed for this analysis (ISR Appendix G) (PacifiCorp 2021), when in use, the proposed extended reservoir operating range could drop the lower limit on water surface elevations, shifting the acreage and location of some water-depth classes compared to the current operating range. This, in turn, could affect the extent, spatial, and temporal distribution of species-specific suitable habitat in the study area.

To assess potential shifts in the location of suitable habitat, the output from the hydraulic model was used to indicate where each water-depth class was located under current and proposed extended operating scenarios. The resulting polygons were compared to indicate the location and calculate the extent of overlap in suitable habitat between the two scenarios.

Figures in Section 6.4 show the habitat location in each water-depth class and in each survey unit at the point during the 10-day operations cycle when differences between the current and proposed reservoir operating scenarios were greatest. The model output reflected 12-hour intervals, and this analysis addresses the same interval. This indicates how much each species would potentially need to adjust its habitat use during the period with the greatest disparity in habitat location.

Each figure in Section 6.4 includes a graph reproduced from ISR Figures 5-8 through 5-27 (PacifiCorp 2021) that provides the total acreage of habitat available within each water-depth class in the study area, indicating whether the habitat is more or less available when comparing each operating scenario. With this presentation, each figure indicates potential changes in both the location and extent of changes for each water-depth class and suitable habitat for the bird species that forage in each depth class.

5.0 STUDY MODIFICATIONS

There were no modifications to Phase 2 of the study plan.

6.0 RESULTS

The results section is organized into four subsections that summarize the findings for each method described in Section 4.0: survey units (Section 6.1), survey results (Section 6.2), temperature data (Section 6.3), and spatial extent of effects (Section 6.4).

6.1 SURVEY UNITS

Survey Unit 1 is primarily shallow water, while Survey Unit 5 is primarily deep water. Survey Units 2, 3, 4, and 6 are a mix of shallow and deep water. The six survey units covered a total of 679.17 acres, accounting for approximately 20 percent of the total surface area of Cutler reservoir (Table 6-1 and Figure 6-1).[1]

TABLE 6-1 SURVEY UNIT SIZES

SURVEY UNIT	ACRES
1	31.36
2	70.62
3	358.42
4	18.50
5	30.67
6	169.60
Total:	679.17

[1] Table 5-4 in Appendix C of the ISR quantified 3,435 acres of open water in the study area.

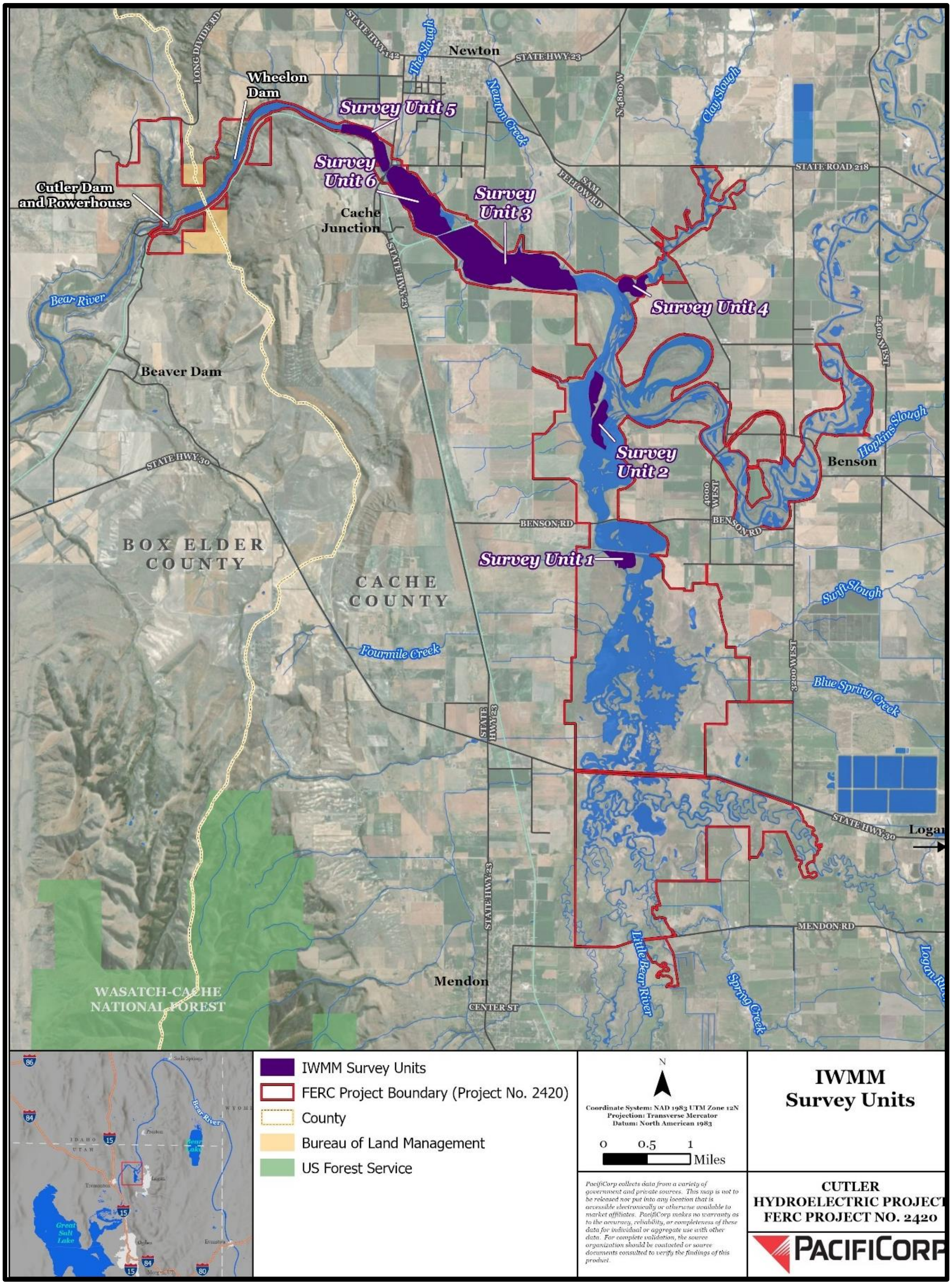


FIGURE 6-1 LOCATION OF IWMM SURVEY UNITS

6.2 SURVEY RESULTS

Twenty-three surveys were completed from November 2020 through the end of March 2021, with one survey completed each week. Forty-one species were observed (Table 6-2), 36 of which were identified as potentially present in ISR Appendix C (Table 6-2) (PacifiCorp 2021). The other five species observed that were not on the final list of 55 species potentially present within the study area were black-billed magpie *(Pica hudsonia*), red-winged black bird *(Agelaius phoeniceus*), ring-necked pheasant *(Phasianus colchicus*), rough-legged hawk *(Buteo lagopus*), and sandhill crane *(Grus canadensis*). These upland species were noted near or flying over the survey units. Since these species do not rely on aquatic habitat for foraging and would not be impacted by changing water levels, they were not included in this analysis.

The highest number of birds observed was in Survey Unit 3, while the lowest number observed was in Survey Unit 5. The most common species, the Canada goose (*Branta canadensis),* was present during 13 of 23 survey days. The least common species, the marsh wren (*Cistothorus palustris*) and ring-necked duck (*Aythya collaris*), were observed only one time.

Table 6-2 summarizes the total number of birds of each species observed within each survey unit. Of the 36 species from the ISR list recorded during the surveys, four were observed in all six survey units: Canada goose, common merganser (*Mergus merganser*), mallard (*Anas platyrhynchos*), and pied-billed grebe (*Podilymbus podiceps*). The remaining 32 were only observed in certain units. As noted previously (Section 4.2), these observations do not represent unique individuals, but rather collective observations made over the time period, some of which are certainly the same individuals counted over subsequent weekly surveys.

Table 6-3 summarizes survey data by month with the average, standard deviation (SD), and range of the weekly survey data for each species observed during each month of the survey. No individual species was observed during all five months of the survey. During all of January, only one bird was observed (great blue heron [*Ardea herodias*]). March and November had the highest number of birds, while December and January had the lowest number. Only species that were observed are included in Table 6-3.

TABLE 6-2 SURVEY RESULTS FOR MIGRATORY BIRD SPECIES POTENTIALLY PRESENT IN THE STUDY AREA

Species Common Names	Species Scientific Names	Survey Unit						Total Observations
		1	2	3	4	5	6	
American Avocet	*Recurvirostra americana*	0	0	23	4	0	0	27
American Coot	*Fulica americana*	203	1,687	1,243	0	4	230	3,367
American Pipit	*Anthus rubescens*	0	0	0	0	0	0	0
American White Pelican	*Pelecanus erythrorhynchos*	3	0	1	2	0	0	6
American Wigeon	*Mareca americana*	133	16	647	8	0	78	882
Bald Eagle	*Haliaeetus leucocephalus*	2	4	6	0	0	1	13
Barrow's Goldeneye	*Bucephala islandica*	0	0	3	0	0	0	3
Belted Kingfisher	*Megaceryle alcyon*	0	0	0	0	0	2	2
Black-crowned Night-heron	*Nycticorax*	0	0	0	0	0	0	0
Black-necked Stilt	*Himantopus mexicanus*	0	0	0	0	0	0	0
Blue-winged Teal	*Anas discors*	0	0	0	0	0	0	0
Bonaparte’s Gull	*Chroicocephalus philadelphia*	0	0	0	0	0	0	0
Bufflehead	*Bucephala albeola*	0	2	1	2	0	0	5
Cackling Goose	*Branta hutchinsii*	0	0	0	0	0	0	0
California Gull	*Larus californicus*	4	124	982	0	5	118	1,233
Canada Goose	*Branta canadensis*	28	430	3,765	14	13	178	4,428
Canvasback	*Aythya valisineria*	0	1	4	1	0	3	9
Cinnamon Teal	*Anas cyanoptera*	2	0	0	0	0	0	2
Clark’s Grebe	*Aechmophorus clarkii*	0	14	4	0	0	8	26
Common Goldeneye	*Bucephala clangula*	0	34	41	0	8	32	115
Common Loon	*Gavia immer*	0	0	0	0	0	0	0

SPECIES COMMON NAMES	SPECIES SCIENTIFIC NAMES	SURVEY UNIT						TOTAL OBSERVATIONS
		1	2	3	4	5	6	
Common Merganser	*Mergus merganser*	7	30	134	17	11	65	264
Double-crested Cormorant	*Phalacrocorax auritus*	0	2	0	0	0	0	2
Eared Grebe	*Podiceps nigricollis*	7	14	15	0	0	6	42
Franklin's Gull	*Leucophaeus pipixcan*	0	0	0	0	0	0	0
Gadwall	*Anas strepera*	18	121	1,307	0	1	232	1,679
Great Blue Heron	*Ardea herodias*	1	0	2	4	1	2	10
Greater Yellowlegs	*Tringa melanoleuca*	0	0	0	0	0	0	0
Green-winged Teal	*Anas carolinensis*	2	0	32	5	0	11	50
Herring Gull	*Larus argentatus*	0	0	0	0	0	0	0
Hooded Merganser	*Lophodytes cucullatus*	0	0	0	0	0	0	0
Horned Grebe	*Podiceps auritus*	0	0	0	0	0	0	0
Killdeer	*Charadrius vociferus*	0	0	0	0	0	0	0
Lesser Scaup	*Aythya affinis*	0	2	172	0	3	15	192
Long-billed Dowitcher	*Limnodromus scolopaceus*	0	0	0	0	0	0	0
Mallard	*Anas platyrhynchos*	23	257	284	7	6	181	758
Marsh Wren	*Cistothorus palustris*	0	0	0	1	0	0	1
Northern Pintail	*Anas acuta*	0	42	164	0	0	0	206
Northern Shoveler	*Anas clypeata*	73	28	19	1	0	0	121
Osprey	*Pandion haliaetus*	0	0	0	0	0	0	0
Pied-billed Grebe	*Podilymbus podiceps*	5	3	9	4	7	5	33
Red-breasted Merganser	*Mergus serrator*	0	0	7	0	0	4	11
Red-necked Phalarope	*Phalaropus lobatus*	0	0	0	0	0	0	0

SPECIES COMMON NAMES	SPECIES SCIENTIFIC NAMES	SURVEY UNIT						TOTAL OBSERVATIONS
		1	2	3	4	5	6	
Redhead	*Aythya americana*	17	42	28	0	0	46	133
Ring-billed Gull	*Larus delawarensis*	0	8	557	0	0	135	700
Ring-necked Duck	*Aythya collaris*	0	0	1	0	0	0	1
Ross's Goose	*Chen rossii*	0	0	0	0	0	0	0
Ruddy Duck	*Oxyura jamaicensis*	1	2	5	0	0	2	10
Snow Goose	*Chen caerulescens*	0	1	7	0	0	51	59
Trumpeter Swan	*Cygnus buccinator*	0	16	97	0	0	6	119
Tundra Swan	*Cygnus columbianus*	0	0	48	0	0	2	50
Virginia Rail	*Rallus limicola*	0	0	0	0	0	0	0
Western Grebe	*Aechmophorus occidentalis*	2	10	1	0	3	4	20
Wilson's Snipe	*Gallinago delicata*	0	0	0	3	0	0	3
Wood Duck	*Aix sponsa*	0	0	0	0	0	0	0
	Total	531	2,890	9,609	73	62	1,417	14,582

TABLE 6-3 SPECIES OBSERVATIONS MONTHLY AVERAGES, STANDARD DEVIATIONS AND RANGES

Species Name	Measure	Month				
		Nov	Dec	Jan	Feb	Mar
American Avocet	Average	0	0	0	0	5.4
	SD	-	-	-	-	5.8
	Range	-	-	-	-	0 – 14
American Coot	Average	292.8	21.8	0	0	304.6
	SD	206.0	25.1	-	-	425.1
	Range	40 – 658	0 – 45	-	-	2 – 1,009
American White Pelican	Average	0.5	0	0	0	0.6
	SD	0.8	-	-	-	1.3
	Range	0 – 2	-	-	-	0 – 3
American Wigeon	Average	0.7	0	0	5.8	171
	SD	1.2	-	-	4.8	214.4
	Range	0 – 3	-	-	0 – 11	19 – 540
Bald Eagle	Average	0.2	1	0	1.3	0.6
	SD	0.4	2	-	0.5	0.6
	Range	0 – 1	0 – 4	-	1 – 2	0 – 1
Barrow's Goldeneye	Average	0.5	0	0	0	0
	SD	1.2	-	-	-	-
	Range	0 – 3	-	-	-	-
Belted Kingfisher	Average	0.2	0	0	0	0.2
	SD	0.4	-	-	-	0.5
	Range	0 – 1	-	-	-	0 – 1
Bufflehead	Average	0	0	0	0	1.0
	SD	-	-	-	-	1.4
	Range	-	-	-	-	0 – 3
California Gull	Average	55.7	0	0	27.5	157.8
	SD	90.9	-	-	39.4	96.0
	Range	0 – 237	-	-	0 – 85	16 – 267
Canada Goose	Average	10.0	2.0	0	483.5	485.2
	SD	19.4	4.0	-	411.1	429.1
	Range	0 – 49	0 – 8	-	22 – 882	87 – 954
Canvasback	Average	0.5	0.3	0	0	1.0
	SD	0.8	0.5	-	-	1.4
	Range	0 – 2	0 – 1	-	-	0 – 3
Cinnamon Teal	Average	0	0	0	0	0.4
	SD	-	-	-	-	0.9
	Range	-	-	-	-	0 – 2
Clark’s Grebe	Average	0.3	0	0	0	4.8
	SD	0.8	-	-	-	8.7
	Range	0 – 2	-	-	-	0 – 20
Common Goldeneye	Average	7.2	3.5	0	9.5	4.0
	SD	13.0	4.7	-	3.7	4.2
	Range	0 – 33	0 – 10	-	5 – 13	0 – 10

Common Merganser	Average	1.5	0	0	27.0	29.4
	SD	2.7	-	-	16.3	21.3
	Range	0 – 7	-	-	14 – 50	1 – 47
Double-crested Cormorant	Average	0	0	0	0	0.4
	SD	-	-	-	-	0.9
	Range	-	-	-	-	0 – 2
Eared Grebe	Average	4.2	0	0	0	3.4
	SD	4.2	-	-	-	7.6
	Range	0 – 9	-	-	-	0 – 17
Gadwall	Average	209.3	7	0	8.3	72.4
	SD	278.6	14.0	-	16.5	78.2
	Range	3 – 724	0 – 28	-	0 – 33	8 – 200
Great Blue Heron	Average	0.7	0	0.3	0.3	0.8
	SD	1.0	-	0.5	0.5	0.8
	Range	0 – 2	-	0 – 1	0 – 1	0 – 2
Green-winged Teal	Average	0	0	0	1	6.4
	SD	-	-	-	2.0	6.1
	Range	-	-	-	0 – 4	0 – 13
Lesser Scaup	Average	2.0	0	0	7.5	29.6
	SD	4.9	-	-	10.9	24.8
	Range	0 – 12	-	-	0 – 23	4 – 66
Mallard	Average	54.3	35.8	0	10.8	49.2
	SD	68.6	64.4	-	9.9	59.1
	Range	5 – 188	0 – 132	-	0 – 21	12 – 153
Marsh Wren	Average	0	0.3	0	0	0
	SD	-	0.5	-	-	-
	Range	-	0 – 1	-	-	-
Northern Pintail	Average	0	0	0	9.0	34.0
	SD	-	-	-	7.4	37.4
	Range	-	-	-	0 – 18	0 – 91
Northern Shoveler	Average	0.2	0	0	0	24.0
	SD	0.4	-	-	-	35.2
	Range	0 – 1	-	-	-	0 – 80
Pied-billed Grebe	Average	4.8	0	0	0	0.8
	SD	7.3	-	-	-	1.1
	Range	0 – 18	-	-	-	0 – 2
Red-breasted Merganser	Average	0.7	0	0	1.8	3.2
	SD	1.6	-	-	3.5	6.6
	Range	0 – 4	-	-	0 – 7	0 – 15
Redhead	Average	0.5	5.8	0	0	21.4
	SD	1.2	11.5	-	-	18.9
	Range	0 – 3	0 – 23	-	-	0 – 47

Ring-billed Gull	Average	0	0	0	1.8	138.6
	SD	-	-	-	3.5	237.0
	Range	-	-	-	0 – 7	0 – 550
Ring-necked Duck	Average	0	0	0	0.3	0
	SD	-	-	-	0.5	0
	Range	-	-	-	0 – 1	0
Ruddy Duck	Average	0	0	0	0	2.0
	SD	-	-	-	-	1.9
	Range	-	-	-	-	0 – 4
Snow Goose	Average	0.2	0	0	0	11.6
	SD	0.4	-	-	-	24.8
	Range	0 – 1	-	-	-	0 – 56
Trumpeter Swan	Average	2.2	0	0	5.0	17.2
	SD	3.1	-	-	5.8	18.2
	Range	0 – 7	-	-	0 – 11	0 – 43
Tundra Swan	Average	2.8	0	0	0	6.6
	SD	2.5	-	-	-	13.7
	Range	0 – 5	-	-	-	0 – 31
Western Grebe	Average	2.5	0	0	0	1.0
	SD	3.2	-	-	-	2.2
	Range	0 – 7	-	-	-	0 – 5
Wilson's Snipe	Average	0.5	0	0	0	0
	SD	1.2	-	-	-	-
	Range	0 – 3	-	-	-	-

Note: SD = Standard Deviation

6.3 TEMPERATURE DATA

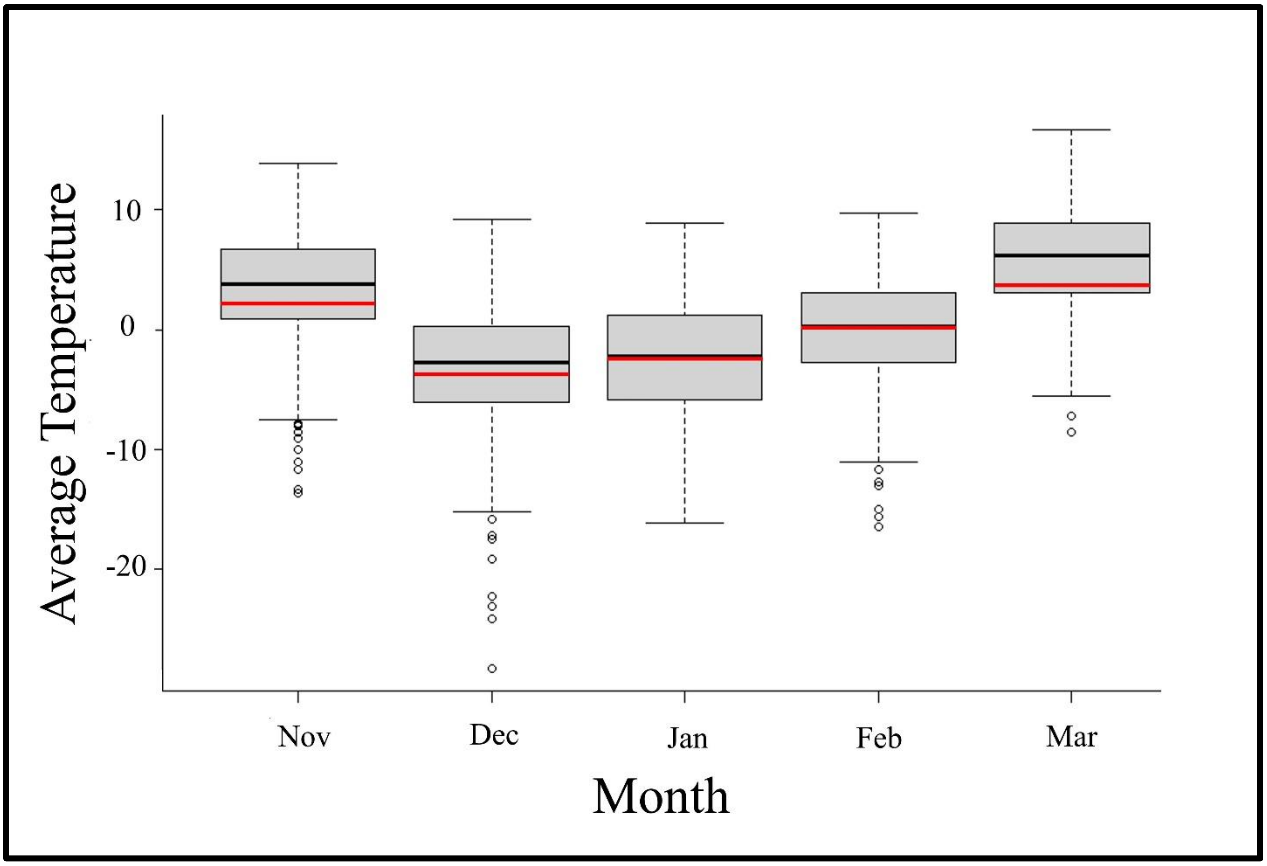
As noted in Sections 4.2 and 4.3, the approximate proportion of ice coverage for each survey unit was recorded at the time of the survey, and the average temperature for the week prior to the survey was collected from the Utah Climate Center (2021) (Table 6-4). No data was available for the week prior to December 29, 2020, at either the Cutler Dam station or the Logan Cache station, but it is expected that the average weekly temperature would have been approximately the same as the previous week and the following week since there was little change in ice coverage.

The average monthly temperature for 2020–2021 was lower than the average monthly temperature for 1990–2020 for all five months of the survey (Figure 6-2). However, the average temperature during the survey months was well within the normal range of temperatures for the years 1990-2020. In 2020–2021, Survey Unit 1 was completely ice covered for 57 percent of the survey days; Units 2, 3, and 5 for 26 percent of the survey days, Unit 4 for 17 percent of the survey days, and Unit 6 for 30 percent of the survey days (Table 6-4). It should be noted that Survey Unit 4 always remained one or two percent ice-free due to a point-source inflow of warm water. January and February had the most days with ice-covered conditions; however temperatures were only slightly lower than the average monthly temperature for 1990–2020 (Figure 6-2). Therefore, the ice-covered conditions observed during the surveys in 2020–2021 were likely common in the past and would be expected in the near-term future.

TABLE 6-4 AVERAGE TEMPERATURE AND PROPORTION OF SURVEY UNIT ICE COVERED

SURVEY DATE	AVERAGE TEMP[1] (°C)	SURVEY UNIT – PERCENT ICE COVERAGE					
		1	2	3	4	5	6
October 26, 2020	6.0	15	10	10	40	40	20
November 2, 2020	4.7	0	0	0	10	0	5
November 9, 2020	9.2	30	10	10	60	40	40
November 18, 2020	2.7	98	70	75	100	70	50
November 23, 2020	3.0	98	85	75	100	40	40
November 30, 2020	-2.7	100	75	85	99	95	90
December 7, 2020	-2.8	100	100	100	99	100	100
December 15, 2020	-5.7	100	98	98	98	98	100
December 21, 2020	-3.6	100	75	75	99	60	80
December 29, 2020	NA	100	100	100	98	100	100
January 6, 2021	-3.7	100	100	100	99	100	100
January 11, 2021	-4.6	100	100	100	99	100	100
January 18, 2021	-3.8	100	100	100	100	100	100
January 25, 2021	-2.9	100	100	100	100	100	100
February 1, 2021	-1.6	99	95	75	99	99	95
February 8, 2021	0.3	100	65	60	90	50	80
February 17, 2021	0.1	100	50	40	97	30	55
February 22, 2021	-1.4	100	30	35	96	30	60
March 1, 2021	-1.5	100	20	30	98	15	60
March 8, 2021	3.3	98	10	5	90	2	5
March 15, 2021	3.1	65	1	1	70	0	0
March 23, 2021	3.8	0	0	0	30	0	0
March 31, 2021	1.8	0	0	0	0	0	0

[1] Note: Average temperatures for the week prior to each survey.



Note:
Average temperature 1990-2020 = black horizontal line; Average Temperature 2020-2021 (survey period) = red horizontal line; 25th Percentile (1990-2020) = gray shaded box; 75th Percentile (1990-2020) = dashed lined; Outlier Temperatures (1990-2020) = points

FIGURE 6-2 AVERAGE TEMPERATURES FOR 1990-2020 AND 2020-2021

Fewer birds were observed on survey days with a higher proportion of ice-covered survey units (Figure 6-3). Birds that utilized the study area when the reservoir became ice-covered likely moved to locations that had open water, either within or outside of the study area. Migratory species observed during the surveys migrated through Utah and were only temporarily present as they moved south then back north along their migration routes (Table 6-2). It is assumed that a combination of the ice-covered reservoir, food resource availability, and fewer species present in the region during the times when it was most often ice-covered (January and early February) resulted in fewer birds being recorded in the coldest weeks (Table 6-2, Table 6-3, Figure 6-3).

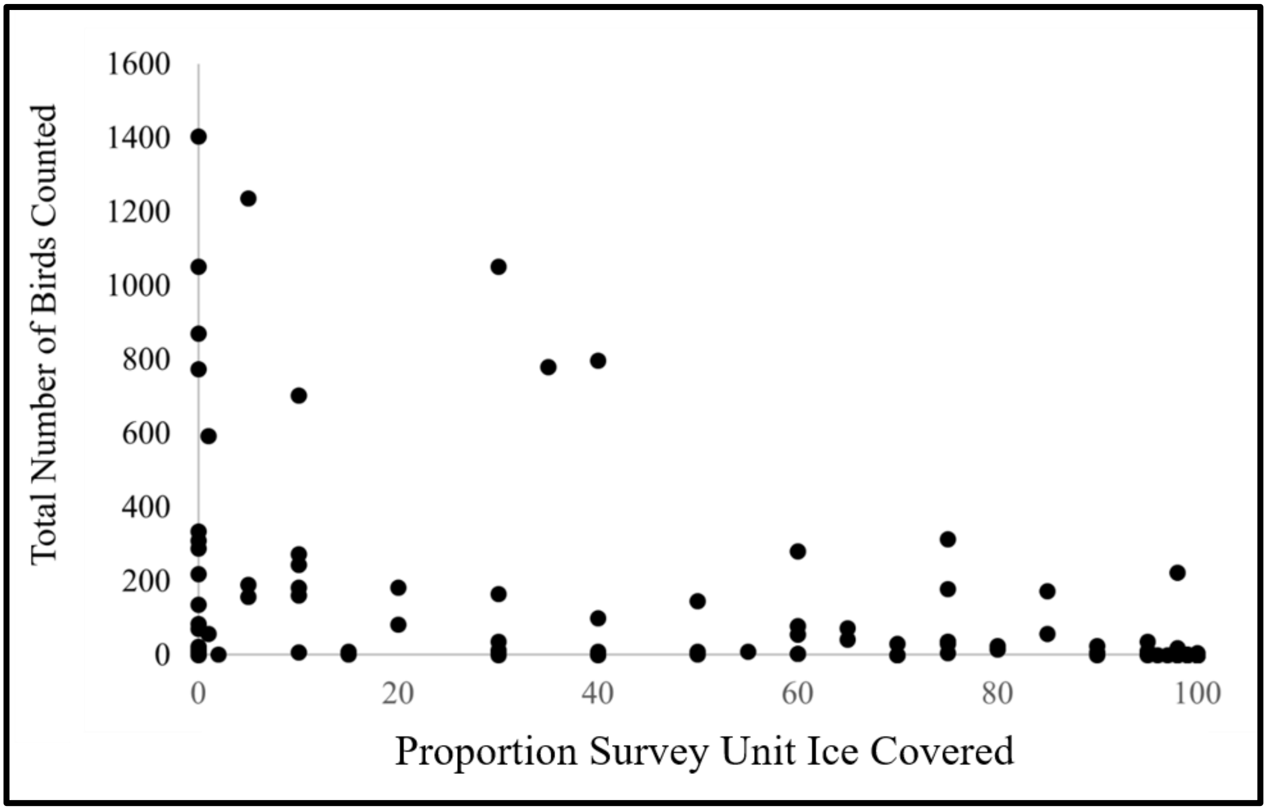


FIGURE 6-3 TOTAL NUMBER OF BIRDS COUNTED DURING EACH SURVEY RELATIVE TO PROPORTION OF ICE COVER

Some bird migration patterns are changing because of changing climates in both the winter and summer ranges (Jenni and Kery 2003; Fiedler et al. 2004; Zaifman et al. 2017). Some species may become more or less frequent users of the study area, while others may shift the timing of their migration in the spring and fall (Fiedler et al. 2004). This could alter the species and the numbers of individuals utilizing Cutler Reservoir over the next 40 years. Increased temperatures could reduce the number of days that the reservoir is ice-covered, providing increased habitat availability for waterbirds within the study area.

It is difficult to predict exactly what changes may occur over a future FERC license period with regard to bird use of the reservoir, as the response to climate change depends on the ecology and life history of each species (Jenni and Kery 2003). The species and numbers presented here represent the best available science regarding which species and how many individuals may be present when the proposed extended reservoir operating range would be utilized, and thus which species may experience changes in habitat availability that have the potential to affect their populations.

6.4 SPATIAL EXTENT OF EFFECTS

The following sections evaluate the potential shifts in the location of suitable habitat derived from the hydraulic model (ISR Appendix G) (PacifiCorp 2021) in the context of the survey data, as described in Section 4.4. Though included in the Shoreline ISR, water-depth classes 0-9 centimeters (cm), 0-11 cm, 0-16 cm, and 0-50 cm are not discussed further in this section because no birds were observed during the surveys that utilized these habitats.

6.4.1 WATER-DEPTH CLASS OF 0 TO 4 CENTIMETERS

Wilson's snipe (*Gallinago delicata*) utilize a water-depth class between 0 and 4 cm for foraging. This species was observed three times, each time in Survey Unit 4 in November, however Survey Unit 4 was not the only unit with suitable habitat available (Table 6-2, Table 6-3). While this species was only observed a few times, it can be a cryptic species, making it hard to detect even when present. However, given the limited habitat available in the reservoir under the current operating conditions, this species may in fact occur infrequently at the reservoir during the period of interest, as observed (Figure 6-4).

The 0 to 4 cm water-depth class is available in every unit, but only a small amount occurs in Survey Units 5 and 6. For the 12-hour period shown in Figure 6-4 (i.e., the interval when projected differences between the current and proposed operating scenarios are greatest) (Section 4.4), no survey unit would have overlapping habitat between the current operating range and the proposed extended operating range, meaning that any Wilson's snipe utilizing the area would need to locate new suitable foraging habitat during part of the 10-day cycle of proposed extended operations.

Survey Units 1, 2, 3, and 4 could realize shifts in habitat availability within the same survey unit. While Wilson's snipe were only observed in Survey Unit 4, should this species utilize the other units, habitat would be available in the same general location as under the current operating range. Survey Units 5 and 6 could realize a small increase in habitat availability compared to the current operating range.

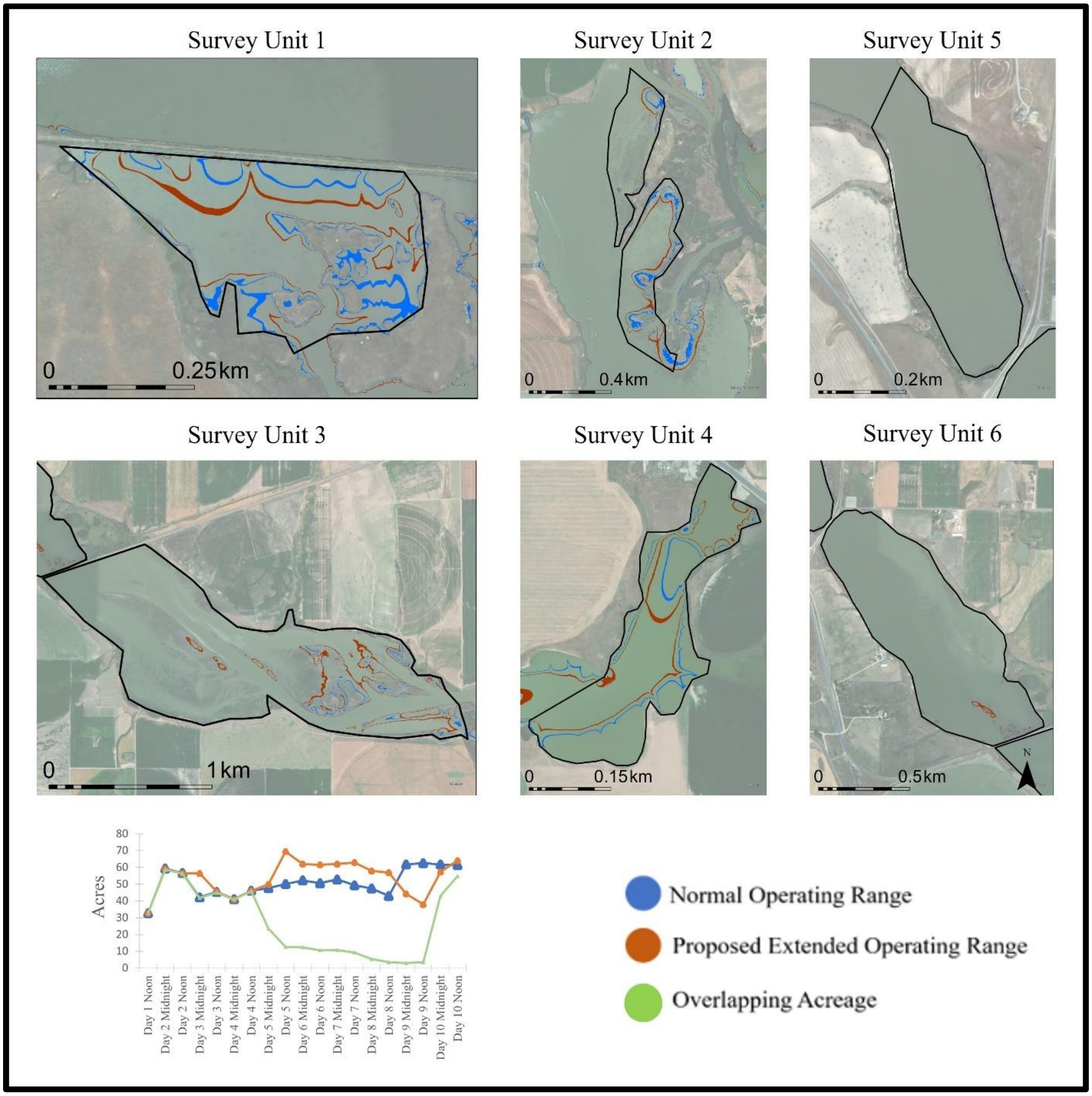


FIGURE 6-4 LOCATION OF 0 TO 4 CM WATER-DEPTH CLASS AND TOTAL ACRES OF HABITAT IN STUDY AREA

The potential habitat changes depicted in Figure 6-4 and described previously appear to be representative of the changes that may occur over the entire study area, with habitats in this depth class shifting to different areas with little overlap (although they may be adjacent) between existing conditions and those under the proposed extended operating range. During most days in the 10-day cycle of proposed extended operations, more habitat of this water-depth class would exist in the study area than under the current reservoir operating range (Figure 6-4).

6.4.2 WATER-DEPTH CLASS OF 0 TO 12 CENTIMETERS

Green-winged teal (*Anas carolinensis*) utilize a water-depth class between 0 and 12 cm deep for foraging and were observed in Survey Units 1, 3, 4, and 6 in February and March (Table 6-2, Table 6-3). Foraging habitat in this depth class was available in all six survey units (Figure 6-5). For the 12-hour period shown in Figure 6-5 (i.e., the interval when projected differences between the current and proposed operating scenarios are greatest), no survey unit would have overlapping habitat between the current operating range and the proposed extended operating range, meaning that any green-winged teal utilizing the area would need to locate new suitable foraging habitat during part of the 10-day cycle of proposed extended operations.

Survey Units 1, 2, 3, and 4 could realize shifts in habitat availability within the same unit. Habitat in these units would potentially be available in the same general location as under the current operating range. Survey Unit 5 had very limited habitat availability and would potentially gain only a small amount of habitat under the proposed extended operating range. Survey Unit 6 had limited habitat availability but did support green-winged teal, as they were observed in low numbers in February and March surveys. The proposed extended operating range would increase the amount of habitat available within this Survey Unit, potentially increasing its use in the future compared to the current operating range. However, note that it is possible green-winged teal are selecting this unit for some resource other than for foraging, given the limited foraging habitat available under the current operating conditions.

The habitat changes depicted in Figure 6-5, and described previously appear to be representative of the changes that may occur over the entire study area, with habitats in this depth class shifting to different areas with little overlap (although they may be adjacent) between existing conditions and those under the proposed extended operating range. During most days in the 10-day cycle of proposed extended operations, the same amount or more habitat of this water-depth class would potentially exist in the study area than under the current operating range (Figure 6-5).

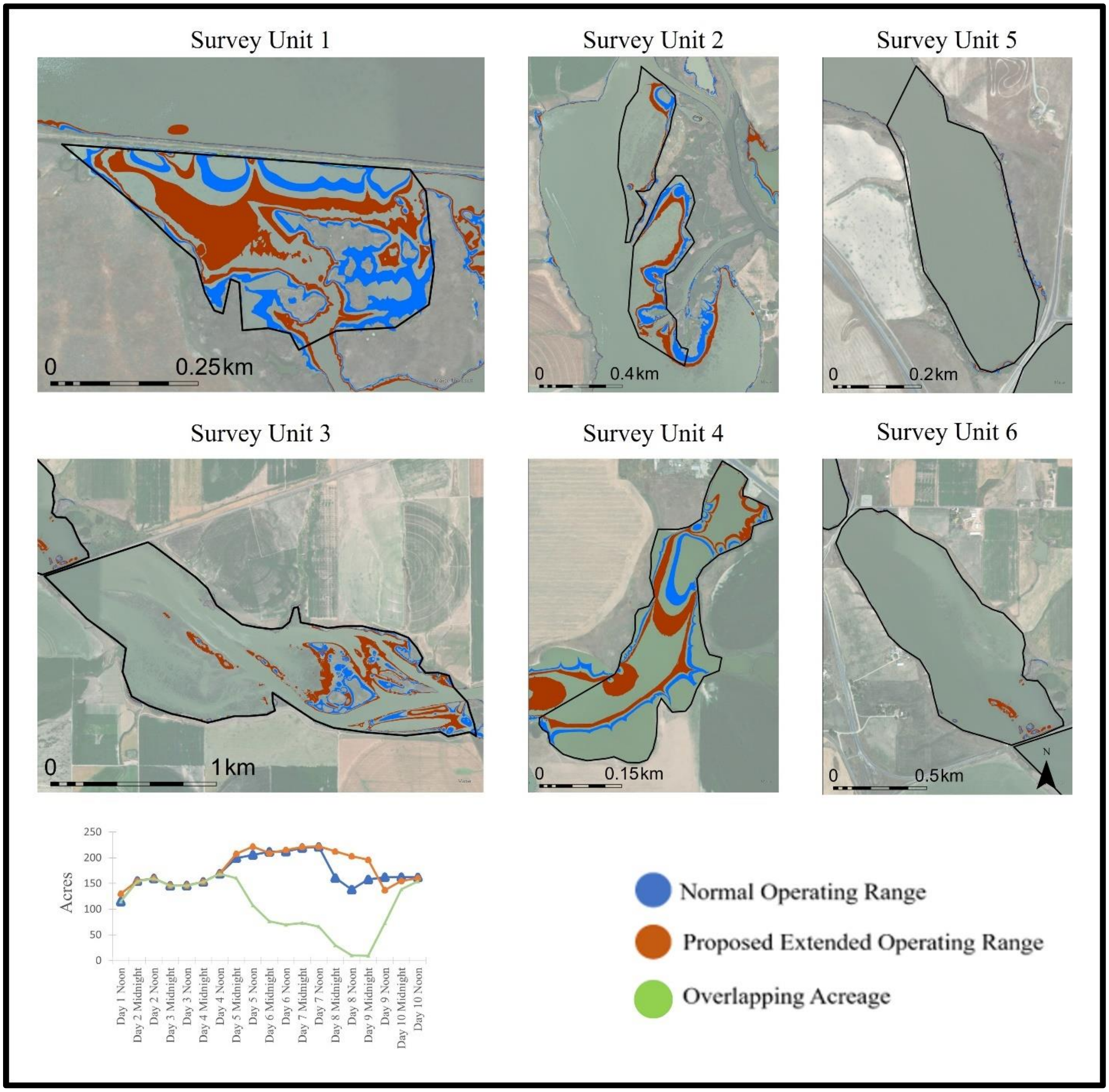


FIGURE 6-5 LOCATION OF 0 TO 12 CM WATER-DEPTH CLASS AND TOTAL ACRES OF HABITAT IN STUDY AREA

6.4.3 WATER-DEPTH CLASS OF 0 TO 15 CENTIMETERS

Snow geese (*Chen caerulescens*) utilize a water-depth class between 0 and 15 cm deep for foraging and were only observed once in November and then more frequently in March. Snow geese were observed in Survey Units 2, 3, and 6 (Table 6-2, Table 6-3). Foraging habitat in this depth class was available in all six survey units (Figure 6-6).

While snow geese do forage in shallow water, they also often forage on land, particularly in newly planted agricultural fields (Cornell Lab of Ornithology 2021a). When not foraging, snow geese often return to water for rest and security, therefore the snow geese in the study area may be selecting survey units that have suitable resting habitat. In that case, it would not be expected that snow geese would utilize the units that necessarily had the greatest amount of foraging habitat. Given their use of survey units without much suitable foraging habitat, and because there were no detections in some survey units with foraging habitat, it is assumed that this is likely the case. Snow geese are likely to continue to utilize areas with suitable resting habitat under the proposed extended operating range, which would still be available under the proposed extended operating range.

The potential habitat changes depicted in Figure 6-6 and described previously appear to be representative of the changes that may occur over the entire study area, with foraging habitats shifting to different areas with little overlap (although they may be adjacent) between existing conditions and those under the proposed extended operating range. During most days in the 10-day cycle of proposed extended operations, the same amount or more habitat of this water-depth class would potentially exist in the study area as under the current operating range (Figure 6-6).

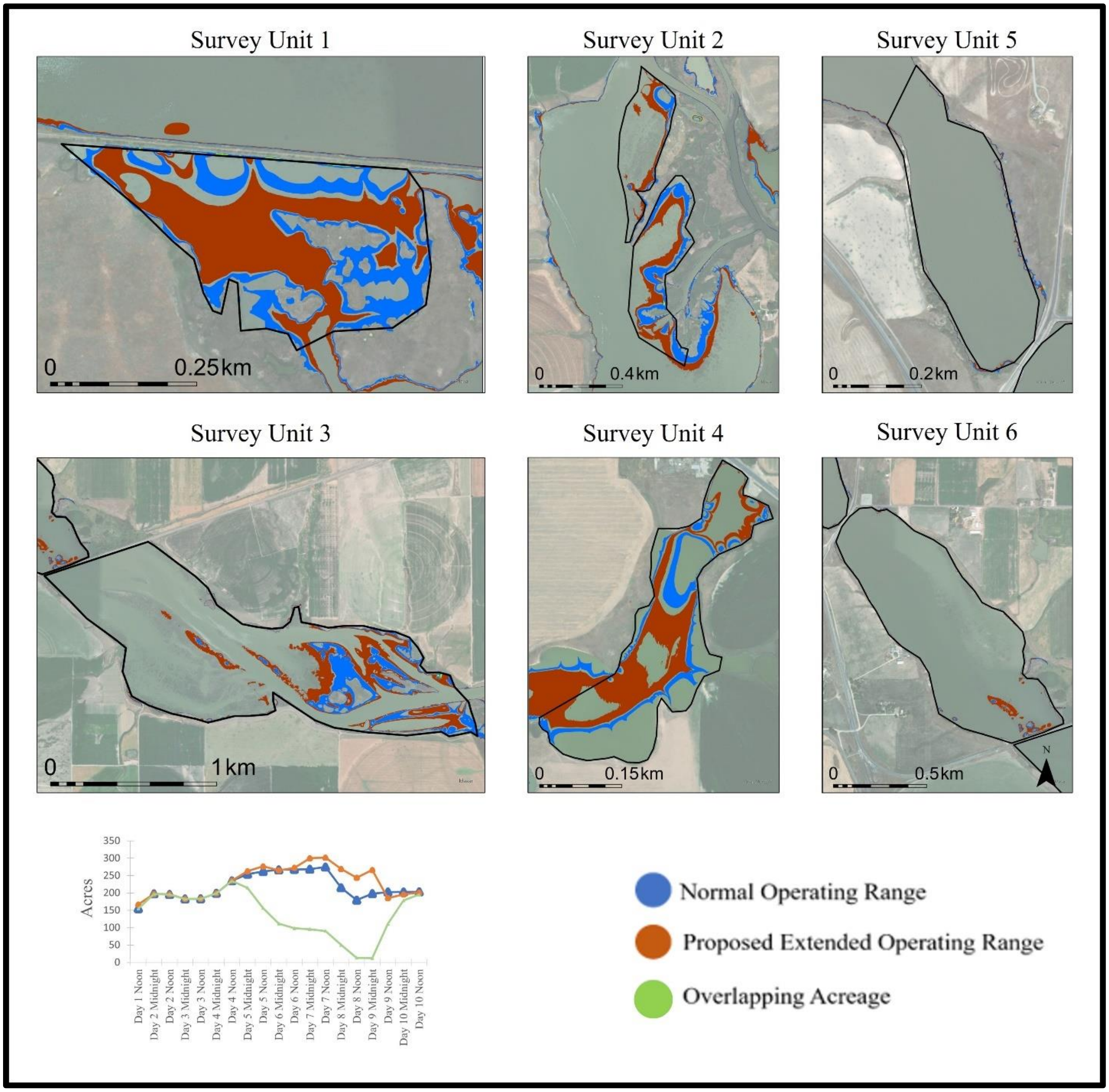


FIGURE 6-6 LOCATION OF 0 TO 15 CM WATER-DEPTH CLASS AND TOTAL ACRES OF HABITAT IN STUDY AREA

6.4.4 WATER-DEPTH CLASS OF 0 TO 20 CENTIMETERS

American avocets (*Recurvirostra americana*) and cinnamon teal (*Anas cyanoptera*) utilize a water-depth class between 0 and 20 cm deep for foraging. American avocets were observed in March in Survey Units 3 and 4; however, only two cinnamon teal were observed during the entire survey period, in Survey Unit 1 in March (Table 6-2, Table 6-3). Foraging habitat in this depth class was available in all six survey units (Figure 6-7).

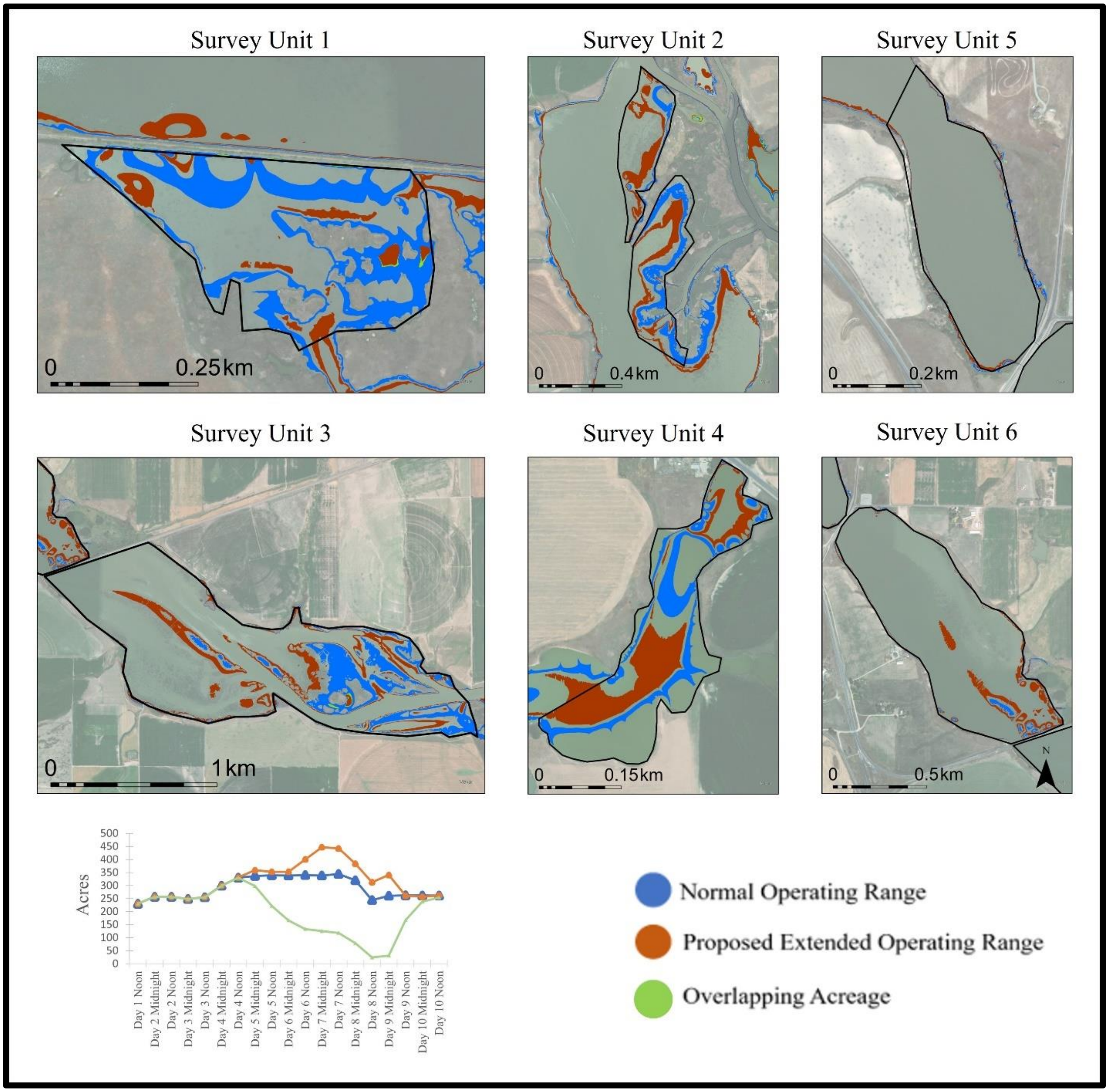


FIGURE 6-7 LOCATION OF 0 TO 20 CM WATER-DEPTH CLASS AND TOTAL ACRES OF HABITAT IN STUDY AREA

For the 12-hour period shown in Figure 6-7 (i.e., the interval when projected differences between the current and proposed reservoir operating scenarios are greatest), no survey unit would have overlapping foraging habitat (although they may be adjacent) between the current operating range and the proposed extended operating range, meaning that American avocets or cinnamon teal utilizing the area would potentially need to locate new suitable foraging habitat during part of the 10-day cycle of proposed extended operations.

Survey Units 1 and 3 would potentially have less suitable foraging habitat under the proposed extended operating range compared to the current operating range. While suitable foraging habitat would still be available, these units could become less suitable for these species given the limited habitat availability. Survey Units 2, 4, and 6 could potentially realize a shift in foraging habitat within the same unit. Should these species continue to or start utilizing these units, foraging habitat would be available in the same general location as under the current operating range. Survey Unit 5 has very limited foraging habitat availability and would not gain a large amount of habitat under the proposed extended operating range.

The potential habitat changes depicted in Figure 6-7 and described previously appear to be representative of the habitat changes that may occur over the entire study area, with habitats shifting to different areas with little overlap (although they may be adjacent) between existing conditions and those under the proposed extended operating range. Throughout the 10-day cycle of proposed extended operations, the same amount or more habitat of this water-depth class would potentially exist in the study area than under the current operating range (Figure 6-7).

6.4.5 WATER-DEPTH CLASS OF 0 TO 30 CENTIMETERS

Northern pintails (*Anas acuta*) and trumpeter swans (*Cygnus buccinator*) utilize a water-depth class between 0 and 30 cm deep for foraging. Northern pintails were observed in Survey Units 2 and 3 during February and March, while trumpeter swans were observed in Survey Units 2, 3, and 6 in November, February, and March (Table 6-2, Table 6-3). Foraging habitat in this depth class was available in all six survey units (Figure 6-8).

For the 12-hour period shown in Figure 6-8 (i.e., the interval when projected differences between the current and proposed operating scenarios are greatest), there would potentially be very limited overlapping (but may be adjacent) habitat between the current operating range and the proposed extended operating range, meaning that any northern pintails or trumpeter swans utilizing the area would likely need to locate new suitable foraging habitat (if that is the use occurring) during part of the 10-day cycle of proposed extended operations.

Survey Unit 1 could lose much of its habitat in this depth class under the proposed extended operating range. Neither northern pintails nor trumpeter swans were observed in this Survey Unit under the current operating range. Survey Units 2, 3, and 4 could realize shifts in foraging habitat availability within the same survey unit. As shown in Figure 6-8, habitat under the current operating range is often located adjacent to the habitat available under the proposed extended operating range. Both species were observed most often in units 2 and 3. Should these species continue to or start utilizing these units, habitat would potentially be available in the same general location as under the current operating range. Survey Unit 5 had very limited habitat in this depth class availability and would not gain a large amount of habitat under the proposed extended operating range. Survey Unit 6 could potentially gain habitat under the proposed extended operating range compared to the current operating range. While few trumpeter swans were observed in Survey Unit 6, it is possible that Survey Unit 6 could be utilized more in the future given the increase in foraging habitat availability. Northern pintails were not recorded in Survey Unit 6, but an increase in foraging habitat availability may increase its use in the future.

The potential habitat changes depicted in Figure 6-8 and described previously show the local variation that could occur under the proposed extended operating range relative to the current operating range. Overall, there would be the same amount or substantially more habitat of this water-depth class, in mostly the same areas, over the 10-day cycle of operations under the proposed extended operating range (Figure 6-8).

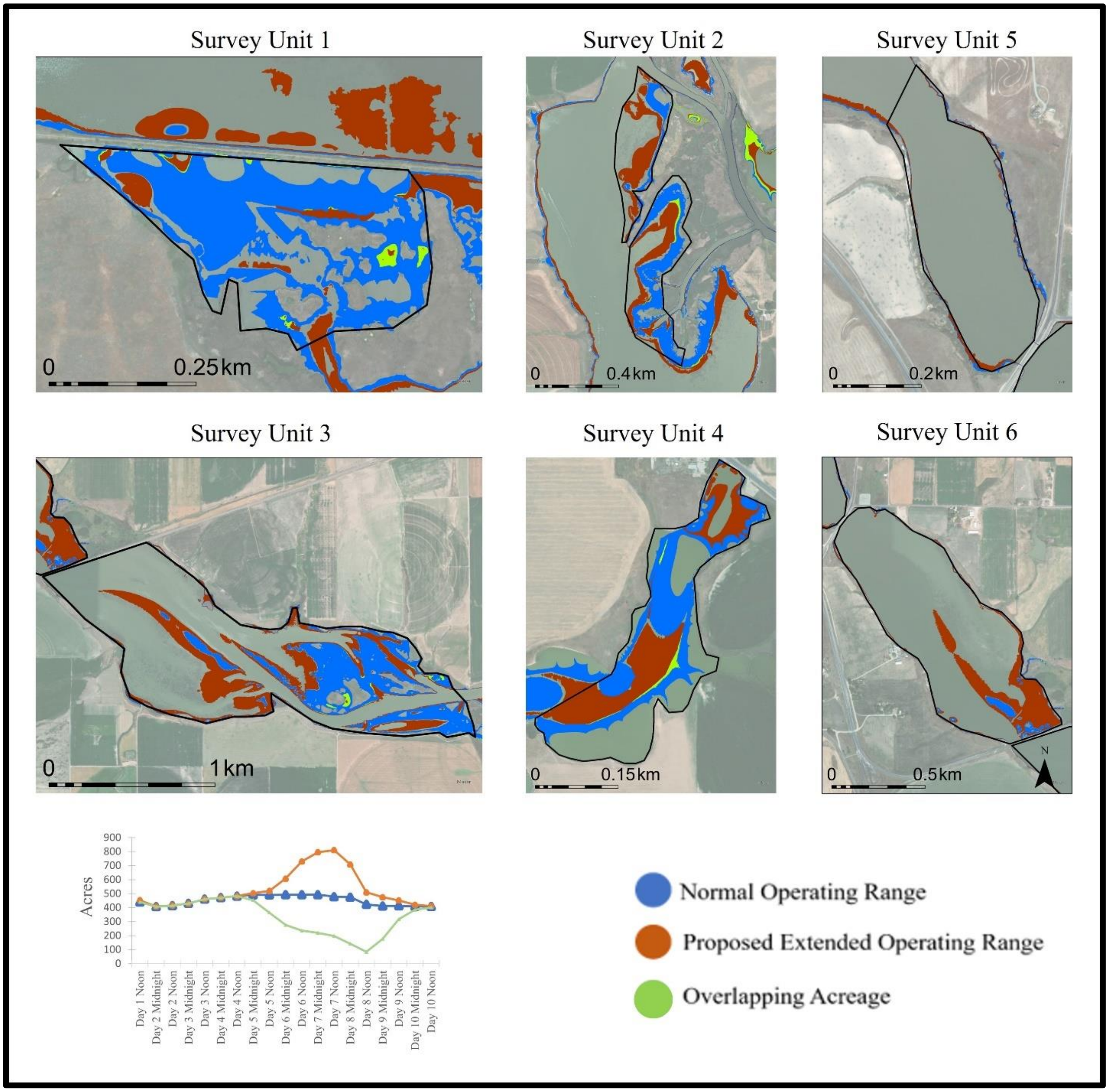


FIGURE 6-8 LOCATION OF 0 TO 30 CM WATER-DEPTH CLASS AND TOTAL ACRES OF HABITAT IN THE STUDY AREA

6.4.6 WATER-DEPTH CLASS OF 18 TO 40 CENTIMETERS

Gadwalls (*Anas strepera*) utilize a water-depth class between 18 and 40 cm deep for foraging and were observed at Survey Units 1, 2, 3, 5, and 6 in all months except for January (Table 6-2, Table 6-3). Foraging habitat in this depth class is available in all survey units, with the least habitat amount in Survey Unit 5 (Figure 6-9). For the 12-hour period shown in Figure 6-9 (i.e., the interval when projected differences between the current and proposed operating scenarios are greatest), there would potentially be very limited overlapping (but may be adjacent) habitat between the current operating range and the proposed extended operating range, meaning that any gadwalls utilizing the area would likely need to locate new suitable foraging habitat during part of the 10-day cycle of proposed extended operations.

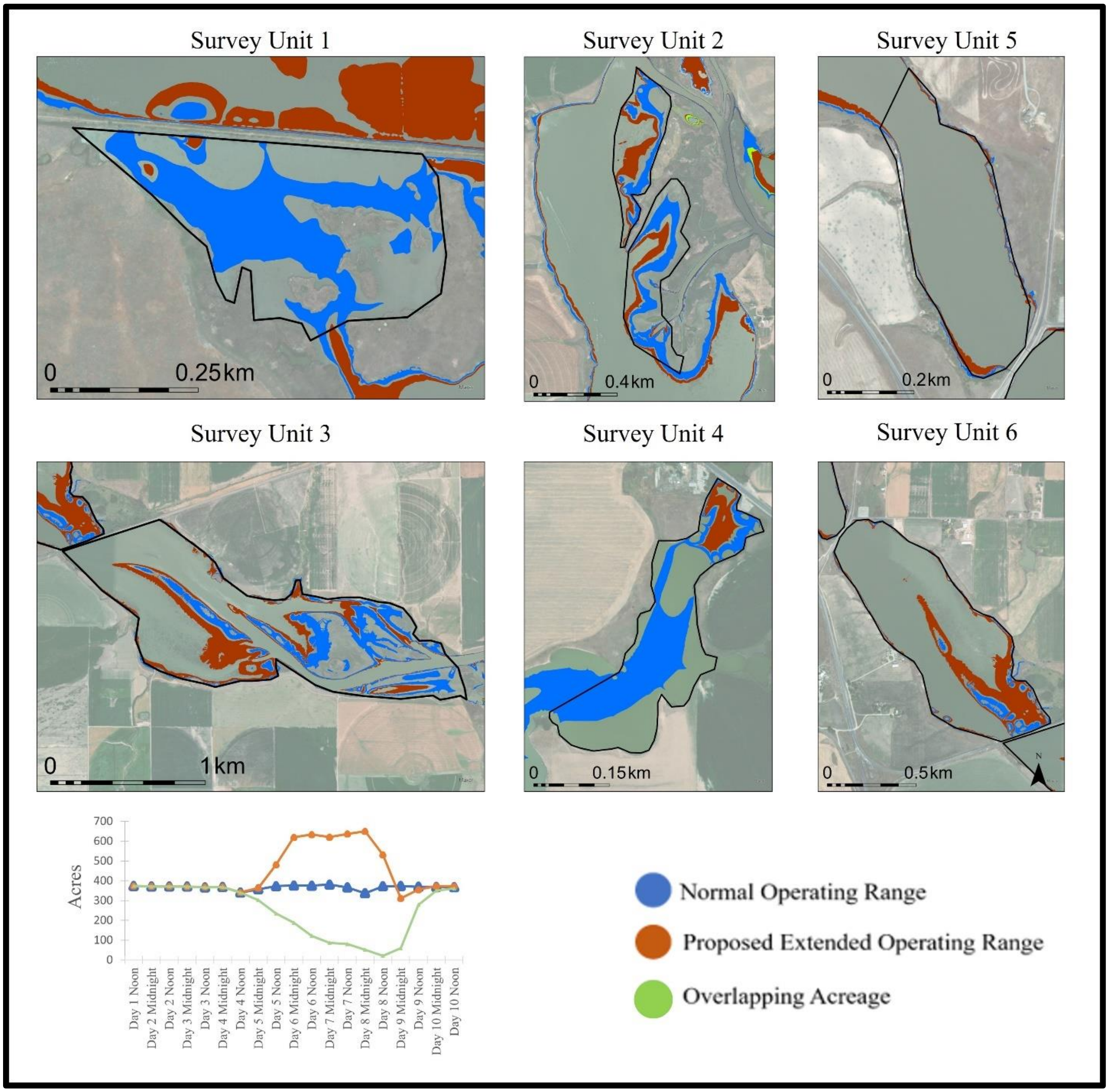


FIGURE 6-9 LOCATION OF 18 TO 40 CM WATER-DEPTH CLASS AND TOTAL ACRES OF HABITAT IN STUDY AREA

Survey Unit 1 would lose much of its habitat in this depth class under the proposed extended operating range and therefore would potentially become less suitable for foraging gadwalls.

Survey Units 2, 3, and 6 could realize potential shifts in habitat availability within the same survey unit. Habitat under the current operating range is often located adjacent to the habitat available under the proposed extended operating range (Figure 6-9). Gadwalls were noted most often in Survey Units 3 and 6 and, should this species continue to utilize these units' habitat, would be available in the same general location as under the current operating range. Survey Unit 4 could lose much of its habitat in this depth class, with only a small amount remaining in the northern part of the unit. No gadwalls were observed in Survey Unit 4 and it seems unlikely this species would begin using this Survey Unit with more frequency than under the current operating conditions. Survey Unit 5 could gain a small amount of habitat compared to the current operating range; however, only a single gadwall was noted in Survey Unit 5.

The habitat changes depicted in Figure 6-9 and described previously provide the local variation that could occur under the proposed extended reservoir operating range relative to the current operating range. Overall, there would potentially be the same amount or substantially more habitat of this water-depth class, in mostly the same areas, over the 10-day cycle of operations under the proposed extended operating range.

6.4.7 WATER-DEPTH CLASS OF 0 TO 40 CENTIMETERS

Great blue herons, mallards, and marsh wrens utilize a water-depth class between 0 and 40 cm deep for foraging. All three of these species were observed in various survey units from November through the end of March (Table 6-2, Table 6-3). Only one marsh wren and 10 great blue herons were observed over the five-month survey period, suggesting that while these species are present, they may not be that common near the reservoir during the period of interest. Mallards, however, were recorded in every survey unit and during every month except for January.

The 0 to 40 cm water-depth class is available in every survey unit (Figure 6-10). Habitat in this depth class under the current operating range is often located adjacent to the habitat available under the proposed extended operating range. Given the location of the 0 to 40 cm water-depth class under the current operating range and the proposed extended operating range, some changes in foraging habitat usage would potentially be expected for these three species.

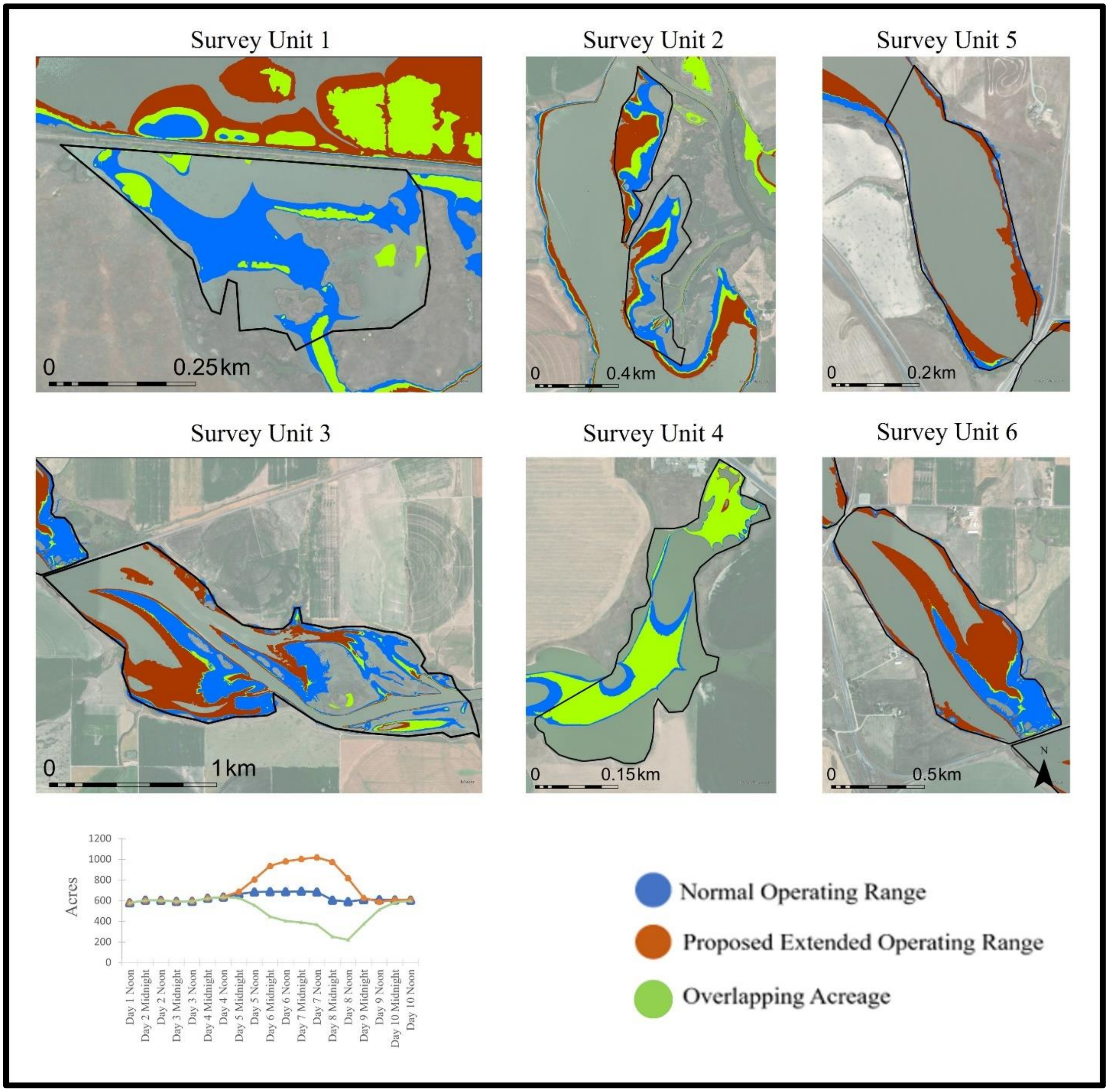


FIGURE 6-10 LOCATION OF 0 TO 40 CM WATER-DEPTH CLASS AND TOTAL ACRES OF HABITAT IN STUDY AREA

In Survey Unit 1, habitat would potentially shift from available along the south side of the trail to mostly available on the north side of the trail (Figure 6-10). For all three species utilizing this water-depth class, Survey Unit 1 received little to no detected use (Table 6-2). Survey Units 2, 3, and 6 would potentially realize shifts in habitat availability within the same survey unit. Mallards were noted most often in these three units, along with the occasional great blue heron. Should these three species continue or start utilizing these units, foraging habitat would be available in the same general location as under the current operating range. Survey Unit 4 would remain mostly unchanged, with slightly less habitat potentially available under the proposed extended operating range. Survey Unit 4 received the most use by great blue herons and the only recorded marsh wren. The small potential amount of change in foraging habitat availability in this unit would likely maintain this area as a suitable spot for great blue herons and marsh wrens. Survey Unit 5 would potentially gain habitat under the proposed extended operating range compared to the current operating range. This Survey Unit received very little use by mallards and great blue herons, and no detected use by marsh wrens. The increase in foraging habitat availability may potentially encourage more utilization by these species under the proposed extended operating range.

The habitat changes depicted in Figure 6-10 and described previously depict the local variation that would potentially occur under the proposed extended reservoir operating range relative to the current operating range. Overall, under the proposed extended operating range there would be the same or substantially more habitat of this water-depth class, in mostly the same areas, available over the 10-day cycle of operations (Figure 6-10).

6.4.8 WATER-DEPTH CLASS OF 0 TO 100 CENTIMETERS

Redheads (*Aythya americana*) and tundra swans (*Cygnus columbianus*) utilize a water-depth class between 0 and 100 cm deep for foraging. Redheads were noted in Survey Units 1, 2, 3, and 6 in November, December, and March. Tundra swans were observed in Survey Units 3 and 6 in November and March (Table 6-2, Table 6-3). Habitat is available in all units under the current operating range, although there was no detected use in some units, as shown in Figure 6-11. There is a large amount of overlap between the current operating range and the proposed extended operating range for all survey units, except for Survey Unit 1. Any redheads or tundra swans utilizing these survey units would not have to change their habitat use to a great extent, although some local shifts would potentially be expected.

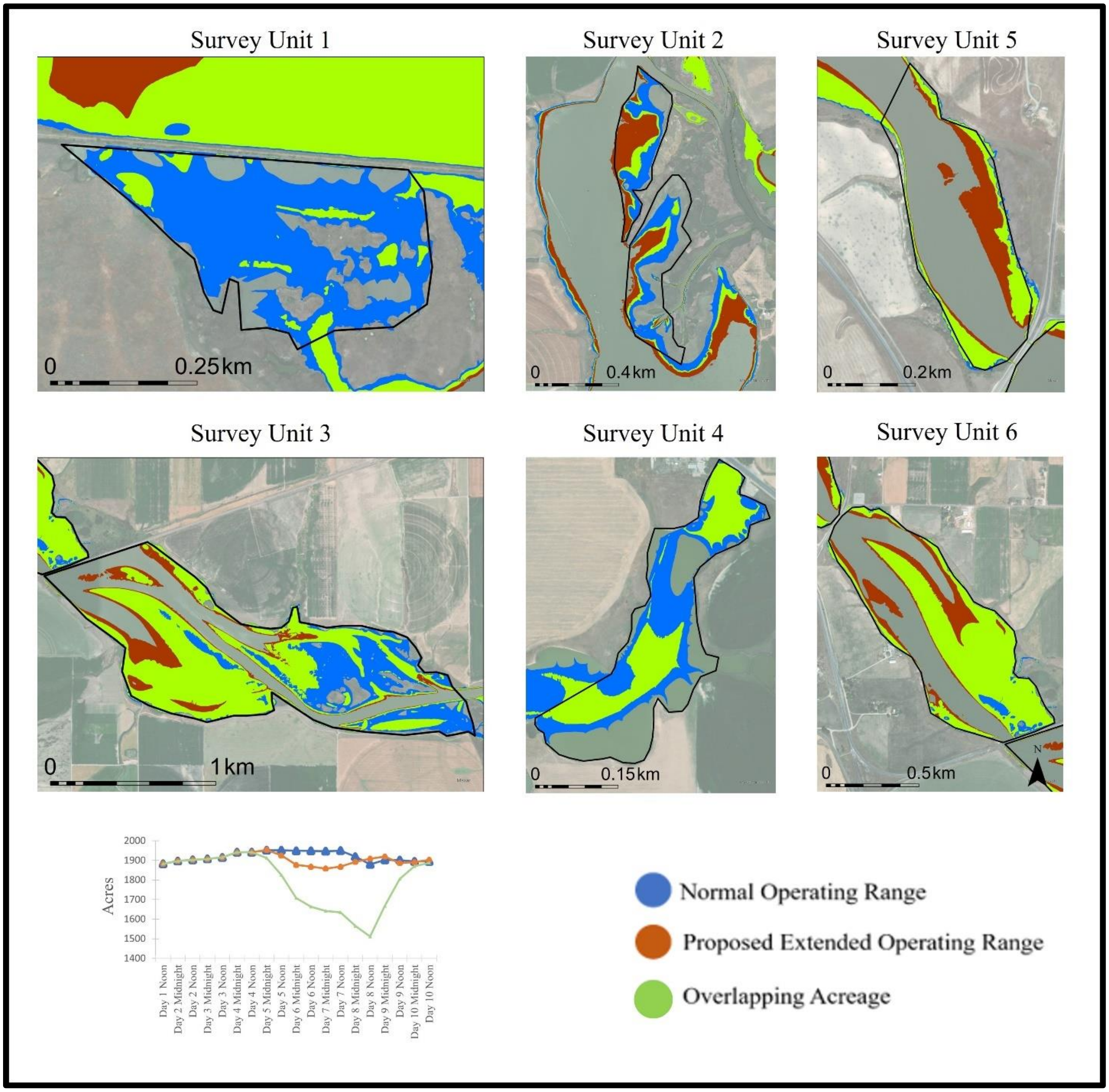


FIGURE 6-11 LOCATION OF 0 TO 100 CM WATER-DEPTH CLASS AND TOTAL ACRES OF HABITAT IN STUDY AREA

Survey Unit 1 would lose the most habitat in this depth class, with a relatively limited amount remaining throughout the unit. However, note that only three redheads and no tundra swans were observed using this unit; less use (resulting from less availability) would potentially be expected under the proposed extended operating range. While Survey Units 2, 3, and 4 would potentially lose some foraging habitat for these species overall, a large amount would remain unchanged from the current operating range. No redheads nor tundra swans were observed in Survey Unit 4.

Should these species continue to or start using these units (2,3, or 4, respectively), habitat would be available in the same general location as under the current operating range. Survey Units 5 and 6 would potentially gain habitat compared to existing conditions; however, neither species was observed utilizing Survey Unit 5. It is possible Survey Unit 5 could receive more use in the future due to the increase in foraging habitat availability. Only two tundra swans were observed in Survey Unit 6, but it was the most-utilized survey unit for redheads. The potential increase in habitat may retain or increase its use compared to the current operating range for these two species.

The habitat changes depicted in Figure 6-11 and described previously show the local variation that would potentially occur under the proposed extended reservoir operating range relative to the current operating range. Overall, under the proposed extended operating range there would potentially be the same or slightly less habitat of this water-depth class, in mostly the same areas, available over the 10-day cycle of operations (Figure 6-11).

6.4.9 WATER-DEPTH CLASS OF 0 TO 150 CENTIMETERS

Ring-necked ducks utilize a water-depth class between 0 and 150 cm deep for foraging. Only a single ring-necked duck was observed in Survey Unit 3 in February (Table 6-2, Table 6-3).

Suitable foraging habitat was available for this species in all survey units as shown in Figure 6-12. It is likely that this species was not observed in survey units other than unit 3 due to low overall numbers of this species utilizing the Project area from November to March. Records from eBird indicate substantial usage of nearby sewage lagoons by this species during this time period (Cornell Lab of Ornithology 2021b). Should this pattern change, and ring-necked ducks begin to utilize the survey units during the period of interest, habitat would potentially be available in all survey units under the proposed extended operating range (Figure 6-12).

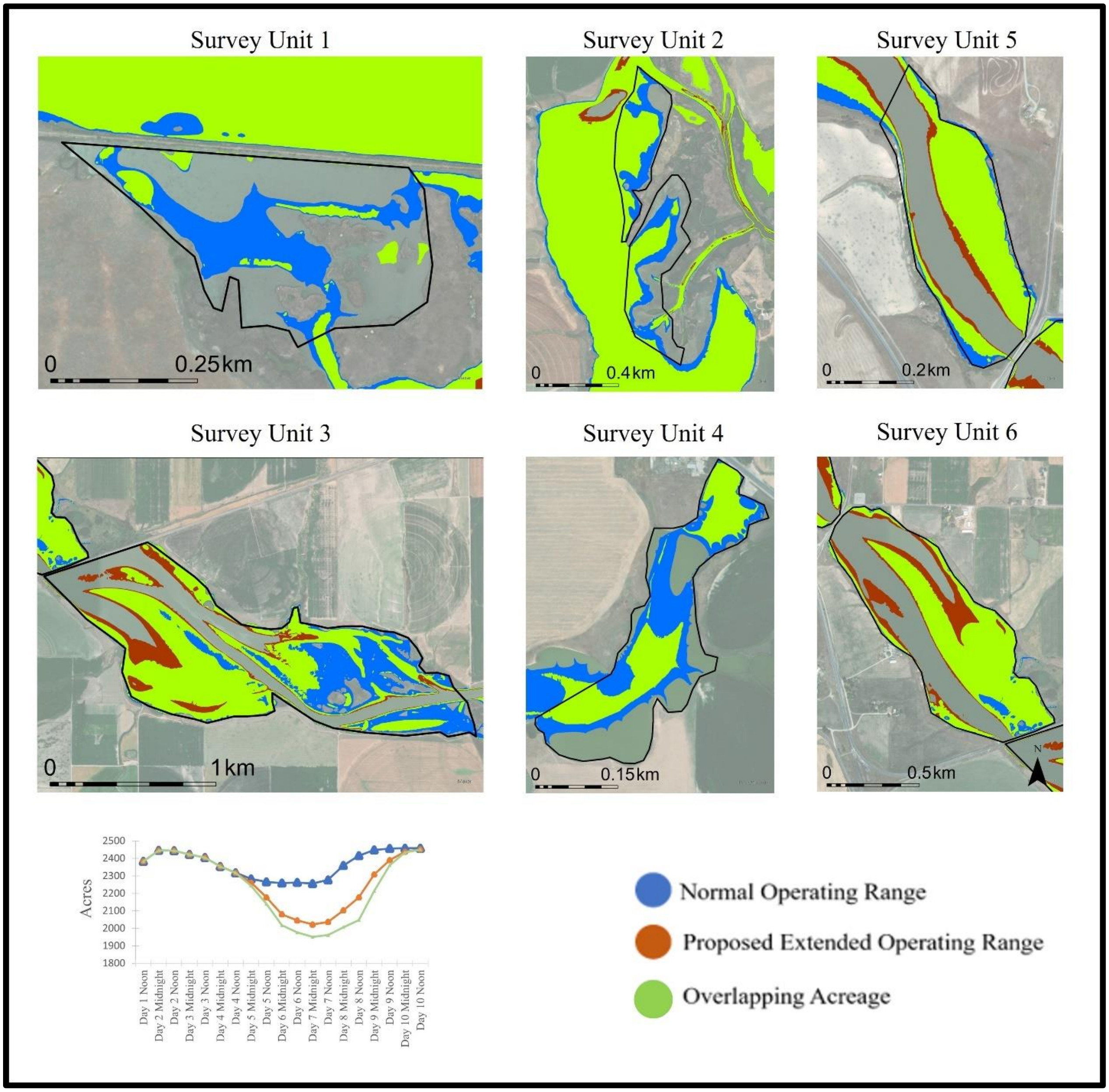


FIGURE 6-12 LOCATION OF 0 TO 150 CM WATER-DEPTH CLASS AND TOTAL ACRES OF HABITAT IN THE STUDY AREA

6.4.10 WATER-DEPTH CLASS OF 0 TO 200 CENTIMETERS

Ruddy ducks (*Oxyura jamaicensis*) utilize water-depth classes between 0 and 200 cm deep for foraging. Ten ruddy ducks were observed in March in Survey Units 1, 2, 3, and 6 (Table 6-2, Table 6-3). This water-depth class is available in all survey units as shown in Figure 6-13. There would potentially be a large amount of overlap between the current operating range and the proposed extended operating range, except for Survey Unit 1. Any ruddy ducks potentially utilizing these survey units would not have to change their habitat use to a great extent, although some shifts would be expected.

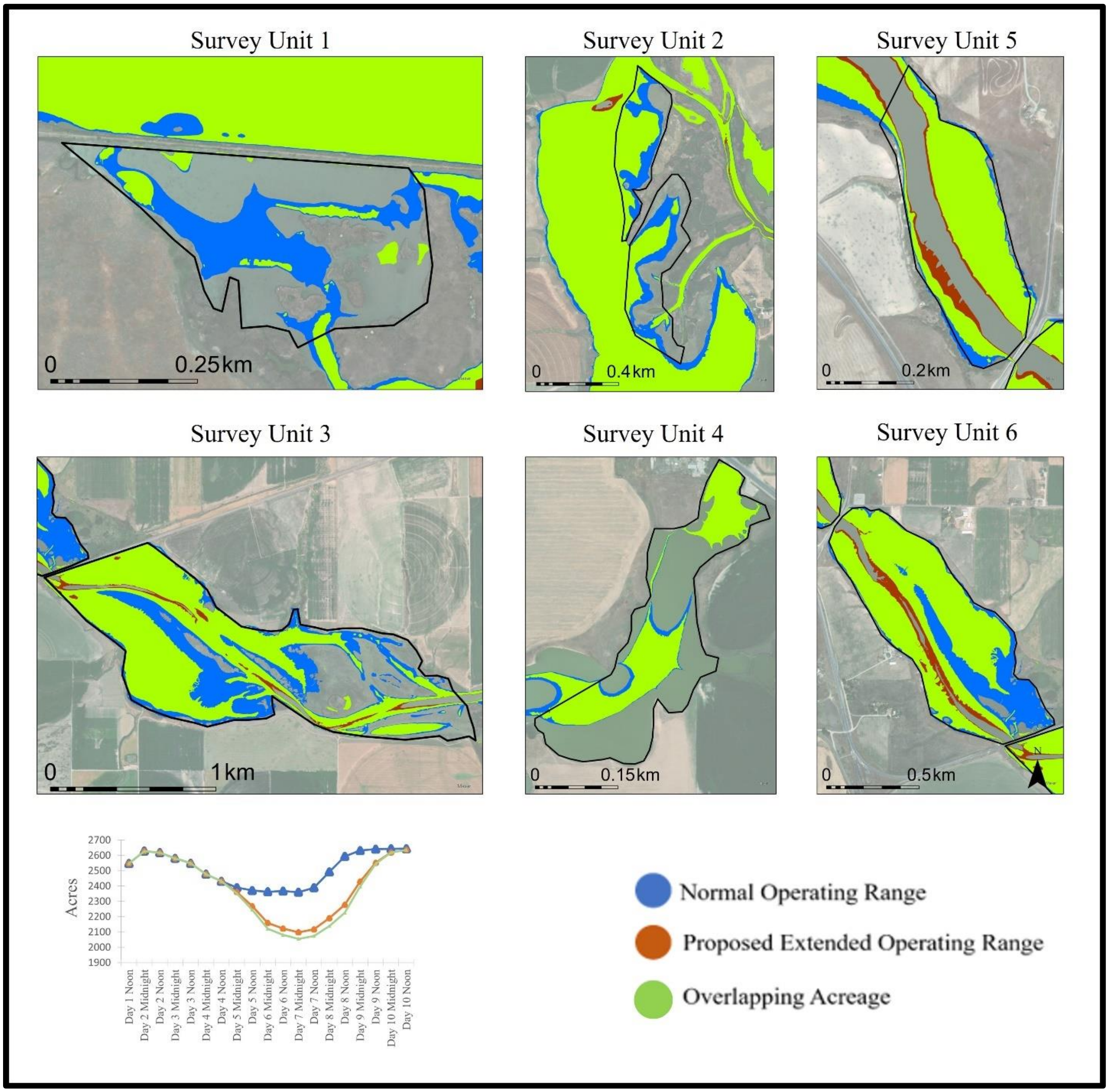


FIGURE 6-13 LOCATION OF 0 TO 200 CM WATER-DEPTH CLASS AND TOTAL ACRES OF HABITAT IN STUDY AREA

Survey Unit 1 could lose the most habitat in this depth class under the proposed extended operating range, with a relatively limited amount of habitat potentially remaining throughout the Survey Unit. However, note that only one ruddy duck was observed in this unit, suggesting this area may not receive much use from ruddy ducks. Given the potential reduction of suitable foraging habitat within Survey Unit 1 under the proposed extended operating range, this area would likely continue to realize limited use. While Survey Units 2, 3, 4, and 6 would potentially lose some habitat overall, a large amount of the habitat would remain in the same general locations as under the current operating range. Should this species continue or start utilizing these units, habitat would potentially be available in the same general location as under the current operating range. Survey Unit 5 would potentially gain habitat compared to existing conditions. While no ruddy ducks were observed in Survey Unit 5, it is possible it could receive increased use in the future due to the potential increase in habitat availability.

The potential habitat changes depicted in Figure 6-13 and described previously show the local variation that could occur under the proposed extended reservoir operating range relative to the current operating range. There would potentially be less habitat of this water-depth class relative to current operations for most of the 10-day cycle of the proposed extended operations, with most of the acreage reduction occurring on the margins, and the central areas remaining suitable (Figure 6-13).

6.4.11 WATER-DEPTH CLASS OF 50 TO 200 CENTIMETERS

Canvasbacks (*Aythya valisineria*) utilize a water-depth class between 50 and 200 cm deep for foraging. Nine canvasbacks were observed in Survey Units 2, 3, 4, and 6 in November, December, and March (Table 6-2, Table 6-3). This water-depth class is available in all Survey Units except for Survey Unit 1, as shown in Figure 6-14.

Survey Unit 2 would potentially lose most of its habitat in this water-depth class under the proposed extended operating range. Any canvasbacks utilizing this unit would likely need to locate new suitable foraging habitat during part of the 10-day cycle of proposed extended operations.

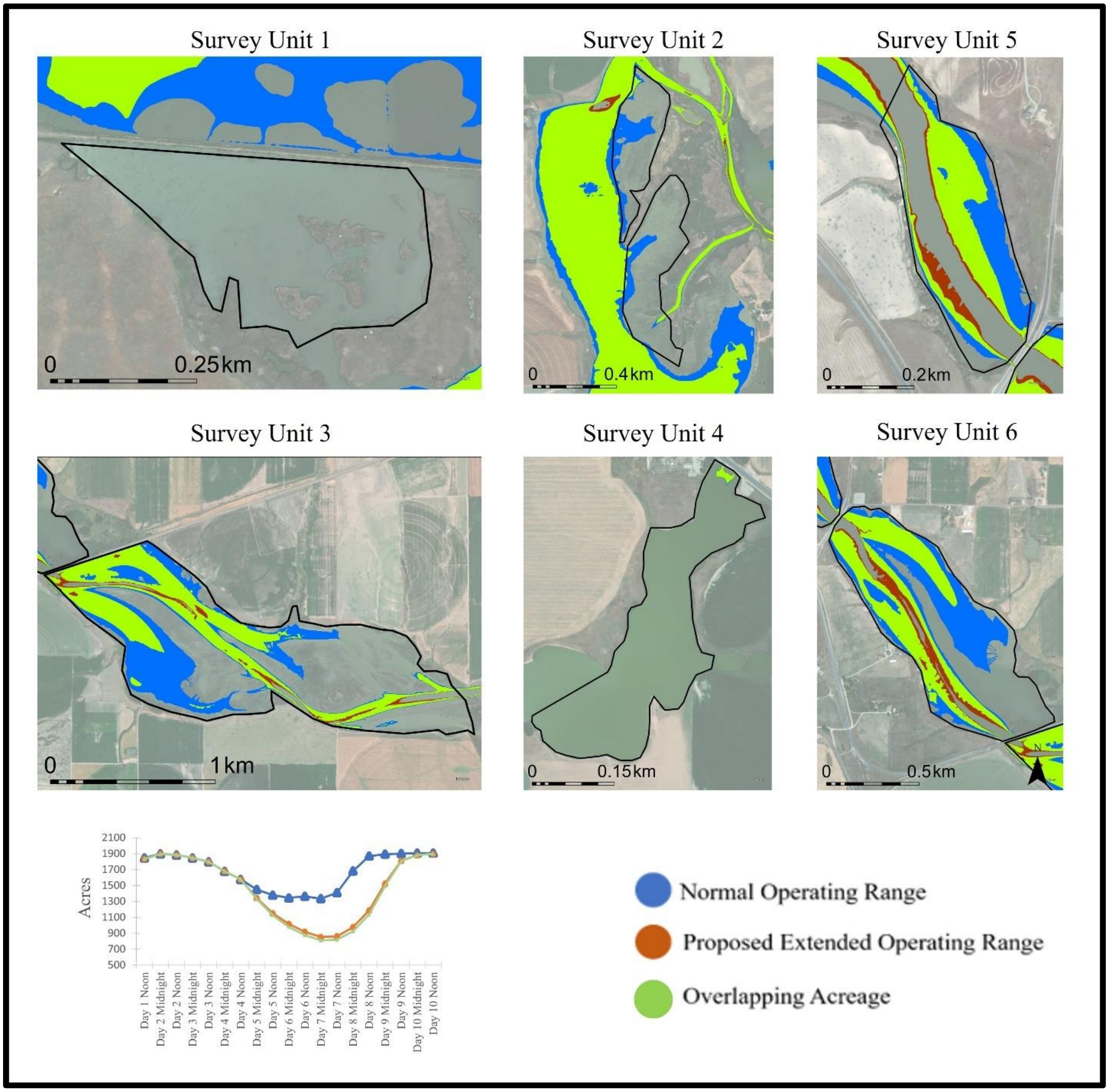


FIGURE 6-14 LOCATION OF 50 TO 200 CM WATER-DEPTH CLASS AND TOTAL ACRES OF HABITAT IN STUDY AREA

Survey Units 3, 5, and 6 would potentially lose some suitable foraging habitat overall, but suitable habitat would remain within the survey units where it is currently located. While there is generally less habitat available, should this species continue or start using these units, habitat in this depth class would potentially be available in the same general location as under the current operating range. Survey Unit 4 has very little habitat in this depth class under both the current operating range and the proposed extended operating range; only a single canvasback was recorded in Survey Unit 4 in the small patch of suitable habitat (Figure 6-14). This patch of habitat would potentially exist under both operating conditions.

The habitat changes depicted in Figure 6-14 and described previously show the local variation that would potentially occur under the proposed extended reservoir operating range relative to the current operating range. There would potentially be less habitat of this water-depth class, relative to current operations, for most of the 10-day cycle of the proposed extended operations, with most of the potential acreage reduction occurring on the margins, and the central areas remaining suitable or expanding towards the center of the unit (Figure 6-14).

6.4.12 WATER-DEPTH CLASS OF 0 TO 250 CENTIMETERS

American white pelicans (*Pelecanus erythrorhynchos*) utilize a water-depth class between 0 and 250 cm deep for foraging. Six American white pelicans were recorded in Survey Units 1, 3, and 4 in November and March (Table 6-2, Table 6-3); other units had suitable habitats but were not utilized as shown in Figure 6-15. There is a large amount of overlap between the current operating range and the proposed extended operating range for all survey units, except in Survey Unit 1. Any American white pelicans potentially utilizing these survey units would not have to change their habitat use to a great extent, although some shifts would be expected.

Survey Unit 1 would potentially lose the most habitat, with a limited amount remaining throughout the Survey Unit. Because the six American white pelicans observed used Survey Unit 1 the most, it is assumed that this area may provide important foraging needs for pelicans compared to the other units. Given the potential reduction of suitable foraging habitat within Survey Unit 1 under the proposed extended operating range, this area may receive less use. While Survey Units 2, 3, 4, and 6 would potentially lose some habitat overall, a large amount would remain where it is located under the current operating range. Should this species continue or start using these units, habitat would be potentially available in the same general location as under the current operating range.

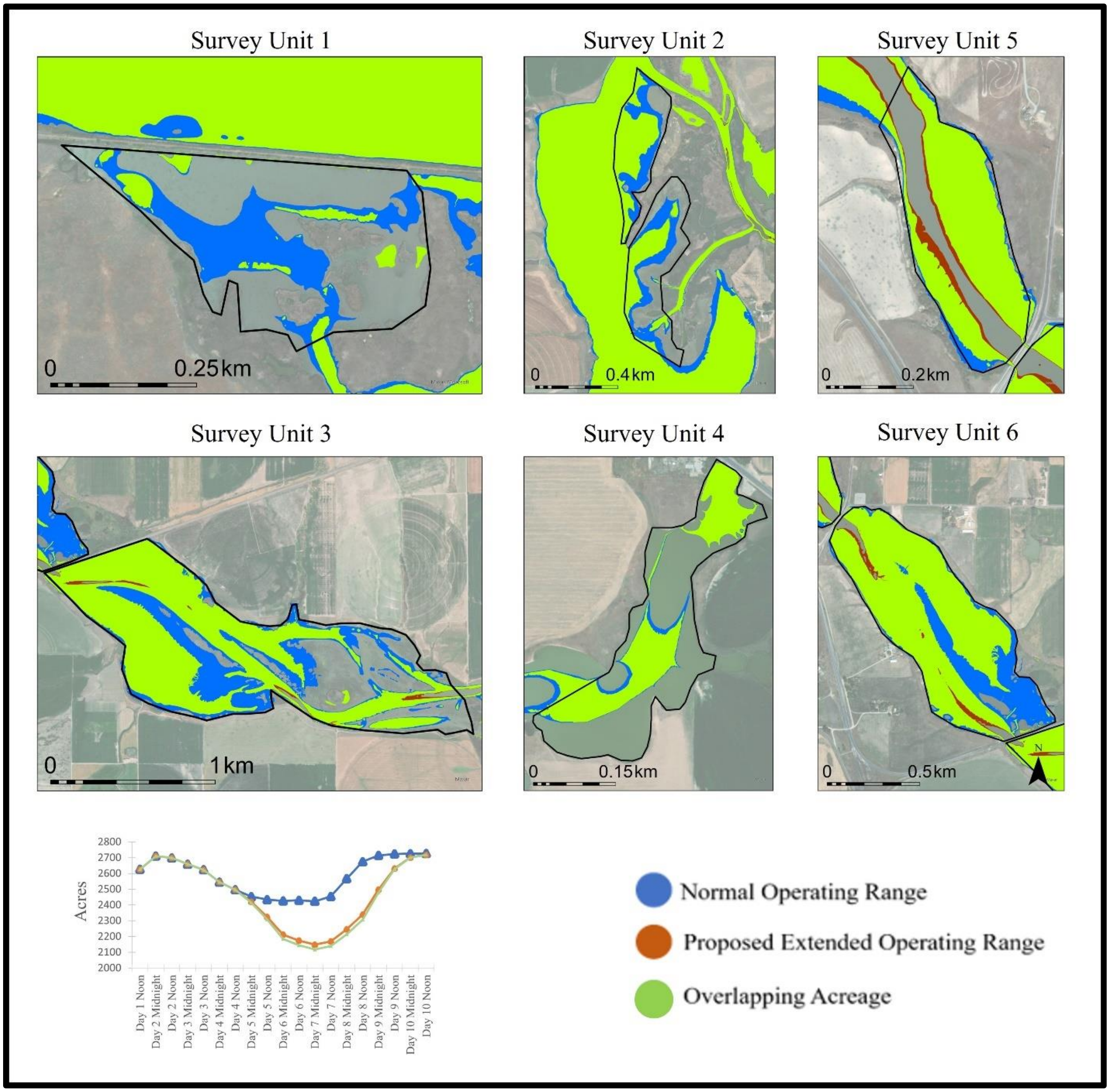


FIGURE 6-15 LOCATION OF 0 TO 250 CM WATER-DEPTH CLASS AND TOTAL ACRES OF HABITAT IN THE STUDY AREA

Survey Unit 5 would potentially gain habitat compared to existing conditions. While no American white pelicans were observed in Survey Unit 5, it is possible that this unit could receive increased use in the future due to the increase in habitat availability. It is also possible that no individuals were observed in this unit simply due to the low number of American white pelicans observed in the survey units overall during the relevant seasonal period.

The potential habitat changes depicted in Figure 6-15 and described previously show the local variation that would occur under the proposed extended reservoir operating range relative to the current operating range. There would potentially be less habitat of this water-depth class relative to current operations for most of the 10-day cycle of the proposed extended operations, with most of the acreage reduction occurring on the margins and the central areas remaining suitable or expanding towards the center of the unit.

6.4.13 WATER-DEPTH CLASS OF 0 TO 300 CENTIMETERS

Bufflehead (*Bucephala albeola*) and western grebes (*Aechmophorus occidentalis*) utilize a water-depth class between 0 and 300 cm deep for foraging. Five bufflehead were observed in March in Survey Units 2, 3, and 4 and 20 western grebes were observed in November and March in Survey Units 1, 2, 3, 5, and 6 (Table 6-2, Table 6-3). Habitat was available in all six survey units (Figure 6-16), although neither species were observed utilizing all units. There is a large amount of potential overlap between the current operating range and the proposed extended operating range for all survey units, except Survey Unit 1. Bufflehead or western grebes potentially utilizing these survey units would not have to change their habitat use much, although some shifts would be expected.

Survey Unit 1 would potentially lose the most habitat, with a limited amount remaining throughout the unit. No bufflehead were recorded in this unit, despite the large amount of available habitat under the current operating range. Two western grebes were observed in Survey Unit 1. Under the proposed extended operating range, this area may receive less use. While Survey Units 2, 3, 4, and 6 would lose some foraging habitat in this depth class, a large amount would remain where it is located under the current operating range. Should these species continue or start using these units, habitat would potentially be available in the same general location as under the current operating range. Survey Unit 5 would potentially gain habitat compared to existing conditions. Three western grebes were observed in Survey Unit 5, however no bufflehead were observed. It is possible this unit could receive increased use in the future due to the increase in habitat availability under the proposed extended operating range.

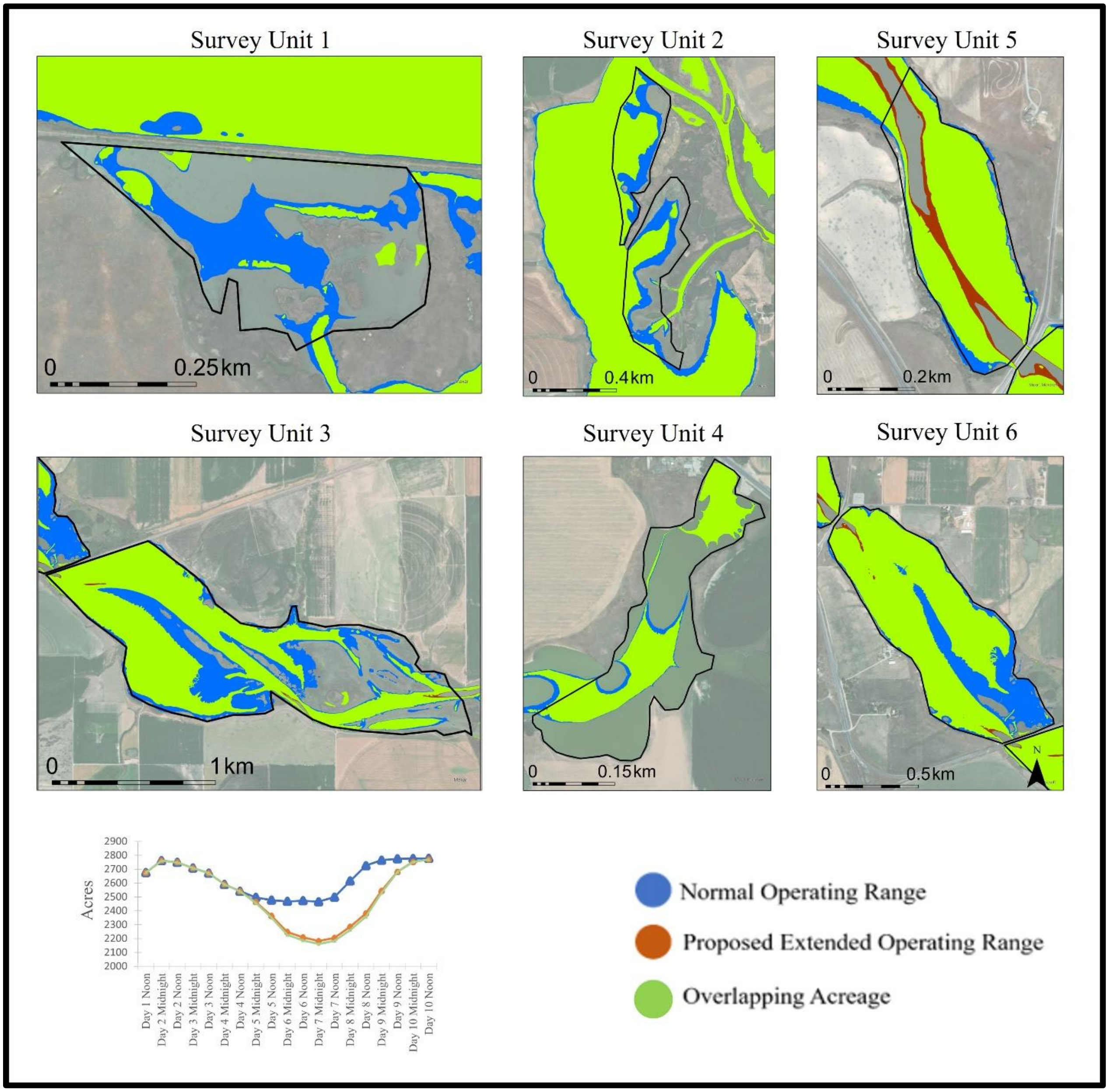


FIGURE 6-16 LOCATION OF 0 TO 300 CM WATER-DEPTH CLASS AND TOTAL ACRES OF HABITAT IN STUDY AREA

The potential habitat changes depicted in Figure 6-16 and previously described confirm that the local variation could occur under the proposed extended reservoir operating range relative to the current operating range. There would potentially be less habitat of this water-depth class relative to current operations for most of the 10-day cycle of the proposed extended operations, with most of the acreage reduction occurring on the margins, and the central areas remaining suitable or expanding towards the center of the unit.

6.4.14 WATER-DEPTH CLASS OF 0 TO 400 CENTIMETERS

Barrow's goldeneyes (*Bucephala islandica*), Clark's grebes (*Aechmophorus clarkia*), common goldeneyes (*Bucephala clangula*), and common mergansers utilize a water-depth class between 0 and 400 cm deep for foraging. All four of these species were observed in various survey units from November through the end of March, except for January (Table 6-2, Table 6-3). Habitat was available in all survey units despite their varied use (Figure 6-17). There is a large amount of overlap between the current reservoir operating range and the proposed extended operating range for all survey units, except Survey Unit 1. Any of the four species potentially utilizing these survey units would not have to change their habitat use to a great extent from that under the current operating range, although some shifts would potentially be expected.

Survey Unit 1 would potentially lose the most habitat, with a limited amount of habitat remaining throughout the unit. Only common mergansers were observed in Survey Unit 1, and it was the least used Survey Unit for this species. While Survey Units 2, 3, 4, 5, and 6 would potentially lose some habitat, under the proposed expanded range, a large amount would remain where it is located under the current operating range. Should these species continue or start utilizing these units, foraging habitat in this depth class would be available in the same general location as under the current operating range.

The potential habitat changes depicted in Figure 6-17 and described previously show that the local variation could occur under the proposed extended reservoir operating range relative to the current operating range. There would potentially be less habitat of this water-depth class relative to current operations for most of the 10-day cycle of the proposed extended operations, with most of the potential acreage reduction occurring on the margins and the central areas remaining suitable or expanding towards the center of the unit.

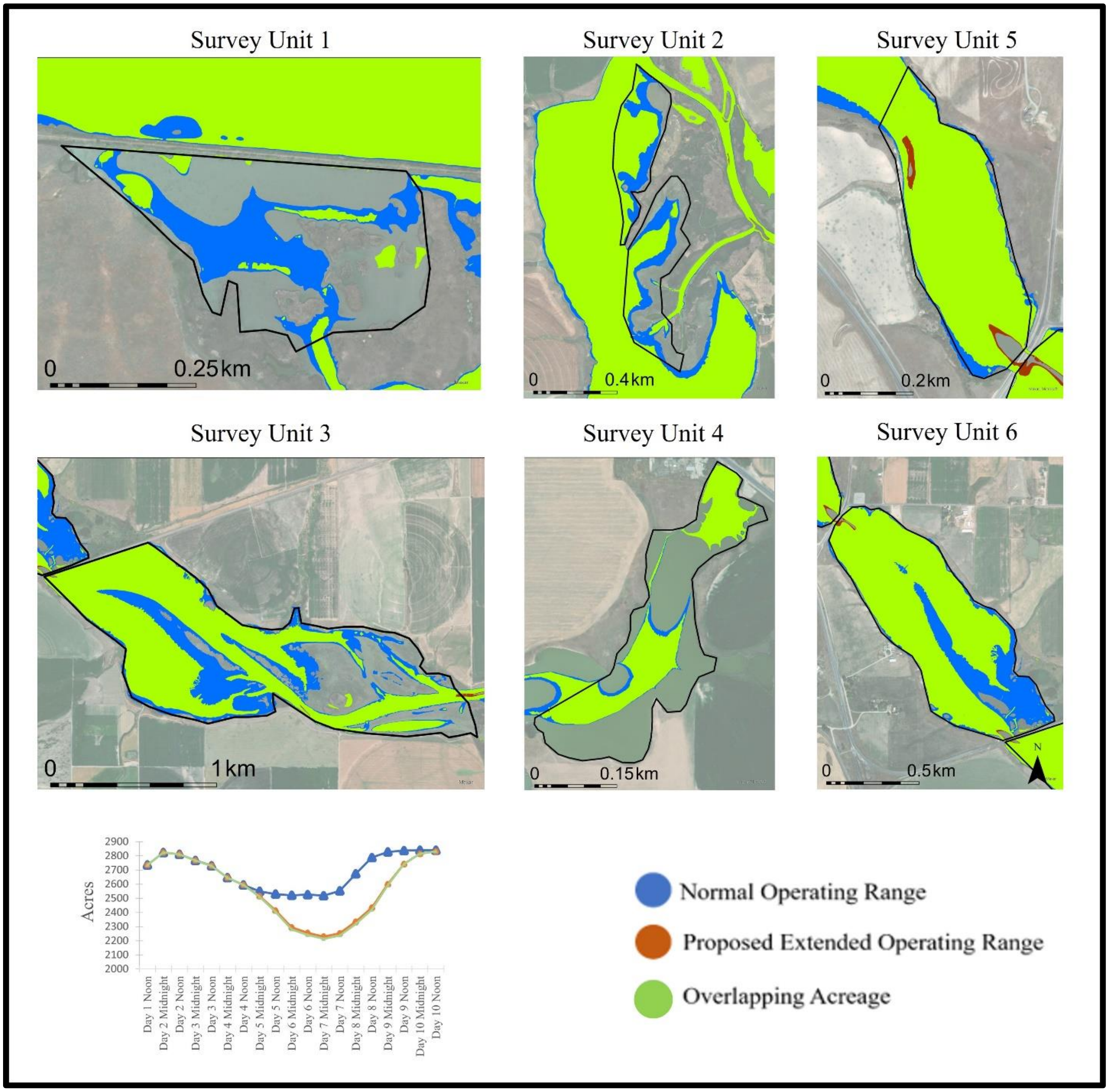


FIGURE 6-17 LOCATION OF 0 TO 400 CM WATER-DEPTH CLASS AND TOTAL ACRES OF HABITAT IN STUDY AREA

6.4.15 WATER-DEPTH CLASS OF 0 TO 500 CENTIMETERS

Eared grebes (*Podiceps nigricollis*), lesser scaup (*Aythya affinis*), pied-billed grebes, and red-breasted mergansers utilize a water-depth class between 0 and 500 cm deep for foraging. All four of these species were observed in various survey units from November through the end of March, except for January (Table 6-2, Table 6-3). Habitat is available in all units despite their varied use (Figure 6-18). There is a large amount of overlap between the current operating range and the proposed extended operating range for all survey units, except Survey Unit 1. Any of the four species potentially utilizing these survey units would not have to change their habitat use to a great extent, although some shifts may be expected.

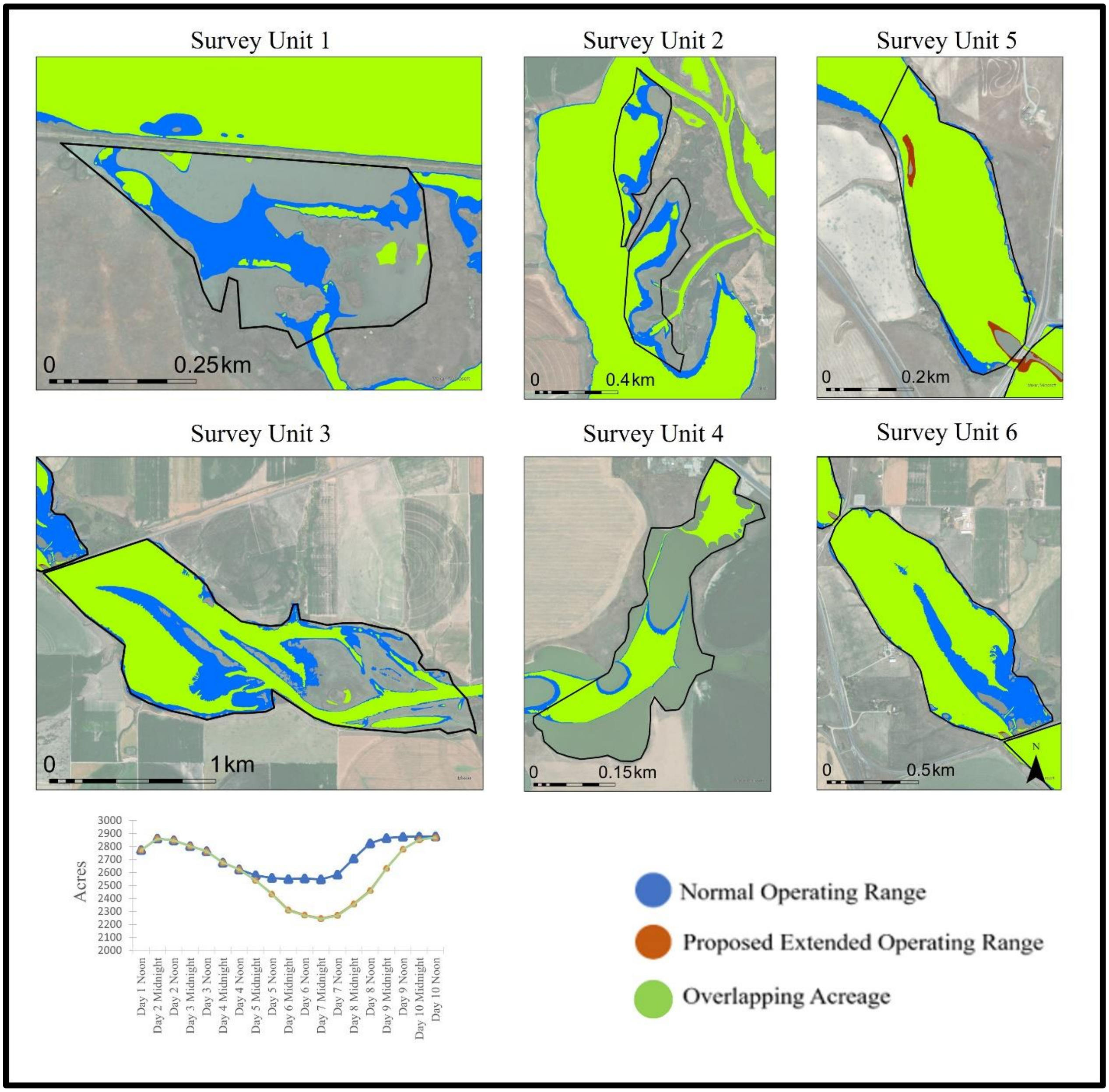


FIGURE 6-18 LOCATION OF 0 TO 500 CM WATER-DEPTH CLASS AND TOTAL ACRES OF HABITAT IN STUDY AREA

Only eared grebes and pied-billed grebes were recorded in Survey Unit 1. Survey Unit 1 would potentially lose the most foraging habitat in this depth class, with a limited amount remaining. While Survey Units 2, 3, 4, 5, and 6 would potentially lose some habitat overall, a large amount would remain as it is located under the current operating range. Should these species continue or start utilizing these units, habitat would be available in the same general location as under the current operating range.

The potential habitat changes depicted in Figure 6-18 and described previously show the local variation that could occur under the proposed extended reservoir operating range relative to the current operating range. There would potentially be less habitat of this water-depth class, relative to current operations, for much of the 10-day cycle of the proposed extended operations, with most of the acreage reduction occurring on the margins, and the central areas remaining suitable or expanding towards the center of the unit.

6.4.16 ALL WATER IN RESERVOIR

American coots (*Fulica americana*), American wigeon (*Mareca americana*), bald eagles (*Haliaeetus leucocephalus*), belted kingfishers (*Megaceryle alcyon*), Canada geese, California gulls (*Larus californicus*), double-crested cormorants (*Phalacrocorax auratus*), northern shovelers (*Anas clypeata*), and ring-billed gulls (*Larus delawarensis*) utilize all water-depth classes for foraging, and thus use the entire study area. All species in this water-depth class were observed utilizing a variety of survey units during various months except for January (Table 6-2, Table 6-3). All survey units have suitable habitat under the current and proposed extended operating range and all units have a large amount of overlap between the current operating range and the proposed extended operating range (Figure 6-19). The nine species utilizing these survey units would not have to potentially change their habitat use much, although some shifts may be expected.

The potential habitat changes depicted in Figure 6-19 and described previously show the local variation that could occur under the proposed extended operating range relative to the current operating range. There would potentially be less habitat of this water-depth class relative to current operations for some of the 10-day cycle (up to three days) of the proposed extended reservoir operations, with most of the acreage reduction occurring on the margins, and the central areas remaining suitable or expanding towards the center of the unit.

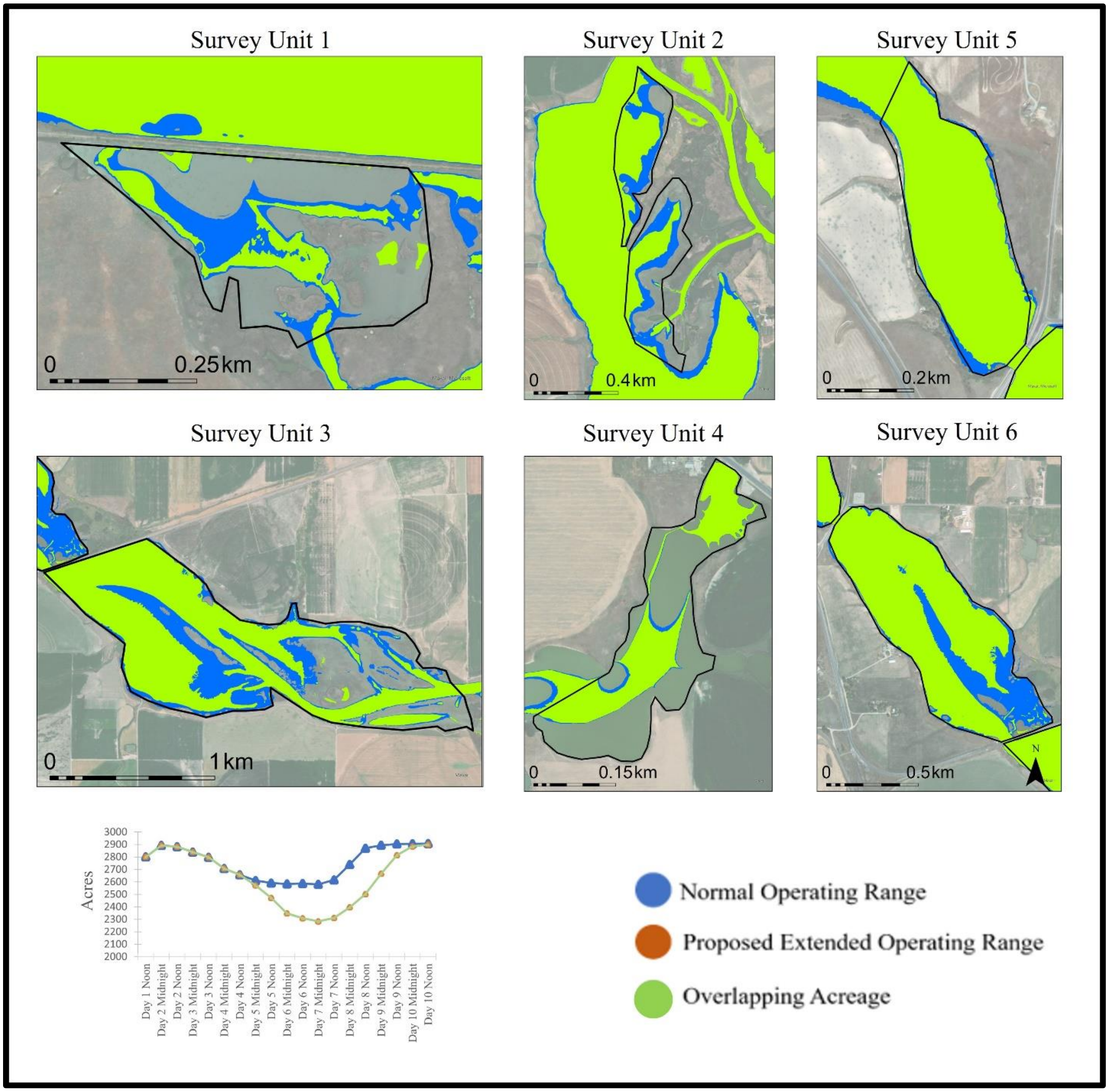


FIGURE 6-19 LOCATION OF ALL WATER-DEPTH CLASSES AND TOTAL ACRES OF HABITAT IN STUDY AREA

6.4.17 EFFECTS COMMON TO ALL WATER-DEPTH CLASSES

Wetland managers who are deliberately trying to attract specific guilds of migratory birds, including shorebirds, dabbling ducks, or diving ducks, frequently manipulate water depths over the course of weeks or months during the winter or early-spring seasons (Baschuk et al. 2012, Taft et al. 2002). Shallower winter and early-spring water depths often increase the diversity of species utilizing managed wetlands (Elphick and Oring 1998, Taft et al. 2002). While the proposed extended operating range would potentially reduce the water depth in some areas of the reservoir, it is possible, although not known, whether the temporary time period (occurring over 10-day cycles) would potentially lead to an increase in species diversity compared to what is observed under current operating conditions. Figure 6-4 to Figure 6-19 demonstrate the return to original habitat availability within 10 days; in fact, the greatest shift between the two ranges is typically present for approximately two days or less (and the greatest change is frequently within 12 hours) of the 10-day cycle.

The majority of birds observed during the surveys appear to utilize the survey units as temporary habitat during migration, as they were only observed during November and late-February to March. These species would be present for only a portion of the winter, limiting how often they could potentially be impacted by changing water levels in the reservoir.

A potential shift in foraging habitat usage for all species that currently utilize the reservoir during the affected season (November-March) could be expected given the demonstrated temporary change in habitat location at all water-depth classes. However, waterbirds are highly adapted to changing water levels, and thus changes in water-depth class availability, at many scales (Skagen and Knopf 1993). Birds that rely on aquatic habitat have adapted to the ephemerality of natural wetlands and are often seen utilizing many different locales within and among wetland complexes to meet their various habitat needs (Farmer and Parent 1997; Taft et al. 2002). Therefore, the likely outcome from the proposed extended operating range would be potential shifts in habitat use within the reservoir, or temporary displacement of the birds from some areas of the reservoir to other areas, until the appropriate water-depth classes were restored within the 10 day cycles. These potential changes may or may not be distinguishable from natural fluctuations or movements resulting from changes in temperature (and resultant ice cover), hunting pressure, and other factors present in the reservoir under the current operating range.

7.0 SUMMARY

This study implemented the methods specified for the FERC Project Boundary of the Shoreline Habitat Characterization as identified in the RSP and the ISR. The methods specified for Phase 2 have been completed. Phase 2 results identified the number of each species present at the reservoir during the period of the proposed extended reservoir operating range (November through the end of March). The use of each survey unit by all the species identified during the survey was evaluated to determine the potential magnitude of effects for each species under the proposed extended operating range. Given the selection of survey units with larger potential changes in water levels and a survey unit south of Benson Marina where modelled changes reported here may be higher in magnitude than reality given the unaccounted-for potential effect of groundwater exfiltration, the results are assumed to be conservative estimates of the potential magnitude of effects for each species under the proposed extended operating range. This study provides a sufficient basis for meeting the study objective, to conduct an impact analysis for the Draft License Application.

8.0 FUTURE STUDIES

The Phase 2 results presented in this USR represent the final study conducted for this resource.

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APPENDIX C

LAND USE UPDATED STUDY REPORT

LAND USE
UPDATED STUDY REPORT

CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

Prepared for:

PacifiCorp

Salt Lake City, UT

Prepared by:

Cirrus Ecological Solutions, LC

AUGUST 2021

LAND USE
UPDATED STUDY REPORT

CUTLER HYDROELECTRIC PROJECT
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LAND USE
UPDATED STUDY REPORT

CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)
PACIFICORP

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LAND USE
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CUTLER HYDROELECTRIC PROJECT
(FERC NO. 2420)

PACIFICORP

1.0 INTRODUCTION

The Cutler Hydroelectric Project (Project) Initial Study Report (ISR) was filed with the Federal Energy Regulatory Commission (FERC) on February 8, 2021. As noted in the ISR, this Land Use Updated Study Report (USR) addresses only the study results pertaining to bank stability downstream of Cutler Dam. This element of the Land Use Study was described in the Revised Study Plan (RSP) approved by FERC on February 7, 2020. The necessary field investigation of bank profiles was originally scheduled to occur in late winter/early spring of 2020, following the release of FERC's Study Plan Determination (SPD). However, field efforts were postponed partway through due to rapid seasonal changes in both temperature and flow volume that would have potentially confounded study results. Therefore, the field surveys were re-scheduled in December of 2020 and concluded in January 2021, after the ISR was drafted, resulting in this USR. A detailed description of the overall Land Use Study objectives, study area, methods, and results are provided in ISR Appendix D.

2.0 PROJECT NEXUS AND RATIONALE FOR STUDY

The Project's Preliminary Application Document (PAD), Sections 7.1.9 and 7.1.10 describe the nexus between future Project operations and land use. Proposed changes in operations could affect Bear River channel bank erosion and stability downstream of Cutler Dam. Any increase in bank erosion could lead to loss of land area, impacting wildlife habitat, livestock grazing, and agriculture. Eroding banks could contribute to water quality degradation and potentially affect aquatic species, which are discussed in the studies addressing those resources (ISR Appendices E and F).

The Land Use ISR (ISR Appendix D) provides an explanation of how the Project relates to land-use resources.

3.0 STUDY OBJECTIVES

Objectives for the Land Use Study are provided in the Land Use ISR (ISR Appendix D). This USR supplements information provided in the Land Use ISR, addressing the objectives for bank erosion on the Bear River downstream of Cutler Dam associated with proposed changes in Project operations.

3.1 STUDY AREA

This USR addresses study locations that lie between Cutler Dam and the city of Corinne (Figure 3-1). Land use in these locations is primarily agricultural or riparian/wetland buffer. ISR Appendix D provides a description of the full study area.

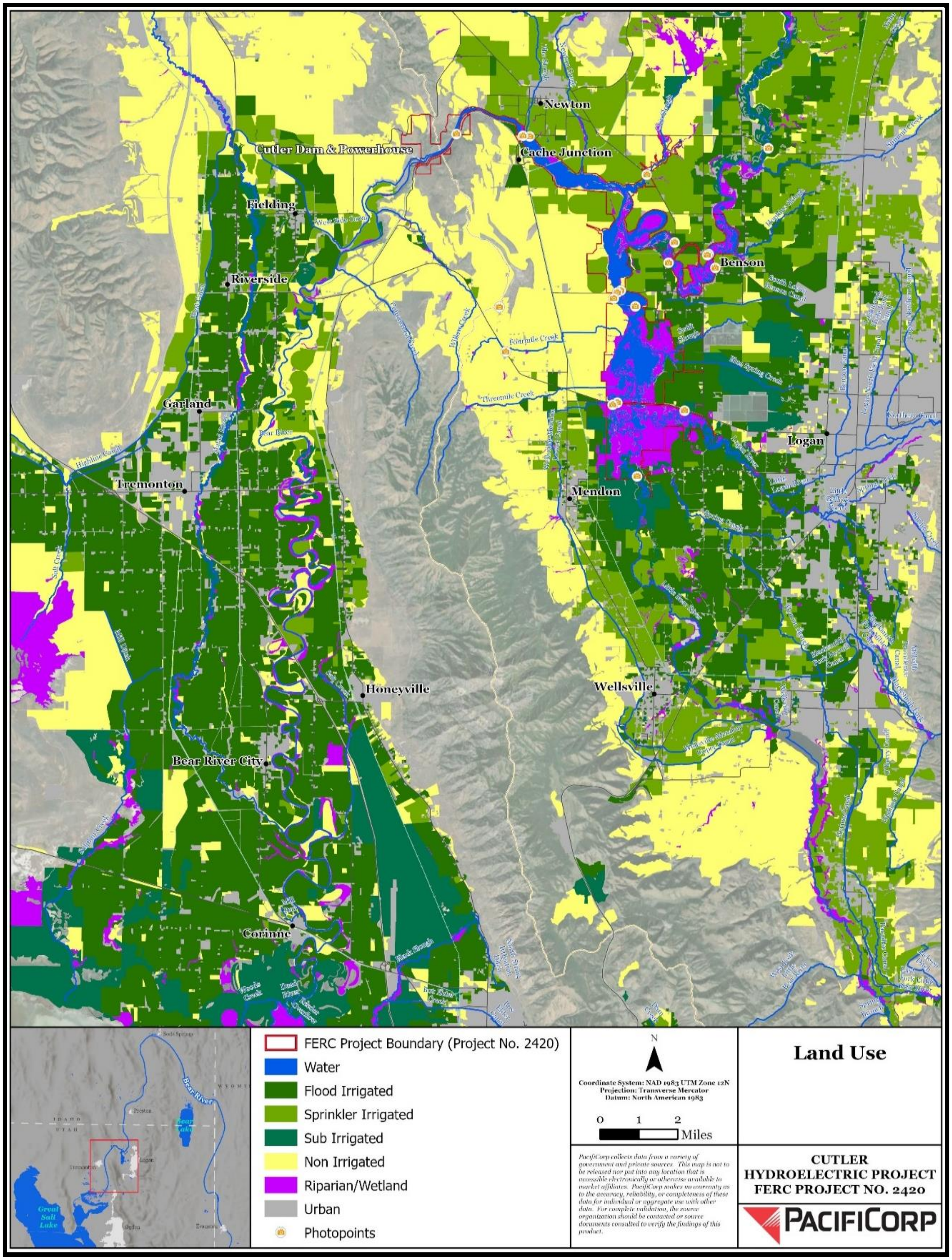

FIGURE 3-1 LAND USE STUDY AREA, INCLUDING FERC PROJECT BOUNDARY AND BEAR RIVER FROM CUTLER DAM TO CORINNE

4.0 METHODS

The following methods were developed to assess bank stability at Bear River downstream of the Cutler Reservoir.

4.1 BACKGROUND INFORMATION

Literature discussing bank erosion and the influencing factors, in general and on the Bear River downstream of Cutler Dam, was reviewed to provide background information and context for this study. These included documents prepared by PacifiCorp, the Utah Division of Water Quality (UDWQ), and other sources. A complete list of documents reviewed for background information can be reviewed in ISR Appendix D.

4.2 FLOW FLUCTUATION EFFECTS

Assessment methods of flow fluctuation effects included attenuation, site selection, experimental flows, and bank profile measurements.

4.2.1 ATTENUATION

Stage data from the Collinston and Corinne gages (700 feet downstream of Cutler Dam and approximately 40 miles downstream, respectively) were compared to assess attenuation of flow fluctuations associated with proposed power generation cycle. Stage measurements covered the period of power optimization flow conditions discussed in Section 4.2.3.

4.2.2 SITE SELECTION

A reconnaissance-level survey was completed on the Bear River between Cutler Dam and the city of Corinne in February 2020 to identify potential monitoring sites where erosion was evident and bank profiles could be measured. Several stakeholders who commented on the RSP expressed an interest in assisting with identifying appropriate monitoring sites. Their recommendations were considered in selecting monitoring sites.

4.2.3 EXPERIMENTAL FLOWS

Bank profiles were measured during two instream flow conditions provided by PacifiCorp through releases from Cutler Dam: (1) two weeks of run-of-river Project operations (i.e., reservoir inflow equals outflow, with only gradual stage changes), and (2) four weeks of power generation cycling two times daily, simulating proposed power optimization[1] operations, with frequent stage changes. Baseline profile measurements were taken prior to initiation of run-of-river flows, to compare the measurements made prior to and after the power optimization flows.

4.2.4 BANK PROFILE MEASUREMENTS

Bank profile measurements were collected using a Class 2 laser measurement sensor (Leica DISTO X4 and DST 360, accurate to 0.04 inches at a distance of 495 feet) to define the bank profile at three locations per monitoring site. Typical methods for measuring bank profiles manually, from within the channel, were not used due to safety concerns associated with river ice, water depth, and velocity. The three bank profile locations were spaced approximately 20 feet apart. Survey pins (metal rods 24 to 48 inches long) were placed horizontally in the eroded bank at each location, approximately 8 feet above the water surface or within 3 feet of the top of bank. The outer end of each pin was covered with a metal cap centered on a 12-inch-diameter plastic target that could be easily identified from the opposite bank. A survey hub (24-inch metal stake with a 2-inch-diameter plastic cap) was placed across the river from the eroded bank to use as a benchmark. The laser sensor was centered vertically on a tripod above the survey hub using a plumb bob and string, then leveled manually and electronically before collecting survey measurements.

Snow was carefully removed from eroded banks prior to each survey to expose bare soil. Ice cover was not removed due to soil disturbance that would have resulted. Measurements collected from ice and snow surfaces were identified in field survey notes when they occurred.

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[1] Actual flows gaged at Collinston gage (located 700 feet downstream of the Cutler powerhouse) during experimental flow release.

A field spotting scope (KOWA TSN-883) was used to identify the laser pointer from the survey hub and center the first survey measurement of each profile directly on the survey pin. The measurement of the survey pin was later used to reference each profile and measure the differences between profiles collected on different survey dates.

The coordinates of each measurement point in a bank profile were calculated in a spreadsheet and used to create profile plots at each site. Differences between profiles collected on different measurement dates were identified by overlaying profiles on the same plot.

4.3 RESERVOIR DISCHARGE

Hydrographs and basic statistics were developed to illustrate simulated discharges from Cutler Reservoir to the Bear River downstream of the powerhouse under normal and extended operations.

4.4 HISTORIC BANK MOVEMENT

Historic bank movement was assessed at two of the four monitoring sites where erosion appeared to be most active to facilitate evaluation of study results for this USR. This study component was not included in the RSP but was developed later as a supplemental assessment of long-term bank erosion. This assessment centered on interpretation of past aerial photography to gauge the extent of long-term channel change. Sources of aerial photo coverage included the Utah Geological Survey, Utah Automated Geographic Reference Center, and PacifiCorp, covering the period from 1937 to 2017.

5.0 STUDY MODIFICATIONS

The methods described in Section 4.0 include two changes from the Land Use RSP and the FERC SPD. First, the extent of flow attenuation was determined using continuous flow-gage monitoring data instead of a hydrological model, as described in the RSP. Sufficient data on channel characteristics in the downstream reach was not available to support the model originally proposed. The length of the monitored river segment was extended to roughly 40 miles to ensure sufficient coverage and to satisfy commenter recommendations.

Six monitoring sites were established in accordance with the RSP. A complete data set for bank stability monitoring could only be acquired for four of these sites due to seasonal safety concerns that developed at two sites over the course of the winter monitoring period. The four sites that were surveyed are geographically distributed between Cutler Dam and Corinne and capture the range of eroding bank conditions in this reach.

The study modifications did not alter the study process in terms of meeting the Land Use Study objectives.

6.0 RESULTS

The results of each step described in the methods section (Section 4.0) are presented below.

6.1 BACKGROUND INFORMATION

The 1995 Resource Management Plan (RMP) identified eroding shorelines and stream channel banks in the Project Area. Reasons cited for erosion in these areas included fine-textured soils, vertical banks, lack of vegetative cover, agricultural activities extending to the water's edge, and water-level fluctuations. A more recent study discusses erosion of Bear River banks downstream of Cutler Reservoir (UDWQ 2018) as a water-quality concern. However, the 2018 study does not link this erosion to the Project operations.

Numerous factors contribute to bank erosion on the Bear River downstream of Cutler Dam, including the composition of local soils, normal riverbed and floodplain processes, adjacent land-use practices, hydroelectric power generation operations, wave action created by motorized recreation on the river, vertical and overhanging banks, and freeze-thaw cycles (UDWQ 2002, 2018; PacifiCorp 1995). Regardless of whether power generation is occurring, Bear River banks downstream of Cutler Dam experience erosion due to natural variations in hydrology and the fundamental nature of rivers and soils.

Physical characteristics such as soil texture and bank dimensions can influence bank stability following changes in soil moisture and temperature (Leopold 1994). Saturated soils will drain from exposed surfaces in response to a decrease in water surface elevation. As soils are draining, the internal pore pressure of saturated soils may cause instability and sloughing (Duncan et al. 2014). Bank instability can also occur in the spring following cycles of freezing and thawing that create cracks, fissures, and generally disrupt soil structure (Gatto 1995, Ferrick, Gato and Grant 2005, Korshunov, Doroshenko, and Nevzorov 2016). Surface vegetation protects soil surfaces and provides internal structure to shorelines and channel banks to resist slumping and other types of instability (Leopold 1994, Camporeale, Perucca, and Ridolfi 2013).

Past agricultural practices on lands adjacent to the Bear River reduced vegetation through tilling, herbicide application, and livestock grazing (PacifiCorp 1995). These factors reduced soil stability in affected areas. These activities can increase the potential for stormwater run-off and overland flow, another potential cause of bank instability (Leopold 1994).

During periods of exceptionally cold temperatures when substantial amounts of ice can accumulate on the river, PacifiCorp matches incoming reservoir flows to outgoing flows as closely as possible to reduce the possibility of ice-dam flooding and ice shearing on banks. Future project operations propose to follow this practice avoiding flow fluctuations during winter periods of ice build-up.

6.2 FLOW FLUCTUATION EFFECTS

This section describes site selection, discharge patterns during the monitoring period, and bank profile survey results.

6.2.1 ATTENUATION

Figure 6-1 provides superimposed hydrographs for the Collinston (700 feet downstream of Cutler Dam) and Corinne (roughly 40 river miles downstream) stream gages to assess the degree of attenuation of flows released from the dam. Superimposing the hydrographs allows for comparison of changes in total range of stage (black arrow), without regard for the time it takes for the change, and rate of stage change (visually defined in Figure 6-1 by blue and orange arrows) to assess potential effects of flow releases on bank stability longitudinally in the river segment downstream of Cutler Dam. The hydrographs are based on data recorded at the two gages during the power optimization flow condition. The Corinne gage data was adjusted to reflect the average 24-hour travel time from the Collinston gage to facilitate comparison of stage changes between the two sites.

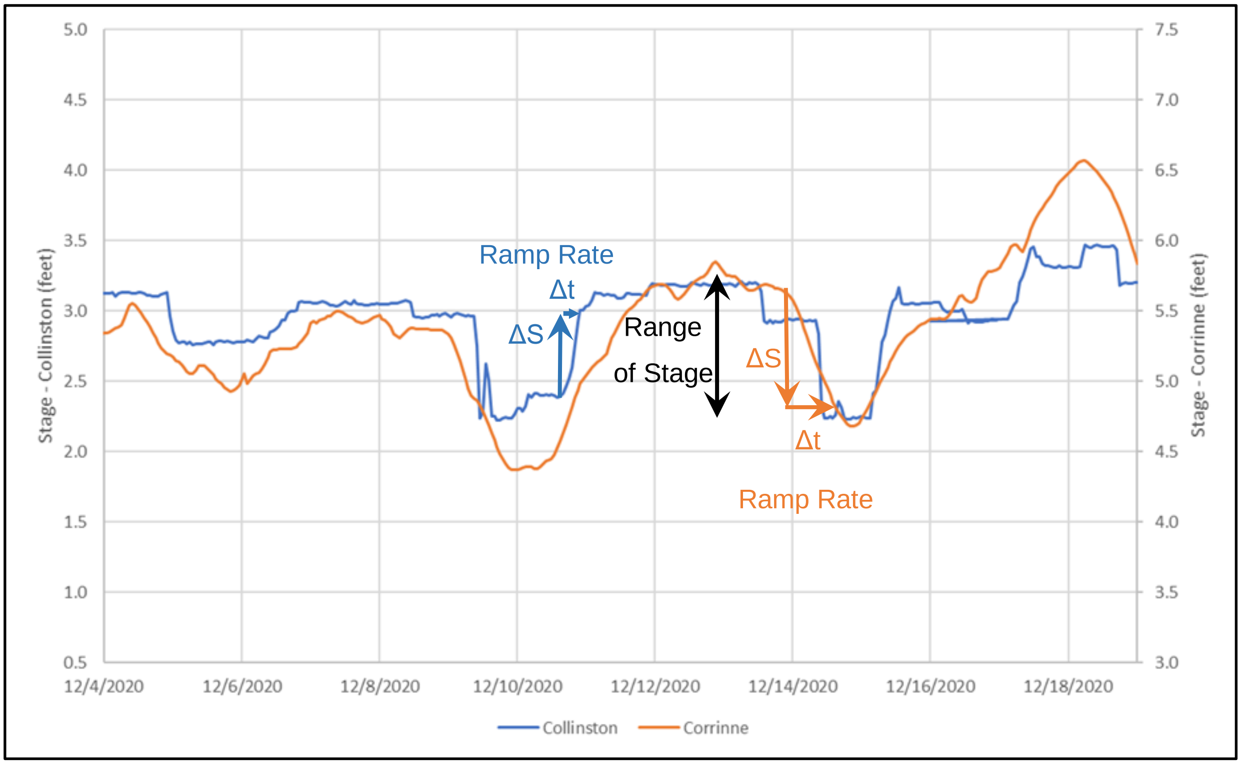


FIGURE 6-1 HOURLY STAGE HYDROGRAPHS FOR COLLINSTON AND CORINNE STREAM GAGES, ADJUSTED FOR TIME OF TRAVEL

Comparison of the Collinston and Corinne hydrographs confirms that the total range of stage fluctuation (maximum stage less minimum stage at each site, black vertical arrow in Figure 6-1) is quite *similar* between these two gaged sites roughly 40 miles apart from each other on this reach of the Bear River. The (initially surprising) similarity in the total range of stage fluctuation is a coincidence attributable to the difference in slope and channel shape between these two sites. The channel is narrow with a steep slope and fast velocities at Collinston, and the channel is wide with a shallow slope with much slower velocities at Corinne.

However, the rate of change in stage per unit of time at a single site *does* attenuate (blue and orange arrows in Figure 6-1). The shifts in the Collinston hydrograph reflect substantially faster upward and downward changes relative to the longer, more gradual curves in the Corinne hydrograph. The attenuation in rate of change is expected due to the long reach length between these two gaged sites as the flow spreads out as the channel changes shape and the sharp change in stage dissipates.

As discussed in more detail below (Section 6.2.2), the rate of stage change – particularly on the downward leg – can be a consideration because rapid decreases in pore pressure occur when water drains quickly from bank soil profiles, with corresponding decreases in bank stability, while the total range of stage fluctuation by itself is a less important factor in bank stability.

However, as noted in the following sections, there are no obvious differences between run-of-river and power optimization flows in terms of bank erosion at any of the sites in the reach downstream of Collinston (at several sites along the reach between Collinston and Corinne, not just the Corinne gage where continuous stage measurements are available).

Based on the substantial attenuation of the rate of change between the Collinston and Corinne gages, this reach of the river adequately encompasses the downstream extent of potential bank erosion effects of the proposed operational changes. Further, the lack of visible bank erosion differences between run-of-river and power optimization experimental flows, even at the site nearest the Collinston gage approximately 5.6 river miles downstream, indicates the affected reach length is substantially smaller than the 40-mile stretch evaluated.

6.2.2 SITE SELECTION

Six monitoring sites were selected from more than 40 potential locations with input from Utah Division of Environmental Quality and based on accessibility to both sides of the river, bank angle, surface cover, channel width and spatial distribution between the Cutler powerhouse and Corinne (Figure 6-2).

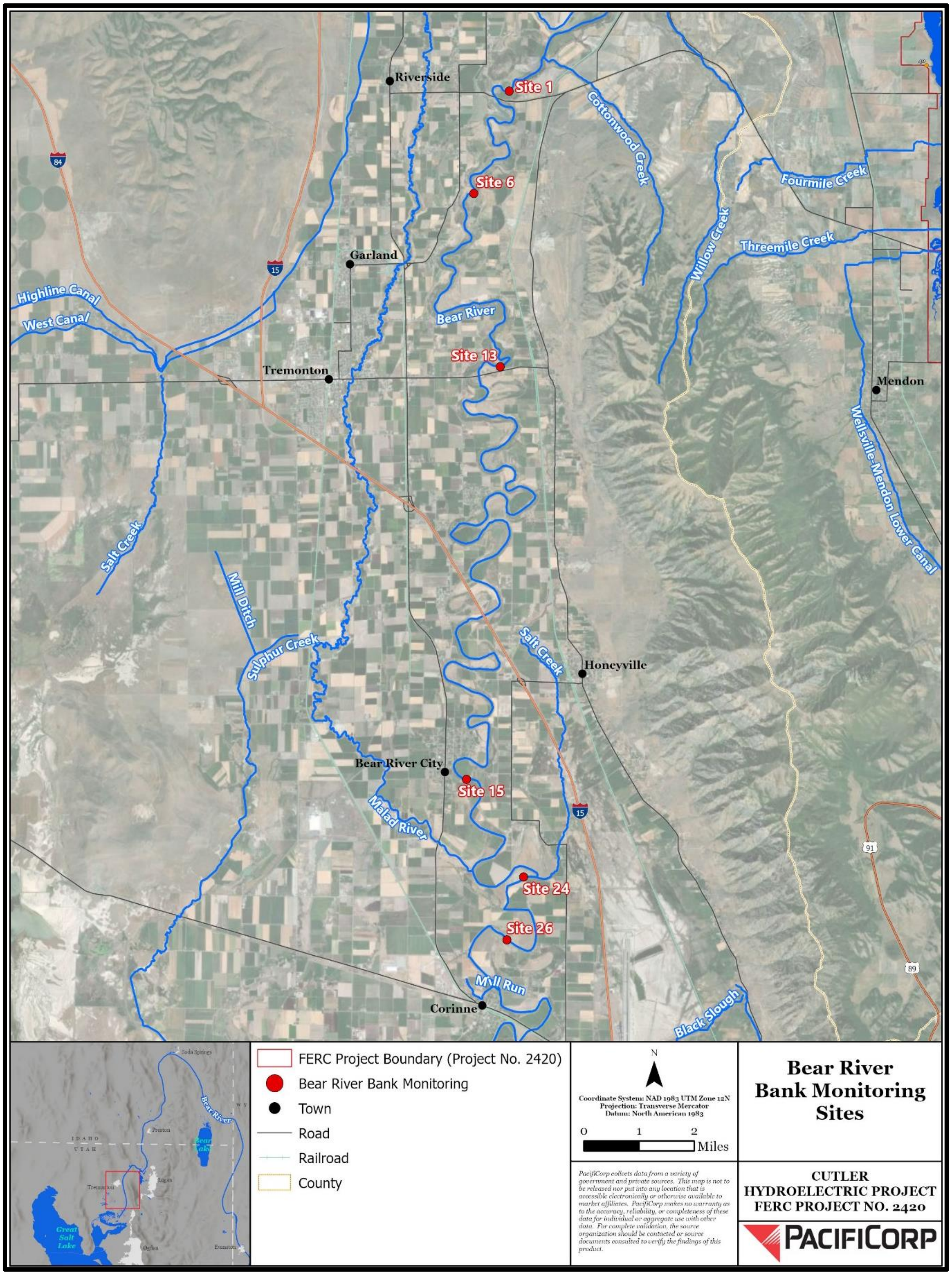


FIGURE 6-2 BANK MONITORING SITES ON BEAR RIVER DOWNSTREAM OF CUTLER DAM

These monitoring sites are located either on the outside of meander bends, where water velocities are typically greatest, or on runs between meander bends. Table 6-1 summarizes other site characteristics relevant to this analysis. With the exception of Site 24, all sites are generally north-facing. Adjacent land use at four of the six monitoring sites includes livestock grazing and agricultural crop cultivation (similar to most surrounding land use). Moderately dense forest/shrub is found on slopes above the remaining two monitoring sites. The bank below each survey pin was barren of vegetation with the exception of scattered tufts of grass growing on previously sloughed bank material at some locations.

The monitoring sites exhibited differing bank characteristics that influence soil erosion potential. Vertical heights (from top of bank to water surface) are 7 to 11 feet high, with some sites including more than 50 percent vertical or overhanging bank angles. Overall bank angles are 27 to 61 degrees.

TABLE 6-1 BANK MONITORING SITE CHARACTERISTICS

SITE	TOTAL BANK HEIGHT[1] (FT)	LENGTH OF VERTICAL OR OVERHANGING BANK[2] (FT.)	BANK SLOPE (°)	LANDFORM TYPE[3] - ASPECT	ADJACENT LAND USE
1	7	5	47	Run - Northwest	Livestock Pasture
6	11	0	27	Run - Northwest	Forest/Shrub
13	11	1	44	Meander - North	Forest/Shrub
15	7	<1	36	Meander - North	Livestock Pasture
24	10	3	61	Meander - Southeast	Agriculture (crops)
26	11	5	45	Run - Northeast	Livestock Pasture

Notes:

[1] Measured as the vertical distance (to nearest foot) from survey pin to water surface.

[2] Sum of bank profile (to nearest foot) with a vertical (90 degrees) or overhanging (> 90 degrees) slope.

[3] Type refers to landform features observed in rivers including meanders (sinuous curves) or runs (river segments between curves).

6.2.3 SOIL TYPE

The soil type at all monitoring sites is primarily Martini Fine Sandy Loam with small portions of Sunset Silt Loam (NRCS 2020). Land with these soil types is classified as Prime Farmland with irrigation due to deep, well-drained soil profiles consisting of loam and silt textures. Soil erosion hazard from sheet and rill erosion under normal climatic conditions is defined as slight for these soil types. Erosion hazard is determined from a combination of slope and soil erodibility factor K (ranging from 0.02 to 0.69). Although surface slope is typically very low for these soil types, the erodibility factor is high at 0.55 for more than half of the soil profile down to 63 inches. This characteristic identifies the susceptibility of the lower soil profile (exposed in riverbanks) to erosion by flowing water.

6.2.4 EXPERIMENTAL FLOWS

Stage height at the Collinston gage, located 700 feet downstream of Cutler Dam, ranged from 2.3 feet to 3.3 feet during the two-week duration of the run-of-river flows and from 1.0 foot to 4.3 feet during the four-week power optimization flows. These figures indicate that the change in stage height was more than three times greater under the power optimization flow, increasing from 1.0 foot to 3.3 feet (Figure 6-3 and Table 6-2). During the power optimization flow, stage-height increases occurred for approximately 3 to 4 hours in the morning and 6 to 7 hours in the evening each day.

The rate of change in stage height, or ramp rate, could potentially have more effect on bank stability than the magnitude of stage change due to the internal pore pressure created by rapidly draining riverbanks. Stage-height changes cycled between high and low flows only three times during the entire two-week period of the run-of-river flow compared to twice daily during the power optimization flow.

As discussed in Section 6.2.1, the total range of stage fluctuation was similar between the Collinston and Corinne gages during the power optimization flow, but ramp rates attenuated substantially.

The maximum discharge during the power optimization flow was lower than the 3,600 cubic feet per second (cfs) maximum capacity power generation flow at the Cutler powerhouse. However, this flow did reflect the maximum discharge of roughly 2,000 cfs that is sustainable for the 10-day cycles described in the ISR (Section 3.1), under the proposed extended operations, with typical winter inflow conditions of roughly 1,000 cfs (as winter is the only time that the proposed extended operations and resultant power optimization flow could likely occur).

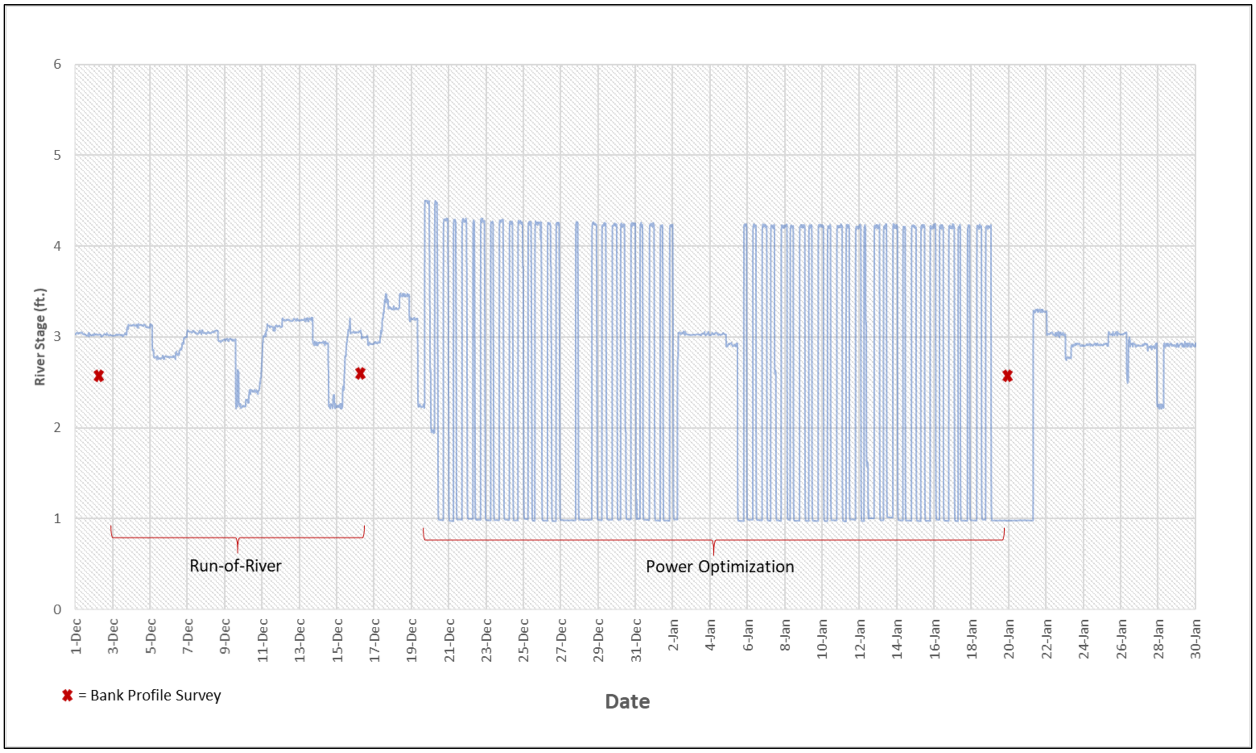


FIGURE 6-3 COLLINSTON GAGE STAGE HYDROGRAPH (DEC. 2020 – JAN. 2021)

TABLE 6-2 DISCHARGE STATISTICS AT COLLINSTON GAGE (DEC. 2020 – JAN. 2021)

FLOW CONDITION	MIN. FLOW (CFS)	MAX. FLOW (CFS)	MIN STAGE (FT.)	MAX STAGE (FT.)	MAX UPRAMP (FT./5 MIN.)	MAX DOWNRAMP (FT./5 MIN.)
Run-of-River Flow	816	959	2.3	3.3	0.03	-0.04
Power Optimization Flow	69	2,071	1.0	4.3	2.7	-1.5

6.2.5 BANK PROFILE MEASUREMENTS

Surveys of bank profiles were completed on three dates between December 2020 and January 2021 (Table 6-3).

TABLE 6-3 BANK EROSION SURVEY DATES

	BASELINE	POST RUN-OF-RIVER OPERATION	POST POWER OPTIMIZATION
Site 1	December 3, 2020	December 16, 2020	January 19, 2021
Site 6	December 3, 2020	December 15, 2020	N/A
Site 13	December 2, 2020	December 15, 2020	January 19, 2021
Site 15	December 2, 2020	N/A	N/A
Site 24	December 2, 2020	December 18, 2020	January 20, 2021
Site 26	December 2, 2020	December 16, 2020	January 20, 2021

Each monitoring site was accessed by boat until mid-to-late December 2020 when ice and snow conditions prevented boat access to all sites except Site 13. For the remainder of the survey, sites 1, 23, and 24 could only be accessed by land, an unforeseen complication. Land access to clear the survey pins of snow at Sites 6 and 15 was not possible due to safety concerns (i.e., unstable slopes, bank heights more than 30 feet, and water depths more than 5 feet). As a result, only baseline data was collected at these two sites. However, the four remaining sites are geographically distributed between Cutler Dam and city of Corinne and capture the range of eroding bank conditions in the study reach.

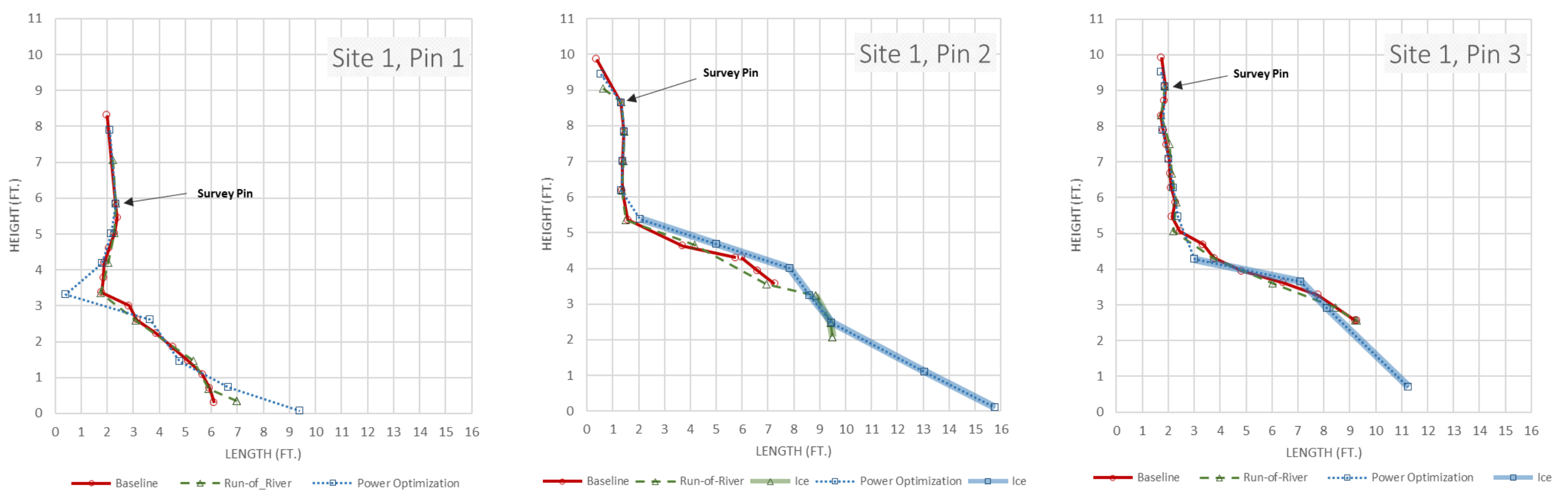
Bank profiles were plotted for each of the three survey pins at each monitoring site. Soil loss and accumulation were assessed by comparing profiles at each location from one survey date to the next. Loss in bank profiles was due to sloughing, erosion from flowing water, or reduction in ice since the previous survey date. Accumulation of ice was the result of sloughing from higher in the profile, upstream erosion, formation of ice that could not be removed prior to surveying, or expansive frozen soil. The results of this comparison were reviewed to identify patterns of loss and accumulation; profiles were categorized based on similar patterns.

Table 6-4 provides a description of each of the five categories and the number of profiles in each category measured under the run-of-river and power optimization flow conditions. Figure 6-4 through Figure 6-7 include one plot for each survey pin. Each plot identifies the profiles measured on each of the three survey dates shown in Table 6-3.

TABLE 6-4 BANK PROFILE CATEGORIES AND COUNT OF PROFILES UNDER RUN-OF-RIVER OR POWER OPTIMIZATION FLOW CONDITIONS

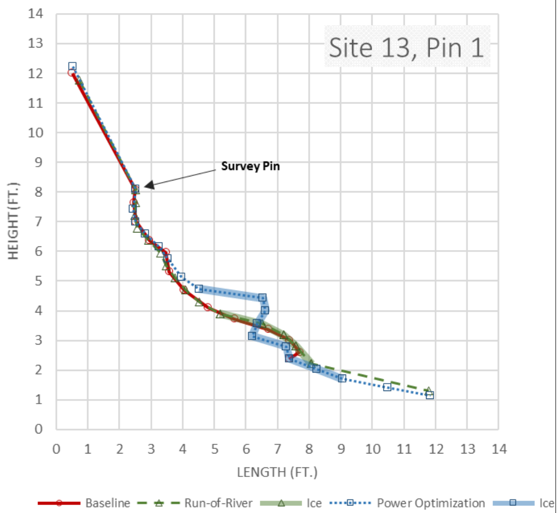
CATEGORY	DESCRIPTION	RUN-OF-RIVER COUNT	POWER OPTIMIZATION COUNT
1	Soil loss throughout bank profile (sloughing from upper portion and erosion by flowing water from lower portion).	4	0
2	No change in upper portion, erosion on lower portion.	1	5
3	Sloughing from upper portion, soil accumulation on lower portion.	2	1
4	No change in upper portion, accumulation on lower portion.	5	4
5	Unknown change in profile due to ice cover.	0	2

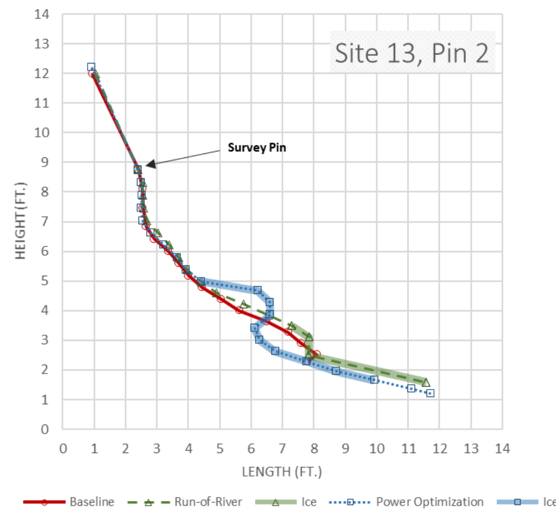
Note: 12 profiles/two flow conditions

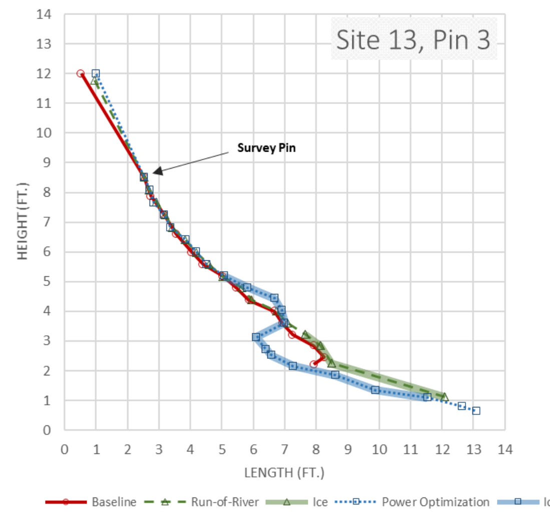


Run-of-River: Category 4 Power Optimization: Category 4	Run-of-River: Category 1 Power Optimization: Category 5	Run-of-River: Category 2 Power Optimization: Category 2

FIGURE 6-4 BANK PROFILES MEASURED ON LOWER BEAR RIVER AT SITE 1 DURING RUN-OF-RIVER AND POWER OPTIMIZATION FLOW CONDITIONS

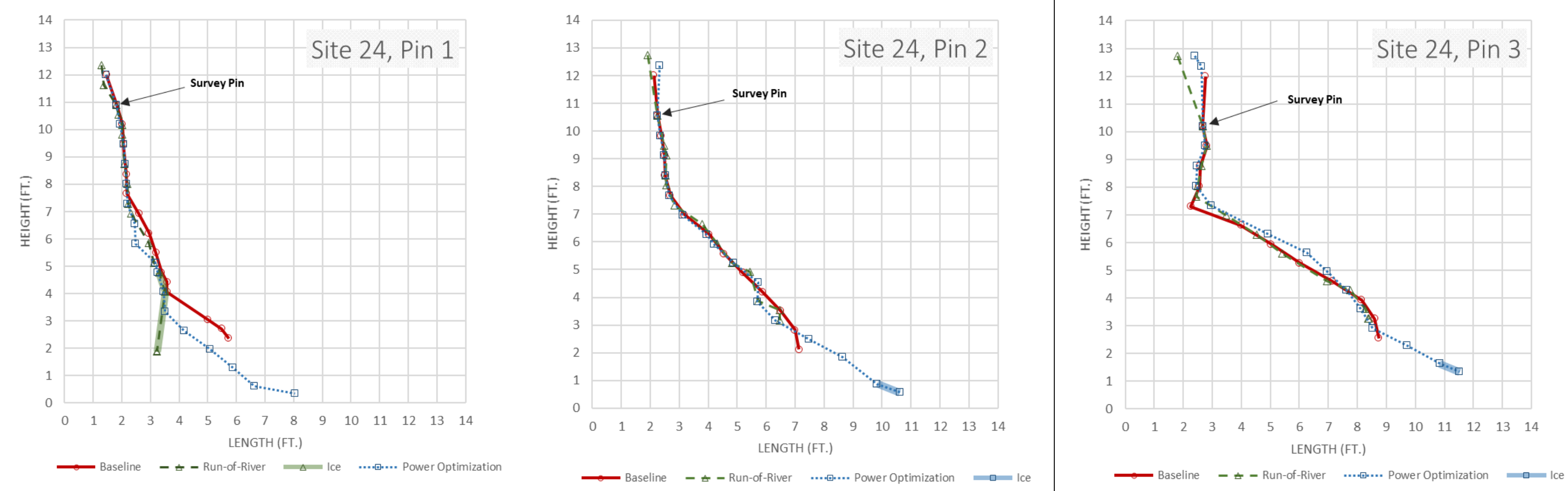






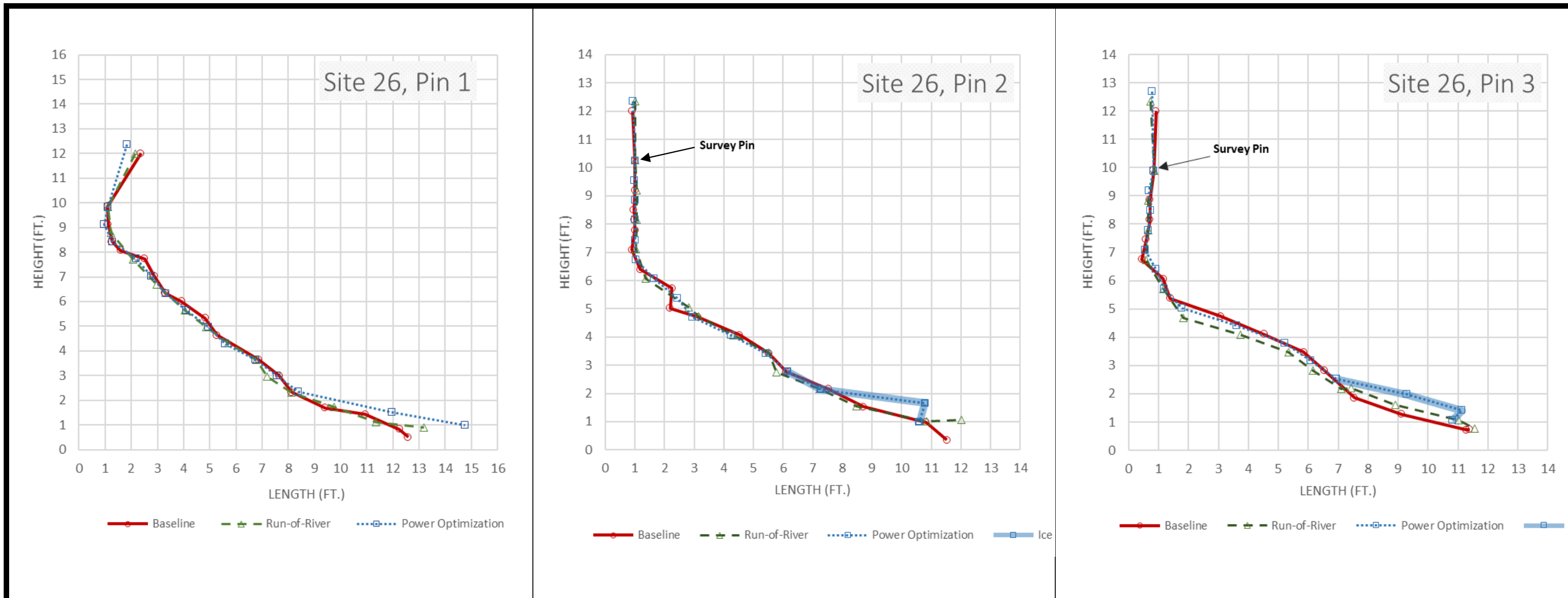
Run-of-River: Category 4 Power Optimization: Category 2	Run-of-River: Category 4 Power Optimization: Category 2	Run-of-River: Category 4 Power Optimization: Category 2

FIGURE 6-5 BANK PROFILES MEASURED ON LOWER BEAR RIVER AT SITE 13 DURING RUN-OF-RIVER AND POWER OPTIMIZATION FLOW CONDITIONS



Run-of-River: Category 1 Power Optimization: Category 4	Run-of-River: Category 1 Power Optimization: Category 2	Run-of-River: Category 1 Power Optimization: Category 5

FIGURE 6-6 BANK PROFILES MEASURED ON LOWER BEAR RIVER AT SITE 24 DURING RUN-OF-RIVER AND POWER OPTIMIZATION FLOW CONDITIONS



Run-of-River: Category 3 Power Optimization: Category 3	Run-of-River: Category 4 Power Optimization: Category 4	Run-of-River: Category 3 Power Optimization: Category 4

FIGURE 6-7 BANK PROFILES MEASURED ON LOWER BEAR RIVER AT SITE 26 DURING RUN-OF-RIVER AND POWER OPTIMIZATION FLOW CONDITIONS

The following sections discuss changes in bank profiles that occurred under each flow condition. The profile at a given site is referred to using the site and pin numbers. For example, the profile surveyed from the first pin at Site 26 is referred to as Profile 26-1.

BANK PROFILES – RUN OF RIVER

Bank profile changes during the run-of-river flow were identified by comparing the post-run-of-river profiles to baseline profiles. These profiles are represented by the green and red colored lines, respectively, in Figure 6-4 through Figure 6-7.

Most changes in bank profiles during the run-of-river flow were classified as Category 1 (erosion from the upper and lower portions of the bank) or Category 4 (accumulation in the lower portion of the profile). All profiles surveyed at Site 24 (24-1, 24-2, and 24-3) as well as Profile 1-2 were classified as Category 1, showing some soil loss from both upper and lower bank areas. Most changes were small except for Profiles 24-1 and 24-3. Profile 24-1 had a measured loss of approximately 2 feet at the lower end. Profile 24-3 had a loss of approximately 1 foot at the top.

All three profiles at Site 13 as well as Profiles 1-1 and 26-2 were classified as Category 4. With the exception of Profile 13-1, all accumulation occurred within 1 foot of the water surface. Approximately 4 feet of bank was exposed at the lower end of Profile 13-1 that was submerged during the previous visit. Based on the lack of change observed in the upper portion of the profile, this accumulation was likely due to upstream erosion.

Accumulation in the lower portion of the profile was observed in Category 3 profiles (sloughing from the upper portion; accumulation in the lower portion of the profile), including Profiles 26-1 and 26-3. Profile 26-3 provided a good representation of loss in the middle portion of the profile and accumulation directly below in the lower portion.

Profile 1-3 was the only profile observed in Category 2 (erosion on the lower portion of the profile only) under the run-of-river flow. Although this profile showed slight erosion approximately 1 foot above the water surface, the lowest surveyed points at the bottom of the profile showed no change during the run-of-river flow.

Note that ice-covered areas that were present on a survey date at each profile are represented by a wide line. Ice cover occurred most commonly in the lower portion of the profile and extended down to the water surface. However, a section of exposed bank was noted downslope of ice cover and above the water surface in profile 13-1.

BANK PROFILES – POWER OPTIMIZATION

Bank changes correlated with the power optimization flow condition were determined by comparing profiles measured after power optimization flows to profiles measured after the earlier run-of-river period. These two flow conditions are represented by the blue and green lines, respectively, in each plot of Figure 6-4 through Figure 6-7. Ten of the 12 bank profiles that were surveyed following the power optimization flow had some portion of the bank covered by ice. All the profiles at Site 13 had sections of exposed bank located downslope of ice cover.

Most bank profile changes correlated with the power optimization flow were classified as Category 2 (erosion in the lower portion of the profile only) or 4 (accumulation in the lower portion of the profile only). A total of five profiles were observed in Category 2, compared to only one profile from the run-of-river flow condition. All profiles at Site 13 as well as Profiles 1-3 and 24-2 were classified as Category 2. Figure 6-5 illustrates the presence of ice cover in each profile at Site 13. For some of these profiles, the ice cover overlayed areas of soil loss, while other profiles indicated accumulation of either soil or ice. Profile 24-2 indicates a slight amount of loss occurred.

Category 4 describes four profiles under the power optimization flow, which is one less than under the run-of-river flow. Profiles 26-2 and 26-3 show minor accumulation above the point where ice cover occurs. Profiles 24-1 and 1-1 confirm that a relatively large amount of accumulation occurred in the lower portion of the profile near the water’s edge. Category 3 (sloughing from the upper portion; accumulation in the lower portion of the profile) only includes profile 26-1. This profile confirms the accumulation although some of this increase is due to ice that covers the lowest end of the profile.

No profiles were classified as Category 1 (erosion from the upper and lower portions of the bank), compared to four profiles under run-of-river flow.

Two profiles are classified in Category 5 (unknown change in profile due to ice cover) including Profiles 1-2l and 24-3. The lower end of each profile was measured at a lower water surface elevation under the power optimization period than occurred during the run-of-river. Although the profiles in Category 5 match well with the previous profile down to the water's edge, no comparison can be made to the profile below that point to determine if erosion or accumulation occurred.

6.3 RESERVOIR DISCHARGE

As noted previously, reservoir discharge, or flow released to the river downstream, is another potential factor in bank erosion, considering the additional foot of reservoir drawdown under proposed extended operations.

Power generation and subsequent discharge (or discharge regardless of power generation, such as during the irrigation season or when the Project is offline due to maintenance) at the Cutler powerhouse is limited by available active storage, the magnitude and timing of inflows to refill the reservoir, irrigation withdrawals from the reservoir, and variability in power demand over different timeframes. Historical Project operations indicate that approximately 2,000 cfs is the maximum power flow at which the required reservoir operating range can be maintained, based on an average winter inflow of 1,000 cfs.

Hydrographs prepared by PacifiCorp comparing the normal and proposed extended operating ranges illustrate the effect of the additional foot of drawdown on power flows/discharges to the Bear River and on reservoir elevations during a 10-day generation cycle (Baldwin 2021) (Figure 6-8).

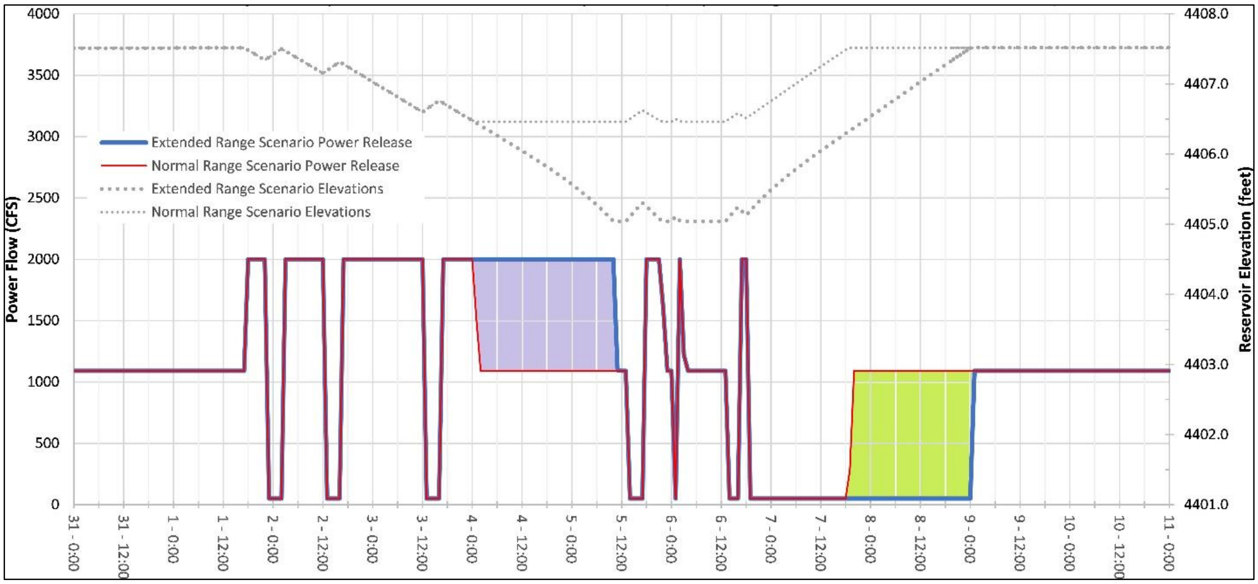


FIGURE 6-8 POWER RELEASE DIFFERENCES BETWEEN NORMAL AND PROPOSED EXTENDED OPERATIONS

As reflected in these hydrographs, total release of flows to the Bear River would be the same under normal and proposed extended operations because the inflow to the Project does not change regardless of operations, and the Project has very little water storage capability. The only difference in flows between the two operation modes would be in timing. Under the extended range, approximately 2,500 acre-feet of water (roughly 14 percent of the total released during a 10-day cycle) would be discharged to extend the period of higher generation during the middle of the cycle (Figure 6-8, purple block). Under normal operations, the period of higher generation at the middle of the cycle would be shorter before operations reverted to run-of-river generation, and the 2,500 acre-feet retained in the reservoir would allow it to refill quicker, so run-of-river generation could begin sooner (Figure 6-8, green block). Use of the retained 2,500 acre-feet would be delayed within the cycle by approximately 3.5 days.

As shown by these hydrographs, there would be no change between normal and proposed extended-range operations in maximum flow rate, minimum flow rate, or ramp rates, simply a delay (of a maximum of three days) in achieving the same water volume released.

Table 6-5 provides summary statistics projected for normal and proposed extended-range operations and for the 28-day duration of the experimental power optimization flow condition (mid-December 2020 to mid-January 2021), when reservoir levels were fluctuated to reflect proposed power optimization operations.

TABLE 6-5 STATISTICS FOR HOURLY DISCHARGE UNDER PROPOSED PROJECT OPERATIONS

	FLOW STATISTICS			
PROJECT OPERATIONS	AVERAGE	MAX	MIN	STD DEVIATION
Normal Operating Range[1]	1,090	2,000	50	882
Extended Operating Range[1]	1,090	2,000	50	682
Power Optimization	901	2,361[2]	58	926

Notes:
[1] Flows based on projections, not gage data.
[2] The maximum flow occurred for one day only.

The average, maximum, and minimum discharge values were similar for all periods of Project operation during the study. A *t*-test on the standard deviation values in Table 6-5 results in a 95 percent confidence interval of 507 to 1,153 cfs, which comfortably accommodates all flow scenarios and expected flow variations under the proposed normal and extended operating ranges. The experimental power optimization flow was representative of proposed operations, including the additional foot of drawdown.

6.4 HISTORIC BANK MOVEMENT

A supplemental assessment of long-term bank erosion was completed at Sites 1 and 26 using historical aerial photos obtained from the Utah Geological Survey, Utah Automated Geographic Reference Center, and PacifiCorp, covering the period from 1937 to 2017. Sites 1 and 26 were selected for long-term analysis because bank erosion appeared to be most active compared to the other study sites.

The change in bank movement at Site 1 and Site 26 over this period was measured from a series of historical aerial photos with sufficient resolution to define top-of-bank features at these two locations. Table 6-6 provides the collection date, source, and resolution of the images used to complete this assessment. The abrupt change in slope at bank tops usually creates a distinct contrast with surrounding areas that can be digitized and compared with images collected over the years. Figure 6-9 and Figure 6-10 provide a comparison at Sites 1 and 26, respectively, on four different dates.

In general, these top-of-bank features follow typical patterns of natural meander formation, including erosion along outside meanders, banks that form opposite flow-deflection points, and other areas where velocities are high, as well as deposition along inside meander bends and other areas where velocity decreases. Bank tops in some areas overlap, indicating no consistent movement over time. Inset photos on Figure 6-9 and Figure 6-10 provide closeup views of locations where consistent changes in top-of-bank have occurred in response to erosion processes. Table 6-7 includes a summary of top-of-bank changes that occur at each location.

TABLE 6-6 AERIAL PHOTOS USED TO DEFINE HISTORIC LATERAL MOVEMENT AT SITE 1 AND SITE 26

SITE	IMAGE DATE	SOURCE	DESCRIPTION
26	12/1/1937	[1]UGS Aerial Imagery Collection	Black and White Resolution: 800 dpi Scale: 1:20,000
1	5/1/1966	UGS Aerial Imagery Collection	Black and White Resolution: 800 dpi Scale: 1:20,000
1 and 26	8/17/1993 – 9/26/1995[2]	Utah [3]AGRC Digital Orthophoto Quad	Black and White 1-meter pixel
1 and 26	10/3/2006	Utah AGRC High Resolution Orthophotography	Color 1-foot pixel
1 and 26	9/7/2017	PacifiCorp Lidar and High-Resolution Imagery	Color 6-inch pixel

Notes:
[1] UGS = Utah Geological Survey
[2] Orthophotos were created from a mosaic of images collected 1993–1995.
[3] AGRC = Automated Geographic Resource Center

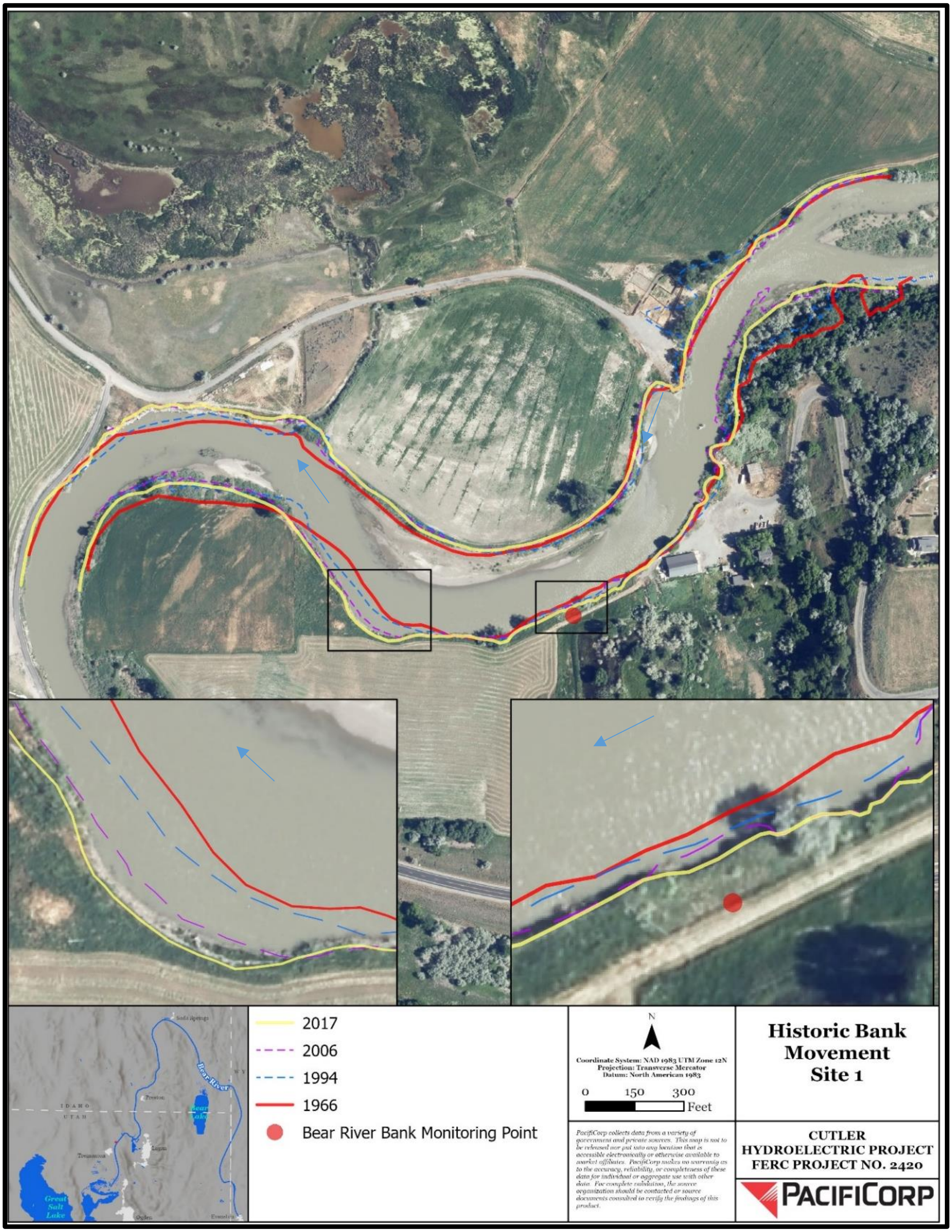


FIGURE 6-9 TOP-OF-BANK MOVEMENT AT MONITORING SITE 1 MEASURED FROM AERIAL IMAGERY COLLECTED, 1966, 1994, 2006, AND 2017

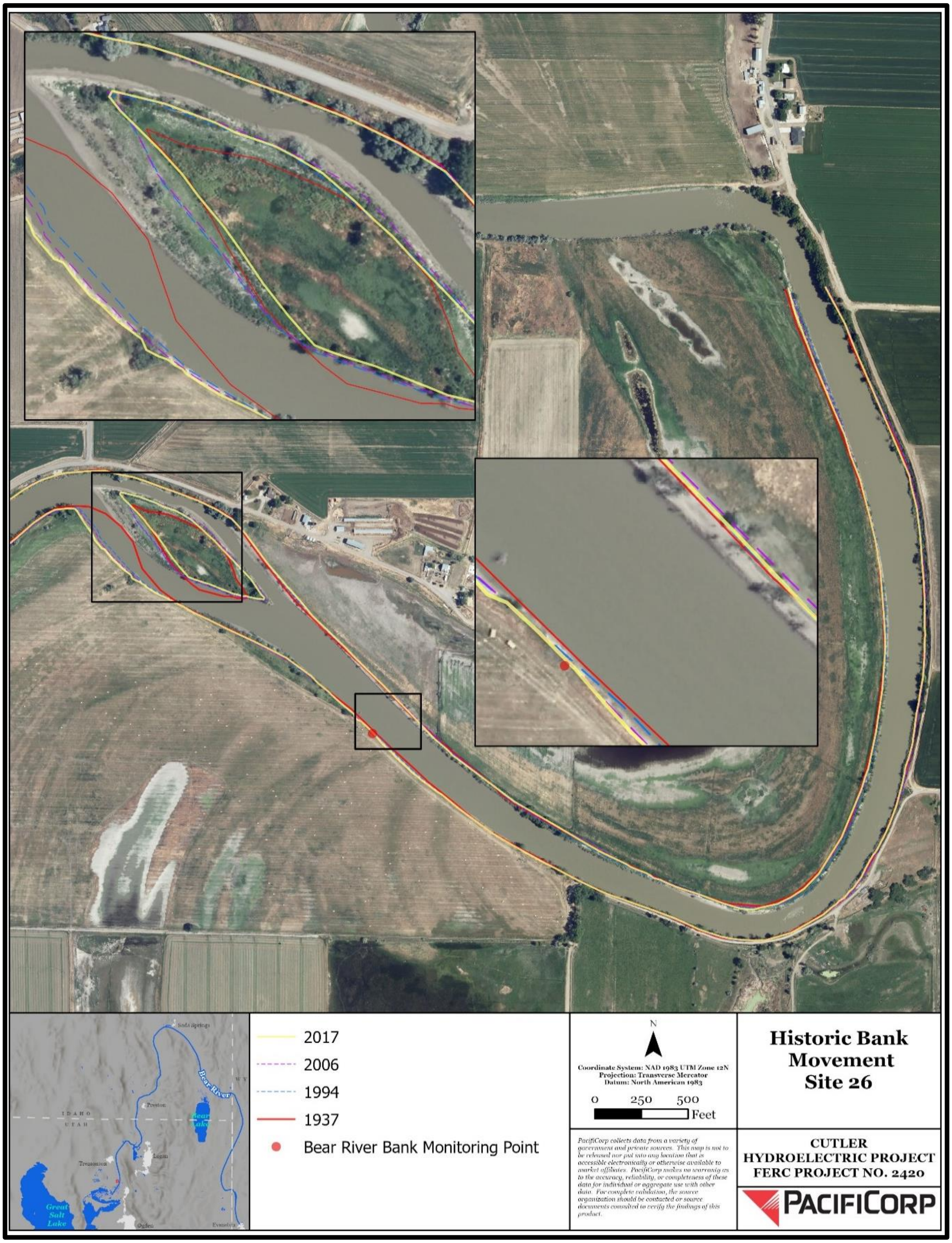


FIGURE 6-10 TOP-OF BANK MOVEMENT AT MONITORING SITE 26 MEASURED FROM AERIAL IMAGERY COLLECTED IN 1937, 1994, 2006, AND 2017

TABLE 6-7 LATERAL BANK MOVEMENT MEASURED FROM HISTORICAL AERIAL PHOTOS AT MONITORING SITES 1 AND 26

SITE – LOCATION	YEAR	TOTAL LATERAL MOVEMENT (FT)	AVERAGE MOVEMENT (FT/YR)
1 - Upstream	1966–1994	6.6	0.2
	1994–2006	3.1	0.3
	2006–2017	8.7	0.8
		18.4	**0.4**
1 - Downstream	1966–1994	25.6	0.9
	1994–2006	38.3	3.2
	2006–2017	26.7	2.4
		90.6	**1.8**
26 - Upstream	1937–1994	10.9	0.2
	1994–2006	8.1	0.7
	2006–2017	2.3	0.2
		21.3	**0.3**
26 - Downstream	1937–1994	122.6	2.2
	1994–2006	18.8	1.6
	2006–2017	14.5	1.3
		155.9	**1.9**

The flow direction for the Bear River segments shown in Figure 6-9 and Figure 6-10 is shown with arrows, but generally goes from right to left in the two photo figures. Total lateral bank movement is greatest at downstream measurement locations (i.e., left side of figure) at each site. The downstream location at Site 1 is near the end of a meander on the outside bank where lateral movement totals 90.6 feet since 1966 (Figure 6-9). The downstream location at Site 26 is opposite a midstream island formed just above a meander (Figure 6-10). The island deflects flows outward to the channel bank which has moved more than 150 feet since 1937.

Upstream lateral movement at each site is much less than movement at the corresponding downstream location. Upstream movement was measured on relatively straight segments between meanders. Total movement from the upstream location at Site 1 is 18.4 feet and 21.3 feet at Site 26.

Average lateral movement was calculated by dividing total lateral movement by the number of years between the collection date for each image. The range of average lateral movement at each site was similar; Site 1 ranged 0.4–1.8 feet per year and Site 26 ranged 0.3–1.9 feet per year. These results are noteworthy given the measurement periods are different, including 51 years (1966–2017) at Site 1 and 80 years (1937–2017) at Site 26. Except for the upstream location at

Site 1, average movement decreased slightly in the 2006–2017 period compared to the earlier period (1994–2006). Project operations included daily ramping during the earlier period and roughly half of the latter period. For the last five years of the latter period, operations were run-of-river.

7.0 SUMMARY

This study implemented the methods specified for the downstream bank erosion component of the Land Use Study in the RSP, modified as noted in this USR. No data gaps remain following implementation of this study plan. Results of the bank erosion component are reported in this USR. These results meet the first objective in the RSP, which is to characterize the current status of downstream bank erosion and the processes through which Project operations could potentially affect downstream bank erosion. This provides a sufficient basis for meeting the second study objective, to conduct an impact and effect analysis for the Draft License Application.

8.0 FUTURE STUDIES

The downstream erosion results presented in this USR represent the completion of the outstanding portion of the full study conducted for this resource.

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